APPENDIX B

ANALYSIS PROCESS

THIS PAGE INTENTIONALLY BLANK.

TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

INTRODUCTION

Appendix B presents a technical discussion of the analysis process and computer models used in the plan revision effort. The discussion focuses on the quantitative methods used to perform the analysis, and documents the methods by which the analysis was done.

The Forest's major planning goal is to provide enough information to help decision makers and the publics determine which combinations of goods, services, and land allocations will maximize *net public benefits* (NPB). The regulations (*36 CFR 219*) developed under the National Forest Management Act (NFMA) provide the analytical framework within which these decisions are made.

The NFMA and its regulations also state that the requirements of the National Environmental Policy Act (NEPA) and its regulations (*40 CFR 1500–1508*) must be applied in the analytical process. The NEPA regulations require that the environmental effects of a proposed action, and alternatives to that proposed action, must be disclosed in an *environmental impact statement* (EIS).

Information presented in this appendix supplements the broader and less technical descriptions included in the body of the EIS. This discussion includes basic assumptions, modeling components and inputs, rules, methods, and constraints. Additional information and documents used in the analysis process are contained in the planning records. The planning record in its entirety is incorporated here by reference.

The results from the modeling process are estimates of what can be expected if alternatives are implemented. As such, they facilitate the comparison of alternatives. Land and resource management planning requires that processes formerly used to make individual resource decisions be combined into integrated decision-making methods. It also requires that mathematical modeling techniques be used to identify the most economically efficient solution to meet the goals and objectives of any alternative.

FRAMEWORK OF THE PLANNING PROCESS

The general planning process described in *36 CFR 219.12* guides the revision of a Forest Plan. This section describes ten steps that lead from the completion of a Forest Plan to the completion of a revised Forest Plan.

THE 10-STEP PLANNING PROCESS

The 10–step process defined in the NFMA regulations was followed in the development of the Chattahoochee-Oconee revised Forest Plan. This appendix describes the analysis phase of this process that includes steps 3 and 6. Steps 1, 2, 4, 5, 7, and 8 are described in Chapters 1 and 2 and Appendix A of this EIS. Plan implementation and monitoring, steps 9 and 10, are discussed in the revised Forest Plan. A brief discussion of the 10-step process follows.

Step 1 - Identification of Purpose and Need: Issues, Concerns, and Opportunities

The Forest interdisciplinary team assessed changes in public issues, management concerns, resource use, and developmental opportunities (ICOs) since the 1985 Forest Plan was initially developed and subsequently amended. Appendix A of this EIS documents this step.

Step 2 - Planning Criteria

Criteria are designed to guide the collection and use of inventory data and information; the analysis of the management situation; and the design, formulation, and evaluation of alternatives.

The NFMA regulations require planning criteria be developed to guide each step in the planning process. Process criteria are standard rules and tests to guide and measure the effectiveness of the planning process. They apply to collection and use of inventory data and information; analysis of the management situation; and the design, formulation, and evaluation of alternatives. Planning criteria are based on:

- Laws, executive orders, regulations and agency policy as set forth in the *Forest Service Manual*
- Goals and objectives in the USDA Forest Service's Strategic Plan
- Recommendations and assumptions developed from public issues, management concerns, and resource use and development opportunities
- The plans and programs of other federal agencies, state and local governments, and Indian tribes
- Ecological, technical, and economic factors
- The resource integration and management requirements in *36 CFR 219.13 through 219.27*
- Alternatives that are technically possible to implement
- Alternatives that meet management requirements or standards
- Various levels of multiple–use objectives and outputs achieved

This step establishes guidelines for accomplishing the next five steps. The work plan and other process records document this step.

Step 3 - Inventory Data and Information Collection

The kind of data and information needed is determined in Step 2 based on the issues, concerns, and opportunities identified and the resulting assessment of the management situation and determination of what needs to change. Data collection is part of normal forest operations. Existing data is used whenever possible and supplemented with new data, when practicable, if new data will contribute to more responsive analysis. Data accuracy is continually evaluated. Much of this data and background documentation is part of the planning process records on file in the Supervisor's Office.

STEP 4 - ANALYSIS OF THE MANAGEMENT SITUATION

This step consists of assessing the existing situation on the forest and determining opportunities for resolving issues and concerns. This information provides the basis for formulating an appropriate range of reasonable alternatives.

Analysis of the management situation brings existing information together, puts it into a total forest perspective, and examines the range of possible alternatives to resolve issues. It examines supply potentials and market assessments for goods and services, and determines suitability and feasibility for meeting needs. Other objectives of the analysis of the management situation are:

- Assessing current direction, including a schedule of the goods and services that are most likely to be provided if current direction is continued.
- Assessing the demand for goods and services from national forest lands.
- Determining if there is a need to change current management direction.

STEP 5 - FORMULATION OF ALTERNATIVES

A reasonable range of alternatives is formulated according to NEPA procedures. Alternatives are formulated to assist in identifying one that comes nearest to maximizing NPB. They provide for the resolution of significant issues and concerns identified in Step 1. The alternatives reflect a range of resource management strategies. Each identified significant issue and management concern is addressed in different ways in the alternatives. The programs and land allocations in each alternative represent the most cost–efficient way of attaining the goals and objectives for that alternative. Both priced and non–priced goods and services (outputs) are considered in formulating each alternative.

STEP 6 - ESTIMATED EFFECTS OF ALTERNATIVES

The physical, biological, economic, and social effects of implementing each alternative are considered in detail, responding to the issues and need for change. The SPECTRUM model estimates some, but not all, of the economic and physical effects. Other effects examined outside the model include ecological and social considerations. The effects of the alternatives are disclosed in chapters 2 and 3 of this EIS.

STEP 7 - EVALUATION OF ALTERNATIVES

Significant physical, biological, economical, and social effects of implementing alternatives are used to evaluate each alternative and compare them with each other. Typically, each alternative can be judged on how it addresses the significant issues identified in chapter 1 of the EIS. chapter 2 of the EIS summarizes the comparisons of the alternatives with regard to the issues.

STEP 8 – DEVELOPMENT OF PREFERRED ALTERNATIVE

The Forest Supervisor reviews the interdisciplinary team's evaluation of each alternative and the public issues and concerns. The Forest Supervisor then recommends a preferred alternative to the Regional Forester, who in turn either accepts the recommendation, selects another alternative, or modifies the recommended alternative. That alternative is described as the preferred alternative in the Draft EIS and is displayed as the proposed revised Forest Plan. Public comments are then solicited and considered in finalizing a revised Forest Plan and Final EIS.

STEP 9 - PLAN APPROVAL AND IMPLEMENTATION

After the interdisciplinary team has reviewed public comments and incorporated any necessary changes into the Draft EIS or proposed Forest Plan, the Regional Forester reviews and approves the revised Forest Plan and final environmental impact statement. A record of decision (ROD) documents this step.

STEP 10 - MONITORING AND EVALUATION

The revised Forest Plan establishes a system of measuring, on a sample basis, actual activities and their effects, and compares these results with projections contained in the revised Forest Plan. Monitoring and evaluation comprise an essential feedback mechanism to ensure the revised Forest Plan is dynamic and responsive to change. Chapter 5 of the revised Forest Plan displays the monitoring and evaluation program.

TIMBER

ANALYSIS OF TIMBER PRODUCTION

We began the timber analysis by analyzing the supply and demand. A timber supply and demand was prepared as part of the analysis of the management situation required by the National Forest Management Act of 1976. That analysis is summarized in the *Supply and Demand* section of this appendix. We decided early on to do a separate analysis for each of the Chattahoochee and the Oconee NF because they differed significantly in historic product mix, terrain, and stumpage values.

We used a four-part process for each supply and demand report; (1) identify market area, (2) characterize timber supply, (3) characterize timber production, and (4) characterize demand as revealed by prices. We defined a timber market area using the locations of those mills that had historically bought Forest Service timber in the 1985 through 1996 period. (These maps are shown in the 'Forest Products' topic of the FEIS.) We then requested custom reports from the Forest Inventory and Analysis Unit of the Southern Forest Experiment Station for 1986 forest inventory data and also for timber product output (TPO) data for each of the market areas. Within the market areas, we characterized all land use, amount of timberland, ownership of timberland, and characteristics of those owners relative to timber harvest. We analyzed both the National Forest generally and the Chattahoochee-Oconee specifically in regard to timber supply and in terms of total amount, operability, stocking, diameters, species-product combinations, and tree quality. We further investigated timber supply dynamics; harvest rates, growth, mortality, how they related to each other, and how they related to future timber supply. Consideration was also given to marketplace dynamics in terms of factors both tending to increase and to decrease timber supply. We analyzed how much timber the Forest Service had historically sold within each market area, compared it to the total bought at mills, and calculated our production share in total and by product. We also characterized wood-using industry in each of the market areas in terms of type, numbers, raw material used, and employment. We considered factors tending to increase and factors tending to decrease demand. We analyzed delivered timber prices for various products for trends over time.

Our findings closely paralleled the findings of the Southern Appalachian Assessment. We found that in general the Forest Service has greater significance as a holder of timber inventory (supply) than as a timber producer. National Forest timber harvest rates are far below the rate of growth and even far below mortality. Trees are growing more wood than we harvest in any year. More trees die than we harvest in any year. National Forest timber is typically of larger average diameter and higher quality than that found on other ownerships. National Forest has a higher proportion than its land area would indicate of the highest-value species and product combinations. Both the Chattahoochee and the Oconee have un-realized potential to produce high-quality hardwoods. The Chattahoochee controls 51-percent of white pine sawtimber supply in its market area and could be a very significant supplier in a white pine specialty market. National Forest has been a locally significant but not a dominant supplier of wood raw material. Timber production from National Forest as a percentage is from two to three times more than its percentage of timberland area; that is, it is a more important supplier than its timberland area would indicate. Forest Service timber production as a proportion of all timber production has historically been greatest in the interior of the Blue Ridge Mountains at approximately 40-percent; dropping to about 15-percent around the Blue Ridge foothills, 4-percent for the Armuchee RD, and 5-percent of softwood sawtimber on the Oconee. The only strong trend in prices was for high-quality hardwood - a Forest Service supply strength. However, overall other products showed no price trend. The probable net effect within the next ten to fifteen years of factors tending to both increase and decrease supply and demand is rather finely balanced and difficult to predict.

We concluded that for timber analysis National Forest timber would continue to be in demand similarly with historic market behavior; that is, without significant supply or demand shifts in the overall market areas that would directly effect National Forest timber value. We also concluded that we were not likely to shift management toward capitalizing on our supply and demands strengths such that our timber production would be of the highest value timber and therefore exhibit a real price increase over historic prices.

INTRODUCTION TO SUITABILITY ANALYSIS

In addition to timber supply and demand analysis, the National Forest Management Act (NFMA) of 1976 requires an analysis of National Forest lands to examine their '*suitability*' for '*sustained yield timber production*' (Office of the Federal Register, 1994).

The Act divides the complete suitability analysis into three parts; designated within Section 219.14 "Timber resource land suitability" as paragraphs (a), (b), and (c). In use, these three divisions have come to be called "stage one," "stage two" and "stage three," respectively. The name stems from the analysis being 'staged' in that the three were originally planned to proceed in order; first stage one, then stage two, and finally stage three. Stage two builds on stage one, and stage three builds on stage two. At each of the three stages, the analysis used to achieve the intended result of that stage is different. However, the stages do not conflict, but are rather a complementary set which build step by step to a comprehensive look at which lands should be planned for a sustained yield timber harvest program, the volume estimated to be produced, the value of that production, and the costs of that production. The criteria used, examples of land meeting each criterion, and the outcome of each stage are explained later in this appendix in greater detail.

The analysis in its entirety is very complex. There are very many variables to be handled. And each of the 'stages' are inter-related. To help understand the details of the process, an over-simplified summary is shown here:

1. Screen the land base for lands not to be considered (stage one),
2. Complete a cost-effectiveness analysis (stage two) on remaining land by:
    - packaging the land into like areas,
    - modeling wood growth and on these areas through time,
    - modeling harvest methods and schedules,
    - calculating the value of wood harvested,
    - calculating the costs of producing harvested wood,
    - systemmatically comparing revenue to cost
    - identifying lands that are not cost effective,
3. Analyze alternatives by:
    - Re-packaging the land into like areas, including management emphasis,
    - modeling wood growth on these areas through time,
    - modeling harvest methods and schedules,
    - calculating the value of wood harvested,
    - calculating the costs of producing harvested wood,
    - systemmatically comparing revenue to cost
    - estimating acres by harvest method.

The beginning point of the analysis is with a clarification of the meaning of those terms used throughout the analysis. The National Forest Management Act also specifically defined many of them and those definitions are shown verbatim in this analysis as needed. Three key terms and their definitions are:

<u>Suitability</u> - *The appropriateness of applying certain resource management practices to a particular area of land, as determined by an analysis of economic and environmental consequences and the alternative uses foregone. A unit of land may be suitable for a variety of individual or combined management practices*.

<u>Sustained yield</u> - *The achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the National Forest System without impairment of the productivity of the land.*

<u>Timber production</u> - *The purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use. For purposes of this subpart, the term timber production does not include production of fuelwood.”*

It is important to understand that ‘suitability’ is a determination made as an outcome of the analysis. The Regional Forester’s decision on the plan revision includes identifying those lands that are suitable.

Note that both ‘suitability’ and ‘sustained yield’ are defined to mean more than just timber production. Suitable, for example, can refer to appropriateness of designation of a stream as a National Wild and Scenic River. In actual practice, however, since each of these terms has historically been used most frequently in connection with timber management, they are often understood to be timber and forestry terms. Recent usage is more in line with NFMA in that sustainability is referred to in a holistic way to mean all resources.

It is also very important to understand that sustained yield for timber refers specifically to the orderly, planned and recurrent harvest of living trees. On lands found to be not suitable for sustained yield as a result of suitability analysis, "*…salvage sales, sales necessary to protect other multiple-use values, or activities that meet other objectives on such lands if the forest plan establishes that such actions are appropriate….*" are permitted by the Act *(36 CFR 219.27 (C) (1)).* However, decisions made by authority higher than the Regional Forester may impose greater restrictions on harvest than would the NFMA. In those cases, such decisions will take precedence over the Forest Plan. This is because the Regional Forester is the Deciding Official on a forest plan, and does not have the authority to re-decide an earlier decision made by higher authority. For example, Experimental Forests, designated by the Chief, may permit the use of timber harvest to create the conditions desired for a research program or project, or to protect from insects or disease. Congressionally-designated Scenic Areas, Wild and Scenic Rivers, or National Recreation Areas may or may not have wording permitting some type of timber harvest. For this reason, having lands identified as 'unsuitable' at any stage of suitability analysis should not be understood as always meaning that no timber harvest whatsoever can occur on those lands. Rather it means: (1) there are no timber program plans for harvest volume from those lands, and (2) the planned timber program harvest rate (volume per year or per decade) has normally been set so as to not exceed the growth rate of trees on the 'suitable' land base (that is, the harvest level is sustainable when only the suitable land base is considered). Timber harvest volumes from 'unsuitable' lands are incidental, generally not 'regular' in occurrence, and do not increase or decrease the sustainable level of harvest that may occur on 'suitable' lands.

The Forest Service has set direction in Forest Service Handbook (FSH) 2409. 13 "Timber Resource Planning Handbook" for carrying out the suitability analysis required by the National Forest Management Act. The Handbook contains the 'how to' of efficiently carrying out the stated requirements and intent of the law (FSH 2409.13).

The major tool used to help perform the timber suitability analysis is an Oracle database called CISC (pronounced "SISK"). This acronym stands for Continuous Inventory of Stand Conditions. The CISC database has numerous fields of attribute data for each forest cover type mapped on the Forests. Data have historically been kept current by periodic field inventory and data edits using standardized definitions, codes, and data collection procedures. CISC data are the most comprehensive, accurate and precise records available of tree cover characteristics at the scale of the entire forest. The level of detail of CISC data is typically for individual areas of from ten to forty acres with relatively low variability (high homogeneity) in forest community characteristics. These units are called stands. Some pre-1980 data are for large stands of one hundred acres or more but these are generally within already withdrawn areas, primarily Wilderness. In some exceptional cases, stands less than five acres will be recognized in the database. But areas this small are not feasible to show on large-scale GIS maps covering entire Districts. In short, the data are not perfect but provide a fine level of resolution that is more than sufficient for timber modeling at landscape scale. (Refer to either of the Chattahoochee or Oconee NF Timber Supply/Demand reports in the AMS or the "Forest Cover" topic of the FEIS for more details about CISC.)

Throughout the revision process, CISC data were continually updated. These edits were made for a variety of reasons, from correcting minor errors detected by district personnel to adding blocks of recently acquired land. The Forest Service made an effort to obtain and use the best, most current data available; however, there are undoubtedly still some errors and inaccuracies within the dataset. In part as a result of the effort to utilize the most current and accurate data, some inconsistencies may be seen in acreages between different tables that were generated at different points in time. Also, dates on some tables may differ.

STAGE ONE SUITABILITY ANALYSIS

The primary outcome of stage one suitability analysis is the identification of the acreage of National Forest unsuitable for timber management. That acreage is obtained by summing the acres of each stand in the CISC database meeting any one of six criteria for unsuitability. A secondary outcome is the identification of the acreage "*tentatively suitable*" for timber management. Tentatively suitable acres are those left after stage one unsuitable acres have been subtracted from total National Forest acreage. The tentatively suitable acreage figure is carried forward into stage two analysis. Stage one unsuitable acreage is dropped from modeling timber production but, if within the Regional Forester's authority, can be re-considered for a new and different land allocation to uses other than sustained yield timber production.

CRITERIA FOR IDENTIFYING 'UNSUITABLE' LAND

The Act stipulates six criteria for identifying unsuitable land. But FSH 2409.13, WO Amendment 2409.13-92-1, effective 8/3/92 identifies two more criteria. These additional criteria are consistent with the intent of stage one analysis in the Act. In applying any of these criteria, cost efficiency is not a consideration. The criteria and their order from the Handbook are detailed below with examples for each. In stage one analysis, these criteria are applied in the order shown.

1. **The lands are not forest.** The Act defines forest land as Land at least 10 percent occupied by forest trees of any size or formerly having had such tree cover and not currently developed for non-forest use. Lands developed for non-forest use include areas for crops, improved pasture, residential, or

administrative areas, improved roads of any width, and adjoining road clearing and powerline clearing of any width *(36 CFR 219.3)*. The specific non-forest uses listed are not all inclusive. Water bodies, areas of exposed rock without a tree cover, or wildlife openings are other possible examples. FSH 2409.13 further clarifies that 'occupancy' of forest trees is to be by canopy cover of live forest trees at maturity; the minimum mapping size is one acre or greater consistent with Regional mapping standards, and that unimproved roads, trails, streams, and clearing in forest areas be classified as forest if they are less than 120 feet in width Improved and unimproved roads are not defined.

2. **The forest land has been withdrawn from timber production by an Act of Congress, the Secretary of Agriculture or the Chief of the Forest Service.** General examples of such withdrawals are units of the National Wilderness Preservation System designated by acts of Congress and Research Natural Areas designated by the Chief. In addition, Experimental Forests - also designated by the Chief - are considered withdrawn if management objectives preclude timber production on a regulated basis (FSH 2409.13). These management objectives are set by the Research Branch of the Forest Service and not by the National Forest System.

   This category affects the greatest number of acres. On the Oconee Ranger District, the Hitchiti Experimental Forest is considered withdrawn while the Scull Shoals Experimental Forest is not. Other specific examples of withdrawn lands on the Chattahoochee NF are the Coosa Bald Scenic Area, the Ed Jenkins National Recreation Area, and the Chattooga Wild and Scenic River - each designated by Congress. The details of this category for each of the Chattahoochee and the Oconee are shown in the folloing tables.

Table B-1. Detail of Chattahoochee National Forest Stage 1 Unsuitable Criteria 2 'Withdrawn by Congress, Secretary of Agriculture, or Chief of the Forest Service' 17 September 2003

Category and Names of Areas	Withdrawn By	Acres
National Wilderness Preservation System		
Blood Mountain	Congress	7,736
Brasstown	Congress	13,406
Cohutta	Congress	35,484
Ellicott Rock	Congress	2,007
Mark Trail	Congress	17,077
Raven Cliffs	Congress	9,309
Rich Mountain	Congress	10,540
Southern Nantahala	Congress	11,555
Tray Mountain	Congress	10,425
		Subtotal 117,539
National Wild & Scenic River System		
Chattooga River	Congress	6,887
		Subtotal 6,887
Other Congressionally-Designated Areas		

Category and Names of Areas	Withdrawn By	Acres
Ed Jenkins National Recreation Area	Congress	23,449
Coosa Bald Scenic Area	Congress	7,044
		Subtotal 30,493
Other Areas		
Sosebee Cove	Chief	74
Cedar Mountain	Chief	18
		Subtotal 82
		TOTAL 155,001

Source: GIS 'stands' data layer as modified for Plan revision September 2003

The details of acres within criteria 2 'Withdrawn by Congress, Secretary of Agriculture, or the Chief [of the Forest Service]' for the Oconee National Forest are shown in the following Table.

Table B-2. Detail of Oconee National Forest Stage 1 Unsuitable Criteria 2 'Withdrawn by Congress, Secretary of Agriculture, or Chief of the Forest Service,' July 23, 2002

Names of Areas	Withdrawn By	Acres
Hitchiti Experimental Forest	Chief	4,666
Murder Creek Research Natural Area	Chief	1,007
Total		5,673

Source: Plan revision GIS stands data layer July 2002.

Lands where management activities are strongly limited to meet the requirements of other Acts, such as the National Historic Preservation Act, the Endangered Species Act, or the Clean Water Act are not considered a 'withdrawal' under this criteria, even though meeting the requirements of the law may preclude timber harvest. These are considered as part of stage three.

3. **The forest land is incapable of producing crops of industrial wood.** This category is not stipulated in the Act but rather has been identified by the Forest Service in FSH 2409.13 as a category consistent with the intent of stage one analysis. The primary criteria is that the species of trees growing on these lands are not currently utilized nor likely to be within the next ten years; that is, there is no market for the species. Note that the ability of the site itself to grow wood (productivity) is not what is being considered.

   On the Chattahoochee or Oconee NF, each species of tree capable of forming a forest cover is currently utilized; that is, the wood products industry does not reject any wood because of its species alone.

4. **Technology is not available to ensure timber production without irreversible resource damage to soils productivity, or watershed conditions.** This criterion actually has two parts; (a) availability of technology, and (b) irreversible damage to soils productivity or watershed conditions. These are addressed individually below.

FSH 2409.13 defines available technology as technology that is in use or that current research and experience indicates is feasible to use … for the site, species, and other factors involved. It further clarifies that current use need not be within the Forest or Region. However, current untested technology is not to be considered, nor is there speculation about future development of new technology.

For irreversible damage, an interdisciplinary team determines *'… whether or not it is possible to carry out the activities involved in timber production …'* without such damage. At a minimum, the Handbook requires consideration of the activities for access, harvesting, slash disposal, and regeneration. However slash disposal is a Western practice not used on either the Chattahoochee or Oconee NF.

Cost efficiency is not a factor in meeting either the overall lack of technology criteria or its subparts; that is, 'feasibility' is not economic feasibility because that is what stage two analysis evaluates. For example, helicopter logging is available technology that would result in no direct soils or watershed condition damage on the harvest unit. It is physically 'feasible' in that it has been used. It can be used to meet this criteria at stage one even though many areas do not have the timber value to be economically feasible for helicopter logging; that is, costs exceed value. Similarly, the costs of environmental mitigation are not considered at stage one.

The IDT also considered irreversible damage to soil productivity. This level of damage would be considered irreversible, because the resource has been destroyed or removed, or has deteriorated to the point that renewal can occur only over a greatly extended period or at great expense. The concern considered on the Chattahoochee was the occurrence of mass failures or the soil sliding downhill and reaching a stream or creating an un-vegetated area that eroded with sediment reaching the stream. Mass failures have historically occurred on the Chattahoochee, typically in hurricane-related rainfall or intense thunderstorms that produce rains exceeding ten inches in a twenty-four hour period or equivalent. These storm events have been rare, however, a small number of landslides have been documented occurring within the Tennessee River basin on slopes in excess of 60 percent and on granite or gneiss geology. Typically a weakening of a toe slope position due to heavy inflows of moisture has triggered the landslides. The weight of the soil mass simply cannot hold on the slope angle and gives way to slide down slope and create a landslide. Documented slides are generally less than 100 yards long, moving soil, rock and vegetation material down slope to a final angle of repose, or flat slope.

Road building across slopes greater than 60-percent could be a problem if the geology or soils were unstable, such as when the rock strata are aligned parallel with the ground surface. Road construction is not anticipated across these conditions; however any proposal for road construction across slopes that steep would require interdisciplinary planning that would consider the landslide hazard. Without considering costs and with the availability of helicopter or cable logging, the IDT concluded that there were no National Forest system lands on the Chattahoochee that met the criteria for withdrawal from suitability due to irreversible damage.

5. **There is not reasonable assurance that such lands can be adequately restocked within five years after final harvest.** This is a criterion of the Act. The Act defines adequate restocking as meaning …the cut area will contain the minimum number, size, distribution, and species composition of regeneration as specified by regional silvicultural guides for each forest type. *(36 CFR 219.27 (c) (3)* at the time of final harvest. The Act further stipulates that five years after final harvest is five years after each of; clearcutting, final overstory removal in shelterwood cutting, seed tree removal in seed tree cutting, or selection cutting. FSH 2409.13 provides additional clarification as follows:

    Current research and experience provide the basis for determining whether or not the planned practices are likely to be successful at the time the final harvest is planned. If existing knowledge is not adequate for determining which practices will be successful on certain lands, but on-going research should resolve this question before the scheduled final harvest, then, include the applicable lands as tentatively suitable, but maintain them as a separate, non-interchangeable component of the allowable sale quantity…. Such assurance applies to normal conditions for the site and does not constitute a guarantee. Abnormal conditions, such as drought, disease, or other unplanned events, may preclude meeting this requirement, Identify forest lands failing to meet this requirement as unsuitable for timber production. Cost efficiency is not a factor in this determination.

   The NFMA has required the annual collection and reporting to the Secretary of Agriculture of first and third year survival of planted stands and fifth year stocking on naturally regenerated stands since 1976. Chattahoochee and Oconee NF personnel have been collecting this information for twenty-four years. In all that time, no stand has failed to be adequately restocked by the fifth year after final harvest.

6. **There is inadequate response information.** This is not a criterion of the Act, but rather is identified by Forest Service policy in Forest Service Manual (FSM) 2409.13 where, in Chapter 21.5, the following direction is given:

    Identify forest land as unsuitable for timber production if there is not adequate information available, based on current research and experience, to project [timber growth] responses to timber management practices. Until such time as adequate responses are available,

> identify these lands as needing further inventory, research, or information and do not consider them part of the tentatively suitable land base.

The insertion of “timber growth” in this Manual quote is a Regional Office clarification. It follows logically from the earlier use of the ‘adequate restocking’ criteria. If land can be adequately restocked, then the next question is how the trees will grow beyond the ‘five years after final harvest.’

FSM 2409.13 gives two Western examples; pinyon-juniper and mesquite, which might fit this category. It also calls for giving …special attention to lands classified as incapable of producing 20 cubic feet/acre/year if they formerly met this criterion and were previously part of the timber base. Both Chattahoochee and Oconee NF acreage were screened for low productivity stands that might meet this criterion. Forest stands incapable of producing more than 20 cubic feet/acre/year (productivity class 7) are very rare on the Chattahoochee, and do not occur on the Oconee National Forest. However, soils inventory data was used to identify a soils unit called ‘rocklands’ on the Chattahoochee. These are typically small, scattered occurrences of rock outcrop that are included in the larger stand polygon mapping. For the suitability analysis they were deducted under this category even though their acreage is so small it is insignificant to the outcome.

In addition, FSH 2409.13 identifies a category called physically suitable forest land. These are lands for which technology is available to ensure timber production without irreversible resource damage to soils productivity, or watershed conditions, and lands for which the possibility of adequate restocking within five years is reasonably sure.

STAGE ONE AND THE SOUTHERN APPALACHIAN ASSESSMENT

The multi-agency Southern Appalachian Assessment (SAA) published in 1996 includes information on the acres defined as unsuitable in a stage one analysis for the Chattahoochee NF. (The Oconee NF was not included in the SAA.). These acres were compiled from information extracted from the Forest CISC database. Table 3.17 on page 136 of the *Social, Cultural, and Economic Report* shows a total of 205,360 acres as unsuitable on the Chattahoochee (SAMAB, 1996).

As the IDT worked with the SAA results, it became increasingly clear that this figure was too high and that the number most suspect was 200,998 acres shown as withdrawn from timber production (criteria 2 in previous section of this report). Further checking disclosed that there was a major problem with this number. It included significant acreage that had been withdrawn from sustained yield timber management by the Regional Forester’s decision on the existing 1985 Forest Plan within a category called “not appropriate - other objectives cannot be met”. Examples of these lands include developed recreation sites, rugged high-elevation lands, foreground of the Appalachian Trail, pre-existing Scenic Areas, and botanic areas. While these lands are indeed currently unsuitable; that is, they do not have a sustained yield timber harvest management regime, and the timber volume which can be harvested per decade from the Forests does not include yields from them, they do not meet the criteria of the Act. In fact, the National Forest Management Act specifically requires the re-consideration of these lands as part of Plan revision. They are examples of stage three withdrawals.

The source of this discrepancy was coding by District personnel to match the allocations of the 1985 Plan as near as possible. The correspondence is not always a clear one-to-one. As Plan implementation began it was important to have this match for monitoring and reporting, but the timetable of the SAA effort did not allow for extensive review and correction of this hidden problem. Therefore, the IDT had to completely re-do the stage one suitability analysis for the Chattahoochee.

DATA SOURCES AND METHODS

The primary data source for initial screening of National Forest System lands is the computerized CISC database. The major reason for relying on it is that it includes a data-field called Land Classification, shortened in day-to-day use to Land Class. This data field has three-digit classification codes that correspond to each one of the NFMA or Forest Service Handbook criteria for stage one analysis. These codes are detailed in the Forest Service R8 Silvicultural Examination and Prescription FIELD BOOK dated June, 1992. These codes also include information useful to the other stages of suitability analysis.

The dataset used by the SAA was a subset electronically extracted from the ‘working’ CISC database and called SAA_CISC. Once the IDT identified that the SAA stage one analysis was incorrect and why, it was clear that land class data had to be reviewed and corrected. At a meeting in the Supervisor’s Office in September 1997, key representatives from each District were given a printout of their District SAA_CISC data and a colored GIS map with each of their land class codes plotted to show their distribution on the landscape. They were instructed to use the map to check all land class codes. Specifically, for ‘withdrawn’ lands, they were instructed to change land class codes to permit the accurate separation of lands withdrawn by the Regional Forester’s decision on the Forest Plan (a stage three unsuitable category) from those lands withdrawn by authority higher than the Regional Forester (a stage one criteria). They were directed to code lands withdrawn by authority higher than the Regional Forester in the 300 or 400 land class code series. Lands withdrawn by the Regional Forester’s decision on the existing Forest Plan were to be coded in the 800 land class code series. As needed, they were to make pen and ink changes on the printout and return it to the IDT.

After corrected printouts were received by the IDT, a copy of the SAA_CISC database was made and called Revision_CISC. This database then became the primary working tool for plan revision. Erika Mavity, forest analyst, then manually edited it by keying in the pen and ink corrections from each District’s hardcopy printouts. Then land classification code maps were re-plotted (except for the Toccoa and Oconee which were reviewed on-screen) and reviewed again by Ron Stephens, Forest silviculturist and IDT member, and by Erika. A second round of corrections was needed, at least in part because instructions on the use of land class coding had not been clear enough, particularly in the use of series 400 which means "deferred pending final action." This category is correctly reserved for areas recommended to Congress by the Regional Forester for designation as - for example - a unit of the Wilderness or Wild and Scenic River systems. Districts should not have been instructed to use that series since neither the Chattahoochee or the Oconee had areas pending before Congress. Obvious coding errors, inconsistencies in code usage, missing data, and so on were identified District-by-District. These problems were corrected interactively on the computer screen using ARCVIEW software for simultaneous display and data edits. During this step each stand was also coded with its Management Area number under the 1985 Plan, as amended, and land class coding was edited to be a consistent match to the management emphasis of each management area. For example, Management Area 12 (lakes, vistas, and seen areas) was assigned land class code 640 to identify it as land suitable for sustained yield timber management, but with a special emphasis on visual quality. The purpose of identifying the management area was to be able to display current management (i.e., the No-Action alternative) which, in turn, provided a basis for showing change later in the acreage allocated to specific management within individual alternatives.

Over the course of Plan implementation, District personnel had also made their own judgments about the most accurate land class code to use for individual stands at the scale of individual project areas of thousands or tens of thousands of acres. These land class codes did not reflect a Regional Forester's decision and had not been used consistently across the Forests, but were valuable information. In order not to lose it, stands with an original land class code in series 500, 600, or 800 within Management Area 16 (general forest) had the number five thousand (5000) added to the existing code and a new four-digit land class code created. This avoided second-guessing someone who had first-hand knowledge of individual stands and retained their information for use later in formulation of alternatives. The two most common cases were that Management Area 16 lands had been coded as belonging to either: (1) lands that were suitable for sustained yield timber management but had a special emphasis such as water, wildlife, or visual; or (2) lands not appropriate for sustained yield timber management such as new recreation developments.

In addition, lands which had been acquired by the Forest Service since 1985, but which had not been allocated to a management emphasis by a Plan amendment, were flagged with the addition of the number one thousand (1000) to the existing three-digit land class code thus creating a four-digit code. Also the Management Area column was attributed either with a "99" to indicate 'unallocated' or with the appropriate Management Area number based on surrounding lands, such as land acquisition with a Wilderness. These steps provided a handle to be sure that currently unallocated lands received an allocation since this need had been identified in a "Need for Change" list made early in the planning process. Being able to highlight these stands by themselves allowed them to be considered both on their own and in context with surrounding lands.

A summary of other important land class coding changes are shown in the table below.

Table B-3. Summary of Major Land Class Coding Edits to Match Revision_CISC to 1985 Plan, as Amended.

Plan MA	Code	Translation	Remarks
3	361	MA Name = Hitchiti Experimental Forest	New code
4	830	MA Name = High elevation backcountry	New code
6	831	MA Name = Archaeological/Historical area	New code
7	832	MA Name = Scenic areas (RF designated)	New code
10	834	MA Name = Research Natural Area; Murder Cr.	New code
11	660	MA Name = Major Recreation Waters	Water emphasis
13	835	MA Name = Botanic/Zoologic Area	New code
15	630	MA Name = Semi-primitive non-motorized recreation	Recreation emphasis
18	360	Ed Jenkins National Recreation Area	New code
16	5###	MA 16 - General forest with additional information	New code
"99"	1###	No MA, lands acquired but unallocated	New code

Also, as part of this data editing and checking step, individual data fields were queried to detect erroneous or missing data stand by stand. In many cases, the same stand was repeatedly selected so the database created by the queries was collapsed so that each stand was shown only once. The list of these stands was printed and furnished to District representatives for further editing by comparison with current District stand maps and CISC data. To ensure that edits were for the correct ground location, GIS maps showing the Compartment and stands were plotted at a scale sufficiently large that the information was readable. Stands needing edits were flagged by being color-coded red against an otherwise green background of land ownership and in addition had their stand number printed on the map face within each red stand polygon. District representatives reviewed these maps during June 1998 with written instructions to reach eight objectives. These objectives were:

1. Identify lands acquired since 1985 that had not been allocated to a Plan management direction. The purpose of this was to allocate those lands in the Revision.

2. Identify lands exchanged out of NF ownership but incorrectly identified as still being National Forest. The purpose of this was to correct the NF acreage and location data in GIS.

3. Check that all lands accurately described as water, nonforest, reserved, lack of technology, or incapable of producing crops of industrial wood were shown and that their size, shape, and location was correct. The purpose of this was to correctly identify stage 1 unsuitable lands.

4. Identify lands being managed with the standards and guidelines of a specific 1985 Plan Management Area, but which were not specified by either Plan mapping or description as belonging to that Area. (These were lands which inventories made

after 1985 identified as fitting another allocation but which had not been formally allocated to that Management Area.) The purpose of this was to identify areas for alternative management direction in alternative development.

5. Identify areas incorrectly mapped on the original Plan maps. The purpose of this was to develop a more accurate map of current management than the one in the Plan for use as the ‘No-Action’ alternative.

6. Correct inaccurate or missing stands data. The purpose of this was to ensure that all acres would be reported when queried using different land stratification criteria before running stage two and alternative analysis.

7. Verify accuracy of GIS map of 1985 Plan management allocations, as amended. As with number 5, the purpose of this was to have an accurate mapping of current management as a base in order to show it spatially as the ‘No-Action’ alternative and to show changes with each alternative.

8. Verify accuracy of the 700 and 900 series land class. The purpose of this was both to improve accuracy of data and to fully reflect criteria for the identification of stage 1 unsuitable acres.

District edits were keyed into the database, but before running stage one analysis, each stand was attributed with its appropriate Management Area under the current Plan. Throughout this process, any inaccuracies detected were corrected as found. Once the data had been completely reviewed a second time, we were almost ready to run stage one analysis.

Before stage-one summary acreage was generated, however, a quality control check was made. Total National Forest acreage from Lands Staff records was adopted as the control figure and the sum of Revision_CISC stands acreage was compared to it. Lands Staff acreage was used as the control because: (1) it was an independent data set; (2) acreage is based on recorded deeds, and is therefore the legally recognized National Forest acreage; (3) it is the acreage compiled and reported as official National Forest system lands acreage by the Washington Office; and (4) it is the most current data source. During the process of making this check it was discovered that a major land exchange had just been finalized in January 2000. This information was edited into the Revision_CISC database so that both newly acquired (added) and newly exchanged (deleted) lands would be recognized. When this had been done and the check was made, there was about 0.5 percent difference between the Lands and Revision_CISC data. This percentage was consistent on each of the Chattahoochee and Oconee National Forests. Given that the two data sets used different methods to calculate acreage, this difference was judged insignificant to further planning efforts
.

Next, the database was queried for the acreage meeting each criterion. A new column was inserted in the Revision_CISC database called Stage 1 and the criteria number was filled in for each stand. During this process, it was found that Land Class series 700 and 900 - though involving a small number of stands - still had errors.

These stands were reviewed individually, both in data and on screen, and edited. As a result, the series 900 was reduced to one stand of forest type “99” or “brush species”. The 700 land class series was found to have very few stands correctly coded. This may be because in the 1970’s the 700 series was for a category called “low intensity management”. That category no longer exists, because the land class codes were revised to match the NFMA suitability criteria. But there were likely some stands for which the land class code was never edited, because these are lands that receive only custodial attention.

Some elements of the criteria could not be screened on a stand basis. The best example is the ‘improved roads’ part of the ‘non-forest land.’ Improved roads are not consistently shown as individual stands in the database because of their narrow width. However, they do have a small cumulative effect on the forested acres. Another possible example is areas of very steep slope (>= 70 percent), are rarely stand size but also have a cumulative effect.

Rather than attempt to create stands for each road or localized steep slope, the judgment was made that this was best dealt with as a reduction in timber yields later in the modeling effort.

As the data were being edited the third time, it was found that “administrative sites”, a non-forest land criteria element, were not consistently coded across the Forests. This correction was made using a Stage_1 column value of “1”; that is, non-forest, so that these lands would fall out of suitability analysis at stage one.

Still later, as slope analysis proceeded, stands with both low productivity and steep slope were identified as category 6 unsuitable; that is, “adequate response information lacking” and the data were edited yet again.

Table B-4. Stage One Timber Suitability Analysis Criteria and Associated CISC Land Class Codes.

Stage 1 Unsuitability Criteria	Land Class Codes
1. Not forest land	Series 100 and 200, code 865
2. Withdrawn by Congress, Secretary of Agriculture, or Chief	Series 300
3. Incapable of Producing Crops of Industrial Wood	Code 900
4. Technology not available to produce timber without irreversible resource damage to soils productivity or watershed conditions	Code 720
5. No reasonable assurance that such lands can be adequately restocked within 5 years after final harvest	Code 710
6. Inadequate response information	Code 740

RESULTS

Results of both stage one and stage three analysis for each of the Chattahoochee and Oconee National Forests are displayed in table form below. These are consolidated in order to have the complete results in one place as a handy reference.

Note that because the criteria are applied in sequence, the acreages shown for each category is not necessarily all the acres that occur on each Forest which meet that criteria; that is, the categories may overlap. For example, Wilderness Areas could possibly contain non-forest land, land for which technology is not available, and so on.

Table B-5. Summary of Acres By Timber Suitability Analysis Land Classifications for the Chattahoochee National Forest 17 Sept. 2003

Total national forest land as of September 2003	750,767
Criteria 1 - Non-forest land	-2,126
Forest land	748,641
Criteria 2 - Forest land withdrawn from timber production	-155,001
Criteria 3 - Forest land not capable of producing crops of industrial wood	0
Forest land physically unsuitable:	0
Criteria 4 - irreversible damage likely to occur	0
Criteria 5 - not re-stockable within 5 years	0
Criteria 6 - Forest land - inadequate information	-4,327
Result of Stage One - Tentatively suitable forest land	589,313
Result of Stage Three - Forest land not appropriate for timber production (net)	-222,117
Total suitable forest land (net)	367,196
Unsuitable forest land	383,571

Source: Plan revision GIS stands database September 2003.

The stage three and the total suitable results each initially included their portion of the 4,327 acres of 'rocklands.' This was because these rocklands are less than stand size and are embedded like raisins inside all prescriptions outside of the 'withdrawn' category. As indicated by the (net) in the table, the acres of each category was reduced for the rocklands within them.

Table B-6. Summary of Acres By Timber Suitability Analysis Land Classifications for the Oconee National Forest 17 Sept. 2003

Total national forest land	115,215
Criteria 1 - Non-forest land	-2,216
Forest land	112,999
Criteria 2 - Forest land withdrawn from timber production	-5,673
Criteria 3 - Forest land not capable of producing crops of industrial wood	0
Forest land physically unsuitable:	0
Criteria 4 - irreversible damage likely to occur	0
Criteria 5 - not restockable within 5 years	0
Criteria 6 - Forest land - inadequate information	0

Result of Stage One - Tentatively suitable forest land	107,326
Result of Stage Three - Forest land not appropriate for timber production (net)	-13,427
Total suitable forest land (net)	93,902
Unsuitable forest land	21,313

Source: Plan revision GIS stands data layer September 2003.

STAGE TWO (ECONOMIC) SUITABILITY ANALYSIS – SPECTRUM

A WORD ABOUT MODELS

Stage two and stage three analysis use two different computer models. In order of their use, the first is the Forest Vegetation Simulator (FVS) for timber growth and yield. The second is the SPECTRUM linear programming model. FVS outputs are used as part of the needed inputs to the SPECTRUM model. Each of these is explained in greater detail later.

It is important to understand what models are and how they are used. Models are a simplified representation of reality. They are developed and used because they are useful. But they are 'wrong' if the standard for 'correct' is what actually happens. Models by their very nature are not intended to predict the future with great precision. They produce reasonable estimates such that a decision informed by their use has a high probability of being close enough to what actually comes to pass to remain a quality decision concerning those outcomes that were chosen based on information provided by modeling. This is the standard for their 'correctness'. Monitoring of plan implementation compares what actually happens to modeled results to detect any need for change.

THE ANALYSIS

Stage two analysis examines the capability of the tentatively suitable lands to produce timber cost effectively. The analysis 'shall' do two things. First, 'identify the management intensity for timber production ... which results in the largest excess of discounted benefits less discounted costs'. Another way of saying this is that it will identify the most cost-effective timber management regime. Second, 'compare the direct costs of growing and harvesting trees, including capital expenditures required for timber production, to the anticipated receipts to the government' *(36 CFR 219.14 (b)).*

There are several features of stage two analysis that must be understood. First, no decisions are made at the conclusion of the stage two analysis about the management of the land. Rather the results are used as one of many pieces of information in the formulation of alternatives at stage three. Second, the analysis is not at a single point in time. Instead both costs and returns are considered over a long time frame and discounted to the date of the analysis. The Act also stipulates the nature of the receipts and the expenditures that are to be considered as follows:

Direct benefits are expressed as expected gross receipts to the government.

Direct costs include the anticipated investments (maintenance, operating, management, and planning costs) attributable to timber production activities.
Each of these will be discussed in greater detail later.

The inputs needed for stage two analysis are:

1. The tentatively suitable acres from stage one.
2. An estimate of the timber volume present on these lands both as of the date of the analysis and dynamically into the future.
3. An estimate of the amount of that volume harvested using different harvest intensities and timing.
4. An estimate of the revenue to the Forest Service on a per unit volume sold basis both as of the date of analysis and in the future.
5. The Forest Service activities to produce the timber yield.
6. An estimate of the costs associated with each activity both as of the date of analysis and in the future.

Of these variables, numbers 2, 3, 4, and 6 require considering time (or more correctly change over time) in the calculations. The tentatively suited acres is a fixed input considered not to change over time, that is, it is a base for comparison of change in outputs and economic effects in alternatives. In the analysis, the acres having harvest and other forestry activities, the type of activity, what the Forest Service spends doing each activity, and what the Forest Service collects from the sale of timber are each systematically analyzed; first individually then cumulatively.

We deliberately approached the modeling and analysis process with an intention to do too much rather than too little. Our belief was that it would be easier to aggregate to a lesser refinement should that be called for than to need to 'split' late in the process. And at the beginning we could not predict with certainty what needs for 'lumping' or 'splitting' might arise. In a similar way we present here the details of things initially considered and later dropped. The doucument could be shortter and more focused without this information but we judged that it was worthwhile to include it also.

The analysis problem is far too large and complex to be done without the speed and tirelessness of computers. On the Chattahoochee and Oconee National Forests, stage two analysis was done using a group of inter-related computer models. One of these was FVS, or Forest Vegetation Simulator. The other was SPECTRUM, a linear programming optimization model. FVS provided input data of estimated harvest volumes, called 'yield files' to SPECTRUM. SPECTRUM then estimated a harvest schedule by method, harvest volumes, and the present net value of each alternative.

Each of these two models will be introduced briefly here. Details of their use are presented incrementally in the approximate order in which the work on each topic occurred during the analysis. We have chosen a parallel presentation with both FVS and SPECTRUM discussed relative to each topic as best reflecting the actual process. But the interrelationship of these models makes it difficult to always be crystal clear. We have tried to minimize this but likely have not always succeeded.

The basic growth and yield model chosen for use by the Southern Appalachian Forests in revision was originally called SouthEast TWIGS or "SETWIGS." It had about fifteen years of development to its 1999 form. Its beginnings were in a model called "TWIGS" (The Woodsman's Ideal Growth Projection System) developed by the North Central Forest Experiment Station of the Forest Service in the early 1980's. Ralph Meldahl, then at the University of Georgia, and others adapted the TWIGS model to Georgia using state FIA data, and created the "Georgia TWIGS" or GATWIGS model in 1986. Model development continued with Meldahl and Roger Bolton adding data from Alabama and South Carolina to create SETWIGS in 1989 (Meldahl and Bolton, 1990a; Meldahl and Bolton, 1990b). Each of these are individual tree, distance independent models which means that they 'grow' single trees through time, but they do not require an explicit spatial relationship between trees to be defined, that is, tree locations are not mapped. These models are much more refined than stand (community) level models used in the original 1985 Plan modeling.

While SETWIGS was in development, other activities were going on which would come together into a complete system. In 1973, A.R. Stage of the Forest Service created an individual tree, distance-independent growth and yield model for use in the Intermountain West called PROGNOSIS. Then in the early 1980's the Washington Office Timber Management Staff selected the individual tree, distance-independent growth and yield model type as the nationally supported form of growth and yield modeling for the Forest Service. A national model framework was subsequently developed using PROGNOSIS as the starting point. It is called the Forest Vegetation Simulator (FVS). Within the overall FVS system, numerous model 'variants' which apply to different regions of the US are run. SETWIGS runs within FVS as the 'SE variant.' Its addition within the FVS framework greatly enhanced its capabilities, because model extensions within FVS had already been created; for example, for insects or disease and to simulate regeneration.

The Ecosystem Management Group (http://www.fs.fed.us/institute) at Fort Collins, Colorado in co-operation with the Rocky Mountain Forest and Range Experiment Station developed the SPECTRUM linear programming model. SPECTRUM is an evolution of FORPLAN, an LP-based model used to develop the first set of strategic forest plans. SPECTRUM is also an LP-based forest-planning model and is used to optimize land allocation and activity and output scheduling for a forest over a specified planning horizon. It includes a data entry system, model manager, matrix generator, and report software. A commercial LP package called C-WHIZ is used to solve the LP matrix generated by SPECTRUM. The matrix generator reads and interprets model data and creates rows and columns for the LP software to solve. The report utilities interpret the LP solution and produce a series of reports and database files. Stage two analysis is a straightforward application of a portion of SPECTRUM capabilities once the user has supplied the needed acreage, timber yields, costs, and revenue coefficients. In addition, the user must also specifically describe the kinds of activities that may occur on each unit of land, including their timing and intensity. These descriptions are the prescriptions.

LAND STRATIFICATION

A first phase in the analysis is to simplify its complexity without sacrificing its accuracy. This is done by 'packaging' land into like units of current resource condition and capability. This 'packaging' is called 'stratification.' There are two inter-related stratification steps. First, we stratify for growth and yield modeling in FVS. Second, we extend the initial stratification by adding other variables important to economic analysis in SPECTRUM but not important to the growth and yield modeling. Each of these efforts are complex in their own right and are difficult to present clearly in a sequential fashion; that is, as they were actually used. We have chosen that organization and tried to make it understandable but do not expect to have been completely successful with all audiences.

The tentatively suitable lands include a great variability in tree species, productive capability of the land (ability to provide nutrients and water), age of trees, size of trees (both height and diameter of bole), density of tree stems (number per unit area), quality of tree stems, access, and landform. For example, there are existing on the Chattahoochee and Oconee National Forests combined, about forty-four individual forest cover types, seven productivity classes, fifteen ten-year age classes, four tree size classes, three density classes, and about four general condition classes. (Refer to the Forest Cover report of the AMS for more details.) These have more than 221,000 possible unique combinations but they are not the only variables that need to be considered. Change in any one of the variables within each combination (as well as others) could potentially change the revenues, costs, management activities, volume growth, or timber yield input factors in the stage two analysis. But most of these changes are minor and not significant to the outcome.

Recognizing this complexity, the NFMA stipulates that … *For the purpose of analysis, the planning area shall be stratified into categories of land with similar management costs and returns. The stratification should consider appropriate factors that influence the costs and returns such as physical and biological conditions of the site and transportation requirements* - 36 CFR 219.14 (b). In practice, similarity in management costs generally result when the same activities using the same methods and with the same timing occur on different land. Similarity in returns occurs when, for example, the same species and product combination occur on different land. The quote above is from that portion of the NFMA that deals specifically with stage two analysis. In practice even stage two land stratification needs to be interdisciplinary and consider the analysis needs of each resource for the analysis of each Plan alternative. In particular, land stratification is driven by: (1) the need to predict changes that are linked to each of the issues, both for the present and for the future, and (2) the need to simplify the problem. Its usefulness in forest planning includes helping to establish capabilities of the land, analyzing the effects of alternatives, and displaying model inputs and results spatially by mapping land stratifications through a Geographic Information System (GIS) link.

The process of stratifying the land is not all done in one pass through the data. Different aspects of the problem; i.e. timber yields, costs, returns, or activities, when considered individually may lead to one stratification scheme, but when combined, they may create the need for another one. In practice, variables are identified which are known to be important to a specific resource, issue, or analysis question. Usually a very large number of possible units are identified at first. Then the data are queried to see the actual number of land units which would occur and their total area, since not every possible combination will occur. If the number of existing units is still very large or if some units have very small acreages, a step-by-step process begins of aggregating them back to larger areas by combining within individual stratification criteria. For example, if each of the forty-four forest cover types were initially kept separate, they could be considered for re-combination into similar cover type groups. The data set has to be checked repeatedly testing new combinations and their effect. Throughout the effort, factors such as data availability and reliability for the scale involved, need for and cost of additional data collection, sensitivity of analysis results to a change in the input variables, and the availability of resources to build a more complex model had to be considered and tested.

Within the SPECTRUM model, the units of land used in analysis are called analysis areas. The model permits the use of six 'level identifiers' as they are called to stratify the land. These levels are hierarchical; that is, like an outline, with each level as one moves down being an incrementally more restrictive set of identifiers and thus describing a smaller land area. Conversely, each level as one moves up is an aggregation of all lower-level units. Each level identifier may use up to five alpha-numeric characters. For all six, thirty characters are possible. Combinations of variables may also be used to define any 'level identifier' to increase the level of detail - and complexity - above what would be possible from six levels alone. For example, a slope and soil type combination could be used as one level identifier. Typically, however, just using the basic six results in a very large number of possible combinations. Not all of these will be significant to the outcome of the analysis, but this cannot be known in advance. For this reason, land stratification is 'iterative,' that is, done many times. A common reason is to reduce the number of analysis areas created by an initial over-stratification.

As discussed here, land stratification is focused on that needed for stage two analysis but with consideration being given to the needs of other disciplines. The reason for the stage two focus is that it typically uses a detailed or even very detailed land stratification (that is smaller areas of land) when compared to other resources or issues. For example, it would be possible (though not practical) to use single stands as an analysis area. This is intuitively logical because timber as an output is a vegetation resource characteristic and a vegetational cover database is the primary land stratification tool. Further, within Region 8 at least, the power of the SPECTRUM model is being used primarily to analyze the effects of management on vegetation.

The expectation was that additional 'level identifiers' would be added later at other levels of the hierarchy to further aggregate or refine the analysis areas used in the stage two timber suitability model for use in modeling other resources at either a coarser or finer scale. As alternatives are built and analyzed, a finer resolution of land stratification may become important. For example, the water quality issue may be addressed in some measure by a land stratification aimed at 'riparian areas' that may not directly correspond to a stage two analysis area. Stage two analysis will be unaffected by this, but within an alternative, new timber yield co-efficients may have to be developed if, for example, reduced timber yields will occur from riparian areas for a particular alternative.

Within the overall stratification problem for stage two, there is a subset of stratification that is needed specifically to model timber growth and yield. Growth and yield had to be considered for two reasons. First, the growth and yield modeling required extensive preparatory work before it could be used and work on it could not be delayed. Second, stage two analysis cannot be done without growth and yield modeling capability. The stratification needed and the procedure used for this portion of the effort is discussed first. Later, additional stratification variables that affect costs or revenues or both are brought in.

In following paragraphs, the land stratification variables for stage two analyses on each of the Chattahoochee and Oconee National Forests are shown. In addition, the reason why each variable is needed and where the information came from is also discussed. The procedures used to get a match between the timber growth and yield model inputs used and CISC data are also described.

Ecological Classification Units

The Forest Management Service Center (FMSC) in Fort Collins, CO prepared Forest Inventory and Analysis (FIA) data initially for use with the growth and yield model called 'SouthEast - The Woodsmans Ideal Growth Simulator' (SETWIGS) which runs within the Forest Vegetation Simulator (FVS) program. Later SETWIGS was superseded by the Southern Variant of the Forest Vegetation Simulator. The Southern Variant was used throughout this analysis. Part of the preparation was to correlate FIA plot data with the Forest Service ecological classification coding down to the Subsection level using maps furnished by the Regional Office. This step was necessary because SETWIGS uses Forest Service National Cruize (NATCRUZ) timber volume estimation equations and these differ for each model-identified 'physiographic region.' These regions correspond to Forest Service ecological Section units and are: Southern Ridge and Valley for the Armuchee Ranger District; Blue Ridge Mountains for the Toccoa, Brasstown, Cohutta, Tallulah, and part of the Chattooga Ranger Districts; and the Southern Appalachian Piedmont for the Oconee Ranger District and the southern end of the Chattooga Ranger District. The Subsection unit is the next level below Section but its recognition in land stratification does not change the equations used by the SETWIGS model. What this means is that timber yields will be different for each Section, and SPECTRUM modeling will require a timber yields co-efficient table for each one. Modeling on the basis of ecological Sections is also one component of an 'ecological approach' to planning because it recognizes ecological differences in timber productivity. It also provides a means to disaggregate timber production to each ecological Section in setting Plan goals and objectives. This identifier is also expected to fit well with the analysis needs of other resources in response to the issues.

Tagging Revision_CISC stands with their ecological classification unit also set up a later ability to continue the stratification down through the Subsection, LandType Association, and lower levels should that need arise as the planning process continues.

The process of identifying the ecological Section by stand was very straightforward. A column labeled "ECS" was first added to the Revision_CISC database. For the Armuchee RD, this column was attributed with the code "231D" for each stand. For the Oconee RD, the column was filled with the code "231A." For the Toccoa, Brasstown, Tallulah, and Cohutta Districts, each stand was attributed with the code "M221D." The Chattooga District stands were assigned to the Blue Ridge or the Piedmont by relating the stands layer to the digitized ecological classification layer and using the computer to attribute the "ECS" column with the appropriate code accordingly. Stands within the Blue Ridge were coded "M221D" and stands in the Piedmont were coded "231A."

In the actual labeling of timber analysis land stratifi-cation units, the ecological Section identification was shortened to "B" for Blue Ridge, "R" for Ridge and Valley, and "P" for Piedmont.

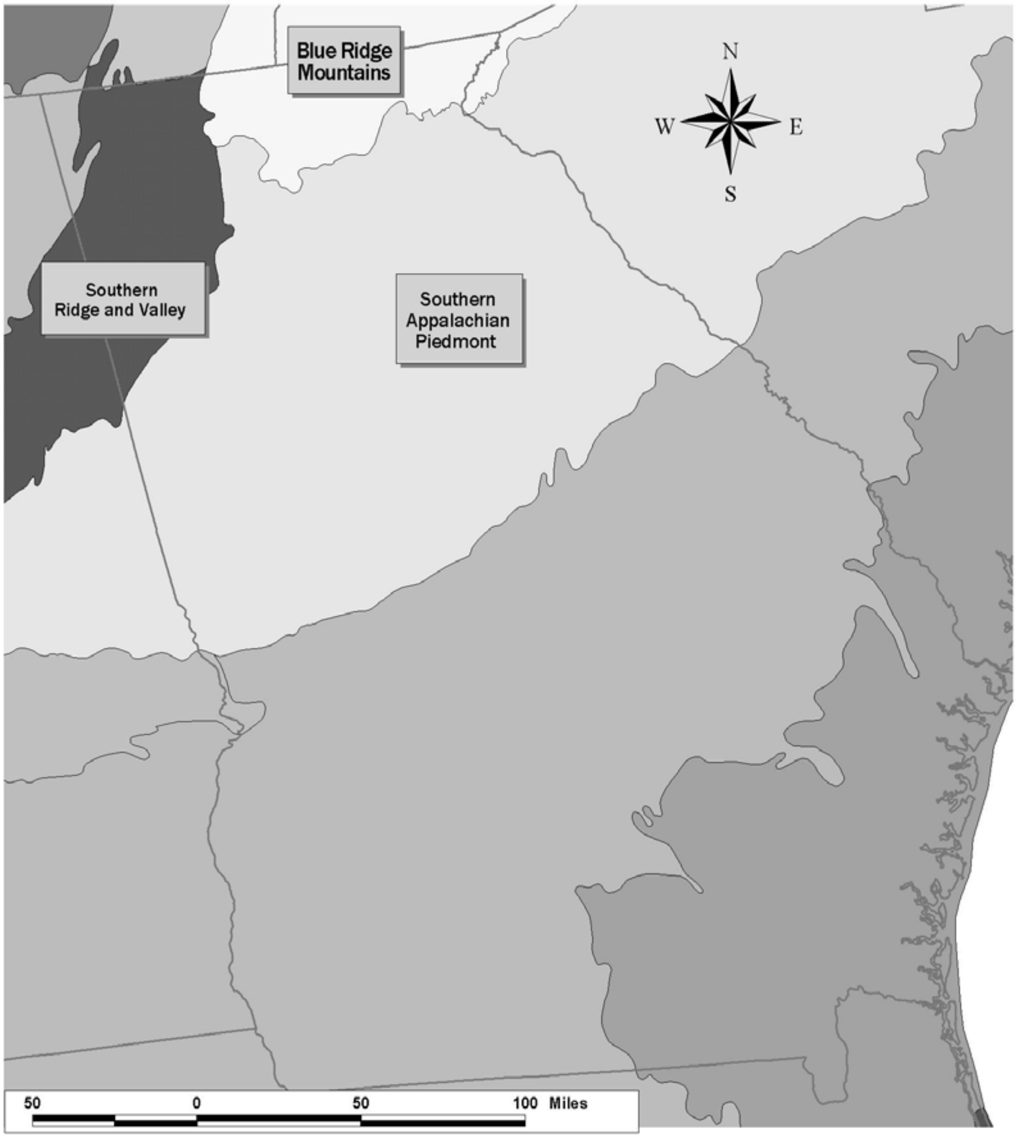

Figure B-1. Ecological Sections in Georgia Containing National Forest

Forest Types Groups (Old Growth Community Types)

Forest cover typing is critical to land stratification because the major emphasis of forest planning is forest cover. Specifically, timber is a well-defined subcategory of vegetation. No meaningful timber model could be run without characterizing vegetative cover. Tree species affect timber revenues very strongly because some species sell for relatively low prices and some for consistently high prices. Management practices used - and therefore costs - are also very strongly correlated with the biological characteristics, called 'silvics', of individual tree species. On the Chattahoochee and Oconee combined, about one hundred and fifty tree species are included within about forty-four existing forest cover types of the CISC database.

The Southern Appalachian Planners, as a group, accepted the recommendation of the team dealing with wildlife and diversity issues (FWRBE Team) to use the old growth community types of the R8 Old Growth report as the forest cover stratification (Forest Service, 1997). A document matching those communities with the included CISC forest cover types had already been developed at the Chattahoochee-Oconee Forest Supervisor's Office as part of the preparation for the validation of old growth definitions on the Chattahoochee and Oconee. In addition, each ecological Section unit had been considered separately in the development of that match.

Stratification for determining the area of each old growth community type was accomplished by querying the Revision_CISC database for those stands and their acres that are within each old growth community type. To ensure that all CISC cover types had a corresponding old growth community type, the 'forest type' datafield was queried to obtain a listing of unique forest type codes by ecological Section. Each forest type listed was then checked to see that it was related with an old growth community type. Doing this required two intermediate steps. First, each CISC forest cover type code used on each Forest was matched to its corresponding old growth community using - to the extent possible - the R8 old growth guidance. Three forest types: 09 - white pine/cove hardwood, 41 - cove hardwoods/white pine/hemlock, and 42 - upland hardwoods/white pine were not matched in the R8 report to any old growth community. Forest types 09 and 41 were assigned to old growth type # 5 - mixed mesophytic. Forest type 42 was assigned to old growth type 25 - dry and dry/mesic oak-pine. Forest types 12, 16, 32, 33, 52, 59, and 60 were matched in the R8 old growth guidance to both 'dry & dry/mesic' and 'dry & xeric' old growth communities but no criteria for making a split was given. Forest type site-index was used as the best indicator of this difference. Stands with a forest type site index of 60 or below were assigned to a 'xeric' community, with those above 60 being assigned to a 'mesic' community. Forest types 62 and 64 were split in the guidance between old growth types 13 and 27, but were assigned to old growth type 13. Once these 'rules' for matching were determined, each stand within the Revision_CISC database was attributed with an old growth community code number. This then allowed querying for old growth community type as a stratification criterion.

Table B-7. CISC Forest Cover Types Included in Each Old Growth Community Type on the Chattahoochee and Oconee National Forests.

OGTY #	Included CISC Forest Cover Type Codes with Site Index Split, if used
02	03, 04, 05, 08
05	09, 41, 50, 56
13	46, 58, 61, 62, 63, 64, 65, 71,
21	51, 52 w/ SI > 60, 53, 54, 55, 59 w/ SI > 60, 60 w/ SI > 60
22	52 w/ SI < 60, 59 w/ SI < 60, 60 w/ SI < 60
24	12 w/ SI < 60, 15, 16 w/ SI < 60, 20, 32 w/ SI < 60, 33 w/ SI < 60, 38, 39
25	10, 12 w/ SI > 60, 13, 16 w/ SI > 60, 31, 32 w/ SI > 60, 33 w/ SI > 60, 42, 44, 45, 47, 48
27	62, 64
28	72, 73, 82

Source: Chattahoochee-Oconee NF local refinement of old growth operational definitions.

Old growth community type is identified in the strata name with its two-digit number code, except that OGTY 25 is separated into two groups by identifying the predominately pine types with the addition of a “p” and the oak-pine types with the addition of an “m” for ‘mixed’.

The Revision_CISC database was attributed with an old growth type column called “OG_type.” A set of computer instructions were then written using the Statistical Analysis Software, SAS (SAS Institute Inc., Cary, NC, USA.), which filled this column for each stand regardless of age with the appropriate old growth community type number. The assignment of old growth community number was based on the forest cover type and - for forest types related to more than one old growth type - also on the forest type site index.

Once each stand had been attributed with its old growth community type, the landscape pattern of old growth communities - regardless of the current age of forest cover - could be mapped as it presently exists and also through time. In addition, tabular summaries of old growth community data could also be made. This capability laid a foundation for wildlife habitat modeling and for demonstrating response to the old growth issue.

Table B-8. Old Growth Community Types for Stage Two Timber Suitability Analysis of the Chattahoochee and Oconee NF.

Old Growth Community Number & Name	Ridge & Valley (Acres)	Blue Ridge Mts. (Acres)	Southern Appalachian Piedmont (Acres)
2 - conifer/northern hardwood	0	69,670	109
5 - mixed mesophytic & western mesophytic	1,382	130,087	5,826
13 - river floodplain hardwood forest	277	951	10,491
21 - dry/mesic oak forest	10,707	233,745	26,288
22 - dry & xeric oak forest, woodland, and savannah	6,934	35,667	384
24 - xeric pine &pine/oak forest & woodland	4,045	34,030	3,672
25 - dry & dry/mesic oak/pine forest	41,382	142,692	107,169
27 - seasonally wet oak/ hardwood woodland	0	0	3,304
28 - eastern riverfront forest	0	112	88

Source: Revision_CISC database and R8 Old Growth direction (Forest Service, 2003)

Age

Age is crucial to stage two analysis for several reasons. First, it is the basis for the timber volume present in existing stands and it’s modeling into the future. Then, as timber harvests are scheduled for those stands in the future, their yield at the time of harvest can be determined. Secondly, there is a strong correlation between tree or stand age and the type of wood products harvested. Young trees between approximately 11 and 30 years of age generally yield primarily pulpwood. Trees between approximately 31 and 60 years old generally yield primarily small or medium-sized sawtimber. Trees older than about 60 years produce primarily large sawtimber which also has higher quality than younger; i.e. smaller, sawtimber because of producing more knot-free wood. (Note, specific definitions of timber products may be found in the Timber Supply and Demand Reports for each Forest in the AMS.) Thirdly, timber yields can actually decline with very old trees because injuries or disease may remove formerly useable wood fiber; such as through rot or stem breakage, faster than growth of new wood occurs. Finally, within even-aged timber management regimes, age is the mechanism for timing the implementation of activities that produce timber yields, such as thinnings.

The age class used for stratification is that of the Southern Appalachian Assessment Terrestrial and Aquatic Issues Team. Age classes are shown in the table below.

Table B-9. Age Stratification By Old Growth Community Type

OGTY #	Early Successional (E)	Sapling/ Pole (S)	Mid Successional (M)	Late Successional (L)	Old Growth (O)
2	0-10 years	11-40 years	41-80 years	81-140 years	140+ years
5	0-10 years	11-40 years	41-80 years	81-120 years	120+ years
13	0-10 years	11-20 years	21-60 years	61-100 years	100+ years
21	0-10 years	11-40 years	41-80 years	81-130 years	130+ years
22	0-10 years	11-40 years	41-80 years	81-110 years	110+ years
24	0-10 years	11-40 years	41-80 years	81-100 years	100+ years
25	0-10 years	11-40 years	41-80 years	81-120 years	120+ years
27	0-10 years	11-20 years	21-60 years	61-100 years	100+ years
28	0-10 years	11-20 years	21-60 years	61-100 years	100+ years

Source: Southern Appalachian Assessment Terrestrial and Aquatic Issues Team.

Once these age groupings had been decided on, computer instructions were written which both created a column in the Revision_CISC data called "seral" and also filled it for each stand. The identifier for each age class was as follows: E = early successional; S = sapling/pole; M = mid-successional; L = late successional; and O = old growth. The base year used for successional class calculation was 1998.

Productivity

Even for the same tree species, different parcels of land have different capabilities to grow wood with some areas having very good growing conditions and other lands having good, fair, or poor growing conditions. On very good sites, trees meeting timber product specifications occur at a younger age, merchantable portions of the bole are longer at any given age because of more rapid height growth, and more trees can grow per unit area at all ages. Many tree species are strongly correlated with rather specific growing conditions and are said to 'prefer' (that is, occur most frequently in) particular locations. For example, southern yellow pines are typically found on dry ridgetops or slopes exposed to the sun. Stratification by forest communities helps to narrow the total range of variability in wood fiber productivity for the Forest. But since productivity is specific to the tree species involved, within communities productivity still ranges widely enough that further stratification is needed.

Within CISC data, productivity is coded for the 'management type' only, not the existing forest type. The management type is the forest cover type that is the objective of management when the stand is regenerated. It is chosen based on two primary factors: the ecological capability of the site, and the desired conditions of the Forest Plan. Often - though not always - the tree species managed for are more productive of wood fiber than the trees currently present. As a result, timber production as a function of site quality needs to be able to reflect both that of the existing forest cover and that of the regenerated forest stand. Therefore, the Revision_CISC database was edited to fill a 'forest type site index' and a 'forest type productivity' field.

The source of management type productivity is a datafield of the Revision_CISC database. Forest type productivity was generated in the planning data as a new datafield and then filled by creating a systematic relationship between the "forest type" field and the "forest type site index" field. For example, within the Blue Ridge Mountains, if the forest type is code 53 (red oak-white oak-hickory) and the forest type site index is 70; then the forest type productivity is class 5 as determined by looking in the site index and productivity class tables of the Compartment Prescription Fieldbook. Individual command statements were written to automate the data-filling step to the extent feasible, again, using SAS. The data were then reviewed to be sure each stand had a forest type productivity assigned.

Once the forest type productivity class field had been created and populated, the existing vegetation resource was stratified with this as a variable. The range of variability is from productivity class 1 through class 7, with class 1 being most productive and class 7 least productive. However, class 7 lands are of such low productivity that they meet only one of the Stage 1 criteria, and are not considered in Stage 2 analysis. Class 1 lands typically have the highest volume and a high stumpage value per acre. These factors provide wide latitude in the choice of management actions. Class 6 lands typically have low volumes and values and the range of management options are more limited. Rather than retain six productivity classes (which add greatly to the number of analysis units) the six were combined into three classes as shown in the table below.

Table B-10. Stratification of Timber Productivity Classes

Productivity Class	Growth (Cubic feet/acre/year)	Stratification Group & Designator
1	225+	High productivity - designated "H"
2	165 - 224	High productivity - designated "H"
3	120 - 164	Medium productivity - designated "M"
4	85 - 119	Medium productivity - designated "M"
5	50 - 84	Low productivity - designated "L"
6	20 - 49	Low productivity - designated "L"
7	Less than 20	N/A - coded for withdrawal in stage 1 of analysis

Source: Compartment Prescription Fieldbook, USDA Forest Service, R8 Atlanta, GA June, 1992

Computer instructions were written to create a new column in the Revision_CISC database called ‘prd_clas’ for the forest cover type productivity and also to fill it with the appropriate productivity group identifier.

Finally, the data were checked to see that each forest type or management type and site index combination had only one code and that the productivity class was the correct one. For example, forest type 53 and site index 70 may have had some stands with a productivity code 5 and some with a 6. The correct code is 5 so each code 6 stand was changed to code 5. In both cases the productivity class was “M” for ‘medium’.

As analysis proceeded, it became increasingly clear that productivity as a stratification variable was adding an enormous amount of complexity to the SPECTRUM model building and complicating growth and yield simulations. Selecting for growth and yield tree data with selection criteria for specific productivities often resulted in too few plots to have a good average value. Using three categories of productivity tripled the number of analysis units and correspondingly decreased the acreage of each. The variable of productivity was therefore dropped from stratification in the SPECRUM analysis areas.

Stand condition

An important variable to timber growth and yield is the density of tree stems per unit area, or stocking. Because of the past land use history of National Forest - and of the Chattahoochee especially - tree density is highly variable. Lands acquired in a logged-over and burned condition in the 1920’s and 1930’s were extremely variable in the number and quality of residual stems at the time of acquisition. Some stands were well stocked but were damaged by fire, grazing, or logging. Some were poorly stocked and also damaged. Even though ingrowth of new, well-formed, and undamaged stems occurred over time following fire and stock exclusion; these lands should not receive a thinning prescription because they are not dense enough to need one silviculturally, do not have enough value to make a silviculturally-correct thinning harvest economically viable, thinning could result in unacceptable stand damage, or some combination of each of these. This situation necessitated including some consideration of tree stocking in the stratification so that thinnings would not be inappropriately prescribed or thinning yields modeled.

The CISC variable, which reflects consideration of existing stocking in comparison to optimal stocking is ‘stand condition.’ Although stand condition class coding is not limited to consideration of stocking only (it actually includes stocking, age, and tree quality considered together), it is a reliable index of stocking. How much land could be involved was tested using the ‘working CISC’ database by querying the data for forest type, acres, grouped stand conditions, minimum basal area, maximum basal area, and average basal area. Stand conditions of *sparse*, *low-quality*, or *damaged* were grouped into one class as not being expected to support a thinning. In addition, since all stands do not have basal area numbers, the acreage of stands having basal area figures was compared to all acres of each uniquely defined combination. The result of this test was to show that although the stand or stands of maximum basal area could perhaps support a thinning, the average basal area was always too low. Also, the smallest sample was 10 percent of the acreage of sparse, low quality, or damaged stands having basal area figures with some being much higher. Together these results confirmed that stand condition could be used as a reliable indicator of which stands should not receive a thinning prescription.

Computer instructions were used to create a new column called "stock" (short for 'stocking' which is a measure of tree density compared to a standard of full occupancy of that site by that species at that age). This column was then filled with one of two values: "0" for 'no thinning' and "1" for 'thinning' for each stand. The stand condition data field in CISC has seventeen possible codes. These codes, their name, the stratification group code assigned, and its significance in the analysis are shown in the table below.

Table B-11. CISC Stand Condition Class Codes and Their Stratification Grouping.

CISC Condition Class Code & Name	Strat. Code	Meaning in Analysis
02 - damaged poletimber	N	no thinning
03 - damaged sawtimber	N	no thinning
04 - forest pest infestation	N	no thinning
05 - sparse poletimber	N	no thinning
06 - sparse sawtimber	N	no thinning
07 - low quality poletimber	N	no thinning
08 - low quality sawtimber	N	no thinning
09 - mature poletimber	N	no thinning
10 - mature sawtimber	Y	no constraint on method of cut
11 - immature poletimber	Y	no constraint on method of cut
12 - immature sawtimber	Y	no constraint on method of cut
13 - seedlings/saplings adequately stocked	Y	no constraint on method of cut
14 - seedlings/saplings inadequately stocked	Y	no thinning
15 - non-stocked	Y	no thinning
16 - group selection management	Y	no constraint on method of cut
17 - individual-tree selection management	Y	no constraint on method of cut

Condition classes 02, 03, 04, 05, 06, 07, 08, and 09 - the sparse, low-quality, or damaged conditions are called 'Poor Stock' and coded with an 'N' in the strata name to show that it should not receive a thinning prescription. The second is all other classes, called 'Well Stock' and coded with a 'Y' in the strata name to show that it could receive a thinning prescription. Within Presuppose, the variable used to make this division initially was "growing stock stocking" and the values used were >66 percent for 'well stocked' and <66 percent for 'poor stock'. The definition of 'growing stock' is as follows:

growing stock - live trees of commercial species qualifying as desireable or acceptable trees.

desireable trees - growing stock trees of commercial species having no serious defects in quality limiting present or prospective use for timber products, of relatively high vigor, and containing no pathogens that may result in death or serious deterioration before rotation age.

acceptable trees - growing stock trees of commercial species that meet specified standards of size and quality, but not qualifying as desireable trees. (USDA Forest Service, 1985. Field Instructions for the Southeast. Forest Inventory and Analysis Work Unit, Southeastern Forest Experiment Station, Asheville, NC.)

Considerable difficulty was encountered in selecting plots to represent stand conditions when including stocking as a variable. In plot selection, the variable that was available was basal area. In attempting to select for stocking while keeping basal area value ranges discrete; i.e. without overlap, the same result as with including productivity occurred, namely fewer plots available. As overlap increased, the value of even having the stratification decreased.

As analysis proceeded, it became evident that stocking as a stratification variable was not adding much to the analysis. The decision was made to not use stocking as a stratification variable. The practical effect of this was that some stands would be thinned and some would not, just as occurs in actuality. Since yields are output as average volumes per acre, with 'acres' being the total acres represented by the input plot set, the average yield per acre was depressed by those acres not thinned. To put it another way, the yields per acre are representative of the entire strata, but are an underestimate of volumes from individual harvested acres or individual harvested stands.

Preliminary Stratification Units

Once the Revision_CISC database had been edited such that the 'tentatively suitable' acres could be identified by land class or suitability code and each of the other needed stratification attributes had been added; it was queried for a report showing the sum of the acres and number of stands for each ecological section, old growth community type, sucessional stage (seral class), productivity class group, and stocking group combinations. That is, each unique combination of each of these variables resulted in one line of output. This preliminary stratification was to identify the units of land to which timber prescriptions would be applied and timber yield would be modeled in the growth and yield simulator. Consideration of slope and access were deliberately deferred until later. The report was reviewed manually to see if each stratification variable was really important to maintain or if acres could be aggregated into fewer units. Similar units were aggregated to eliminate minor acreages using several guidelines. These guidelines were based on professional judgment developed through experience. These guidelines were:

(1) combine within ecological Section,
(2) combine within old growth type if possible,
(3) aggregate to at least 100 acres. Later, during actual SPECTRUM modeling, units of 20 acres or greater were used because approximaterly 20 acres is the average stand size.
(4) a smaller unit could be combined with a larger one if it were less than 20 percent of the resultant combined acreage.

Individual units defined by the manual review of the Revision_CISC report were identified with a seven-place strata name showing in order from left to right the stratification criteria that resulted in the selection of those acres. For example, strata B02MHN means Blue Ridge Mountains ecological section, old growth type 02, Mid-successional age class, High productivity group, and No thinning (poor stock). Where two sucessional classes or productivity groups were combined because of having very few acres, the appropriate place was coded with a “C” for ‘combined’. If all three productivity groups or both stocking classes were combined, the appropriate place was coded with an “A” meaning ‘all.’

A variation on this coding was introduced for old growth type 25, which includes pine, pine-hardwood, and hardwood-pine types. To make the model more sensitive to mixed types, which cover a significant proportion of Chattahoochee acreage and which were judged to become more important in alternatives considered in detail, a modifier of ‘m‘ for ‘mixed’ or ‘p’ for ‘pine’ was added after the old growth type number in the strata name. The ‘mixed’ forest types were the hardwood-pine (CISC forest types 44, 45, 47, and 48). All others in old growth type 25 were put in the ‘p’ group.

As stratification proceeded, it became more and more evident that Virginia pine needed to be broken out of old growth types 24 and 25 as separate strata. There were many reasons. Virginia pine is a significant part of forest composition on the Armuchee District and on localized areas within the Cohutta and Chattooga Districts. It has very different physiological characteristics and ecological function that create the need for different prescriptions for it compared to other yellow pines. It is physiologically mature much earlier than other yellow pines. It has a much lower value than other yellow pines. It is a cover type whose current prevalence is largely due to past land use and is therefore a prime candidate to be restored to other vegetation communities. Its susceptibility to insect, disease, and weather mortality is generally greater than other yellow pines. Accordingly, Virginia pine was separated out for the Blue Ridge and the Ridge and Valley. (Only one small-planted stand of Virginia pine exists on the Oconee.)

GROWTH AND YIELD MODELING (FOREST VEGETATION SIMULATOR)

Representing Timber Analysis Units with Growth and Yield Input Data

Once timber analysis strata had been developed, the ability to predict existing timber volume and model timber growth into the future was needed. Within the chosen growth and yield model, there are three basic pieces of input needed for predicting timber volume present per unit area. They are (1) a tree species list, (2) the dbh of each tree, and (3) the location of the stand being simulated. CISC cannot provide this input.

The Regional Office; the Forest Management Service Center in Fort Collins, Colorado; and the Southern Appalachian Forests in revision jointly chose to build a systematic relationship between the Forest Inventory and Analysis (FIA) plots and their tree data and the CISC stand data. (Those relationships have already been described in the "Land Stratification" portion of this appendix.) This choice was based on: (1) the need for the chosen growth and yield model to have a 'tree list' with species and dbh, such as that provided by FIA plot data, as input; (2) the established expertise, consistent data definitions, well-established procedures, and high-quality standards of the FIA group in collecting inventory information; (3) the large scale covered by FIA, including other ownerships; (4) currency of data (published in 1989 for Georgia); and (5) the fact that FIA data were used to develop the chosen growth and yield model.

The first part of building the relationship was to stratify each of FIA plots and CISC stands by common criteria. These criteria were ecological unit, forest cover type groups, site index (productivity), and age. This initial stratification was tested by Barry Lilly of the Forest Management Service Center in Fort Collins to see how many FIA plots would occur in each stratum. 'Suppose-ready' FIA data were prepared by the Forest Management Staff at Fort Collins. These data made available for download from a website. Plots for each state in the Southeast and each ecological Section within each state were made available as separate files. For the Chattahoochee-Oconee model, plots for the Ridge and Valley of Alabama; the Blue Ridge, Piedmont, and Ridge and Valley of Georgia; the Blue Ridge of Tennessee; the Blue Ridge and Piedmont of South Carolina; and the Blue Ridge of North Carolina were downloaded.

Once the selection criteria of Revision_CISC and the FIA plots were the same, the FIA plot data would then represent the conditions of that timber analysis unit. That is, FIA plot data would be 'imputed' to the CISC stratification units, even though there might be few or even no FIA plots on those National Forest acres. The key was to get a close match between FIA data and CISC data so as to get representative conditions for the stratum, not the conditions at a specific National Forest acre.

The tool to get a match between selection criteria was 'PreSuppose,' a program developed by Don Vandendreische of the Fort Collins, CO Forest Management Service Center. PreSuppose allows the user to select plots from the available dataset using the same general selection criteria which were used to get the original land stratification report from the Revision_CISC database. That is, plots were selected for ecological Section, each included forest type in each old growth community type, age (successional) class, productivity class, and 'growing stock stocking'. For timber growth and yield input, a crosswalk between FIA plot cover types and CISC cover types had to be developed interactively with Fort Collins because FIA does not use cover type codes which are exactly the same as CISC codes. The primary reason for this is that FIA describes forest cover at a very large scale of survey units of several counties while CISC describes it at very small scale of stands and is much more refined. Important points included: (1) agreement among Forests on the FIA-to-CISC match, and (2) all existing CISC and FIA cover types accounted for in the FIA-to-CISC match. Fort Collins staff attributed FIA plot data with a 'CISC Forest Type' code field which permitted plot selection matched to CISC cover types.

During an initial testing phase, available plot data were queried using the selection criteria both for plots on National Forest only, and plots regardless of ownership. In most cases, ownership was not used as a criterion to limit plots to National Forest only, as the most common problem was to have few plots to represent each stratum. This problem usually stemmed from the relatively advanced age of National Forest tree cover comnpared to other ownerships. But in some cases where there were many available plots, only National Forest plots were selected. A summary file named "presuppose.out" (produced by PreSuppose) echoed the plot selection criteria for each stratum, showed the number of plots selected, and calculated statistical measures for the selected plots. Another file, called "presuppose.val," showed details of the individual selected plots. Each of these files were manually re-named with the strata name to (a) protect them from being overwritten, (b) provide a tool to review the included plots in each strata, and (c) provide a record for future understanding as analysis proceeds. These files were also moved to a folder identified by the strata name in order to have all the information about a stratum in one place. As a result of the data-availability check, the reviewed preliminary stratification units were further aggregated because some units either had no plots to represent them or had very few.

During this time, the Pre-Suppose program was being improved to make it possible to use more variables. Also, as skill grew in understanding and interpreting the outputs, it was clear that for the purpose of timber modeling, the statistical measure of greatest interest was the accuracy of the board foot per acre volume estimate. Once attention centered on this, it was seen that the standard error of this estimate varied very widely, quite apart from the number of acres represented by each plot in each stratum. A target standard error of 20 percent was chosen as being appropriate to a strategic planning level. Presuppose plot selections were re-run, reviewed, refined, and run again for stratum having a standard error greater than 20 percent until the standard error was either below 20 percent or it was clear that available data would not allow that precision.

As planning progressed, the SETWIGS model was replaced by a Southern 'variant', which included all States of the Southeast. Support for the SETWIGS model was withdrawn by the Fort Collins staff in favor of the wider application and enhanced capabilities of the Southern variant. All Forests in revision switched from SETWIGS to using the Southern, or “SN” variant.

In July 2001, Erika Mavity, the Forest analyst, and Ron Stephens, the Forest Silviculturist, visited Fort Collins and worked with both the SPECTRUM support staff and the FVS support staff to begin the SPECTRUM modeling effort. It soon became apparent that using the stratification as originally envisioned would require over 26,000 yield files. The decision was made to drop both the productivity and stand condition variables. While yield will vary with site quality, most National Forest land is of average quality and, in addition, the variation is not large (approximately plus or minus 20%) and is not critical to a well-informed strategic decision. Project planning after the plan can easily include that degree of refinement. In fact, that approach maintains the correct relationship between Plan and project - namely that projects use more detailed information for a high-quality, localized decision. It also turned out that the stand condition variable was dealt with very well in that the plots selected included both well-stocked and poorly-stocked stands. The average of them was thus a good estimate of ‘average’ (that is, stratum) conditions.

Activities (Silvicultural Prescriptions)

The next step was to evaluate the strata for the set of silvicultural activities that would be applied to each. (Each unique set is called a ‘prescription’.) Silvicultural activities at stage two modeling are directed at two primary purposes: (a) ensuring regeneration of the stands in a stratum, and (b) improving growth and therefore timber yield.

For stage two modeling in SPECTRUM, growth and yield modeling in the Southern Variant needed to be done only for those strata receiving a thinning or a cultural treatment which would change growth and therefore yields. Neither regeneration cut yields nor uneven-aged management regimes (i. e., group and single tree selection) are modeled in FVS because their yields are calculated in SPECTRUM as a percentage of the volume available at the time the regeneration cut takes place. The total volume per acre available within each stratum is calculated by simply allowing FVS to ‘grow’ stands through time and report the volume per acre at regular intervals. We called these the ‘grow runs.’ In general, those strata appropriate for a thinning prescription were everything but the ‘O,’ or potential old growth, strata.

After many different attempts over many months to develop thinning prescriptions, a straightforward process emerged. For each old growth community type, a ‘master’ keyword component file (.kcp) was developed. This file directed the FVS model to thin to a residual basal area (RBA) at a specific age and subject to a minimum harvest constraint; that is; no harvest occurred if the minimum volume per acre could not be met. A separate statement in the master file was created for each decade beginning at age 20; that is, there was a thinning statement for age 20, 30, 40, 50, 60, etc. Within FVS, these statements were structured to show up on screen individually, even though they occurred in a single file. The last thinning statement was at the minimum old growth age for that old growth type. The residual basal areas (RBA) were taken, when available, from the “Leave Basal Area’ tables of the R8

Compartment Prescription FIELDBOOK 7/92. Where no RBA table was provided – such as for mixed stands – RBAs were calculated by proportioning the hardwood and pine using the average percent composition values in the forest type definition. For example; forest type 45 chestnut oak-scarlet oak-yellow pine, is defined as having from 51 through 69 percent of the dominant and co-dominant trees as hardwoods with the chestnut oak and scarlet oak the most prevalent. The remaining 31 to 49 percent is one of the southern yellow pines. These were simplified to a 60 percent hardwood and a 40 percent pine composition. RBA was then calculated as 60 percent of the upland oak RBA for any specific age and using moderate site quality plus 40 percent of the RBA for yellow pine at the same age and moderate site quality. This step was not done with a great deal of mathematical precision. Calculated RBAs were rounded up or down to the nearest whole 10 using professional judgment.

In simulating thinning regimes, the 'master' .kcp file was added into to the simulation (the 'insert from file' option). Once it was included, each timing choice was shown on screen and combinations could be selected. For specific regimes; for example, three total thinnings with one occurring at each of the ages 40, 60, and 80; both an even-decade choice and an odd-decade choice, were simulated. In the previous example, there was a 40, 60, and 80 timing choice and a 50, 70, and 90 timing choice. This was to give SPECTRUM the widest possible range of choice in scheduling any prescription.

A large set of FVS simulations were developed and run, covering every reasonable combination of thinnings. The range was from three thinnings in the existing stand, such as for an existing pine plantation of less than twenty years old, up to three thinnings in the regenerated stand and all the variations on this pattern. That is, from twelve to fifteen simulations were run for some strata. The strategy was to make too many runs if anything because it would be easier not to use them later than to go back and run new combinations if they were needed. Even as these were being run, it was clear that thinning events built into the run were not occuring because constraints for minimum harvest amount or leave basal areas were not being met. So the effective simulation set was smaller than the processed set. It later became apparent that the number of yield tables was excessive still to cover a reasonable range of options. The number of prescriptions made available to the SPECTRUM model was further reduced. The prescriptions modeled in SPECTRUM are shown below.

Table B-12.- Harvest Options Used in the SPECTRUM Model.

Description of Harvest Options in SPECTRUM Model
Harvest with No thinning.
Harvest with No thinning in existing stand but one thin in the regenerated stand.
Harvest with No thinning in existing stand but three thinnings in the regenerated stand.
Harvest with one thin in existing stand and in the regenerated stand.
Harvest with three thinnings in existing stand and in the regenerated stand.
No harvest of any type -grow only.
Shelterwood Harvest with a portion removed and then the residual removed two decades later.
Shelterwood Harvest with a portion removed and then the residual left standing (used in RCW habitats).
Uneven aged management with 20% removed every two decades.

Source: SPECTRUM model data October 2003.

Guidelines for FVS Simulations

Before growth and yield modeling simulations were written, guidelines to be used were developed. These guidelines were developed in order to; (1) ensure consistency if more than one person developed prescriptions, (2) reduce the workload by elimination of some physically or biologically infeasible prescriptions early, and (3) focus internal review and comment into specific areas needing attention. To help achieve this final objective, the proposed rules were circulated to sister Forests also in revision.

The following guidelines were used in developing the gowth and yield simulations. Also, as explained in more detail later, separate FVS runs were not made for uneven-aged harvest, shelterwood, or seedtree.

1. The same or comparable strata will have the same prescription regardless of ecological Section. For growth and yield, only one simulation per old growth community type or its subdivisions was developed, then run for each ecological section.

2. Initial stage two prescriptions will be classic, straightforward silviculture without mitigations such as required reserve trees to respond to either the issues of the 1985 Plan or the current Plan revision issues.

3. Any harvest prescribed will meet the following minimum harvest volumes by ecological Section and product:
    - Blue Ridge Mountains: Roundwood only 3 CCF/ac; Sawtimber: 2MBF/ac
    - Ridge and Valley: Roundwood only 2 CCF/ac; Sawtimber: 1.5 MBF/ac
    - Piedmont: Roundwood only 2 CCF/ac; Sawtimber: 1.5 MBF/ac

In the FVS runs, a 'MINHARV' constraint was included such that even if other parameters were met, no harvest occurred unless the volume was great enough to be economically feasible.

4. Thinning of eligible stands will use the thinning guides of the R8 Silvicultural Exam and Prescription FIELD BOOK, but leave basal areas may be averaged across productivities, ages, or old growth types as needed to match stratifications and/or reduce the growth and yield modeling workload.

5. Thinnings will not be so heavy as to result in a stand not returning to normal stocking (as measured by average basal area in Suppose outputs) by the 10th year after the thinning compared to the basal areas shown in published guides.

Description of Old Growth Community Types

The old growth community types found to be applicable to the Forests and used as the basis for growth and yield modeling are each identified and described in following paragraphs. Note that where percentages of acreage are shown, the acreage basis is not always the same. For example, it may be either 'all forested acres' or 'tentatively-suitable acres.' The purpose of these descriptions is simply to provide a brief overview of the community as a context for writing and understanding prescriptions. A first draft of these descriptions was shared with District silviculturists and timber modelers on sister Forests in revision via electronic mail. They were invited to make comments and the comments received have been edited into these descriptions.

Old Growth Type 02 - conifer/northern hardwoods

Description - This community type occurs almost exclusively in the Southern Blue Ridge Mountains ecological Section unit where it is about 8 percent of all forested acres. An exception to this generality is 109 acres in the Southern Appalachian Piedmont Section of the Chattooga District. The included forest cover types is 03 - white pine. (Note that forest type 09 - white pine/cove hardwood and forest type 41 - cove hardwoods/white pine/hemlock were unassigned in the R8 old growth report and have been assigned on the Chattahoochee to old growth type 05.) In the white pine cover type on the Chattahoochee, hardwood associates are not usually 'northern hardwoods' but rather upland oaks. White pine is associated with a wide range of sites but is most abundant on uplands between about 1,800 and 3,500 feet elevation. Above 3,500 feet, white pine is usually less than half of the stocking in the stands where it occurs, being intermingled with a predominately oak cover. White pine is considered tolerant in youth but intolerant with increasing age. Typical reproductive strategy of white pine is the slow development and persistence of seedlings in the understory of hardwoods until released by partial or full removal of the overstory canopy. For this strategy to be successful, fire must be absent, or at most, infrequent and of low intensity since white pine is very susceptible to fire mortality, especially as seedlings and saplings, and does not re-sprout.

Using Georgia Blue Ridge plots only, calculated sawtimber CMAI by FVS is 70 years. At a site index of 80 or above, white pine produces more timber volume than any other species.

Old Growth Community Type 05 - Mixed Mesophytic and Western Mesophytic Forest

Description - Forest cover types included in this community type occur in the Southern Ridge and Valley Section, the Southern Blue Ridge Mountains Section, and the Southern Appalachian Piedmont Section. However, not all included cover types are present in each section. Included forest cover types are: 04 – eastern white pine/eastern hemlock, 05 – hemlock, 08 – eastern hemlock/hardwood, 09 - white pine/cove hardwood (Southern Blue Ridge only), 41 - cove hardwoods/white pine/hemlock (Southern Blue Ridge only), 50 - yellow poplar (all Sections), and 56 - yellow poplar/white oak/northern red oak (all Sections). Area involved as a percent of all forested acres is: 20 percent of the Southern Blue Ridge, 2 percent of the Southern Ridge and Valley, and 3 percent of the Southern Appalachian Piedmont. Each cover type is usually associated with cool, moist, sheltered slopes and 'coves.' Type 41 especially is associated with riparian areas and is probably most frequent north of the Blue Ridge Divide crest in the mountain interior. Hemlock is strongly associated with narrow and linear riparian areas (refugia from past burning) where it is most frequent. It is also found on cool slopes and mountain crests above 3,500 feet elevation. Tolerance of included species varies widely, from very tolerant for hemlock to very intolerant for yellow poplar. Reproductive strategy also varies widely within the community; from abundant seed production and long-term soil storage with rapid growth of yellow poplar following canopy removal, through persistent die-back and re-sprouting of oak under moderate disturbance regimes, to slow development of white pine and hemlock seedlings in shade with little or no disturbance until released by breaks in the main canopy. Fires are infrequent and generally low in heat release due to normally high fuel moistures except in severe drought situations. Overall, this community is adaptable to a wide range of disturbance regimes, though species composition shifts do occur along the disturbance continuum with yellow poplar most favored by intense disturbance and hemlock most favored by low disturbance. Canopy removal without adequate oak advance regeneration in place shifts composition away from the oaks.

Using Georgia plots only, calculated sawtimber CMAI in FVS is 100 years in the Blue Ridge Mountains, 60 years in the Southern Ridge and Valley, and 75 years in the Southern Appalachian Piedmont.

Old Growth Type 13 - River Floodplain Hardwood Forest

Description - This community type occurs in all three ecological Sections of the Forests, but is very limited in the Southern Blue Ridge and Southern Ridge and Valley Sections where only three forest cover types are included: 46 - bottomland hardwood/yellow pine, 58 - sweetgum/yellow poplar, and 71 - black ash/American elm/red maple. Each of these three types is associated with riparian areas. In the Blue Ridge, the acreage of all three of these types is less than 1 percent of all forested acres. In the Southern Ridge and Valley only type 58 occurs, but it is less than 0.1 percent of all forested acres. In the Southern Appalachian Piedmont, included forest types are: 46 - bottomland hardwood/yellow pine, 58 - sweetgum/yellow poplar, 61 - swamp chestnut oak/cherrybark oak, 62 - sweetgum/nuttall oak/willow oak, 63 - sugarberry/American elm/green ash, 64 - laurel oak/willow oak, 65 - overdcup oak/water hickory. Together these types occur on 11 percent of all forested acres. Tolerance of species ranges widely, from very tolerant for red maple to very intolerant for yellow pine, but the majority of species are intolerant. This community is adapted to flooding as a natural disturbance. None of these types occur on terrain limited to cable because of slope.

CMAI was not calculated for this community, but may be estimated to be similar to cove hardwoods, which was reported as being 50 years. Within Georgia, only the Southern Appalachian Piedmont has enough FIA plots in this old growth community to calculate a sawtimber CMAI in FVS. There it is 75 years. This same age was applied in the other ecological Sections.

Old Growth Types 13, 27, & 28 - River Floodplain Hardwood Forest, Seasonally Wet Oak-Hardwood Woodland, and Eastern Riverfront Forest.

Note - Due to the small acreage of this old growth type and the lack of leave basal area guides, the thinning prescription for Appalachian mixed mesophytic hardwood with moderate site quality was used.

In later SPECTRUM runs, this old growth type was removed from having harvest for the Blue Ridge and the Southern Ridge and Valley, because it is such a small acreage, is a riparian type and the riparian prescription is unsuitable, and it is more important for other purposes.

Old Growth Type 21 - Dry/Mesic Oak Forest

Description - This community is one of the most common and occurs in all three ecological Sections of the Forests, typically on somewhat sheltered slopes at all elevations and on mountain crests above about 3,500 feet. As stratified for the Chattahoochee and Oconee, included forest types are: Type 51 - post oak/black oak, Type 52 - chestnut oak with site index > 60, Type 53 - red oak/white oak/hickory, Type 54 - white oak, Type 55 - northern red oak, Type 59 - scarlet oak with site index > 60, Type 60 - chestnut oak/scarlet oak with site index > 60. In the Southern Ridge and Valley, it occupies about 17 percent of the total Armuchee RD acreage. In the Southern Blue Ridge it occupies 33 percent of the Toccoa RD; 56 percent of the Brasstown RD; 28 percent of the Tallulah RD; 26 percent of the Chattooga RD; and 22 percent of the Cohutta RD. Species included are the oaks, and are all intolerant to moderately tolerant. There are two typical reproductive strategies: (1) abundant and persistent stump sprouting following topkill, and (2) the development from seed of advance oak reproduction under low to moderate disturbance until a major disturbance releases it to grow. Each of these strategies is dependent upon well-established root systems with starchy reserves to fuel rapid height growth to keep pace with competition. Productivity is commonly low to moderate with most acreage being productivity class 4 or 5. This type occurs on all slope classes.

Using Georgia FIA plots only, the Blue Ridge Mountains had an inadequate number of plots meeting selection criteria. For each of the Southern Ridge and Valley and Southern Appalachian Piedmont, sawtimber CMAI calculated by FVS is 90 years.

Old Growth Type 22 - Dry and Xeric Oak Forest, Woodland, and Savannah

<u>Description</u> - This community type is somewhat similar to type 21, but differs in that it occurs on sites with more exposed, droughty, and shallow soils. It occurs only in the Southern Blue Ridge and the Southern Ridge and Valley, usually on ridge crests and south or west-facing slopes. As stratified on the Chattahoochee, included forest type acreage is: type 52 - chestnut oak with site index <= 60, type 59 - scarlet oak with site index <= 60, and type 60 - scarlet oak/chestnut oak with site index <= 60. About 11 percent of the total Armuchee RD acreage is in this type. Within the Southern Blue Ridge the percent by Ranger District of total District acres is as follows: Toccoa RD, 11 percent; Brasstown RD, 3 percent; Tallulah RD, 8 percent; Chattooga RD, 8 percent; and Cohutta RD, 4 percent. Both chestnut oak and scarlet oak are considered intolerant among the oaks. Typical regeneration strategy is the continual maintenance of sapling and pole-sized reproduction in the understory or midstory and vigorous stump sprouting following major disturbance which topkills the oaks, such as fire. Burial of nuts by blue jays and squirrels accounts for some seedling reproduction. Well established root systems with reserves of starch are needed by oak regeneration to compete successfully with other hardwoods but the low available moisture acts to reduce competition in comparison to more moist sites. Moderate to heavy periodic disturbance is then needed to permit the continued development of sprouts or seedlings into the main canopy, such as naturally occurs relatively frequently on these sites with fire, blow-down, oak decline, drought, or insect defoliators acting singly or in combination. Productivities are typically low for oak (productivity classes 5 and 6) and can be increased by conversion to white or yellow pine.

Using Georgia FIA plots only, there were sufficient plots for FVS to calculate a sawtimber CMAI only in the Southern Appalachian Piedmont were it is 70 years. This figure was used for the other Sections as well.

Old Growth Type 24 - Xeric Pine and Pine-Oak Forest and Woodland

Description - This community type occurs in all three ecological sections, but is least common in the Southern Appalachian Piedmont where it is associated with granitic geology. Like the xeric oak community, typical occurrence is on the exposed, droughty, and shallow soils of ridge crests and south or west-facing slopes. Included forest cover types are: type 12 - shortleaf pine/oak with site index <= 60, type 15 - pitch pine/oak, type 16 - Virginia pine/oak with site index <= 60, type 20 - Table Mountain pine/hardwoods, type 32 = shortleaf pine with site index <= 60, type 33 - Virginia pine with site index <= 60, type 38 - pitch pine; and type 39 - Table Mountain pine. Percent of tentatively suitable acres by District for this community are as follows: Armuchee, 6 percent, Toccoa, 2 percent, Brasstown, 1 percent, Tallulah, 13 percent, Chattooga, 9 percent, and Cohutta, 4 percent. Species are typically intolerant, and the major reproductive strategy is abundant seedling reproduction following major disturbance such as windstorm, especially when coupled with periodic low- to moderate-intensity fire to reduce tolerant understory competition which would shade pine seedlings and also reduce the depth of the litter layer. Protection from fire permits encroachment of hardwood understories and the buildup of hardwood leaf litter which together greatly reduce the establishment of pine seedling reproduction. As juveniles, both pitch and shortleaf pines resprout from the groundline following topkill by fire and as a result can build up seedling numbers over a period of years even if topkilled repeatedly. Another variation is that both pitch and Table Mountain pine hold viable seed in their cones for extended periods and the cones open in response to heat (especially of ground fires) and drop seed into a seedbed with reduced litter depth and available nutrients from the ash. Productivities are typically moderate or low. All slope classes are represented.

Using Georgia plots only, calculated sawtimber CMAI in FVS was 60 years in the Blue Ridge Mountains and 70 years in each of the Southern Ridge and Valley and Southern Appalachian Piedmont.

Old Growth Type 25 - Dry and Dry/Mesic Oak-Pine Forest

Description - This type can be considered as intermediate between community Type 21 - Dry/Mesic Oak and Type 24 - Xeric Pine and Pine-Oak Forest. It occurs in all three ecological Sections and is one of the more common old growth community types. Included forest cover types are shown in the table below.

Table B-13. Forest Cover Types Included in Old Growth Community Type 25 - Dry and Dry/Mesic Oak-Pine Forest.

Forest Type Number	Forest Type Description & Qualifier
31	Loblolly pine
32	Shortleaf pine with site index > 60
33	Virginia pine with site index > 60
10	White pine- upland hardwood
12	Shortleaf pine-oak with site index > 60
13	Loblolly pine-oak
16	Virginia pine-oak with site index > 60
42	Upland hardwood-white pine
44	Southern red oak-yellow pine
45	Chestnut oak-scarlet oak-yellow pine
47	White oak-black oak-yellow pine
48	Northern red oak-hickory-yellow pine

Percents of the tentatively suitable lands in this old growth community by District are as follows: Armuchee, 64 percent; Toccoa, 38 percent; Brasstown, 21 percent; Tallulah, 25 percent; Chattooga, 45 percent; and Cohutta, 46 percent. Occurrence is on sites with moderate productivity for oak (productivity classes 4 and 5) such as the lower third of long south or west-facing slopes, upper third of southeast or northwest slopes, or broad ridge tops with little distinct aspect. The oak species are moderately tolerant and the pine species - except for white pine - are intolerant. Typical reproduction strategy is maintenance of a high stump-sprouting capability by the oaks and seedling regeneration by the pines within a regime of frequent light disturbance (such as fire) coupled with periodic intense disturbance (such as severe fire or blow-down). Well established root systems with reserves of starch are needed by oak regeneration to compete successfully with other hardwoods. Natural regeneration of the yellow pines is dependent upon seed-producing parent trees, exposure of mineral soil or a reduced depth of the litter layer compared to undisturbed equilibrium conditions, and a hardwood competition suppression mechanism or mechanisms. Fire is the most effective naturally occurring mechanism for reducing the litter layer and controlling hardwoods. Without human intervention, species composition can be expected to vary through time on individual sites depending upon the type, timing, and intensity of the last series of events that resulted in stand regeneration. Single catastrophic events which merely remove the overstory, such as southern pine beetle attacks, are unlikely to result in adequate pine regeneration to maintain pine cover types over long periods of time because hardwood competition control is absent, pine seed source is greatly reduced or eliminated, and no seedbed preparation occurs. Under these conditions, pine types shift toward dry or xeric site oak species.

As calculated by FVS - using Georgia plots only – sawtimber CMAI in both Blue Ridge and Southern Ridge and Valley is 60, but is 65 in the Southern Appalachian Piedmont.

Silvicultural Prescriptions - Since pine, pine-oak, and oak-pine types are all within this old growth community, developing basic prescriptions is made more difficult because of the biological variation among them. The type of prescription being applied also depends upon whether the objective is to maintain the existing forest cover or replace it. So a three-way split in the stratification was introduced for old growth type 25 as follows:

- The 'mixed' forest types (CISC forest types 44, 45, 47, and 48) were split out from the other forest types and identified in the strata name with a lower case "m." This was done to make the model more sensitive to mixed types, which cover a significant proportion of Chattahoochee acreage and were judged to become more important in alternatives considered in detail.
- Except for Virginia pine, all others in old growth type 25 were put in 'pine' group identified in the strata name with a lower case "p".
- Virginia pine was separated out from the larger 'pine' group and identified with a lower case "v" in the strata name.

Prescriptions for the mixed types then become the same as for old growth type 21 and prescriptions for the pine types become the same as for old growth type 24.

Old Growth Type 27 - Seasonally Wet Oak-Hardwood Woodland

Description - This community type may occur on the Oconee NF in the Southern Appalachian Piedmont Section. Specifically, the "Monticello Bottomland Hardwoods" and the "Gladesville Glades" areas are good examples of this community. Each of these areas is a rare community and is currently withdrawn from timber management. For modeling purposes at stage two only, these areas should be considered as being the same as old growth community type 13, as they share the same forest types that exist on the Oconee.

Prescriptions - Prescriptions are the same as for Old Growth Type 13.

Old Growth Type 28 - Eastern Riverfront Forest

Description - This community is mapped as occurring only on the Chattahoochee and is extremely limited in acreage. Included forest types are: 72 - river birch/sycamore, 73 - cottonwood, and 82 - black walnut. Acreage of the tentatively suitable land base by District is as follows: Brasstown, 52 acres; Chattooga, 88 acres; and Cohutta, 60 acres. The river birch/sycamore type is typically a narrow 'stringer' on each bank of large streams. Cottonwood and black walnut types have usually been planted on alluvial flats that were in a non-forest land use when they were first acquired. The 60-acre block on the Cohutta is three stands in the Alaculsy Valley along the Conasauga River. The primary natural disturbance agents are periodic flooding, bank sloughing, and beaver feeding. (Streams are too large to be dammed by beaver.) Included species are typically intolerant. Reproductive strategy is typically seedling or vegetative establishment on flood-deposited sediments or on water-scoured banks. Productivities are high. No terrain requiring cable occurs in this community.

Using Georgia FIA plots only, there were sufficient plots meeting selection criteria to calculate a sawtimber CMAI in FVS only on the Southern Appalachian Piedmont where it is 75 years. This figure was used for each of the other Sections.

Prescriptions - Prescription are the same as for Old Growth Type 13.

In later SPECTRUM runs, this old growth type was removed from harvest on the Blue Ridge and Southern Ridge and Valley because it was such a small area, was important for other values, and was so strongly associated with large streams.

Timber Volume (Growth and Yield Output)

Timber volume per unit area is not a constant because trees grow, are damaged, rot, and die. For the stage two problem, the ability to predict volume at different points in the future; that is, a dynamic estimate, is required. Timber growth and yield simulation models provide this ability. These models, given required input data describing beginning conditions, can: (1) 'grow' individual trees or communities, (2) estimate the amount of timber that would be harvested within specified parameters of time and harvest method, and (3) change tree or community dynamics as a result of a management action, such as a thinning.

The SE variant was added to FVS in 1997 and continued under development to add capabilities and improving existing ones for a brief period. About 1999 it was replaced by the Southern variant; hereafter called the "SN" variant, of FVS and all the Southern Appalachian Forests switched to it.

Input data for the SN model were two files created by the PreSuppose program called a ".loc" and a ".slf" file. The "slf" is the 'stand list file' and identifies the plots that are 'matched' to the stratum. The user then specifies such things as; the length of the simulation, the types of management actions - if any, specific 'keywords' needed, and the type of output desired.

The starting date of 2000 was chosen for each simulation. The reason this date was selected is that it coincided (at the time) with the expected date when the plan would begin to be implemented. In addition, it meshed well with SPECTRUMS decadal periods. Suppose treats plot data 'as if' it were for the year 2000. The base year for calculating the seral class in Revision_CISC attribute data of the GIS stands data layer was 2000.

The length of the simulation period chosen in FVS was 40 ‘periods’ (the maximum permitted) of five years each, or a one hundred and ninety year planning horizon (the first and last cycles are not used). The basis for this choice stems from the economic efficiency analysis of stage two. A model period equal to at least one ‘rotation’ (from one regeneration harvest to another on the same piece of ground) is needed because the highest costs in timber management occur at stand establishment and the highest returns occur at regeneration harvest. The SPECTRUM model needs to consider the net effect of these together in compounding and discounting to calculate present net value. Traditionally, 15 periods of a decade each, or 150 years is considered long enough to do this. The additional periods were included simply to hedge against a belated need for other cycles that would be a major problem if re-running all simulations were to be required at some point along the way.

Management actions were primarily in one of two categories; no management, or thinnings. No management (or ‘grow only’) simulations were made for all stands to: (a) reflect no harvest, and (b) serve as the input data for calculating regeneration harvest yields as a percent. Thinnings were modeled for stands that were dense enough to have improved growth as a result of a thinning, including future growth as the simulation progressed. As previously mentioned, it was unnecessary to model yields for regeneration cuts in stage two analysis, since a percentage of all volume could be used with this percentage entered in SPECTRUM rather than in FVS.

Keywords are a powerful feature of FVS that allow tailoring a simulation to specific local conditions. For example, keywords were used to set custom merchantability specifications in the calculation of volumes. These specifications are those used in timber sale contracts on the Chattahoochee and Oconee NF. The growth and yield simulation process requires repeated use of the same keywords such as those for simulation length, beginning year, merchantability specifications, and so on. The shortcut method for having these readily available was to create an ‘addfile’ by copying these keyword sequences into a single file which could be added into subsequent simulations. However, since stratum had been defined to be difference from each other, addfiles could not do the whole job per stratum.

FVS timber yields, as originally reported, were simply total cubic foot volumes and sawtimber volumes. They were not broken down into even hardwood or softwood, much less the appraisal groups for which historic price data were available. A report of volumes by appraisal group was important to evaluate revenues because appraisal groups are combinations of species that have similar market values. The range of values across all appraisal groups is very wide, approximately a ten-fold change from the lowest-valued sawtimber group to the highest-valued sawtimber group.

Fort Collins staff modified FVS to report volumes by appraisal group. In order to do this, Forest Silviculturists, in consultation with Forest Sales Foresters, identified the appropriate appraisal group for each species recognized in the Southeastern Variant. For the Chattahoochee-Oconee, Barry Lilly sent a spreadsheet with a list of species. Ron Stephens, Forest Silviculturist, in consultation with Rich Aubuchon, Sales

Forester, entered the appropriate appraisal group abbreviation opposite each species.

The initial set of appraisal groups were those that had been used in the timber sales evaluated for stumpage prices. However, it was clear that, in several cases, there were minor differences in stumpage price and minor volumes involved. For example, hemlock or hickory as separate appraisal groups each had small volumes sold historically, and there was no reason to suppose that would change. Therefore, historic appraisal groups were combined somewhat in the initial coding sent to Fort Collins.

The initial appraisal group coding set was judged by Fort Collins staff as still being too large and the Forest was asked to further reduce them. The hardwood group offered the best opportunities to do that, and the high, medium, and low value hardwood species were combined into like-value groups with ‘new’ appraisal group names. This re-combination resulted in seven appraisal groups - five sawtimber and two pulpwood. Barry Lilly of the Fort Collins Forest Management Service Center wrote the COMPUTE keyword file which would, when included in a simulation, calculate volume for each of seven appraisal groups: (1) high-value hardwood, (2) mixed hardwood, (3) southern yellow pine, (4) Virginia pine, (5) white pine, (6) pine roundwood, and (7) hardwood roundwood. (See “Revenues” section of this document for an explanation of appraisal groups.) Instructions were included in this file to not add in the volume of tree class 3 or “rough trees” as part of sawtimber volume. These are defined as: “(a) live trees of commercial species that does not contain at least one 12-foot saw log, or two noncontiguous saw logs, each 8 feet or longer, now or prospectively, primarily because of roughness, poor form, splits and cracks, and with less than one-third of the gross tree volume in sound material; and (b) all live trees of miscellaneous species and tropical species.” (Forest Service, 1997)

Concurrent work being done with the SPECTRUM modeling effort surfaced the constraint that SPECTRUM could handle only six appraisal groups for timber valuation. A reduction to six groups was accomplished by combining pine and hardwood pulpwood into simply a “pulpwood” group. These were combined because: (a) their values have recently been trending toward convergence so that they are not far apart in stumpage price, (b) their volumes in a Forest Service program are typically low, and (c) whether the volume is predominately pine or hardwood is usually highly predictable based on the stratum.

Barry Lilly’s subroutine was then modified to result in computed volumes for only the six appraisal groups. The modified subroutine was then included in the simulation for each stratum as part of an addfile called “comm2all” (or ‘common to all’ stratum). In addition, the ‘SPECTRUM Export File’ post-processor was chosen in the simulation as well. This post-processor created a SPECTRUM export file ([filename].spc) as a ‘handshake’ with the SPECTRUM model. The export file reported boardfoot volume per acre for sawtimber for each appraisal group and each stratum. Pulpwood volume was reported as cubic feet per acre and was not differentiated between pine or hardwood.

At the end of this process, it was discovered that the addfile was too complex and used all of the space made available within FVS for calculations. The run would terminate at around ten periods. As a result of this, a switch was made to a post-processor called FVSSTAND ALONE or “FVSSTAND.” It uses a file produced by the FVS run, called a “.fst” file, to generate volumes by user-defined species groups. Once the user specifies these groupings, they continued to be used in all subsequent simulations unless modified by the user.

One of the results of the July 2001 trip to Fort Collins was agreement on using six sawtimber ‘appraisal groups.’ These are not the same as the ‘appraisal groups’ used in preparing a timber sale appraisal but are consistent in intent. The re-defined groups were: (1) softwood low value, (2) softwood moderate value, (3) softwood high value, (4) hardwood low value, (5) hardwood moderate value, and (6) hardwood high value. Also on that a trip, a calculation was developed that would derive the seventh and eighth groups; (7) softwood roundwood, and (8) hardwood roundwood. These last two volumes include ‘topwood’ or that portion of the bole between a sawtimber top diameter and a 4” top diameter; i.e. the roundwood limit.

Each individual simulation results in a keyword file called a “.key” file. This file can be re-opened, modified, re-run, and saved by a new name if desired. Output files are placed by default into the same file folder as the original input files.

Timber Harvest Volume in SPECTRUM (Yield)

The FVSSTAND program produced a yield file for each simulation (called *tot.spc). It contained volumes per acre by each of the appraisal groups by cycle. The handoff between growth and yield modeling and the stage two and three SPECTRUM modeling came with the importation of these files into SPECTRUM.

An important point to note at this juncture is that the volume outputs are characterizations of the ‘average’ acre of each stratum. It would be very difficult, if not impossible to find a single acre on the ground that has the volumes reported as average for an entire stratum. That is, yields do not represent any single stand of a stratum. At a strategic planning level, it is the stratum that is being characterized. Stands will be characterized at the project planning level.

Once growth and yield files had been produced by the FVS program, the SPECTRUM model also had to be structured to use these yields correctly. There were a number of common features to SPECTRUM model runs as follows:

1. Regeneration yields were a percentage of the volume estimated in an FVS ‘grow’ simulation for each old growth type. Shelterwood harvest leave percentages were calculated for each old growth type group individually and for each of three separate ages working from summary FVS output rather than using a more generic single value. The target leave basal area was reached working backwards from the largest trees present then the sum of the leave tree basal area was

divided by the total basal area to calculate a leave percentage. Harvest percentage was 100-percent minus the leave BA percent. Uneven-aged harvest was 20-percent of the volume present in each uneven-aged harvest entry.

2. In SPECTRUM modeling, analysis areas with a potential old growth (O) seral class in suitable prescriptions had a regeneration prescription only; i.e. no thinning in these age classes. In the FVS growth and yield simulations thinning was not simulated at or beyond the minimum old growth age for each old growth community type so there was no yield for thinning.

3. Uneven-aged management prescriptions included pre- or post-harvest site preparation treatments as an activity of these silvicultural systems. (The 'Forest Cover' topic of the EIS explains and Appendix F of the Plan explains the basis of this in great detail.)

4. In SPECTRUM modeling, sale preparation and silvicultural treatment costs for even-aged management were not varied to reflect different costs by method, rather a single cost figure favoring the most commonly used historic methods; i.e. not either least or most cost, were typically used.

5. The second and subsequent timber harvest re-entries in uneven-aged management were timed at twenty years apart so there would be merchantable products to be removed in thinnings from previously regenerated age classes.

6. Analysis areas in old growth types 13 – river floodplain hardwood, and old growth type 27 – eastern riverfront forest in the Blue Ridge Mountains and Southern Ridge and Valley ecological sections were not made available in the SPECTRUM model for any type of harvest.

7. Volumes were reduced within the model in each old growth type and in each prescription for the effect of the riparian prescription (management prescription 11) by a percentage reduction; that is, proportionate to area, using a 100-foot riparian corridor. GIS analysis was used to calculate the area within this corridor by old growth type.

8. Volumes produced by the SPECTRUM model were reduced outside the model for southern pine beetle mortality in the 1999 througfh 2003 period. The procedure used is explainerd in detail elsewhere in this document.

9. SPECTRUM was constrained not to apply a regeneration form of harvest until a minimum age (rotation age) was reached. The minimum age varied by both old growth type and also by management prescription. The table below details this variation.

Table B-14. Minimum Regeneration Harvest Ages by Management Prescription and Old Growth Community type Modeled in SPECTRUM. 15 October 2003

		Old Growth Community Type Number with Modifier										
Mgmt RX	**Basis of Min Age**	**2**	**5**	**13**	**21**	**22**	**24**	**25m**	**25p**	**25vp**	**27**	**28**
6D	Min OG Age	140	120	100	130	110	100	120	100	80	100	100
7A	midpoint CMAI saw & OG	110	100	90	110	90	90	100	80	60	100	100
7B	midpoint CMAI saw & OG	110	100	90	110	90	90	100	80	60	100	100
7.E.2	CMAI Saw	80	90	90	100	80	80	80	70	60	100	100
8A2	midpoint CMAI saw & OG	110	100	90	110	90	90	100	80	60	100	100
8.B	CMAI Total	50	50	70	70	70	60	70	50	40	70	70
8D*	CMAI Saw	80	90	90	100	80	80	80	70	60	100	100
8D1	CMAI Saw	80	90	90	100	80	80	80	70	60	100	100
8.E.1.	CMAI Total	50	50	70	70	70	60	70	50	40	70	70
9A3	midpoint CMAI saw & OG	110	100	90	110	90	90	100	80	60	100	100
9H	CMAI Saw	80	90	90	100	80	80	80	70	60	100	100
10A	CMAI Total	50	50	70	70	70	60	70	50	40	70	70
10B	CMAI Saw	80	90	90	100	80	80	80	70	60	100	100
10E	CMAI Saw	80	90	90	100	80	80	80	70	60	100	100

Source: SPECTRUM modeling worksheets 15Apr2003.

Volumes produced by SPECTRUM were dependent on the management prescriptions. SPECTRUM was constrained by each management prescription to meet the early successional wildlife habitat objective within an overall SPECTRUM objective of maximizing the present net value (PNV). Beyond the wildlife habitat constraint, the model was free to do any other activities made available to it to maximize PNV. Variation between alternatives derived from: (1) the mix of management prescriptions, and/or (2) the variation in the acres within a management prescription.

Adjustment for SPB

Volumes as estimated by the SPECTRUM model were adjusted downward outside the model for the pine component, including white pine, because of the mortality caused by southern pine beetle during the period 1999-2003. This adjustment was made on an ecological section scale basis except for the Piedmont portion of the Chattooga Ranger District, which had its own more localized adjustment.

The basis for the adjustment was a correlation between SPB spots geo-referenced through aerial reconnaissance and the CISC stands data. A primary source of spot location was a series of flights done by the Georgia Forestry Commission in the late summer and fall of 2002. (This data was not available in time to be included in the DEIS.) To this set was added any GPS spots from other sources, including Forest Service flights or ground recon. All of these data sets were combined regardless of time period and with the understanding that some of the locations would be for the same SPB spot. For the manner in which this data was used, this did not result in a double count.

There were a total of 1,027 points on National Forest on the Chattahoochee and 133 points on the Oconee. The Oconee data was by county and did not include all counties with National Forest land. Partly because of this, the final adjustment number was rounded up for the Oconee.

Once the SPB spot data set had been built, analysis proceeded in several steps as follows:

1. Spot co-ordinates were systematically related through GIS to the individual CISC stands of the GIS 'stands' data layer.

2. A GIS report was generated of numbers of spots by forest type.

3. Any spots in a hardwood-pine or hardwood forest cover type; that is, non-host for SPB, were given new co-ordinates in the nearest adjacent stand that was host type.

If there was no adjacent host type stand, the spot was dropped under the assumptions that either; (1) the GPS location was in error, or (2) more likely, the stand contained a low amount of SPB host type and did have SPB mortality but the forest type did not show SPB host because it was less than 30-percent of the canopy cover. In this latter case, a forest cover remained and no reduction was needed. The number of spots not used as a result of this step was low, ninety-one points or 8.9-percent of the total number.

The refined set of SPB host stands with SPB spots was carried forward in the analysis.

Host type stands with one or more spots were assumed to be lost; that is, 100-percent SPB mortality of that stand. This would not be true in all cases as SPB often creates only a small spot within a stand but we preferred that the estimate be liberal rather than conservative.

The sum of the acreage by ecological section of stands having an SPB spot was then divided by the total host type acreage in that ecological section. The result was an estimate of the *area* affected by SPB. These were as follows:

Piedmont portion of Chattooga Ranger District	31%
Southern Ridge and Valley Section	11%
Blue Ridge Mountains Section	11%
Southern Appalachian Piedmont – Oconee RD	6%

The assumption was made that area affected was proportionate to volume loss; that is, if 10 percent of the host type area was affected then the volume loss would be approximately 10 percent.

The estimate was compared with historic SPB epidemic area affected, about 2 to 3 percent with active suppression, and found to generally be three times higher.

However, the 1996-1998 epidemic on the Chattooga affected about 4,000 acres, or 14.6 percent of host type. The degree of increase over historic was judged to be reasonable because this epidemic has had little or no suppression activity.

The estimate of SPB host type area affected by ecological section was then shared with Districts with a request that they tell us if the estimate was reasonable and, if not, what they would say was a reasonable estimate.

Except for the Chattooga District, the estimates were found to be reasonable. In the case of the Chattooga – historically the hardest hit part of the Chattahoochee – the estimate was increased from 31 percent to 50 percent.

The final adjustment value chosen was rounded to the nearest ten as follows:

Piedmont portion of Chattooga Ranger District	50%
Southern Ridge and Valley Section	10%
Blue Ridge Mountains Section	10%
Southern Appalachian Piedmont – Oconee RD	10%

A single average reduction was calculated for the Chattahoochee and the Oconee combined. First, total host type per section was summed from the GIS stands layer. For this purpose, host type was inclusion of white pine and white pine-hardwoods types as recommended by the Forest Health Unit. Second, for each section, total host acres were multiplied by the fraction estimated to have been lost. Third, these mortality acres were summed. Fourth, mortality acres were divided by the total SPB host type. Mortality was assumed to have equally affected all areas of SPB host and was therefore not management prescription specific. The result was an average 13-percent reduction.

SPECTRUM outputs of the total volume of 'all softwood' were reduced to 87-percent (that is, reduced by 13-percent) in decade 1 for most alternatives. In Alternatives E and G, the amount of deduction was too small to result in a change.

Roading in SPECTRUM Analysis

The Act specifically addresses "*capital expenditures required for timber production*" as being part of the costs to be considered in stage two. And in discussing land stratification "*transportation requirement.*" is identified as being a factor to consider. Construction of forest roads that become part of the permanent transportation system is a capital expenditure required in areas without roads to move timber from the woods to the mill. It is a major cost item. And it is an issue with the public, especially so in inventoried roadless areas. For these reasons, two 'roading classes' were used as a stratification criterion: roaded or unroaded.

In roaded areas, no new system roads need to be built to harvest timber. In unroaded areas, some timber can be harvested without road construction but some road construction is required for complete access. Also in unroaded areas, no timber harvest requiring roads is possible until roads are built, although helicopter logging is still possible. However, the expense of helicopter logging still requires the separate modeling of unroaded land.

Note that roading as a stage two analysis variable does not consider separate costs for 'temporary' roads. These are short (less than 1 mile), typically dirt surface, and unditched roads that are used for a short time then seeded, blocked, and allowed to revert to forest. The cost of building these roads is reflected in the advertised minimum bid price set by the Forest Service and in the amount bid by purchasers of National Forest timber. The cost of these roads is not a 'capital investment.'

During the time the roads analysis was being worked on, there was National movement on roads policy. The trend of all of it was clearly in the direction of little or no new road construction, obliteration of some existing roads, or conversion to trails. In addition, in all of our alternatives, the 64,000 or so acres of inventoried roadless areas were receiving management prescriptions that would not include road construction. The expected return for the effort of doing a very rigorous and detailed roading estimate procedure in the Plan was low or very low.

The roads analysis proved to be the most difficult part of the complete analysis. Basically, this is because the needs for roads, the costs of roads per mile, and the number of miles of road are all sensitive to terrain. Experience has shown that even when an individual road corridor location is very carefully delineated and measured on 1:24,000 scale topographic maps, an actual ground location and survey typically varies by ten percent or more. In addition, the last mile of area accessed does not require system road construction because it can be accessed by temporary roads. But each constructed road needs a terminus on good terrain for a turn-around or, for a timber-purpose road, a log deck. So the amount of road construction is not simply a function of distance. Deriving a reasonable estimate of the number of miles of roads needing to be constructed at a strategic plan level at first seems easy, but quickly becomes bogged down in complexity.

At first we tried simple buffering within GIS from existing roads. This is too simplistic in that buffers are air-distance and ignore terrain. For example, one mile of road constructed across an average 40 percent slope cannot reach a one-mile air-distance buffer when the road grade is constrained to average no more than 10 percent. In addition, road buffers typically cross major streams, especially along valley bottom roads. Yet in practice, we avoid stream crossings as much as possible and would choose access from above, along watershed divide ridges, if at all possible.

Our second attempt was to make the buffers terrain-sensitive in some way. This also sounds simple and straightforward, but proves to be very complex. What is required is for the GIS to evaluate terrain shape independently on each side of each existing road pixel by pixel and vary the width of the buffer by some user-defined formula. To begin with, roads are not as wide as individual pixels. And roads may occur within a pixel in a great many variations of locations. Finally, the buffer from each pixel will be at right angles to the road but real life road locations may require new roads to parallel another road to maintain road grades.

Our third attempt was to use the Forest transportation plan analyses done in the 1980's and early 1990s. At that time, an individual plan was developed for each Transportation Analysis Unit (TAU) using interdisciplinary input. At the time these plans were prepared, they were state of the art. Included within them were the existing road mileage, and the planned construction mileage. Each TAU also had a road network identified for the 'preferred alternative' on a mylar overlay. Our plan was to review these TAUs and identify the roads and their mileage remaining to be constructed. Almost immediately we ran into the need for greater local knowledge.

Our fourth attempt was to print paper topographic quad maps from GIS data with streams, ownership, vegetation, and roads and also a separate mylar overlay showing the roads for each quad. Next we would have District personnel match these two and, using the TAUs as a guide, identify roads that: (a) had already been constructed, (b) still needed to be constructed, or (c) were no longer needed due to land withdrawals, exchanges, etc. They were to draw roads still needed on the mylar as well as write down summary data for them. The sum of the road mileages would then give us the Forest estimate of roading needs. It very soon became apparent that this was a very detailed and complex approach for a strategic plan and would consume more time and person-days than we had available. Part of the reason for this was that timberland withdrawals of the Chattahoochee Forest Protection Act and, in some cases, withdrawals from the mid-80's were not reflected in the TAUs. Not only that, but planned roads may have been constructed on different locations because of intensive on-the-ground reconnaissance.

Ultimately, the land was stratified into two road classes; unroaded and roaded. The unroaded class was identified by displaying on screen through GIS the combination of: (a) each 5th level HUC, (b) terrain form a 30-meter digital elevation model, (c) National Forest land, (d) existing roads, (e) streams, and (f) stands. On this display, existing roads were buffered with a conservative air-distance buffer of three-fourths mile. Lands not covered by a buffer became a 'window' to evaluate road needs. The display was 'zoomed' into these areas one by one. At each area a case-by-case determination was made of the need for, and approximate location of, new road construction. Each stand that would require the construction of a new road, or road segment, to be accessed was selected. The selected set was then attributed in a '*roads*' data column with a code identifying it as belonging to the class 'unroaded'. Once all of these stands had been classified in this way, remaining stands with no code in the '*roads'* data column were classified as 'roaded'.

The result was a rather refined estimate of overall roading needs in terms of general location and area accessed. The area-by-area look ensured the correct consideration of numerous important variables. One of these was 'control points' on the terrain that a road alignment would have to reach such as gaps, saddles, spur ridges, and so on. Another was the most-appropriate location for skid trails, temporary roads, log landings and stream crossings. Still another was the effect of private ownership, Wilderness boundaries, steep slopes and other features on road alignment. For needed skid trails and roads, the area each would access could also be visually estimated. Consequently, the size and shape of each unroaded area was a well-informed judgment.

It is worth noting that access as stratification criteria is not a factor in growth and yield modeling. It is reflected only in SPECTRUM. Rather its importance is in the limitations it imposes on logging systems and the resultant costs.

We coordinated with the Cherokee National Forest to use a shared road cost co-efficient on a volume basis. We used the same co-efficient because there was no reason to expect a significant difference. In each case, (a) unroaded areas are in the shared Blue Ridge Mountains ecological section, and (b) sale contracts and procedures are standard. Cherokee NF personnel manually compiled system road construction and reconstruction miles from a sample of their past sales, then divided those miles by the volume of each sale. The result was a road increment per unit volume co-efficient. In this way, they reflected the effects of sale 'packaging' or the combining of accessed and un-accessed units in each sale. These co-efficients were entered into SPECTRUM such that each harvest in an unroaded analysis unit 'built' an increment of road. In addition, harvest also was 'charged' with costs of reconstruction of roads as a recurrent cost.

Physical Conditions of the Site

NFMA states that the stratification for stage two analyses "*should consider appropriate factors that influence the costs and returns such as physical … conditions of the site.*" It also speaks about mitigation measures that may be required.

Slope gradient is a physical site condition that strongly influences the logging system used, hence logging costs and therefore revenues; that is, timber purchasers must bid less as their logging costs increase unless the cost increase is offset by an equal or greater increase in the value of the timber product being harvested. This is true regardless of the roading class. If a specific logging system, such as overhead cable, is required by the Forest Service, a 'break even' timber value per unit area harvested may be required before the sale will be purchased.

Southern Appalachian planners agreed that slope needed to be a land stratification variable. As with roading class, slope had to be generated and then systematically related to the 'stands' and Forest Service ownership layers. The source of slope data was United States Geologic Survey (USGS) 30-meter digital elevation models (DEMs). These DEMS were prepared for the analysis within GIS by first using a "fill" procedure that finds anomalies in the data then, by analyzing adjacent pixels, assigns values to these. Following this, a "resample" procedure extrapolated intermediate elevations and changed the 30-meter DEM to a 10-meter DEM. As a result of this resampling, the pixel size being evaluated for slope changed from 0.23 acres per pixel to 0.023 acres per pixel, and the number of samples per stand increased by a factor of almost ten. GIS grid analysis capabilities were then used to analyze the slope in percent for each pixel within each stand (in 1 percent increments) within Forest Service ownership. A variety of statistics for each stand was generated by this analysis; such as mean, median, min, max, range, and majority. These statistics were evaluated by on-screen review of the maps and also numeric analysis to determine which was the better measure of slope for the stand. Although there was not a lot of variation, the mean was chosen, in part because it is readily understood by the public.

Because slope percent to finer resolution than that needed by timber modeling alone was judged to be needed by other disciplines, each stand was attributed in the Revision_CISC database with its own specific mean slope value to the nearest 1 percent. Note that this procedure is not classifying every acre, so that stands can contain areas of either steeper or gentler slopes or both. However, the original slope analysis file with slope percents by pixel remained available for other slope-related analysis needs. Very fine scale resolution can be dealt with at the strategic plan level with standards and guidelines if they are judged to be needed.

Slope means by stand were aggregated into slope classes for initial timber model stratification. These classes were; 0-20 percent, 21-45 percent, and 45+ percent. Classes were used because ground-based logging systems which use wheeled or tracked vehicles to move logs are usable up to about 40 to 45 percent slope. Cable-logging or aerial logging system is usually required above 40 to 45 percent slope.

Based on the slope analysis, we decided not to model any yields in SPECTRUM from slopes over 45 percent for either the Armuchee Ranger District or the Oconee. In each case the land area was small and had other associated values that made it not appropriate to plan for sustained yield harvest even if it occurred within otherwise suitable prescriptions.

Between the DEIS and FEIS we also decided to not model yield from cable slopes on the Chattahoochee. These lands were not re-allocated to an unsuitable prescription, just not made available to the model in projecting habitat amounts and associated timber volume yield. There were a number of reasons for this decision. Not modeling those acres was more responsive to the roading issue. Existing roads built for other reasons would, in some cases, not provide the type of access needed for cable. We are not likely to provide a stable enough timber supply on cable ground to enduce loggers or wood industry to buy cable systems. And historically we had sold only a few cable units within sales that were usually for predominantly ground based systems.

Similarly, as already mentioned, we evaluated the percent of riparian area by each old growth type and ecological section. We used a 100-foot buffer distance on each side of perennial streams regardless of management prescription to generate acres of riparian. This value was then divided by all acres in that old growth type in that ecological section. Yields in SPECTRUM were then reduced by that percentage. The underlying assumption of this procedure was that suitable (that is, modeled for yield) prescriptions are average in their proportion of riparian area. There is no reason to think this is not the case. It was also as part of this effort that we structured SPECTRUM to produce no yields from old growth community types 13 or 28 in the

Blue Ridge or Ridge and Valley. The reduction for riparian area volume matched with our direction in management prescription 11 that those lands were unsuitable for sustained yield timber production.

Table B-15. Percent of Each Old Growth Community Type By Ecological Section Not Modeled in SPECTRUM for Timber Yields.

	Percent of Total Community Acres Not Modeled		
Old Growth Type	Blue Ridge Mountains	Southern Ridge & Valley	Southern Appalachian Piedmont
2	8	n/a	8
5	14	14	19
13	100	100	25
21	7	7	17
22	5	5	5
24	3	3	3
24v	3	3	3
25m	6	6	15
25p	6	6	3
25v	6	6	6
27	n/a	n/a	22
28	100	n/a	49

By themselves, neither slope nor riparian area are variables of importance to growth and yield modeling because they are not factors that directly affect tree growth and thereby yield. However, FIA plots do have a measured slope class and that information could be used to make a closer match between the growth and yield and the SPECTRUM stratification model if that were judged to be necessary in the future. For the Chattahoochee, lands over 45-percent slope required adjustments to timber revenues. Those adjustments are described in detail later.

REVENUES

As previously noted, the Act provides that a part of stage two analysis shall be a comparison of direct benefits to direct costs and direct benefits are *"… expressed as expected gross receipts to the government."* For timberland suitability analysis, these 'gross receipts' are the dollars paid or value given by purchasers of National Forest timber. These amounts are of four different types: (1) the money paid to the Forest Service for trees standing in the woods (stumpage); (2) the value determined by the Forest Service for 'purchaser credit' roads accepted as a payment-in-kind; (3) 'associated charges' (primarily road maintenance), which the purchaser is required to pay in addition to stumpage; and (4) interest and penalties paid by the purchaser through the life of a sale.

Of these, stumpage is the critical one and will receive the most attention. However, the other revenue sources will be addressed first in the following paragraphs.

The Act further requires that *"Such receipts shall be based upon expected stumpage prices and payments-in-kind from timber harvest considering future supply and demand situation for timber …." 36 CFR 219.14 (b) (1).* The term 'payment-in-kind' explicitly included purchaser credit roads at the time the Act was passed. These were roads constructed or reconstructed by timber purchasers to Forest Service specifications as part of the terms of their timber sale contract. Upon satisfactory completion of the work, the value of the road, as determined by the Forest Service, was accepted as a payment-in-kind for timber. The value of the road credited to the purchaser did not include any profit margin. That is, the value received by the Forest Service was a facility (a road) and cash rather than just cash.

The purchaser credit program was terminated by law in 2000 or thereabouts. Timber purchasers must now bear the cost of any necessary road construction. So it is currently inaccurate to include any consideration of purchaser credit as a 'payment in kind'. Therefore the SPECTRUM modeling did not include it. This change did not compromise the use of historic bid prices in any way because, even for historic sales that included purchaser credit roads, those bid prices were exclusive of purchaser credit. The value of the road was 'credited' to the purchaser as it was accepted by the Forest Service and then became a payment in lieu of money. Timber value was still competitive bid prices based on fair market value.

Also required by the Act was a projection of how the timber demand, or price paid per unit, is expected to change in the future. This factor is intended to deal with a 'real'; that is, above inflation, price trend in timber driven by an increase in demand. If real prices are increasing, previously not cost effective land or not cost effective prescriptions can become cost effective. In turn, an entire timber sale program could become more cost effective.

We chose not to attempt a projection of a real price trend increase in timber. There are a number of reasons for this. The time period of particular significance in revision is primarily the first ten year period, with a lesser emphasis on the second decade. This is because the decision being informed by the model is only for that period and will then be superseded by another plan revision as required by NFMA. Any real price increases over that time period would be small. Historic stumpage prices for the 1985 through 1996 period, comparable to that time frame, included a period of high prices and a period of low prices so there was no strong trend in prices paid. National Forest is not dominate in its market areas and therefore does not constrain supply such that a constrained supply would drive real price increases. Finally, the long running economic downturn since about 2000 reversed a trend of increase in pine sawtimber that had previously existed and further strengthen the judgment that projecting a real price increase would be of debatable accuracy and of little real value in informing the decision.

If there is a trend of real price increases, the effect of not projecting it would undervalue timber revenues and thus potentially show more land not cost effective. We decided to run the SPECTRUM model at least initially in this conservative way. Before the final SPECTRUM runs, we evaluated the amount, distribution, and characteristics of lands identified at stage two as being not cost effective. We found that there were relatively few acres in total. Their pattern was of small and widely scattered areas. This pattern did not identify relatively large blocks of land that could be considered for re-allocation to a 'not appropriate' prescription. Rather their small size showed that project level planning with its choice of methods of harvest and reforestation activities were the best place to deal with cost effectiveness.

Timber purchasers are required as part of their sale contract to deposit funds for 'associated charges.' On the Chattahoochee and Oconee this means 'deferred' road maintenance. Deferred maintenance is typically gravel surfacing. These funds are in addition to stumpage. However, they are also obligated to be spent only on road maintenance so are therefore not cash available to be spent on other objectives. Figures for the amounts of deferred maintenance deposits collected by the Forest Service as part of the historic sales program were not available. The value of this portion of a timber program is not reflected in SPECTRUM modeling as a revenue from a timber sale program. Once again, this makes the revenue side of the modeling effort conservative.

Timber purchasers also occassionally pay interest and/or penalty charges as a part of overall timber program revenues. Interest charges typically result from delays in financial transactions. Penalty charges are charges provided for in contract clauses for specified types of damages to National Forest resources. For example, the Forest Service has the contractual authority to charge twice the bid rates for timber volume and has the discretion to allow its removal or not. This could apply to 'excessive damage' to the residual stand as one example. However, these revenues are uncommon, unpredictable, and typically for relatively small amounts. They cannot be reliably related to harvest acres or harvest volume. And their ability to influence program cost effectiveness is insignificant. This source of revenues is not modeled in SPECTRUM.

To develop the revenue side of stage two analysis, stumpage prices for the years 1986 through 1996 on the Chattahoochee and for the years 1986 through 1997 on the Oconee were analyzed. (There were no sales awarded on the Chattahoochee in 1997, which met selection criteria.) This time period was chosen because it corresponds with implementation of the existing Forest Plan, and prices reflect its management requirements of methods of harvest, logging systems, specific mitigation measures, etc. Note that use of these revenues is strictly accurate only if current mitigations that have affected the purchasers' costs under the 1985 Plan would not be either significantly relaxed or significantly tightened in the future under any alternative considered in detail. We judged this was not likely to be a significant source of cost variation, particularly since sensitive lands such as riparian areas were not being modeled anyway.

Data Source and Methods

The data source for stumpage prices was a form for each timber sale, FS2400-17 "Report of Timber Sale". These were available in the hardcopy files of the Natural

Resources Staff unit of the Forest Supervisor's Office in Gainesville, GA for each of the selected years.

Before beginning to compile the raw data, certain ground rules were set in discussion with Rich Aubuchon, Sales Forester. These were: (1) the sale must have been sold under competitive bidding procedures; and (2) the sale must not have been salvage. These criteria were chosen because competitive bidding ensures stumpage prices reflecting open market dynamics of supply and demand, and stumpage values for salvage material are typically much lower than that of green timber. Each sale meeting these criteria had selected information entered into a Lotus 1-2-3 spreadsheet for further analysis. To force a sale-by-sale verification of selection criteria, data on the 'sale method' and 'salvage status' was entered for each sale.

In anticipation that it might become a factor later in the analysis, each sale meeting the first two criteria also was coded for whether or not it was a 'small business set-aside.' This is a Federal program designed to favor small business entities over large business under certain conditions. When these conditions are met, sales are 'set aside' and big business is not eligible to bid on that sale. This raised the concern that stumpage prices the Forest Service accepted in those cases may not truly reflect competitive bidding; that is, a big business purchaser might have paid more. Although sales were coded such that set asides could be recognized, two factors later emerged which showed this to have been unnecessary. First, few sales were set-asides. Second, the Regional representative of the Small Business Administration had reported to Regional Timber Staff that this had been analyzed and there was no evidence to suggest that the set aside program had this effect (Karl Stoneking, 1998).

'Report of Timber Sale' hardcopy forms were manually screened against the criteria. Two Lotus 1-2-3 spreadsheets were built from these data, one for each of the Chattahoochee and Oconee National Forests. Each sale meeting the criteria had the following information recorded: (1) sale contract number, (2) Ranger District, (3) date of bid opening, (4) salvage status, (5) set-aside status, (6) method of sale, (7) product, (8) unit of measure, (9) a 'flag' column, (10) species or species group; that is, the appraisal group, (11) volume sold, and (12) the exact bid value. The sale contract number is a unique number for each sale. For 'salvage status' the only valid entry was "N" for 'non-salvage'. Set-aside status could be either "Y" for yes, or "N" for no. As it turned out, the only valid entry for method of sale was "S" for 'sealed bid'. The 'flag' column was a way to track individual sale anomalies which, when encountered, might or might not prove to be important in the long run. As it turned out, the 'flag' column rarely had an entry and the entries made were about minor details, such as combining species groups with unalike prices when the volumes of one or both were very small. Once each spreadsheet had been built and an overview of the data obtained, the method of sale and 'flag' columns were not used in subsequent analysis.

Each sale typically had several rows (lines) of entry. For any one sale, the information in the first five columns was the same for each row. However the product, unit, species, volume, and bid values was different for each row. This is because each sale typically included both multiple species groups and multiple products. These combinations were faithfully maintained just as they appeared for each sale on the Report of Timber Sale forms.

The intention at this stage was to create a detailed database of ‘raw’ data for further analysis and grouping. For example, having the Ranger District as an entry would allow testing to see if a particular species/product combination showed a consistent pattern of higher stumpage values on one District than on others and possibly lead to a different land stratification recognizing Ranger District. The timber sale contract number permitted tracing data back to individual sales if necessary to check specific data. Since much of the planning process involves repetition, a detailed set of background data allows re-searching and re-sorting as planning proceeds, if new questions are asked. (New questions could surface much later and have nothing to do with stage two analysis.)

Once the raw data were compiled, it was sorted hierarchically as follows : first into the two product groups of either sawtimber, or pulpwood; second into species groups; third into fiscal years; and fourth into fiscal quarter. This sorting was hierarchical from the first criteria through to the last. A very little combining of species groups was done; for example, yellow poplar and yellow poplar/sweetgum were combined into one. However, distinct species or species groups were maintained regardless of number of sales or low volumes, such as hemlock, for a later reasoned decision on whether they should be combined.

Next, the bid values of the sorted data were adjusted to 1996 base year dollars. To do this, an additional column called ‘factor’ was added immediately after the bid value column and a ‘GNP deflator’ value was keyed in for each fiscal year in this column. The GNP deflators were furnished by Clair Redmond, regional economist, using 1996 as the base year. Then another column called ‘real $’ was created to receive adjusted bid values. Using the computational capability of Lotus, each value of the bid column was multiplied by its corresponding factor and the ‘real $’ column was filled with bid values rounded to the nearest whole dollar. The general relationship was that bid prices prior to 1996 were reduced, 1996 bids remained unchanged, and 1997 bids were increased.

Later in the analysis, because so much time had passed. The 1996 dollar values were adjusted upward again to year 2000 dollar values for the PNV calculations of the FEAST spreadsheet of the ‘Social and Economic’ topic of the EIS. This change was not made in SPECTRUM.

To this point, all the changes had been made by adding columns to the original spreadsheet of source data. For the next step, this spreadsheet was queried for each individual species/product combination and the following variables reported out to a query table: (1) sale contract number, (2) Ranger District, (3) fiscal year, (4) quarter, (5) product, (6) unit, (7) species, (8) volume, and (9) ‘real $.’ This query table was then sorted in ascending order by fiscal year and a ‘Vol.Wt.Avg.$’ (volume-weighted average dollars) column added. A single volume-weight average 'real' bid value by fiscal year was then computed for each species/product combination.

Table B-16. Softwood sawtimber volume-weighted average 'real' dollars by MBF (base year 1996) by species group and fiscal year sold for the Chattahoochee NF, 1986 - 1996

Species Group	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
SYP	120	123	111	115	115	135	140	178	173	164	140
LGSftwd*	n/a	n/a	53	57	63	50	89	149	94	89	99
WPine	118	88	80	92	100	102	103	154	249	163	119

Source: 'Report of Timber Sale' forms (2400-17) on file in Natural Resources Staff Unit, Forest Supervisor's Office, Gainesville, GA
**LGSftwd is 'low-grade softwood,' primarily Virginia pine, but also including small volumes of hemlock.*

Table B-17. Hardwood sawtimber volume-weighted average 'real' dollars by MBF (base year 1996) by species group and fiscal year sold for the Chattahoochee NF, 1986 - 1996

Species Group	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Ypoplar*	104	61	75	90	123	116	165	215	186	121	65
WOak	85	68	66	72	80	108	116	158	144	123	40
Hardwood	66	44	31	44	65	58	56	132	77	89	41
NRedOak	139	110	141	68	149	155	162	361	313	233	141
Oak	58	38	42	55	51	18	n/a	n/a	119	31	72
LGHdwd	n/a	n/a	n/a	n/a	n/a	31	33	n/a	7	n/a	n/a
Hemlock	n/a	71	n/a	n/a	n/a	n/a	11	n/a	n/a	n/a	n/a
Hickory	55	n/a	n/a	n/a	n/a	60	n/a	n/a	n/a	n/a	n/a

(Source: 'Report of Timber Sale' forms (2400-17) on file in Natural Resources Staff Unit, Forest Supervisor's Office, Gainesville, GA
**Includes PopBasCu or yellow poplar, basswood, and cucumber.*

Table B-18. Pulpwood volume-weighted average 'real' dollars by CCF (base year 1996) by species group and fiscal year sold for the Chattahoochee National Forest 1986 - 1996

Species Group	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Mx. Sftwd.	5	2	2	14	15	22	13	24	12	5	8
Mx. Hdwd.	1	1	1	4	6	4	3	4	5	2	4

Source: 'Report of Timber Sale' forms (2400-17) on file in Natural Resources Staff Unit, Forest Supervisor's Office, Gainesville, GA

Table B-19. Sawtimber volume-weighted average ‘real’ dollars by MBF (base year 1996) by species group and fiscal year sold for the Oconee National Forest 1986 - 1996.

Year	SYP	MxHdwd	SwtGm	Y.Poplar	LGSftwd
1985	$174	$ 55	n/a	n/a	n/a
1986	$140	$66	n/a	n/a	n/a
1987	$173	$65	n/a	n/a	n/a
1988	$191	$63	n/a	n/a	n/a
1989	$205	$75	n/a	n/a	n/a
1990	$204	$71	n/a	n/a	n/a
1991	$191	$48	n/a	$61	n/a
1992	$231	n/a	$ 49	$68	n/a
1993	$262	n/a	n/a	n/a	n/a
1994	$330	n/a	n/a	$83	n/a
1995	$362	n/a	n/a	n/a	n/a
1996	$142	n/a	$29	$31	n/a
1997*	$201	n/a	$62	$87	$11

Source: ‘Report of Timber Sale’ forms (2400-17) on file in Natural Resources Staff Unit, Forest Supervisor’s Office, Gainesville, GA

**Converted from ‘per CCF’ basis to ‘per MBF’ basis by dividing the per CCF high bid value by .55.*

Table B-20. Pulpwood volume-weighted average ‘real’ dollars by CCF (base year 1996) by species group and fiscal year sold for the Oconee NF, 1986 - 1996.

Species Group	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
MxSftwd	15	17	14	19	18	20	19	21	19	10	15	13	7
MxHdwd	5	n/a	1	5	1	n/a	n/a	6	1	14	n/a	12	4

Source: ‘Report of Timber Sale’ forms (2400-17) on file in Natural Resources Staff Unit, Forest Supervisor’s Office, Gainesville, GA.

Once the volume-weighted average annual bid prices by appraisal group had been calculated, we still needed three more steps. First, we aggregated appraisal groups into the value groups agreed on at Fort Collins. (To maintain a distinction from previous discussion, these will be called ‘value groups’.) Second, we derived a single price for each value group; that is, an average of the averages. We rounded these values to the nearest ten. We also used judgment in cases where there were few bid prices for a particular appraisal group and especially if values were very high or very low. We made these values conservative because in the early nineties there was a strong market with high prices then litigation shut down the program and we had no recent bid values. Yet the market had declined in the meantime and prices had fallen. So we judged that it was more appropriate to use moderate values than to use very high ones. Third, we converted prices to the common unit basis of MCF, or ‘one thousand cubic feet’. For sawtimber, the conversion was the MBF value multiplied by 5.5; that is, five and one-half board feet per cubic foot. For pulpwood, we did not use the arithmetic average. Instead we took a more current market value of approximately $4/CCF for hardwood and $5/CCF for pine.

For value groups on the Oconee that would be an output of the model but for which we had no Oconee bid prices; we used the Chattahoochee price. Again, this is likely to be a conservative estimate because of more favorable terrain and lower logging costs on the Oconee.

Table B-21. SPECTRUM Model Timber Stumpage Value Groups for the Chattahoochee National Forest. September 2003.

SPECTRUM Value Group	Value Group Name	Included Appraisal Group
HVH	High Value Hardwood	NRedOak
		Woak
HVM	Moderate Value Hardwood	Ypoplar
HVL	Low Value Hardwood	Hardwood
		LGHdwd
		Oak
		Hickory
SVH	High Value Softwood	SYP
SVM	Moderate Value Softwood	Wpine
SVL	Low Value Softwood	LGSftwd
		Hemlock
Pulp	Pulpwood - all species	Mx. Sftwd
		Mx. Hdwd

Source: Summary of previous tables and text explanation

Table B-22. SPECTRUM Model Timber Stumpage Value Groups for the Oconee National Forest. September 2003.

SPECTRUM Value Group	Value Group Name	Included Appraisal Group
HVM	Moderate Value Hardwood	Y.Poplar
HVL	Low Value Hardwood	MxHdwd
		SwtGm
SVH	High Value Softwood	SYP
Pulp	Pulpwood - all species	MxSftwd
		MxHdwd

Source: Summary of previous tables and text explanation

Table B-23. SPECTRUM Model Timber Stumpage Revenue Co-efficients, Base Year 1996 September 2003

Product & Unit	Species Group	SPECTRUM Value Group	Chatt. NF $	Chatt. NF $/MCF	Oconee $	Oconee $/MCF
Sawtimber	Softwood	SVH	138	770	138	770
(MBF)		SVM	124	680	n/a	N/a
		SVL	83	450	n/a	N/a
	Hardwood	HVH	138	760	138	760
		HVM	91	500	91	500
		HVL	45	250	45	250
Pulpwood	Softwood	SVP	5	55	5	55
(CCF)	Hardwood	HVP	4	40	4	40

Source: Summarization of previous tables and explanations.

Adjustments for Cable Logging

Historic timber revenue information included only a few sale units in a few sales that used cable-logging systems. The revenue figures generated from historic sale records were therefore applicable only to ground based systems. Yet, on the Chattahoochee at least, about 45-percent of the total land area is on slopes needing cable systems. So we adjusted the historic revenues numbers for both: (a) reduced bid price due to increased logging costs, and (b) increased revenue due to higher quality.

As the basis in making this adjustment, we assumed several points:

- Historic timber sale bid prices; which are almost totally from ground-based logging system sales, reflect the occurrence of grade volume due to competitive bidding whether or not the Forest Service graded trees or included a quality adjustment in the appraisal.
- Correct valuation for cable sales needs to reflect the higher proportion of Grade 1 volume on slopes greater than 40% because it can reasonably be expected to increase bid prices in a competitive market.
- Use of aerial systems on the Armuchee or Oconee Districts either will not occur at all or so infrequently that modeling them for regular periodic harvest is not appropriate. An adjustment to volume may be useful on the Armuchee, but the area of steep slope on the Oconee is so small that no adjustment is needed.
- Use of helicopter logging on the Chattahoochee either will not occur at all or so infrequently that modeling its use for regular periodic harvest is not appropriate. In addition, there is no locally available cost data for the use of the system.
- Variation in land area of cable ground, and therefore volume, will be captured by alternative using the acres of analysis area in 'suitable' prescriptions and on slopes greater than 40 percent.
- The softwood sawtimber modeling group did not need an adjustment because: (a) softwood on steep slopes involves minor acreages; (b) the primary species affected is expected to be white pine, which does not have a

strong market and has not historically been very sensitive to grade as a market consideration; and (c) local wood industry is not configured well to sort, save, and forward grade softwood to a distant market.

- Although the HVH modeling group includes species other than select red and select white oaks, and their volume will also be given an oak 'grade premium,' this effect is judged to be insignificant to the outcome because: (a) oak volume is by far the largest portion of all volume; (b) grade is important in other associated hardwood species also, and an increased bid for them based on quality is not unreasonable; and (c) bid prices already reflect species and quality mixes across the Forest, and the basic figure being adjusted is the historic average bid price.
- Historic timber sale bid prices on the Blue Ridge section of the Chattahoochee National Forest for the High Value Hardwood modeling group are assumed to be on average reflecting a Grade 2 sawtimber product quality.
- The higher price bid on higher quality Grade 1 sawtimber stumpage will be proportionate to the difference between a delivered log Grade 2 price and a delivered log Grade 1 price.

The ratio of NF Grade 1 sawtimber inventory volume on steep slopes compared to all NF sawtimber inventory volume published in the Southern Appalachian Assessment is a reasonable estimate of the proportion of Chattahoochee volume by grade on steep slopes.

Logging Costs Adjustment

Sale preparation and logging costs increases were taken from a document written by Jim Shearer, Forest Service Zone Logging Engineer in Asheville, NC, entitled *"Stage II Suitability Analysis Logging Costs"* and dated April, 1998. Jim stated costs in terms of CCF (100 cubic feet) and our SPECTRUM model uses MCF (1,000 cubic feet) so his figures are multiplied by ten to put them on a common unit basis.

Table B-24. Costs by Major Variable for Logging Systems ($ per MCF)

Logging System	Fell & Buck Costs	Yarding Costs	Layout, mark, & volume est.	Harvest admin.	Net change from skidder cost
Skidder/tractor	100	250	20 - 30	30	N/a
Skyline	100	350 - 450	20 - 40	20	140
Helicopter	150	850 - 1200	60	10	1085

Source: "Stage II Suitability Analysis Logging Costs" by Jim Shearer, Zone Logging Engineer,

The layout, marking, and volume estimation plus the harvest administration are Forest Service costs. Sale preparation costs are higher for cable, but harvest administration is lower. The net effect of these is no change when the average of $30/MCF for layout, marking, and volume estimation is used.

The important piece is the $140/MCF higher operating costs for the logger, which means the bid rate per MCF must be reduced to reflect it.

Logging Revenues Adjustment

The calculation of a revenue adjustment involved several steps:

1. Decide which modeling groups needed a grade premium adjustment.

Only select red oak and select white oak FIA groups contained within the "High Value Hardwood (HVH)" modeling group need to have a 'grade premium' calculated, other species modeling groups on cable terrain will have increased harvest costs so they will use the average timber sale bid values for their appraisal group minus the increased cost.

2. Calculate the difference between the Grade 2 and the Grade 1 delivered log prices for each year and for each group needing adjustment using the Grade 2 price as the base figure.

3. Calculate the average of the decimal difference to derive a single 'grade premium' adjustment.

Grade Adjustment Factor (GAF) = (0.65 + 0.53)/2 = +0.59

4. Calculate the decimal difference between the proportion of NF Grade 1 timber inventory on steep slopes compared to the proportion of NF Grade 1 in all NF timber inventory using Table 3.7 on page 110 of the SAA Social Cultural Economic Report. (Note, this step is included because only that portion of yields from cable ground receiving a grade premium and that portion of grade volume that is greater than that historically encountered on ground-based logging system sales will affect revenues.)

The Grade 1 proportion on slopes of 36 percent and above is 0.2016, or 20 percent. The grade 1 proportion on ground-based system slopes of 35 percent and below is 0.1489, or 15 percent. Therefore, 5 percent more Grade 1 volume on average will be occurring on slopes of 36 percent or greater.

5. Multiply #3 by #4. This is the percent increase in historic average timber sale bid prices to be expected due to higher volumes of higher-grade material on steep slopes.

Table B-25. Calculation of a Grade Premium for the High Value Hardwood (HVH) Modeling Group. Note: Volume basis is per MCF

		RED OAK				WHITE OAK			
Year		Grade 1	Grade 2	Dollar Increase from Grade 2	Decimal Increase from Grade 2	Grade 1	2	Dollar Increase from Grade 2	Decimal Increase from Grade 2
1978	Mar	382	229	153	0.67	352	229	123	0.54
	Sept	441	221	220	1.00	243	162	81	0.50
1979	Mar	450	222	228	1.03	229	152	77	0.51
	Sept	480	205	275	1.34	320	237	83	0.35
1980	Mar	360	238	122	0.51	291	215	76	0.35
	Sept	314	196	118	0.60	213	146	67	0.46
1981	Mar	313	219	94	0.43	198	136	62	0.46
	Sept	325	224	101	0.45	274	213	61	0.29
1982	Mar	301	201	100	0.50	271	211	60	0.28
	Sept	300	200	100	0.50	270	210	60	0.29
1983	Mar	349	199	150	0.75	269	209	60	0.29
	Sept	345	222	123	0.55	296	207	89	0.43
1984	Mar	364	242	122	0.50	291	218	73	0.33
	Sept	417	266	151	0.57	339	218	121	0.56
1985	Mar	370	242	128	0.53	327	206	121	0.59
	Sept	315	205	110	0.54	291	184	107	0.58
1986	Mar	348	224	124	0.55	299	199	100	0.50
	Sept	354	228	126	0.55	304	202	102	0.50
1987	Mar	420	259	161	0.62	321	210	111	0.53
	Sept	444	271	173	0.64	314	205	109	0.53
1988	Mar	525	310	215	0.69	406	250	156	0.62
	Sept	515	304	211	0.69	398	245	153	0.62
1989	Mar	498	294	204	0.69	407	249	158	0.63
	Sept	492	290	202	0.70	402	246	156	0.63
1990	Mar	508	302	206	0.68	420	258	162	0.63
	Sept	507	283	224	0.79	443	251	192	0.76
1991	Mar	432	313	119	0.38	475	281	194	0.69
	Sept	494	290	204	0.70	473	279	194	0.70
1992	Mar	496	291	205	0.70	475	280	195	0.70
	Sept	506	295	211	0.72	485	284	201	0.71
1993	Mar	588	336	252	0.75	567	325	242	0.74
	Sept	652	389	263	0.68	589	358	231	0.65
1994	Mar	650	388	262	0.68	587	357	230	0.64
					21.69				17.60
		Avg. 21.69/33 = 0.65				Avg: 17.60/33 = 0.53			

Grade Adjustment Factor = (0.65 + 0.53)/2 = +0.59

Table B-26. National Forest Distribution of Grade 1 Volume in Southern Appalachian Assessment Area. **(Unit of measure is billion bard feet)**

Slope Class & Logging System	Sawtimber Inventory	Grade 1 Sawtimber Inventory	Grade 1 Fraction of Total Volume
0 thru 35% - ground-based	10.14	1.51	0.1489
36 thru 60% - skyline (cable)	10.32	1.99	0.1928
61% & greater – skyline (cable)	2.48	0.59	0.2379
Total	22.94	4.09	0.1783

Source: The Southern Appalachian Assessment Social Cultural Economic Report, Table 3.7 page 110.

This calculation is: 0.59 X 0.0527 = 0.0311, or an approximate 3 percent increase in historic bid prices for the High Value Hardwood group on cable slopes. The resulting Grade Premium Factor is 1.03.

Table B-27. Net Value for SPECTRUM Modeling on Cable Ground

Modeling Group	Historic Bid Price ($/MCF)	Bid Price Reduction for Greater Costs ($/MCF)	Estimated Cable Bid Value ($/MCF)	Grade Premium Factor	Net Value for SPECTRUM Modeling On Cable Ground ($/MCF)
HVH	760	-140	620	1.03	639
MVH	500	-140	360	0	360
LVH	250	-140	110	0	110
HdwPulp	40	-140	-100	0	-100
HVS	770	-140	630	0	630
MVS	680	-140	540	0	540
LVS	450	-140	310	0	310
SftwdPulp	55	-140	- 85	0	- 85
Source: Compilation of data from previous tables.					

Activities

As previously shown, the Act requires that "*direct costs include anticipated investments, maintenance, operating, management, and planning costs attributable to timber production activities…*". A key point is that the activities must be attributable to timber production. In practice, few actions benefit only one resource. Prescribed burning done for wildlife habitat management has benefits for the timber program as well and vice versa. Thinning may benefit acorn production and therefore wildlife habitat. The logical test used by the Forest Service for planning, budgeting, and reporting is to answer two questions: 'What resource receives the primary benefit?' and 'What is the intent of the action?'

The Forest Service financial management framework was used to focus into the answer to these questions and thus identify the activities '*attributable to timber production*.' Within the Forest Service automated Central Accounting System (CAS) maintained at the National Finance Center (NFC) in New Orleans, Louisiana, there are two main categories of timber activities: (1) timber resource operations, and (2) timber resource improvements. These are identified as “ET1” and “ET 2”, respectively. Within these categories, there are finer and finer divisions as more codes are added successively to the right. Other Forest Service automated systems and hardcopy records maintain these categories and their codes. The two main categories and their major sub-categories are described below in the order in which they would occur before, during, and after a typical timber sale.

Timber resource operations - ET1

Silvicultural exams and prescriptions ET1112 - This is an inventory of existing vegetative conditions, entry of current information into CISC, comparison of existing conditions to Plan desired conditions, and prescribing activities to move toward the Plan desired conditions. This element also includes Supervisor’s Office oversight by the Forest Siliviculturist. The unit of measure is ‘acres.’

Sale project design ET1142 - Within this category are the activities required for compliance with the National Environmental Policy Act (NEPA). It begins with the Forest Service proposing a timber sale project and beginning internal and public review, called ‘scoping.’ It also includes interdisciplinary involvement such as botanical surveys, archaeological surveys, and participation on interdisciplinary teams. This phase ends with a signed decision on a timber sale design. The unit of measure is MCF or million cubic feet estimated to be harvested based on the silvicultural exam.

Appeals ET173 - Forest Service timber sale project decisions can be appealed by the public. Decisions on these appeals are made by the Regional Forester, but Forests compile a record and send it to the RO as the basis for a decision. This phase ends with a decision on the appeal. An appeal decision may require more sale project design work, but if so, this would be charged to ET1142.

Timber sale preparation ET114 - In this phase, the approved sale project has cutting unit boundaries marked, timber marked for cutting and cruised for volume estimation, fair market value timber appraisals prepared, timber sale contracts prepared, engineering surveys made, road design plans completed and approved, timber sale bid packages prepared and mailed, bids received, Sales Tracking and Reporting System (STARS) data entered, and bids opened and recorded. Money is spent for in-the-woods activities, District office work, and Supervisor’s Office work. Included in this phase is Supervisor’s Office oversight of timber marker certification, data recorder training and updating, and auditing of sale packages received from Districts for accuracy and completeness. This phase ends with award of the sale to a purchaser. The unit of measure is MCF based on timber marking, timber tally, and volume estimation.

Timber harvest administration ET12TC - This set of activities includes field inspections by trained and certified Forest Service Timber Sale Administrators (TSA) for compliance with the terms and conditions of the timber sale contract on the ground. On-the-ground administration includes designation of stream crossings, log landings, temporary roads, and constructed skid roads to meet Plan standards. It also includes maintenance of databases required for upward reporting on the timber program, most notably the Sales Tracking And Reporting System (STARS) and the Automated Timber Sale Accounting system (ATSA), also Timber Sale Administrator training and certification. There are three sub-categories of timber sale administration costs, corresponding to the timber sale purpose codes. These are: (1) TC for 'timber commodity', FS for 'forest stewardship', and PP for personal use. The activities are the same regardless of purpose code but only 'timber commodity' is appropriate for stage two analysis. Harvest administration ends for an individual sale when the sale is closed. The unit of measure is one thousand cubic feet or MCF.

Road construction and reconstruction – Road construction would be needed anytime the SPECTRUM model harvested in an analysis unit identified as 'unroaded' but not otherwise. We also planned for reconstruction of some portion of the existing road system in each decade. This need is based on experience and also on a general relationship that the life of a road facility is approximately twenty years before it needs work too extensive to be called maintenance.

Litigation ET173 - The Forest Service may be sued in the implementation of a timber sale project or projects. Activities associated with a suit include preparation of an administrative record, giving depositions, answering interrogatories, and reworking approved projects as a result of a decision. The unit of measure is dollars.

Timber resource improvements - ET 2

Reforestation ET24 - Activities in this sub-category are those needed to re-establish tree cover. For the purposes of stage two, this would be following a timber harvest. Site preparation after harvest is typically the first activity and may be done using a wide variety of methods. Secondly, planting is done for some species, usually the southern yellow pines and white pine, although in the past five years hardwood planting is also being done on a small scale. Thirdly, survival and stocking surveys of planted trees and certification exams of naturally-regenerated stands are done within five years of final harvest. Activities to protect the new stand from plants or animals may also be included. This phase ends with the certification of the new stand as stocked. NFMA requires that this certification be done by the end of the fifth year following final harvest (not site preparation). The unit of measure is acres.

Timber stand improvement ET25 - These are activities once a stand is established that manage a stand in early and mid-life and do not produce timber yields. The earliest treatment of this type is usually release of desired trees from the competition of other vegetation, especially planted seedlings that lack the large established root systems of trees present before the harvest. Weeding or cleaning treatments may occur to remove individual stems not contributing to objectives. Thinning may be done before trees reach a merchantable size (precommercial thinning) or without a timber sale when trees are of merchantable size but are economically sub-marginal or marginal (non-commercial thinning) to favor those species contributing most to objectives and to maintain a fast growth rate. Prescribed burning or other actions may be done to reduce understory or prepare seedbeds for future regeneration. The unit of measure is acres.

Genetic tree ET27 - This is a family of activities that supports the timber program through selection of superior trees and installing, maintaining, and collecting information on genetic test plots. Most of these test plots historically were of pine. In recent years this entire program area has been de-emphasized. There is very little likelihood that expenses will be incurred in this program area in support of timber objectives within the next fifteen to twentry years, if ever. The unit of measure used for the cost analysis is dollars.

Costs

As previously noted, stage two analysis is intended to show a comparison of *"… the direct costs of growing and harvesting trees, including capital expenditures required for timber production, to the anticipated receipts to the government…." 36 CFR 219.14 (b).* The National Forest Management Act further directs that "*Direct costs include the anticipated investments, maintenance, operating, management, and planning costs attributable to timber production activities…*"

A key to stage two analysis is including only those costs "*attributable to timber production activities*." The Forest Service has been criticized in the past both on the basis of what it considers costs in the first place, and which of those costs the timber program should bear. These criticisms focus on three different areas.

Environmental effects are often considered by critics to be 'costs'. However, these social and ecological costs are not part of stage two analysis. Instead they belong in 'stage three' analysis (which is the same as required NEPA analysis) which considers effects to the environment and tradeoffs among resources when alternative uses are chosen.

The value of purchaser credit roads is often cited as a cost to the timber program, or called a subsidy to purchasers. As previously discussed in the "Revenues" section of this report, NFMA explicitly identified purchaser credit roads as a 'payment-in-kind' receipt. However, since the purchaser credit road program no longer exists, the point is moot.

Finally, required transfer payments the Forest Service must, by law, make to others is cited by some as a cost. The two primary examples of transfer payments are the '25 percent fund' and a '10 percent fund.' The 25 percent fund is 25 percent of annual gross revenues from each National Forest returned to the States to compensate local county governments because the Federal government does not pay property taxes. The 10 percent fund is 10 percent of annual gross revenues from each National Forest returned to States for roads. These transfer payments are not part of stage two analysis for two reasons. First, they are not attributable to timber production activities. The amount of timber either growing in the woods, on log decks, or on the mill yard has no relationship to the formula for transfer payments. Timber growth and yield or volume reaching the market would not change if the percentages used were halved, doubled, eliminated altogether, or set equal to gross receipts. Second, Congress' decision to transfer the money to the States by the passage of the legislation requiring it does not change the fact that the money was first a revenue to the Federal government, which Congress has chosen to spend by transferring it to the States.

In 2000, an Act was passed which gave individual counties receiving payments tied to National Forest revenues to opt for a 'flat' amount that is an average of past high years. As of 2002, all or nearly all counties with Chattahoochee or Oconee National Forest ownership had opted for the 'flat' (called 'full payment') option. These funds are not generated from National Forest receipts, so required transfer payments no longer apply to a timber program.

Costs were compiled separately for each of timber resource operations, timber resource improvements, and roading using different data sources. Considerable time was spent researching and testing various options to derive the timber resource improvement costs without impacting District personnel. Planned average costs per acre of Knutsen Vandenberg (KV) sale area improvement plans were multiplied by acres reported accomplished in the Timber Resource Activity Control System (TRACS) and compared to actual expenditure data but it was found that the results were too variable to use with confidence. A Forest-level average per acre cost by work activity could also have been calculated. The procedure would have been to query the Central Accounting System to sum either the ET24 (reforestation) or ET25 (timber stand improvement) expenditures, then divide by the total acres reported accomplished in a fiscal year in each category in the Timber Resource Activity Control System (TRACS). However, this figure - while a useful indicator - was too coarse, because it was neither activity, method, nor location specific and would not be very useful in stage three analysis. Unit costs for reforestation and timber stand improvement were therefore developed by District personnel.

For each cost category, Oconee and Chattahoochee data were compiled separately because historically some costs have been much less on the Oconee, and also because there are logical technical reasons to anticipate different costs. In addition, as data were compiled it was reviewed to see if there was a pattern of either lower or higher costs for specific activity groups on the Armuchee District in the Southern Ridge and Valley.

The objective of cost analysis was to have ecological Section level dollar per unit volume for timber resource operations or dollar per acre figures for timber resource improvements which were detailed enough to (1) relate to specific activities, and (2) be generally insensitive to further cost breakdowns.

Data Sources and Methods

A wide variety of data in budgeting, work planning, accomplishment reporting, and financial management systems is available for costs. Each particular system has been designed to accomplish specific objectives and therefore has its own characteristics. Sometimes these objectives do not include the ability to calculate refined per unit costs for specific activities; that is, the level of detail is to the timber program level or an activity group, not an individual activity. Therefore no single data source nor method of collection was sufficient for all costs figures. Instead, different data sources had to used, and used in different ways, depending upon the cost data needed. Data sources and methods are discussed individually by activity groups.

All cost data had the problem that it was for a period of great uncertainty and change. Several factors beginning in about 1992 greatly changed timber costs, which had already increased significantly from Plan estimates as a result of shifts away from clearcutting. Examples include: longer time frames for NEPA procedures; greatly expanded environmental assessments from about 10-page documents in 1986 to about 150 pages in 1996; rework of sales as a result of litigation; overhead assessments for the implementation of a Geographic Information System (GIS) computer database; and steadily increasing upward reporting requirements through automated timber tracking programs such as the Sales Tracking And Reporting System (STARS), the Automated Timber Sale Accounting system (ATSA), and the Timber Sale Program Information Reporting System (TSPIRS). While these costs were increasing, the amount of volume being sold and acres being reforested were decreasing, thus raising unit costs even more. At the same time, the number of personnel with salary being paid from ET work activities was steadily decreasing as four consecutive 'buyouts' gave financial incentives to employees to retire early as a result of Federal downsizing efforts. The costs of these buyouts, however, were charged to the timber program if the individual retiring was primarily a timber position. In short, the last six to eight years have not been routine ones in the timber management program. It is unclear if stability at any level of harvest will return anytime soon. In such a situation, the stage two analysis needs to exclude extraordinary costs that are not "attributable to timber production activities" and to include varying costs to test the sensitivity of the results to this particular activity group. In practice, it is impractical to manually track down each such cost. Rather cost figures should be considered liberal.

In this section, costs are considered for the same categories as shown in the "Activities" section of this appendix. Data sources and analysis specific to each category are described individually for that category.

As cost figures were compiled, they were inflated or deflated to 1996 dollars. There were two reasons for doing so. First, they needed to be on a common basis with revenue figures so the comparison required by NFMA could be made. Secondly, making this adjustment was needed to reveal 'real' cost trends. The same GNP deflators were used as for revenue calculations. (See "Revenues" section of this appendix for more detail.)

<u>Timber Resource Operations</u>

The Timber Sales Program Information Reporting System (TSPIRS) was chosen as the best source for timber resource operations. TSPIRS data were chosen because the system was specifically designed at the direction of Congress as a collaborative effort between the Forest Service and the General Accounting Office (GAO) to be an accounting system for the national forest timber sale program. The Chattahoochee-Oconee was a pilot test Forest and TSPIRS was implemented here in 1988 so we have one of the best time depths in the data within the Southern Region. In addition, it uses ‘generally accepted accounting principles’ and selects from CAS using a computer query only that portion of actual expenditure data that are attributable to timber. In so doing it meets the mandate of NFMA to consider those costs “attributable to timber production activities.”

As compiled each year, TSPIRS costs have been reported in fifteen separate cost categories during the period 1988 through 1997, inclusive. These categories are: (1) harvest administration - timber purpose sales, (2) harvest administration - forest stewardship sales, (3) harvest administration - personal use, (4) general administration sales, (5) sale preparation, (6) analysis and documentation, (7) appeals and litigation sales, (8) road design and construction, (9) other resource support, (10) timber planning, (11) transportation planning, (12) silvicultural exam, (13) genetic tree improvement, (14) appeals and litigation - indirect, and (15) timber program general administration. Not all of these categories have existed the entire time, but have been broken out of other categories along the way. In TSPIRS, the first thirteen of these are considered direct costs; the last two are indirect costs.

Initially, TSPIRS costs were compiled in a spreadsheet for each fiscal year and reporting category just as they came from the annual hardcopy TSPIRS reports. In years where the category did not exist, the costs were zero. An average per unit cost was also calculated for each category and fiscal year. For ‘harvest administration’ the divisor was ‘volume cut’ as reported through the Automated Timber Sale Accounting (ATSA) system each year. For all other categories the unit was ‘volume offered’ which is the volume that was advertised for bid regardless of whether it sold or not. The reason for this difference is that there is no harvest administration activity unless volume is cut. But for all other categories, costs are incurred in working to bring volume onto the market whether it is sold or not. Once they were calculated, the per unit costs were adjusted to a common base year of 1996. The unit used for each of these was one thousand board feet or “MBF.”

This preliminary collation was reviewed and discussed by Paul Arndt, regional planner; Karl Stoneking, regional inventory and planning; and Ron Stephens, forest silviculturist. As a result, the fifteen separate cost categories were re-combined into just six as follows: (1) harvest administration; (2) sale preparation; (3) inventory and NEPA; (4) road planning, design, and construction; (5) general administration sales; and (6) other indirect costs. Categories one through four are direct costs and are modeled in SPECTRUM. Categories five and six are indirect costs and are calculated in Present Net Value spreadsheets and discussed in the ‘Social & Economic’ portion of this Appendix. .

TSPIRS data was not used for road construction activities. Instead an estimate of the miles of road to be constructed and the cost per mile was developed collaboratively with the Cherokee National Forest. An average road construction distance per unit volume was calculated and entered in SPECTRUM as a coefficient for road construction for any harvest in the unroaded class. Average per mile road construction costs for a class D intermittent-service road were obtained from Engineering Staff. Any additional roads to be constructed were assumed to be class D based on the amount, size, and distribution of unroaded areas and historic experience under the 1985 plan. Class D roads are characterized by being managed as closed, having a design vehicle other than passenger cars, typically being spot-surfaced rather than full-surfaced, being unditched, and having vertical cut banks.

Road reconstruction costs were approximately 75-percent of construction costs and were also obtained from Engineering Staff. A road reconstruction coefficient based on volume was used for all harvested volume except for the first harvest in an unroaded area. In that case the road construction coefficent applied.

Timber Improvement Operations

After considering several alternatives, as previously described, it was decided that the way to get silvicultural treatment costs was to ask District personnel to compile them from various records. This option was chosen to simultaneously get accurate figures and to obtain them in a timely manner.

A letter signed by Deputy Forest Supervisor Marisue Hilliard was sent on April 30, 1998, requiring Districts to furnish direct project costs per acre for each of twenty-four silvicultural treatments if they had been used on the District. Attached to this letter were:

(1) a list of treatments needing a cost estimate;
(2) detailed instructions on estimate preparation, including inflation adjustment factors;
(3) a definition of ‘direct costs’;
(4) seedling costs from contracts for each of southern yellow pines and white pine;
(5) herbicide contract prices by year and specific herbicide;
(6) Pay schedules for Forest Service employees;
(7) summary information of silvicultural contracts;
(8) a blank ‘Cost Estimate Worksheet’ created for this need; and
(9) a completed example ‘Cost Estimate Worksheet’.

Each worksheet included space for labor, materials, and equipment costs. Each one identified the number of samples used to calculate any average used and also identified the information source for each cost item. Each worksheet included space for a statement as to whether or not the estimate represented average District conditions, identified factors that would cause the costs to increase or decrease, and a space for an estimate of the percent change due to each factor.

Completed worksheets were returned from the Oconee, Chattooga, and Tallulah Ranger Districts. The Oconee costs were used separately for only the Oconee. The Tallulah and Chattooga costs were averaged together to get costs for use in the Blue Ridge and the Ridge and Valley. In addition, the very refined method-specific data was reviewed for the need to maintain method-specific data at a strategic plan level. The choice of specific methods or tools is properly a project level decision. Beyond this, there was a clear clustering of costs per acre within a narrow range for most methods of vegetation treatment. The two notable exceptions were prescribed burning, our cheapest method, and mechanical treatments, our most expensive. Of these, mechanical treatment has been very little used for several years and is unlikely to be in the future as well. Prescribed burning will be used extensively but was clearly not appropriate as a value representative of any other method.

After our effort was complete, the Regional Office instituted a similar effort across all the Forests in revision using our process as the template. The results were compiled and distributed to Forest silviculturists and analysts. Though compiled independently, the results were generally very comparable with ours.

After considering all the data, we used generic costs per acre for reforestation that were appropriate for a range of methods. They are neither the low end of the range nor the high end. Historically, the cheapest method of site preparation has been prescribed burning and the most expensive has been mechanical treatments such as drum chopping or shear and rake. In the past ten years, burning has been used much more than mechanical treatments and is expected to be in the future. Because they do not rely heavily on prescribed burning, they are probably liberal rather than conservative. These values were not arithmetic averages but were also informed by the emphasis of alternatives and differences in management direction from the past such as reduced numbers of stems in re-stocking standards and explicit acceptance of mixed types of all kinds.

Table B-28. Summary of SPECTRUM Direct Timber Costs, Base Year 1996.

Description	Cost	Unit of measure
Harvest administration costs	$60	MCF
Inventory and NEPA costs	$200	MCF
Road construction costs	$27,750	MILE
Road reconstruction costs	$20,250	MILE
Sale preparation costs	$120	Acres
Site preparation -Artificial	$115	Acres
Site preparation -Natural	$85	Acres