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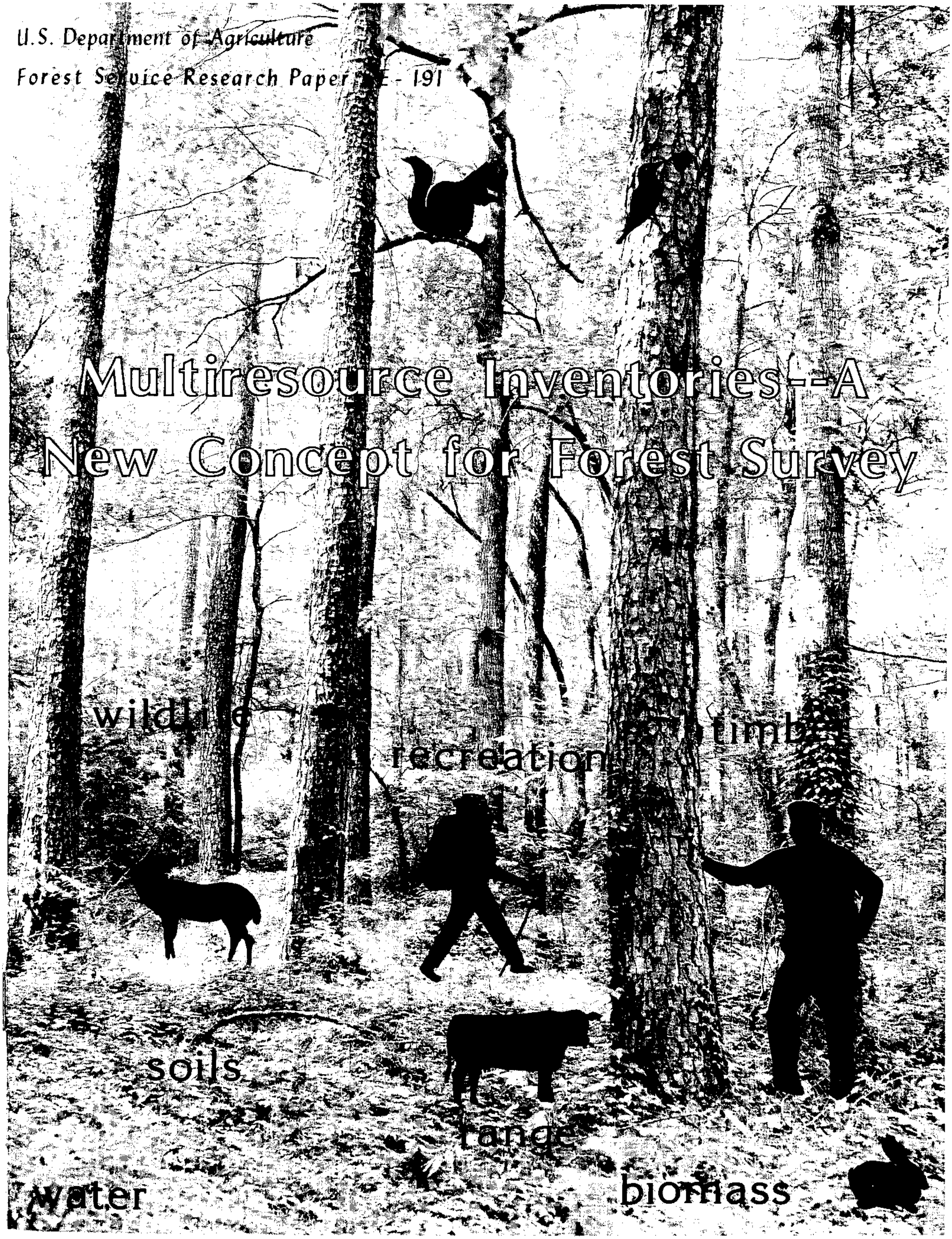
Multiresource Inventories--A New Concept for Forest Survey



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Asheville, North Carolina

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Multiresource Inventories--A New Concept for Forest Survey

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INTRODUCTION

The way a nation manages and uses its natural resources largely determines its economic strength, the integrity and quality of its environment, and the satisfaction and well-being of its people. Finite resources such as oil and minerals are being exhausted, forcing us to rely on renewable resources — those that can be reproduced and perpetuated. America's forest and range resources are good examples.

As America increases its dependence upon forest and range resources, there is a growing need to understand the complex interactions among their many uses. At issue is the optimum allocation of these resources among the various uses. The public and its planners and decision-makers must have adequate. up-to-date information if a rational course of action is to be charted. This Paper describes an approach and system for obtaining the information.

NEED FOR BETTER RESOURCE INFORMATION

The Nation has adopted a policy of multiple use of its forest and rangelands. Strong public pressures are being applied by special interest groups to favor one use over another. There is an acute need for better resource information to help resolve these complex resource issues.

Multiple-use management requires a balance of multiresource information. While conventional forest inventories have provided a wealth of information on timber, they have not been designed to inventory the forests from the standpoint of multiple use. From this standpoint, the species composition, quantity, and spatial arrangement of the lesser vegetation become as important as the trees. Whereas rough, rotten, hollow, or dead trees might have little or no value fortimher, these same trees are valuable for wildlife habitat.

The idea put forth in this Paper is to build multiresource inventories on the foundations already established for timber. The proposal is to expand the scope of conventional timber inventories to include the species composition, quality, and spatial arrangement of total biomass, and nontimber attributes of each significant plant community. The primary objective of these inventories would be to monitor the successional stages of each significant plant community in both the presence and absence of man's intervention. Because of the magnitude of the inventory task. we envision continued reliance upon sampling as opposed to mapping. Nevertheless, ecological information obtained from the inventories would contribute greatly to in-place use and management of the resources.

WHO WILL PROVIDE THE INFORMATION?

Within the research arm of the Forest Service, Renewable Resources Evaluation (RRE) is a logical candidate for assuming the added inventory responsibilities. RRE. formerly known as Forest Survey. dates from about 1930 (Doig 1976). Chartered by the McSweeney-McNary Forest Research Act of 1928, Forest Survey conducted the conventional forest inventories referred to earlier. Passage of the Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 broadened the scope of Forest Survey activities. RRE was directly involved in the initial implementation of RPA.

Organized into regional Work Units. RRE possesses a wealth of experience in both inventory and resource analysis. In response to the RPA requirements, the RRE Work Unit in the Southeast proposed procedures for expanding its Forest Survey activity into a multiresource inventory. The Forest Service authorized RRE to test these procedures in a pilot study during the fifth inventory of South Carolina.

PURPOSE OF THIS PAPER

The purpose of this Paper is threefold: (1) to summarize the background of RRE's forest inventory activity in the Southeast, (2) todocument an approach to multiresource inventories, and (3) to report on the status of the South Carolina Pilot Study.

BACKGROUND

The McSweeney-McNary Forest Research Act of 1928 recognized the importance of timber resource inventories. Section 9 of this Act authorized and directed the Secretary of Agriculture to make and keep current ". . . a comprehensive survey of the present and prospective requirements for timber and other forest products in the United States and its territories and possessions, and of timber supplies including a determination of ways and means to balance the timber budget of the United States." In response to this Act. the Forest Service organized the Forest Survey.

HISTORY OF FOREST SURVEY IN SOUTHEAST

In the Southeast. Forest Survey began statewide forest inventories in Florida and Georgia about 1933 (Knight 1972). The inventory method was patterned after procedures used in Sweden and Finland. Crews followed compass lines spaced 10 miles apart and sampled 114-acre plots at intervals of 660 feet along these lines. Within the forest. crews classified each plot as to forest type and stand size. tallied the trees by species and size to determine volume, and bored selected sample trees to determine diameter growth rates. A field canvass of primary wood-using plants provided information for estimating timber cut.

Data collection in this initial inventory of the Southeast extended over 7 years and was completed in Virginia in 1940. After completion of the initial inventory of the Region. Forest Survey stopped plot sampling during World War II hut continued to compile. analyze. and report information. Since computers were not yet available, most of the computations were performed with desk calculators. Nevertheless. these efforts provided planners and decisionmakers with their first systematic measure of the timber resource for an entire Region.

In 1946, Forest Survey began its second inventory of the Southeast in South Carolina. This inventory was completed in Virginia in 1957. Methods differed significantly from those used the first time around. Aerial photographs. then available for most areas, were used to interpret land use and to select and locate ground sample plots. Crews located and measured 115-acre sample plots randomly selected and systematically distributed by grids printed on aerial photographs. In addition to classifying areas and counting and boring trees, crews tallied stumps of recently cut trees to estimate timber removals. Again. canvasses of wood-using plants provided for breakdowns of the removals by product. Special studies provided utilization factors needed to relate the removal estimates to product output.

A primary objective of the second inventory was to determine trends in the timber resource. For the first time. crews marked anddescribed the locations of the sample plots so they could be rrmeasured. Experience had shown that permanent sample plots were needed to improve estimates of timber growth. mortality. and removals and to monitorchanges in the resources.

By the midfifties. Forest Survey information had been accumulated for most of the country. With this information, the Forest Service made the most extensive review of the Nation's timber resources ever undertaken. The Forest Service published the results of this review in a 713-page report. "Timber Resources for America's Future" (USDA FS 1958).

Without any delay, Forest Survey began its third inventory of the Southeast in 1957: the job was completed in 1966. The basic theory of point sampling had advanced to accepted application. lnstead of tallying all trees on a fixed-area sample plot, an angle-gage was used to select sample trees based on tree diameter and distance from plot center (Grosenbaugh 1952). Crews tried two modified versions of this new sampling technique during the third inventory cycle. In South Carolina. Florida, Georgia, and the Coastal Plain of North Carolina, crews superimposed a single basal area (BA-10) plot over each of the old 1/5-acre plots. In all subsequent inventory work, crews installed a 10-point cluster of BA-37.5 plots at each of the locations. The latter plot design significantly reduced the number of sample locations required to achieve the desired minimum accuracy.

In the third inventory, emphasis was placed on obtaining more reliable measures of the components of change — timber growth, mortality. and removal. While the remeasurement opportunity afforded by permanent plots was under study, crews continued to bore trees for diameter growth rates and to make stump counts for estimating removals. By 1959, most of the technical problems had been worked out and thereafter growth, mortality, and removal were estimated largely from remeasurement data.

Other significant sampling procedures introduced toward the end of the third inventory cycle included (I) a proportionate distribution of the sample plots across all land uses to enhance the measure of land-use change, and (2) a tree-volume subsample to improve volume prediction equations. The computer was fast replacing desk calculators and tabulators in processing the data.

The Forest Service undertook another comprehensive review of the Nation's timber resources in the early sixties. Again, Forest Survey data provided the basis for the appraisal. This appraisal focused on trends and projections of prospective timber supplies. "Timber Trends in the United States" (USDA FS 1965).

The fourth inventory of the Southeast was begun in 1966 and completed in 1977. During this fourth cycle. Forest Survey completed its shift to the 10-point cluster of BA-37.5 plots to determine inventory volume. Estimates of timber growth. mortality. and removals were based entirely on remeasurement data. Forest Survey continued its tree-volume subsample, timber utilization studies. and timber product output studies. The latter studies are conducted through cooperative efforts with the individual States. In 1968. starting with the fourth inventory of Florida, Forest Survey intensified its land-use sample both on photos and on the ground from a grid of single points to a grid of 16-point clusters.

During the early seventies, the Forest Service made still another appraisal of the Nation's timber resources. This appraisal occurred at a time when forest policies and forestry practices were being seriously questioned and reexamined. The appraisal focused on the condition of the forests and the identification of opportunities available for increasing prospective timber supplies, "The Outlook for Timber in the United States" (USDA FS 1973).

Throughout the first four inventory cycles, demand for Forest Survey information on the Southeast increased. While the primary objective of Forest Survey was to provide data for the national appraisals, State and local uses of the data further supported the need for the program. Because of frequent requests for data, Forest Survey established a comprehensive data bank and information retrieval system in 1970. Called Forest Information Retrieval (FIR). the system provides for rapid compilation of forest and timber statistics on a custom basis and at a nominal cost (McClure 1972). With FIR, information can be compiled in three ways: (1) whole counties grouped together, (2) circular areas around a specified point, or (3) irregular boundaries within a closed traverse of short-line segments.

Increased State and local use of the information also generated strong pressure to shorten the inventory cycles, intensify the sampling, and collect additional information. A National Handbook establishes the goals in each of these areas by specifying information required for national appraisals, minimum accuracy standards, and the periodicity of the inventories. Funding and manpower limitations have at times extended the inventory cycles beyond the established goals. At other times, cooperative assistance has enabled Forest Survey to finish early.

TRADITIONAL TIMBER INVENTORIES

All the inventories mentioned thus far focused primarily on timber. While they provided the official estimates of total forest acreage. detailed classifications and measurements were generally confined to lands classified as commercial timberland. Traditional area classifications included forest type, site class, stand size and age. stocking condition, and ownership. In the more recent inventories, additional area classifications have included stand origin, stand history, physiographic class, slope, aspect, and treat!, opportunity.

The inventories have provided tree counts and their associated volumes by species, diameter. and quality along with their growth, mortality, and removal rates. Together, the area classifications, tree counts, and volume estimates have adequately described the makeup of the forest resources from the standpoint of timber. The inventories have largely ignored lesser vegetation and any attributes unlikely to influence timber production.

RESOURCES PLANNING ACT-A TURNING POINT

A growing awareness of the complex interactions among the many forest uses together with a recognition of acute problems in the budgeting process led Congress to pass the Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974. RPA directed the Secretary of Agriculture to prepare a Renewable Resource Assessment not later than December 31, 1975, to be updated during 1979, and each 10th year thereafter. RPA stated the Assessment ". . . shall include but not be limited to:

(I) An analysis of present and anticipated uses, demand for, and supply of the renewable resources of forest, range, and other associated lands with consideration of the international resource situation, and an emphasis of pertinent supply and demand and price relationship trends:

(2) An inventory. based on information developed by the Forest Service and other Federal agencies, of present and potential renewable resources, and an evaluation of opportunities for improving their yield of tangible and intangible goods and services. . ."

RPA superseded the McSweeney-McNary For-est Research Act of 1928 and has been described as a hold new experiment in resolving resource issues. In addition to its requirement for periodic Assessments, the Act directed the Secretary of Agriculture to develop a long-range Program for the Nation's renewable resources that will assure an adequate supply of forest and range resources in the future while maintaining the integrity and quality of the environment. The Act called for the Program to be prepared by December 31. 1975, subject to revision in 1980 and ever-y 5 years thereafter.

Because of the short time available, the 1975 Assessment and Program were prepared from existing data obtained from the Forest Service and other agencies. In developing the Program. the Forest Service grouped all its activities into six resource systems: (I) outdoor recreation and wilderness, *(2)* wildlife and fish habitat. (3) range. (4) timber, (5) Land and water, and (6) human and community development. After analyzing data available for each resource. the Forest Service developed several broad alternative goals for each system. The goals ranged from less than the current trend in activities to well above current program levels.

For each goal, the agency developed targets of measurable outputs of goods and services such as acres of wilderness, animal-unit-months of grazing, or board feet of timber. Each target was translated into specific activities needed to meet that target, by relating inputs of dollars and materials to outputs of resources, benefits, or services. This procedure created more than 5,000 possible combinations of activities from which to select a unified program. From these possible combinations, the agency developed eight alternative programs for public review. These eight alternative programs offered a variety of reasonable options, ranging from a reduction in present levels of operation to intensive management of virtually all activities. After subjecting the eight alternatives to extensive public review, the Recommended Pr-ogram was approved by the Secretary of Agriculture and transmitted to Congress by the President in accordance with RPA.

The final chapter in the first Assessment addressed the subject of scientific information and data needs. The Assessment acknowledged that "inventories of forest, range and inland water resources are basic to almost any decision concerning the management or use of these resources." The Assessment further acknowledged the contributions from Forest Survey and pointed out needs to accelerate the inventory cycles, intensify the samples to provide more precise local data, and expand the Forest Survey to include forest and range resources other than timber. The Recommended Program called for the Forest Service to expand its research activities in several areas, including "resource inventory and evaluation." The agency changed the name of Forest Survey to Renewable Resources Evaluation (RRE) and began techniques research on the problems associated with multiresource inventories.

MULTIRESOURCE PILOT STUDY IN SOUTH CAROLINA

The RRE Work Unit in the Southeast was authorized to test its proposed multiresource inventory procedures during the fifth forest inventory of South Carolina. South Carolina has a representative range of the forest conditions found in the Region. The State contains a portion of the Southern Appalachian Mountains. a large area of rolling Piedmont conditions laced with narrow flood plains, an extensive belt of sandhills, and a broad expanse of flat coastal plain interspersed with swamps and broad flood plains. For inventory purposes, the State is divided into three Survey Units: (I) Southern Coastal Plain. (2) Northern Coastal Plain, and (3) Piedmont. The mountains occur in the Piedmont Unit and the sandhills occur in both Coastal Plain Units.

Fieldwork began in South Carolina in April 1977 and was completed in Seprember 1978. The new data for the Piedmont became available in late 1977. and some of the basic forest statistics have been published (Snyder 1978). Currently, RRE is subjecting the data to validation analysis from the standpoints of both timber and nontimber interests. Plans call for a comprehensive and balanced analysis of all the data at the State level.

APPROACH

The approach taken by Renewable Resources Evaluation was to expand the timber-oriented inventory into a broader. multiresource inventory by making maximum use of established inventory methods and providing an orderly transition. The first major task was to explore possibilities and select an appropriate course of action. The plan that evolved was described in a prospectus, "Evaluating Renewable Forest and Rangeland Resources in the Southeast."

Experience with timber inventories provided us with a good understanding of the problems associated with resource evaluations. There are certain similarities in the ways different renewable resources can be inventoried. Hence, computer and data management systems. maps, aerial photographs, coding systems, and field-data-collection operations designed for timber inventories could likely be used with minor modifications in dealing with the nontimber resources. It was obvious, however, that certain aspects of the multiresource inventory would require highly specialized methodology and techniques.

DEFINING RENEWABLE RESOURCES

One important planning element was a definition and understanding of what should be included as Renewable Resources. Preliminary work by the National RPA assessment team produced a working definition and listing of resources to be included:

Renewable resources.—Those resources whose use can he maintained indefinitely if the use rate does not exceed the ability to renew the supply. Renewable resoul-ces for which the Forest Service has some responsibilities include:

1. Timber	5. Water
2. Range	6. Recreation
3. Wildlife	7. Wilderness
4. Fisheries	8. Land

Forest and rangeland are two major land-use classes which were specifically identified by the Resources Planning Act. Therefore, they were of particular importance to Forest Service resource evaluations and needed to be clearly defined. Again, preliminary work done on the Assessment produced useful definitions for these key classes of land use.[1]

Forest land.—Land at least 10 percent occupied by forest trees of any size or formerly having had such tree cover and not currently developed for nonforest use.

Rangeland.—Land on which the native vegetation (climax or natural potential) is predominantly grasses, grasslike plants. forbs. or shrubs

[1] On July 12. 1976. the Forest Service and Soil Conservation Service jointly agreed on a common set of definitions which differ slightly from those presented here.

suitable for grazing or browsing, and present in sufficient quantity to justify grazing or browsing use. Rangelands include grasslands, savannas, shrublands. most deserts. tundra, alpine communities, coastal marshes, and wet meadows.

The Forest Service elected to place renewable resources into six major resource systems. which provided additional structure for a resource evaluation. For inventory purposes, the definition of a resource system and the six major resource systems were:[2]

Resource system.—A major Forest Service endeavor, mission-oriented, which fulfills statutory or executive requirements and indicates the collection of activities from the various operating programs required to accomplish the agency mission.

1. Outdoor Recreation and Wilderness
2. Wildlife and Fish Habitat
3. Rangeland Grazing
4. Timber Resource
5. Land and Water
6. Human and Community Development

In addition to the six major resource systems. the Forest Service identified eight major uses of forest and rangeland:

1. Wildlife
2. Grazing
3. Outdoor Recreation
4. Timber
5. Water
6. Wilderness
7. Other Uses (parks. scenic rivers, historic sites. etc.)
8. Minerals

Within the broad areas covered by the six major resource systems and eight major-use categories, there are numerous individual renewable resource subjects which relate in one way or another to the general concepts of renewable forest and rangeland resources. The question was: Which subjects would be appropriate for RRE to deal with and how could this be done'?

FOUR WAYS TO GATHER ADDITIONAL INFORMATION

The approach taken by RRE was based on several general concepts. The total land and water area of each county and State can be separated into land-use classes, each with unique and meaningful characteristics. Each class can be further stratified into subclasses that offer relative homogeneous resource-use opportunities. For example, forest lands can be stratified by forest type. stocking, ownership. site class. stand age. etc.; marshlands can likewise be stratified by characteristics such as vegetation type. fresh or salt water, size of marsh. coastal or inland. etc. Water can be separated into streams and lakes and further stratified by width or size.

Assignment of land-use classes offers two distinct advantages: (1) RRE's permanent sample grid points falling in each use class can be revisited. subsampled. or otherwise used as a proportionate sample of the entire land base. (2) Changes in acreage in use classes can best be measured using a permanent grid of samples in all land-use classes. The land-use classes now recognized in the five Southeastern States are:

1. Commercial Forest
2. Productive-Reserved Forest
3. Other Forest (formerly Unproductive Forest)
4. Cropland
5. Improved Pasture
6. Natural Range
7. Idle Farmland
8. Other Farmland (including farmsteads)
9. Urban and Other
10. Marsh
11. Water

Permanent grid points falling in each of the above land-use classes are further classified by using aerial photographs, direct observation from aircraft, or ground checks. Points on forest and rangeland are generally visited on the ground and numerous measurements and classifications are recorded. Points in other land-use classes are simply verified, and a minimum of data is recorded.

Four general methods appeared to be available for gathering additional resource information:

1. Taking additional measurements and observations at the existing permanent grid samples established in all land-use classes in the Southeast.

2. Other sources of information taken from maps and overlays or sample data located by geographic coordinates could be combined with inventory sample data to produce a more complete composite description of the area sampled. This type information can also be summarized by geographic area and used to supplement the analysis.

[2] For its 1980 RPA Program, the Forest Service is using 11 resource elements instead of these 6 resource systems.

3. Special sampling schemes could be developed using some combination of remote sensing, conventional or high-altitude aerial photography, direct aerial observation. and ground sampling.

4. Available information could be obtained in essentially final form from other sources. Statistics on hunting and fishing. populations. employment, and payrolls, for example, can be obtained in this manner.

With at least four possible ways to collect or otherwise acquire additional data on renewable resources. the question became one of where to start. We decided to concentrate on the first method. The reasoning was that it would take a complete inventory cycle of 8 to 10 years to gather new data uniformly across the Southeast, and that the process should begin immediately. The other methods could be used to gather broad coverage information in a relatively short time. Another consideration was that most of the information needs already identified would require ground sampling.

CONSULTING WITH SPECIALISTS AND EXPERTS

When the RPA passed in 1974, Forest Survey had been conducting timber inventories in the Southeast for over 40 years. Because timber had been emphasized, the project team contained specialists in mensuration, timber-resource analysis, sampling, computer science. and timber utilization. The responsibilities associated with the RPA created a need for additional expertise in specialties such as wildlife, range, recreation, ecology, hydrology. and soils. In the long term, this need for additional expertise could be satisfied by adding specialists to the project staff, but an alternative shot-t-term solution was necessary.

The need to gain expertise without adding specialists to the project was partially satisfied by selected reading and study of nontimber resources. The more important source, however, was through contacts with specialists and experts at research stations. universities, State agencies, other Federal Agencies, and throughout the Forest Service.

Help of many individuals was enlisted at a variety of seminars, meetings. and programs attended by RRE scientists. Specialists in wildlife. range. recreation. hydrology. soils, ecology, etc.. were asked to provide suggestions for improving the inventory in their particular area of expertise. The same individual:. were asked to review new procedures, to comment on direction. and. finally. to visit inventory crews at work in the field. Although each individual's contribution may have seemed small. the aggregate contribution of dozens of individual scientists. specialists. and experts was vital in developing an experimental multiresource inventory in South Carolina.

ADAPTING EXISTING INVENTORY METHODS

To expedite the development of a multiresource inventory. the RRE staff searched for nontimbel- inventory methods that were already operational. It was obvious that there would not be enough time to develop and test a completely new set of nontimbel- inventory methods and still meet the 1980 Assessment target dates. The search for proven methods was pal-tially successful. The published works of MacArthur and MacArthur (1961) provided several useful concepts and techniques which were adapted into a procedure for measuring vegetative profiles. The procedure developed in Mississippi (Lentz 1974) for ranking wildlife habitat proved valuable and added to the inventory. Field procedures used by the Tennessee Valley Authority, Norris. Tennessee, were adapted for measuring and coding nontimber variables. The forest range inventory procedures developed in Louisiana (Pearson and Sternitzke 1974) were modified slightly and added to the inventory. Numerous other procedures were gleaned from the literature. And finally. a number of experimental concepts were added on a test basis to achieve a well-balanced coverage of the nontimber resources. As the South Carolina Pilot Study progressed and other specialists reviewed the fieldwork. a number of additions were made to the inventory.

THE SOUTH CAROLINA PILOT STUDY

In 1976. South Carolina was selected as one of the six pilot study areas in the United States to be highlighted in the 1980 RPA Assessment. The specific mission in South Carolina was to develop and test procedures for multiresource inventories (USDA FS 1977). RRE in the Southeast had been involved in a number of nontimber resource studies and had a general conception of the additional inventory needs. The pilot study, therefore, permitted the development and testing of a number of new procedures. There were several reasons why South Carolina was an excellent place to test new inventory methods:

1. The State Forester and the South Carolina Forestry Commission were expected to fully support this inventory.

2. The forest industry in South Carolina was diversified and its reaction would be representative of forest industries throughout the Southeast.

3. The State Extension Forester had indicated his intention of fully supporting and heing involved in the new inventory.

4. Station Research Work Units within the State could provide some expert assistance needed to broaden the survey.

5. The South Carolina Wildlife and Marine Resources Department had indicated considerable interest in working with RRE in several ways.

6. South Carolina is centrally located in the Southeast and has agood representation of southeastern forest conditions.

7. South Carolina is the smallest of the five Southeastern States, and can be inventoried in a reasonably short time. Its three Survey Units offered three separate opportunities to try new procedures.

SPECIAL FEATURES OF THE PILOT STUDY

Since the sampling needs for nontimber resoul-ces and analytical methods were uncertain, orocedures were develooed to take full advantage of 4,230 permanent forest sample locations established during the orevious inventorv of South Carolina in 1966–68. Consultations with experts on soils, hydrology, range, wildlife. ecology, and outdoor recreation prior to the pilot study revealed that many data elements already being collected for timber inventories were equally useful in assessing nontimber attributes (Sternitzke and Pearson 1974). We looked particularly for such link variables, which are indicative of more than one resource condition. This approach permitted us to make additions instead of building an entirely new system. Classifications and measurements made at each sample location focused on special information needs for evaluating wildlife habitat. recreation use, range suitability. water quality, erosion hazards related to forestry practices. and the use-interaction relationshios associated with the numerous forest conditions occurring throughout the State. A major goal in the new procedure was to quantify and describe all the vegetation in South Carolina's forests. The theory was that the vegetative makeup of different forest conditions reflects the basic ecological relationships vital to multiresource evaluations.

A SHOWCASE INVENTORY

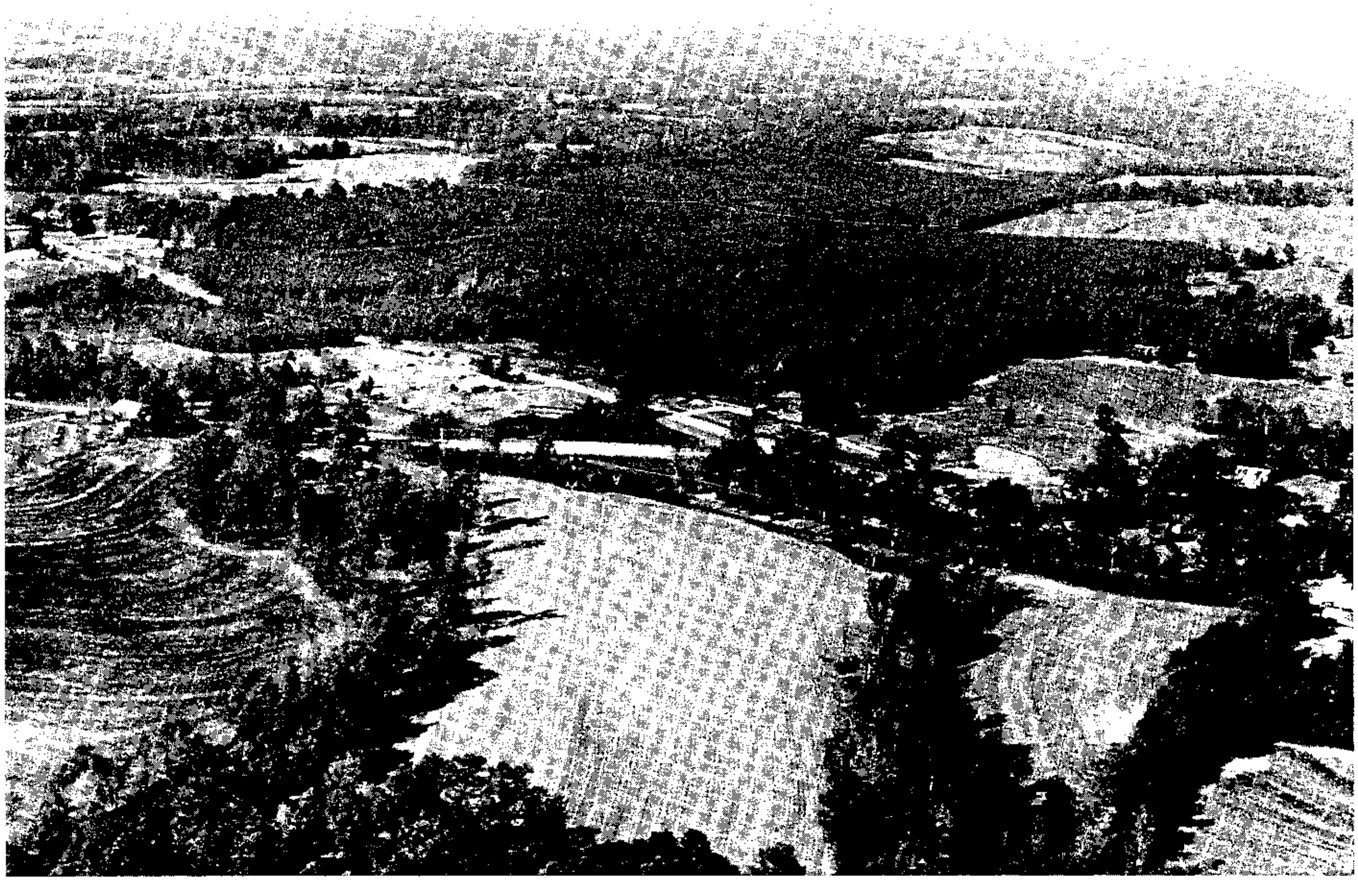
Since the South Carolina multiresource inventory was brand-new, it became a showcase as soon as word about it spread. Many inquiries about procedures were received long before the sampling methods and procedures were outlined in the field guide. Due to the enthusiasm and interest in this new inventory, a number of individuals were invited to review the procedures on the ground. Representatives from other RRE projects, States. Forest Service Region 8 (R-8). Southeastern Area State and Private Forestry (SA), National Aeronautics and Space Administration. and Soil Conservation Service visited sample plots near Spartanburg. South Carolina. Discussion there centered on sampling procedures. plot layout. kinds of information heing collected, and reasons for including items in the study. Our goal was to obtain critical review of our procedures while we were keeping interested specialists informed. Many suggestions and ideas evolved from the mixing of different disciplines on the demonstration plots. For example, soil experts visiting the demonstration plots showed us how slope length should be evaluated. Field vrocedures were later modified to apply the new concept across the entire State. This review generated a lot of support for RRE and involved specialists who would be helpful in the future.

STEERING

To encourage formal communication within the Forest Service as well as to provide direction. an in-Service Steering Committee was formed. Its three members were: Leroy Jones. SA, Atlanta; Jim Sabin, National Forest System. Atlanta; and Dave Olson. Southeastern Station (SEFES). Asheville. Representation from all arms of the Forest Service provided a coordinated reseal-ch effort. The Steering Committee prepared a study plan. helped arrange for external involvement, monitored progress of the inventory, assisted in analysis and evaluation, and assisted in preparation and review of the South Carolina reports.

SOUTH CAROLINA STUDY PLAN

The study plan that the Steering Committee prepared outlined the objectives of the pilot



study, provided a schedule of both In-Service and external involvement, and discussed the types of reports that would be produced. The study plan named experts and specialists from the three arms of the Forest Service who could provide guidance and technical expertise. The specialists listed were:

Forest Resource Planning:	
James Wells	SA
Recreation:	
David Scott	R-8
Nathan Byrd	SA
Kenneth Cordell	SEFES
Soils:	
John Corliss	R-8
Carol Wells	SEFES
Wildlife:	
Malcolm Edwards	R-8
Nathan Byrd	SA
Michael Lennartz	SEFES
Rtchard Harlow	SEFES
Robert Hooper	SEFES
William Moore	SEFES
Range:	
Robert Gashwilder	R-8
Nathan Byrd	SA
Clifford Lewis	SEFES
Hydrology:	
George Dissmeyer	SA
James Douglass	SEFES
Ecology:	
Stephen Boyce	SEFES
Botany:	
Levester Pendergrass	R-8
Andrew Robinson	SA

Specialists from R-8 and the SA (1) reviewed data being collected and made recommendations for changes. (2) field-tested the feasibility of collecting new data, and **(3)** analyzed and evaluated data collected. Specialists from the Southeastern Station were called upon as needed to ensure that the experimental data were being collected in a scientifically acceptable manner. They were also given opportunities to assist in the analysis and reporting.

INFORM AND INVOLVE

Information about the South Carolina Pilot Study was disseminated to individuals and groups in three ways: (1) seminars at universities. (2) field demonstration plots. and (3) work meetings fur all experts and specialists identified in the study plan. The purpose of a work meeting was to review progress, explore possibilities of analyzing data, and seek ways to improve future inventories.

Regardless of the source. each suggestion or new idea was considered. If it fell within the scope of the South Carolina Pilot Study and was suited to out· type of sampling. it was incorporated into the study.

SEMINARS

Seminars were conducted at Clemson University, Virginia Polytechnic Institute and State University (VIP & SU), University of Georgia, Duke University, and University of Florida. We hoped to find professors and graduate students who could devote full time to items of highest priority. These high-priority items included wildlife habitat ranking, forest range, soil erodibility characteristics, diversity, fisheries, and biomass.

Both Clemson University and VPI & SU showed great interest in the inventory, and cooperative research agreements were made to meet several pressing needs. The main objectives in the cooperative agreements with Clemson University were: (I) To assess the potential of the South Carolina multiresource system to supply data useful in recreation planning. *(2)* To provide a method and related criteria for the inventorying of nondeveloped, rural recreation resources through the RRE field crews. Initially, the agreement was set up to run I year, but the preliminary results for the Piedmont Unit looked so promising that a I-year extension was granted to Clemson University.

The cooperative agreement signed with VPI & SU had two major purposes:

1. To review the sampling techniques and habitat criteria being developed for wildlife habitat analysis.
2. To review the habitat evaluation procedure used for ranking wildlife habitat into suitability classes according to potential value.

The agreement with VPI & SU will run for approximately 2½ years.

JOINT RESEARCH PROJECTS

Sometimes it is highly desirable for two units to join forces on a research problem. When this is done, each unit can do what it does best. Presently. RRE has made two joint research agreements with other units to work on problems related to the South Carolina Pilot Study. The first agreement, with the Southeastern Station's Endangered and Threatened Wildlife research unit at Clemson. South Carolina, has a twofold purpose: (I) to estimate the extent and distribution of red-cockaded woodpecker habitat in the South, and (2) to categorize the avian species and communities associated'with forest types and successional stages. The other joint research is with the unit studying Utilization and Technical Characteristics of Southern Timber at Athens, Georgia. The objective of this joint effort is to reliably predict green and dry weights for wood and bark of 140 tree and shrub species growing in the Southeast. With this type of information RRE can express its inventories in tons as well as cubic feet.

ADDING EXPERTISE TO RRE PROJECT

There are five ways to add additional analytical expertise to the RRE Research Work Unit:

1. Recruiting and adding specialists to RRE.
2. Adding specialists to other Research Work Units and assigning them to work with RRE.
3. Developing cooperative agreements with universities.
4. Having formal arrangements with other Research Work Units, Region 8, or SA.
5. Developing expertise within RRE through additional training and education of project staff.

The last three of these methods have been utilized. Even though these steps have been taken, additional analytical expertise is still needed. If pressures were not so great for a shorter inventory cycle and a more complete and intensive sample, the solution would be obvious — reduce the field effort and strengthen all RRE analytical capabilities. This, however, would be contrary to the wishes of most interested RRE supporters. The compromise solution seems to be to keep the RRE field force strong, shorten the inventory cycle, provide adequate sampling intensity along with broad subject-matter coverage, and strengthen analytical capability to the extent possible with available resources. To accomplish this will require a carefully planned strategy and selection of highly qualified specialists.

RRE plans to strengthen its in-house analytical capabilities by recruiting immediately a qualified ecologist to coordinate the analytical work to be done in wildlife. range, ecology. botany. and use interactions. Within 5 years, RRE will: (I) select at least one individual from the RRE field force to add to the Analysis or Techniques Section, (2) add a qualified individual to the Techniques Section, (3) recruit a qualified range specialist, and (4) add additional expertise in subject areas of quantitative sciences. operations research, soils and hydrology. and botany.

NEW CONCEPTS AND TECHNIQUES

Despite efforts to use existing techniques whenever possible, we found it necessary to develop new techniques in all three areas of the inventory process—data collection, data computations. and analysis. For data collection, we designed new field forms for rapid data processing, perfected ways of measuring and recording lesser vegetation in layers, and provided a set of standard procedures for measuring limbs on standing and felled trees. Data processing concepts were developed so that the vegetative information could be stored in layers and used for wildlife habitat ranking. Search of the literature and contacts with individuals did not reveal a suitable approach to analysis. Basically, no one had tried to use the same data base to assess all the different uses, interactions. and conflicts among resources. The studies that follow highlight some of the major techniques developed and adopted.

USE INTERACTIONS

At any point in time some use interactions are compatible while others are not, and the degree of compatibility tends to change over time. We are concentrating attention on interactions among timber, wildlife, range, recreation, and soil, water, and fisheries as a group. Since different management strategies are necessary to optimize use, conflicts develop among uses. Since timber is a primary product of most managed forests in the Southeast, our analysis is designed primarily to show interactions between timber production and that of other resources.

Table 1 demonstrates this approach; it shows effects of possible timber treatments on soil and water quality. Individual rows in the table show the acreages which need silvicultural treatment during the next 10 years. These practices are needed to increase timber supply, but what are the soil and water-quality risks? It is apparent that the intensity of silvicultural practice used to take advantage of the opportunity will profoundly influence soil and water quality. For example, stand conversion could be applied on 50,000 acres. If risk class 3 and above were judged unacceptable impacts, intensive site preparation would be acceptable on 30,000 acres and unacceptable on 20,000 acres. For the unacceptable acres, some other regeneration technique with less impact than mechanical site preparation should be used. The acreage requiring special treatment is of great interest to State and National policymakers.

VEGETATIVE PROFILE STUDY

While planning the South Carolina Pilot Study, we contacted individuals in several disciplines, and they confirmed that information on the lesser vegetation is important for assessing the forest resources. Previously, only trees 1.0 d.b.h. and larger had been measured. The concept of using lesser vegetation (tree seedlings, shrubs, vines, grasses, grasslikes and forbs) to predict relative suitability for different wildlife species, or to rank range capability, was well documented. Lentz (1974) described a wildlife habitat evaluation program which depends on the recognition of lesser vegetation. MacArthur and MacArthur (1961) reported on the relationship between bird species diversity and vegetation complexity.

While RRE field crews were still inventorying Virginia, a procedure for describing lesser vegetation was introduced to determine what problems would be encountered in collecting the vegetative data in winter. Some adjustments were made before the start of the South Carolina inventory. The study conducted across the State incorporated a procedure for determining the horizontal and vertical distribution, density, diversity, and composition of the tree foliage and other vegetation associated with forested ecosystems.

Table 1.—Area of commercial forest, by treatment opportunity and soil- and water-quality risk class

Treatment opportunity	Total	Soil- and water-quality risk class[1]				
		1	2	3	4	5
	....	....	.... *Acres*	....	....	....
No treatment needed	600,000	150,000	250,000	75,000	75,000	50,000
Salvage cut	10,000	4,000	2,000	4,000	—	—
Harvest	60,000	12,000	18,000	3,000	14,000	13,000
Commercial thinning	60,000	30,000	20,000	5,000	5,000	—
Precommercial thinning	50,000	20,000	15,000	7,500	7,500	—
Clearing or release	70,000	18,000	30,000	10,000	11,000	1,000
Stand conversion	50,000	10,000	20,000	7,000	7,000	6,000
Artificial regeneration	100,000	40,000	20,000	10,000	20,000	10,000
Total	1,000,000	284,000	375,000	121,500	139,500	80,000

[1]Soil- and water-quality risk definitions.

1. During the recovery period of the activity, the water-quality impact should be slight (suspended sediment less than 100 milligrams per liter) and soil erosion less than the rate of new soil development.
2. Water quality during the recovery period of the activity can be impaired (suspended sediment greater than 100 milligrams per liter), but soil erosion should not exceed the rate of new soil development.
3. Water-quality impact can be high and soil erosion can exceed the rate of new soil development during the recovery period of the silvicultural activity.
4. Water-quality impact can be serious and soil erosion can exceed the rate of new soil development for 5 to 20 years after treatment.
5. Water-quality impact can be very serious and soil erosion can exceed the rate of new soil development for more than 20 years after treatment.

A Common Link

The species composition, level of stocking, and structural features of the stand directly influence the benefits derived from forests. The vegetative makeup of forests and ranges can be viewed as the common link for study of uses and use interactions. To illustrate, we know that herbage and browse near the ground offer bothgrazing and browsing opportunities to animals. By determining the kinds and amounts of herbage and browse across extensive areas of forest land, we can quantify acres available for wildlife use and determine if this use is compatible with timber production.

Building Upon Existing Timber Inventory

For years, RKE has collected information on trees 1.0 inch d.b.h. or larger, from a 10-point cluster sample. In South Carolina, we measured lesser vegetation at points I, 2, and 3 of each 10-point cluster. At each of these three sample points. all vegetative layers are examined on a plot with a 35-foot radius. Number of vegetative layers. species composition, and relative amounts are tallied. For each naturally occurring layer, a stocking percentage based on a space occupancy is determined. To estimate space occupancy, each vegetative layer is mentally divided into individual cubic feet of space, and the proportion of these cubic feet which contain vegetation is estimated.

The tally of live trees made on all 10 points is used to calculate the space that is occupied by tree crowns. The tree classifications that are used to calculate crown volume are d.b.h., crown ratio (percentage of total height containing green live foliage), tree height, crown class (a measure of the position of the crown in the stand), and tree stocking. During data processing, the tally of trees 1.0 inch d.b.h. and larger from the 10-point cluster sample is combined with the tally of lesser vegetation to produce a vegetative profile. The profile in figure I depicts the vertical and horizontal structure and illustrates how broad species classes occupy the horizontal and vertical space within the sample acre.

One-Foot Sensitivity

As a common link, the vegetative profile will be used by many different disciplines. The heights of interest are quite variable (Lentz 1974), and we could not anticipate all possible demands. We therefore decided to produce profiles in which values are estimated at I-foot intervals from the ground to the tops of tree crowns. By combining values for these individual 1-foot layers on a computer, we should be able to provide all the information most users will want.

Broad Species Classes

Field data for vegetative profiles can be collected by individuals with relatively little training in identification of shrub, vine, and grass species. Aftereach vegetative layer is identified, the broad classes of vegetation within the layer are recorded. The broad classes of vegetation recognized are yellow pines, other softwoods, hardwoods, tropicals, shrubs, vines. grasses and grasslikes, and forbs and others (mosses. lichens. etc.). Within each broad class, there is a detailed list of species. Each species list includes a category called "other." A shrub species that cannot be identified is simply recorded as "other shrub species." This approach allows the cruiser to record the proper broad-species-class code and to account for the space occupied by every species he can recognize.

Potential Values of Vegetative Profiles

Results from the vegetative profile study will open up new avenues in resource evaluation. Some potential uses are:

1. To show distribution of plant species.
2. To show the frequencies ofoccurrence of understory plants.
3. To determine general availability of herbage and browse.
4. To estimate live understory and overstory fuel for predicting fire behavior.
5. To make inferences about water infiltration, surface runoff, water quantity, and water quality.
6. To serve as a base for estimating weight of lesser vegetation.
7. To monitor plant species diversity, distribution. and composition over time.

EVALUATION-SUBJECT APPROACH TO ANALYSIS

There are no standard guidelines to follow in the analysis of multiresource data. One approach is to group the various data elements into subsets pertinent to a particular evaluation subject. Over the years, RRE's involvement in limited studies of deer browse, hydrology, and red-cockaded

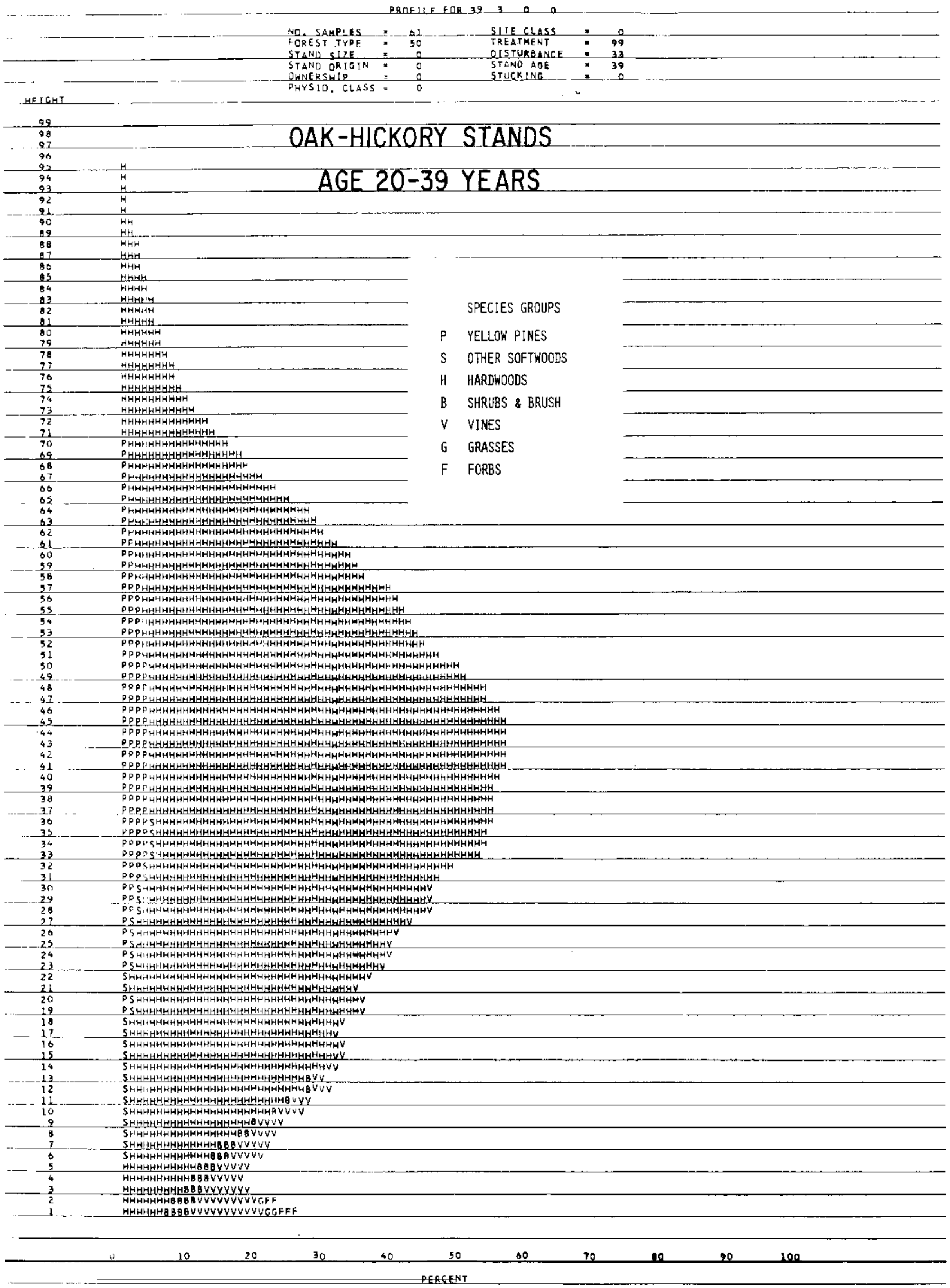


Figure 1.—Horizontal and vertical structure of broad classes of plants for oak-hickory stands, 20 to 39 years, Piedmont, South Carolina, 1977.

woodpecker habitat has provided some experience with the evaluation-subject approach. Experience gained from our studies and information from elsewhere indicate that many items tallied to evaluate timber are equally useful for evaluating other forest benefits.

We first identify those data elements having common value to all the evaluation subjects. These elements, which we call link variables, include items such as sample location, forest type, stand age, stand size, stand origin, site descriptions, and ownership class. Next, we add the more specific data elements to their appropriate evaluation subject. Here, a series of summary cards has proven helpful. Each summary card contains the basic link variables plus those data elements pertinent to the particular evaluation subject. These summary cards are used to develop frequencies, distribution rates, relationships, and correlations among the various resources and evaluation subjects.

BIOMASS INVENTORY CONCEPT

For years, RRE in the Southeast has collected biomass data from standing and felled trees for producing volume prediction equations. Quite recently, RRE modified its measurement procedure to include all the components in a tree, except the foliage and small twigs. Since additional data are being collected on lesser vegetation and foliage and twigs of larger trees, we can predict total biomass for different forest conditions. We will do additional subsampling to establish weight estimates. Total biomass as defined by RRE will not include roots.

Traditional State and regional inventories have usually been designed to provide volume estimates of wood from a I-foot stump to a 4.0-inch-diameter outside bark (o.b.) for trees 5.0 inches d.b.h. and larger. This standard was established in 1963. During the same year, a comprehensive standing- and felled-tree volume study was incorporated into the inventory. The measurement procedure was designed to identify the stump and saw log portion, upper stem and top of main stem and forks, and all usable limbs. The only components not measured were minor limbs (limbs not suitable for pulpwood) and tips of usable limbs. This method of measuring trees provided the necessary data for predicting the standard merchantable volume.

Renewed interest in use of wood for energy and trends toward whole-tree use created a need for measures of the volume in trees 1.0 to 4.9 inches d.b.h., and in all limbs of trees 5.0 d.b.h. and larger. In 1975, measurement procedures were modified to include saplings and all limbs. The details for measuring standing trees are provided in another publication (Cost 1978b).

Since all components of trees 1.0 inch d.b.h. and larger are being measured. total-tree volume can be estimated. Cubic volume in the stump. main stem, forks, and limbs of merchantable trees can be displayed. Volume in saplings can either be included or excluded. Cost (1978a) pointed out that 30 percent of the total hardwood volume in the mountains of North Carolina was in saplings and in stumps. tops, and limbs of trees 5.0 inches d.b.h. and larger.

From cubic volume, weight can be estimated. Steps have already been taken to assemble conversion rates by species. Once this is accomplished, RRE can report timber statistics in both weight and volume.

The data being collected on vegetative profiles will provide estimates of the quantity and distribution of lesser vegetation in the understory and of tree foliage and small twigs in the midstory and overstory. If it is decided that total biomass is the main objective, we could develop weight estimates of the lesser vegetation and tree foliage by subsampling a variety of forest conditions. At each subsample location, the vegetation within a known space could be clipped and weighed. Weight conversions could be developed and applied to the entire population for biomass estimates.

INFORMATION MANAGEMENT

The timber and nontimber data collected in South Carolina can be assembled and presented in many different ways for a wide array of users. Many types of tables and charts can be generated and presented in RRE reports. In addition, by screening the data base, estimates of acreage meeting certain requirements can be generated on request.

In 1970, RRE Project Researchers at the Southeastern Forest Experiment Station made a breakthrough in both the storage of data and the retrieval of information. The result was a Forest Information Retrieval (FIR) system which provides information on a customized basis. The breakthrough in mass storage and retrieval permitted us to screen and interrogate our active data base as needed. The FIR system is a specialized

set of advanced computer programs that searches RRE data tapes and compiles customized forest resource information. With the system, requests that previously required weeks or months to compile can now be processed in a fraction of the previous time and at a reasonable cost. The system is currently geared to provide up to 44 tables of forest resource information, all clearly labeled for the analysis of any geographic area in the Southeast. The user of the system can have the information compiled in three ways: (1) whole counties grouped together, (2) circular areas around a specified point, or (3) irregular boundaries within a closed traverse of short line segments. In addition to the FIR System, we routinely present resource data in tables for States and for Survey Units (major subdivisions of States). A Unit report contains mainly statistical tables and is meant to rapidly convey basic findings. Tables in Unit reports provide data by county. The State report contains the 26 standard tables and meets all other requirements of the RRE Handbook. It is released within 1 year after fieldwork is completed. This report includes a thorough analysis of the timber situation for an entire State.

The presumption in the standard-table approach is that most significant combinations of data can be compiled in a predetermined form that will satisfy both current and future needs. This approach has not always proved adequate in answering new questions. By storing the basic data in a highly accessible form, a screening process can be used as needed to answer specific questions or to produce a chart. Figure 2 is one example of a screening which depicts the occurrence of loblolly pine on rolling upland sites in the Southeast.

The multiresource inventory will obviously generate numerous records and a tremendous amount of data dealing with many resource uses. To disseminate the wealth of new information, we will expand our FIR system, analysis, and reporting to accommodate the full range of forest values and uses.

WILDLIFE HABITAT RANKING METHODS

Earlier work by Lentz (1974) showed that plot data from broad-scale inventories can be used to rank habitat suitability for certain animals. Since a number of wildlife-related attributes were observed and measured in the South Carolina inventory, we decided to develop a screening process which would rank each plot in terms of its habitat suitability. A review of the literature revealed that habitat criteria were available for game animals. but generally lacking for nongame birds and animals. Several wildlife experts were asked to provide habitat criteria for as many different birds and animals as possible. From their responses and from available literature, we assembled enough detailed data to develop screening criteria for 12 animal species or species groups.

1. Gray squirrel
2. Grouse
3. Bobwhite quail
4. Turkey
5. Pileated woodpecker
6. White-tail deer
7. Red-cockaded woodpecker
8. Beaver
9. Cottontail rabbit
10. Small mammal group
11. Raccoon
12. Wood duck

We decided to use two types of screening because some birds and animals are highly specialized in their ecological preferences. The two methods were:

Ranking method.—This method is used for all animals that do not have specialized needs. For each wildlife species, a set of habitat variables are described. Each variable is graduated from good to poor and assigned a numerical value. The habitat of each forest condition sampled is ranked either good, fair, or poor for a particular wildlife species, based on the total accumulated points from its habitat variables. The ranking criteria for gray squirrel are presented as an example (fig. 3).

Discrete method.—This method is used to determine habitat suitability for beaver and red-cockaded woodpeckers. Only good, Pair, and no habitat classes are considered for beaver. For the red-cockaded woodpecker, a remnant-tree class was included with the good, fair, and no habitat classes. To qualify as good, every attribute of good habitat must be present. If any attribute is missing, the next lower class is considered, and so on. The screening of habitat suitability is very dependent on structural features of the stand. For screening, five distinct vegetative layers were recognized:

1. Ground layer	0 to 1 foot
2. Shrub layer	1 to 5 feet

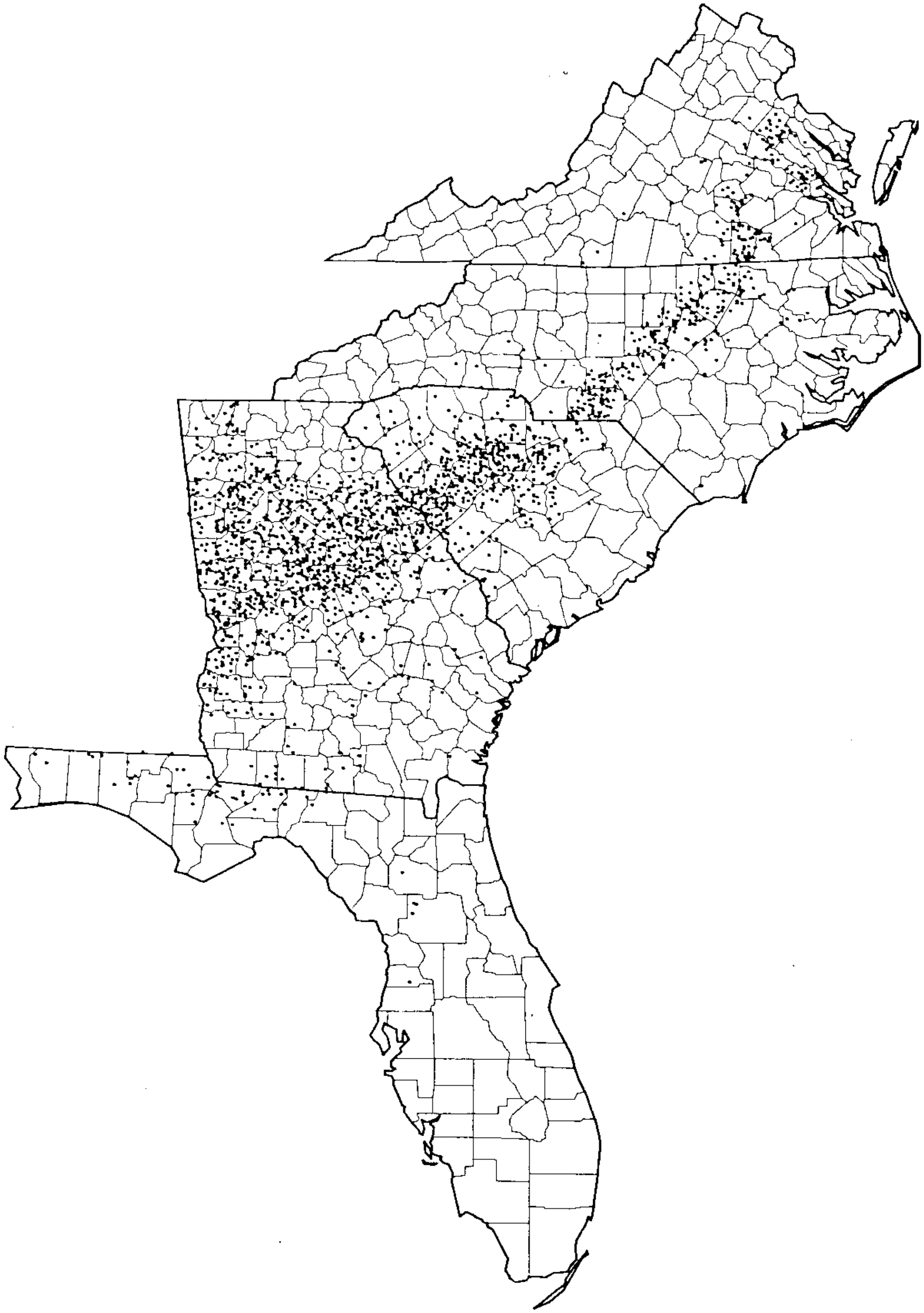


Figure 2.—RRE sample plots assigned loblolly pine type on rolling upland sites in the Southeast.

GRAY SQUIRREL HABITAT CRITERIA

Habitat Variable	Point Value
1. Forest type and stand age—	
a. bottomland hardwood types 41+ years; other forest types 61+ years	3
b. bottomland hardwood types 25 to 40 years; other forest types 41 to 60 years	2
c. bottomland hardwood types 16 to 24 years; other forest types 21 to 40 years	1
2. Vegetative stocking of desirable species in the midstory by 1-foot strata—	
a. 26 percent or more	3
b. 11 to 25 percent	2
c. 1 to 10 percent	1
3. Vegetative stocking of total vegetation in the overstory by 1-foot strata—	
a. 76 percent or more	3
b. 51 to 75 percent	2
c. 26 to 50 percent	1
4. Vegetative stocking of hardwoods in the overstory by 1-foot strata—	
a. 81 percent or more	3
b. 51 to 80 percent	2
c. 21 to 50 percent	1

Habitat Rank Determination

Habitat Rank	Code	Total Accumulated Points
Good	3	9 to 12
Fair	2	5 to 8
Poor	I	1 to 4
No habitat	0	0

Figure 3.—Habitat criteria for gray squirrel.

3. Understory	5 to 15 feet
4. Midstory	15 to 30 feet
5. Overstory	30+ feet

The level of stocking within a vegetative layer is one of the key criteria for evaluating habitat by the ranking method. Levels of stocking within a layer were analyzed in two ways:

1. Stocking by I-foot strata
   Each l-foot zone within a designated layer is examined for a specified level of stocking. Either stocking of all vegetation or that of desirable species can be analyzed.
2. Stocking percentage within a layer
   This stocking concept pertains to the quantity of vegetation that occupies the entire layer.

TIMBER MANAGEMENT AND TREATMENT

During the fourth inventory cycle, started in 1966 and completed in 1977, a number of improvements were made to provide a more complete picture of the region's timber resource. We classified the forest in ways that permitted evaluation of opportunities for increasing timber supplies. Two significant changes were made to improve forest resources evaluation. These included: (1) measuring stand age to nearest year, and (2) adding several new variables to enhance the identification of treatment opportunities. A few examples of significant improvements are summarized below.

Stand History

A procedure for classifying stand history was developed and added to RRE in 1970. This new approach provided information previously lacking on levels of forestry activity and the geographic location of various forestry practices. Activities such as harvesting, thinning, high-grading, and natural disturbance were identified.

Treatment Opportunity

Treatment opportunities and the related factors limiting or influencing such opportunities have been indirectly considered by RRE for many years. In 1970, a procedure was added to specifically identify and quantify forest areas by treatment opportunity classes. Some of the classes recognized are salvage, harvest, thinning, TSI, regeneration. Results indicate the value of this information in making statewide and regional evaluation of opportunities for increasing future timber supplies. For areas covering several counties, this information provides a guide for planning and a basis for allocating program efforts.

Sampling One Condition

When fixed-area plots and single-point variable plots were used in the Southeast, procedures were developed for minimizing overlap through the shifting of plot centers. When the 10-point cluster plot was adopted in 1963, provisions were made for substituting points for those which fell outside the commercial forest, but the shifting of points to keep the effective sampling area within one forest condition was discontinued. A special plot classification in the fourth inventory of Georgia indicated that about one out of every three samples straddled two or more distinct forest conditions. When overlap or straddling is permitted across plantations and natural stands, distinct types, sites, or stand sizes, unrealistic or nonexistent conditions are portrayed.

A study in central Georgia of only those plots contained within a single condition indicated that estimates of average volume per acre did not change significantly. These findings resulted in changing procedures so that each sample plot is confined within the forest condition identified by point 1.

Stand Age

Another recent improvement in inventory techniques is the redefining of stand age. RRE field crews had difficulty in classifying stand age at sample locations. Causes for this difficulty were: (1) sample plots were allowed to straddle two or more conditions, and (2) a wide range of tree diameters at given sample Locations misled field crews into assigning a mixed age.

In 1972, several steps were taken to enhance the validity of the stand-age classification: (1) even-aged management was assumed at each sample location, (2) each sample plot was confined to a single forest condition identified by point 1 of a 10-point sample cluster, (3) stand age was based on stocking of trees which could be featured together in timber management, and (4) greater emphasis was placed on making an adequate number of increment borings for determining stand age. The results of these adjustments are reflected in a report titled "Stand-Age Profile of North Carolina's Timberland" (Knight 1977).

Stand Characteristics

Like stand age, other stand classifications were modified or redefined in order to better describe the existingforest conditions. One useful stand classification that was modified was stand origin. It is used to identify plantations and to separate them into useful categories. Other modifications were made to the stand size and seed source classification. For years, RRE field crews recorded only one stand size, either sawtimber, poletimber, sapling and seedling, or nonstocked. Since most forest stands except pine plantations have two size classes, the stand size classification was expanded to reflect both the primary and secondary size class of the dominant and prevalent stems on the sample acre. Seed source was redefined to indicate the presence or absence of suitable seed trees by species class. The suitability of a particular species as a seed source is dependent upon its square feet of basal area on the sample acre.

Availability Factors

Physical factors prevent intensive culture on some commercial forest land. As part of the inventory, a number of key variables were measured and added to the data base for screening purposes. These key variables can be used to answer questions that have economic implications. For instance: How many acres of pine sites are suited to mechanical site preparation and planting? How many acres of forest land in need of silvicultural treatment would require relatively little road construction to make them accessible for mechanical planting? How much area and volume would be excluded if small drains and narrow stream margins were not available for commercial timber production because of environmental concerns? There are additional questions that can be answered with the variables collected in the South Carolina inventory. Some of the key variables are:

- Accessibility (Describes the degree of difficulty involved in moving men and equipment to the edge of a forest stand)
- Operability (Identifies stands which present special management problems due to water conditions or steep slope)
- Slope
- Aspect
- Physiographic class (Based on soil, terrain, soil moisture, slope, and other nonvegetative conditions)
- Shape of forest condition
- Size of forest condition

EVALUATION SUBJECTS

A multiresource inventory can be regarded as a single integrated activity during planning and data collection. In analysis and interpretation, however, the entire inventory becomes too unwieldy; a breakdown into specific subject areas is a practical necessity. This separation allows the computer systems analyst and the resource analyst to focus attention on one data subset at a time, and it permits specialists to examine the data in their areas of expertise. It can also lead to better balanced and more uniform analysis and evaluation of various resource uses. We do not imply that each evaluation subject should be given equal space or time, but rather that each subject should be separately and fully considered. Some of the possible categories for separation are listed and described below.

LAND BASE

A clear definition of the land base for renewable resources including physical extent and location is necessary for a rational inventory. The inventory should identify specific areas with various specific resource-use potentials. We define the land base to include both land and inland water falling within the recognized political boundaries of each State.

There are many advantages in having a single common land base for evaluating all the renewable forest and rangeland resources. It avoids overlaps and gaps when the resources are combined, and it reduces inventory costs by eliminating duplication of field effort. Use of a single common land base also improves measures of use interaction.

The South Carolina inventory is designed to provide a broad range of information about the land base. It provides area statistics by land-use class at the county, survey unit, and State level. Trends in land use are measured both from aerial photographs and from permanent ground samples. The periodic remeasurement of permanent samples in all land-use classes provides a complete measure of change which can be used to evaluate impacts of resource use. The following evaluation subjects are all tied directly to this common inventory land base.

TIMBER

The objective of a timber-oriented inventory is to produce area and volume statistics in a useful form for analysts, managers, planners. and decisionmakers. The familiar timber resource reports usually contain tables of statistical information by forest type, ownership, site class. stand size, etc. The new multiresource inventory will not reduce the amount of timber data being collected. Collecting timber and nontimber data simultaneously will probably significantly increase the amount of useful timber-related information.

Some new information on timber is being collected as part of the multiresource inventory. New items include stand history, which is coded in terms of treatments and disturbances since the previous inventory. The condition of the forest at each sampling point is used to determine a treatment opportunity based on a set of standards for the Southeast. The structure of the forest at each sample is completely measured to enhance the classification and description of forest stands for management purposes. Several new variables describe the physical factors limiting harvest, treatment, and management of portions of the commercial forest. These chat-acteristics include slope, aspect, accessibility, size of condition. operability, physiographic class, and a better measure of the stocking. Other improvements and refinements in inventory techniques have been made in recent years. including items such as stand age, stand origin, and seed source.

WILDLIFE

Wildlife-related information in the new inventory is confined to measuring, classifying, and evaluating habitat. Our sampling process is well suited for estimating the amounts of forest and rangelands that have the vegetative structure, species composition, and special features required by a given species of wildlife. In contrast, our procedures are totally unsuited for estimating populations of individual wildlife species. For wildlife habitat, we measure the vegetative structure, composition, and density in the overstory, midstory, and understory to estimate the abundance and distribution of wildlife plants and the adequacy of the vegetative community to provide cover, shelter, nest sites, and foraging substrate. We also note the presence of cavities and snags, which are extremely important to certain species of wildlife. Other special features recorded include cover items such as holes, caves, dens, brush piles, and hollow logs. The presence of water is also recorded in various ways to improve the description of forest habitats.

Individual wildlife species range over areas from a few feet to many miles. Some species require specific habitat conditions, while others adapt well to a wide range of conditions. Some species migrate, while others remain in one area throughout their lives. There are also numerous variations in food requirements. sensitivity to disturbance, and living space needs. Some species spend most of their time below ground, some prefer ground level, and some favor selected vegetative layers above ground. This high degree of variation in species habitat selection makes the inventory task extremely complex.

To help organize our thinking about wildlife habitats, we have recognized five broad classes of vertebrates.

I. Migratory Species — Species that use a particular forest condition seasonally outside of the breeding season.

2. Threatened and Endangered *Species*— Species given special status and protection because of unsatisfactory population levels.

3. Recluse *Species*—Species that require large, remote, solitary, or secluded areas of undeveloped or isolated forest. They are sensitive to development and encroachment of civilization.

4. Adaptable *Species*—Species that do not require a single specific habitat but are highly flexible and can successfully shift from one forest condition to another. Species may thrive in diverse or mixed forest conditions.

5. Sensitive Species — Species that require a special combination of habitat characteristics to survive'and reproduce. These species are very sensitive to habitat disturbance.

Our inventory methods are poorest for quantifying habitat of migratory species. The threatened and endangered group includes species from the other groups and is actually not a separate inventory problem. The recluse group is probably better suited to in-place mapping than to broad-scale inventory sampling. The remaining two groups are the largest and our procedures are probably suited to them. The suitability of habitat for sensitive species can be ranked by screening for certain attributes at each sample location. Adaptable wildlife species probably do best where a diversity of conditions is present over a small area.

RANGE

Before the range resource can be evaluated. the land base suitable for range must be determined. Sufficient forage for grazing of livestock is present in a wide variety of situations. In the Southeast, the land-use classes of major importance to range evaluations include forest lands, natural range, and marsh, which are classed as forest and rangeland, as well as improved pasture and cropland. which are excluded from our inventory responsibility. The inventory will determine the current area in each land-use class and also measure the rates of change and trends in area.

Within land-use classes. we are measuring the quantity. quality, and distribution of vegetation suitable for livestock forage. In addition. wc are noting fencing, burning, and current utilization. Our inventory will also show that water is a limiting factor. A few plants are poisonous or noxious to livestock and can be identified as a limiting factor to range use. Other species of plants are preferred or are of special importance to livestock and can be rated accordingly.

RECREATION

Our survey crews will note evidence of recreational uses such as hunting. tishing. and camping, for which signs can be found. Other recreation-related inventory information includes the presence of various types of trails. posting of forest land, and the presence of water. General

information that may prove valuable in judging recreation potential includes slope. soil texture, land-use pattern. accessibility. and a complete description of the vegetation present at the sample location.

SOILS

A limited amount of information on soils is being collected during the inventory so that certain soil characteristics can be directly related to other resource data at ground sample locations. The soils portion of the inventory was carefully designed to prevent any duplication of effort or overlap with the soil surveys being conducted by the Soil Conservation Set-vice. One of our primary goals is to be able to inventory environmental impacts due to management actions which disturb the site. We are tallying a rough estimate of soil texture which, combined with slope, can be used to rank areas into erosion-risk classes. Other information recorded includes soil structure, compaction, and position on slope. Together, these soils characteristics are useful in judging the relative stability of the site. The inventory also includes information on litter depth, humus depth, percentage of bare ground, and acomplete description of the vegetative cover.

WATER

For inventory purposes, water is treated both as a separate land-use class and as a special characteristic of the forest. As a land-use class, water is separated into lake-like and stream-like categories. It is further classified as to size or width and as fresh or salt water. The amount, kind, and distribution of water directly influence many of the other evaluation subjects such as timber, wildlife, recreation, and range.

Water in or near a site may enhance its value for a particular use or create a management problem, depending upon the use being contemplated. The inventory therefore describes the proximity of water to the forest and rangelands being sampled. We distinguish between temporary and permanent water and estimate average depth of temporary water.

The presence of water is used to evaluate the suitability of the forest in meeting the needs of wildlife, recreation, and livestock. It is also treated as a limiting factor to timber management and harvesting operations. And it is a critical input to the next evaluation subject—fisheries.

FISHERIES

Forest and range activities can influence the quality of fish habitat. As described in the preceding segment, the inventory measut-es the amount, kind, and distribution of water. This information on inland waters should help in evaluating fisheries. Other useful inventory information includes the proximity of water to various forest disturbances and the degree of erosion taking place.

BIOMASS

The estimation of total biomass as defined by the ecologists is not our goal. We do not deal with roots, insects, birds nests, or other matter of a similar nature. Thus. we can only estimate the biomass of aboveground woody fiber. We can categorize this material by species. structure. and space occupied. Despite the restrictions, our biomass totals should prove useful because they include a very high proportion of all aboveground biomass. And the data are being collected uniformly across the entire State.

Traditional timber inventories have usually been designed to estimate only the volumes of material meeting certain merchantability standards. Large quantities of lower value material have been excluded. The South Carolina inventory, therefore. will provide a more complete measure of the forest biomass.

A comprehensive standing- and felled-tree volume study was initiated in the Southeast in 1963. The results provide the basic data needed to determine volumes in sapling-size trees (trees 1.0 to 4.9 inches d.b.h.) and in stumps, tops, and limbs of trees 5.0 inches d.b.h. and larger. The lower quality trees, commonly called rough trees and rotten cull trees, can also be included in these volume summaries. Wood volume, bark volume, or a combination of wood and bark volume can be presented.

The remaining step in estimating biomass is to convert volumes into weights. A separate effort is now underway to find the best available conversion rates for the various species of trees found in the Southeast. Precise conversions of volume to weight will require additional work because of variations in wood and bark, tree size, location within the tree, and geographic location.

Data being gathered on understory vegetation include the quantity, distribution, and space occupied by various species of tree seedlings, shrubs, vines, grasses, and forbs. These data will provide a basis for estimating additional vegetative mass.

ECOLOGY

Since inventory coverage is very broad, it seems desirable to examine the data from apurely ecological standpoint. Information on the vegetative structure of all the forest lands in South Carolina offers a unique opportunity to study ecological relationships on a very broad scale. The inventory will provide a picture of the composition of overstory, midstory, understory, shrub layer, ground layer, and various combinations on a statewide basis. The inventory will also provide data on species associations, and the occurrence of trees. shrubs, vines, grasses, and forbs at various stages of succession. It will identify recently disturbed areas and the vegetative responses to those disturbances.

A new procedure for displaying and analyzing the vegetative composition and structure of individual sample areas or aggregates of many sample areas is called the vegetative profile. This technique, explained in greater detail elsewhere in this Paper, is an example of how the massive amount of detail data being collected can be combined into a single clear display of the ecological structure of forest vegetation:

BOTANY

There are many aspects of the multiresource inventory that are of special interest and value to botanists. The inventory will show how the distribution of individual plant species is associated with various site conditions and other species. Understory species such as honeysuckle, kudzu. and poison ivy are of considerable interest because of their potential to create problems. The distribution associations of many other plants are in need of validation and confirmation. Botanists are also concerned about trends in the quantity and distribution of certain plants. Information obtained from the remeasurement of permanent samples will be useful in assessing trends and will help in the selection of plant species as threatened or endangered. In some cases, a plant species may be removed from the threatened and endangered list if it can be shown that its distribution is acceptable and its population trends are stable or increasing.

USE INTERACTIONS

Since our resource base is finite, all uses interact to some degree. In resource inventories and evaluations, therefore, interactions must be considered whenever two or more resource uses are being analyzed. Not all interactions are necessarily bad or harmful. Some can be harmonious and compatible. Over long periods, however, the tendency is for use interactions to be competitive and to generate conflicts.

The evaluation subjects discussed in this section are the uses which tend to interact. The most visible interactions involve timber, wildlife, range. recreation, and acomposite of soils, water, and fisheries. A given piece of forest land cannot simultaneously support two or more uses which require conflicting management actions. The role of inventory is to gather and display the information needed to select a desirable balance of forest use. Measuring and classifying the forest as a single entity establishes a common data base to which specialized information about individual resources can be added.

In theory, use interactions can be thought of as a matrix in which each use interacts with every other use, both singly and in combinations. This model is very complex and suggests many analyses that are of very little interest. Furthermore, it fails to recognize the practical and biological significance of the timber overstory in forests. In the Southeast, timber is the intended product of most managed forests. In addition, the condition of the timber overstory largely controls the biological process beneath. in our first analyses of interactions, therefore, we will focus on timber's relation to other uses. The data will be organized to show the impacts and trade-offs that might be expected if timber production is maximized. Maximizing timber production would require harvesting, regeneration, and treatment strategies that may have rather serious impacts on wildlife, range, recreation, and the quality of the environment. On the other hand, the constraining of timber in favor of increases in the other uses can be evaluated in terms of reduced forest products output at higher prices. This approach does not make any attempt to evaluate use interactions between wildlife and range or recreation and environmental factors.

INFORMATION MANAGEMENT

The multiresource inventory described here

will obviously generate numerous records and a tremendous amount of data that must be properly managed before it can be fully analyzed and evaluated. The bulk of these data is recorded on forms in the field, then transferred onto data cards and magnetic tape for processing and storage. A number of specialized processing systems are used to convert the raw field data into final data storage records. Each system is composed of several individual computer programs which perform a set of mathematical and logical transformations as the data pass through the computer. The final records are sorted and stored for later use in the RRE master data base. This data base contains the accumulated inventory data for the five Southeastern States.

The primary test of an information management system, however, is its ability to retrieve information in desirable forms. If the mass of data produced by an inventory can be retrieved rapidly in forms suitable for a variety of analysts. such as providing customized responses to many different users, it has passed the test.

The FIR system used by RRE in the Southeast is a highly advanced user-oriented system for mass data storage and retrieval. It is designed to provide rapid retrieval of inventory information on a customized basis. The methods for storing, cataloging, updating, and retrieval are all common enough. The unique aspects of the system are that it is relatively inexpensive to operate and has proved to be both flexible and dependable.

THE ROLE OF TECHNIQUES

Research on inventory techniques is a highly specialized activity that can be conducted during multiresource inventories. This research requires a unique feel for what is needed, suitable, practical, and possible, coupled with an ability to make things work.

The initial step in techniques research is to identify needs and recognize opportunities. This requires a thorough grasp of inventory objectives, an appreciation of information needs, an understanding of priorities, and considerable expertise in inventory methods. ltems selected for study should have high priority, be within the scope of the inventory objectives, and be amenable to solution.

The next step is to judge the suitability of existing methods and procedures. Quite often an inventory need can be met by adapting or modifying a piece of equipment, a field-measurement procedure, or a computer program rather than developing a totally new item or procedure. An entirely new technique must be taught to field crews, as must the use of new equipment. Hence, use of an existing procedure, method, or tool often saves a lot of time and money.

Where something new is needed, its development requires innovation and the forming of new concepts. This process is like that of other research; success requires both thought and persistence. A newly conceived procedure is usually incomplete and lacking in detail. Additional development is usually required before it is ready for testing.

All new methods and procedures do not require the same degree of testing. Some are so straightforward that it is obvious to inventory specialists how well they will work and the problems that might develop. Other methods and procedures do, however, require extensive field testing and possible modification before they become part of the regular inventory.

DISPLAY OF RESULTS-EXAMPLES

Multiresource data are now available for one of the three Survey Units in South Carohma—the Piedmont. In this chapter we illustrate the kinds of information available for this Region. We emphasize that these illustrations are only a few examples. Upon completion of the inventory, we plan to make a comprehensive and balanced analysis of all the data collected.

Initial estimates of forest and nonforest areas in the Piedmont Region were developed from classification of 23,831 sample clusters systematically spaced on aerial photographs. Field crews verified the photo classifications on the ground at 1,614 of the 16-point clusters. A linear regression was fitted to the data to develop the relationship between the photo and ground classifications. This procedure provided for adjusting the initial estimates of area for change in land use since date of photography and for photo misclassifications.

The Piedmont Region of South Carolina encompasses more than 6.8 million acres of land and water. The inventory provided a breakdown of this total area into meaningful land classes (table 2). Forest occupied almost 4.6 million acres, or two-thirds of the total area. By county, percentage of total area in forest ranged from 85 percent in Fairfield County to only 42 percent in

Anderson County (table 3). Anderson, Spartanburg, and Greenville Counties each have sizable urban centers. In addition, a large part of Anderson County was inundated by Lake Hartwell, one of several major reservoirs in the State. As of 1977, less than 1 percent of the forests in the Piedmont had been withdrawn from timber use, as indicated by the productive-reserved forest classification.

Table 2.—Total area, by land classes. Piedmont of South Carolina, 1977

Land class	Acres	Percent
Commercial forest	4,528,036	66.3
Productive-reserved forest	38.746	0.6
Other forest	—	—
Total forest	4,566,782	66.9
Cropland	580,348	8.5
Improved pasture	728,065	10.7
Natural range	—	—
Idle farmland	161,337	2.4
Other farmland	94,316	1.4
Marsh	2.319	(1)
Urban and other	510,612	7.5
Water	179,261	2.6
Total nonforest	2,256,258	33.1
All classes	6,823,040	100.0

1Less than 0.1 percent.

Over the past 40 years. Forest Survey has monitored extensive changes in land use in this Region. Forest Survey first inventoried the Region's forests in 1936. At that time, forests occupied only 3.2 million acres or less than half of the total area; about an equal acreage was in agricultural use. Between 1944 and 1969, according to Census of Agriculture statistics, the Region experienced a reduction of more than 1.2 million acres in cropland harvested. A strong correlation between the age distribution of pine timber stands in 1977 and the timing of these reductions in cropland harvested confirms that much of this cropland reverted to pine forests. This successional reversion from cropland to pine timber accounts for today's concentration of pine timber stands in the younger age classes (table 4). Over time. hardwood species tend to develop in the understory of these pine forests and without substantial intervention by man will gradually replace the pines.

Table 3.—Counties ranked by percentage of total area in forest. Piedmont of South Carolina, 1977

County		In forest	
		Area	Percent
	Acres		
Fairfield	453,120	386,015	85.2
Union	329,600	272,386	82.6
McCormick	257,920	207,036	80.3
Chester	376,960	290,814	77.1
Newberry	415,360	315,829	76.0
Edgefield	309,760	234,637	75.7
Lancaster	325,120	235,933	72.6
Greenwood	293,120	206,286	70.4
Abbeville	325,760	220,533	67.7
Oconee	424,454	284,580	67.0
Laurens	460,800	305,701	66.3
Pickens	325,626	214,980	66.0
Saluda	288,000	187.758	65.2
Cherokee	22.800	155.752	61.6
York	446.080	269.252	60.4
Greenville	508.800	299.821	58.9
Spartanburg	532,480	271.268	50.9
Anderson	197.280	208.201	41.9
All counties	6,823,040	4,566,782	66.9

We contend that this is the kind of information needed to make assessments.

For evaluation purposes, we need to relate the timber component of the forest resource to the distribution in table 4. On the 4.5 million acres of commercial forests in the Piedmont, the solidwood content between a I-foot stump and a 4-inch top of all live trees 5.0 inches d.b.h. and larger averaged 1,462 cubic feet per acre (table 5). The sawtimber component of this timber inventory averaged 3,750 board feet per acre' (table 6). In addition, these forests contained an average of 664 saplings per acre (table 7). Together tables 5 through 7 quantify the distribution of timber by stand-age class and forest types. Whet-e needed. these distributions can be further refined by ownership and site classes and can be developed for smaller geographic areas within the Region.

Wildlife evaluations can be based on quantities of forage in various vegetative layers or on values assigned to plots as habitat for certain species. Here we show the ranking of gray squirrel habitat suitability and a screening of potential red-cockaded woodpecker habitat.

Our plot data on gray squirrel habitat for the Survey Unit show that conditions are best for this animal in the hardwood-forest type (table 8 and fig. 4). By county. the proportion of commercial

Table 4.—Area of commercial forest land by stand-age class, by forest types, Piedmont of South Carolina, 1977

Stand-age class (years)	All types	Forest type				
		Pine plantations	Natural pine	Oak-pine	Upland hardwood	Lowland hardwood
				Acres		
0–9	577,094	153,051	113,014	117,216	189,619	4,194
10–19	495,296	148,603	224,492	38,661	75,919	7,621
20–29	650,273	77,260	434,591	59,250	66,936	12,236
30–39	866,408	16,750	448,262	148,606	212,990	39,800
40–49	948,661	10,266	372,643	151,931	389,396	24,425
50–59	587,657	—	173,580	88,890	320,527	4,660
60–69	212,133	—	51,183	33,605	108,405	18,940
70–79	87,983	—	19,516	22,346	42,783	3,338
80+	102,531	—	12,642	13,095	63,481	13,313
All classes	4,528,036	405,930	1,849,923	673,600	1,470,056	128,527

Table 5.—Average volume of all live timber[1] per acre of commercial forest land by stand-age class, by forest types, Piedmont of South Carolina, 1977

Stand-age class (years)	All types	Forest type				
		Pine plantations	Natural pine	Oak-pine	Upland hardwood	Lowland hardwood
				Cubic feet		
0–9	202	51	242	258	266	—
10–19	853	1,422	645	527	476	986
20–29	1,266	1,943	1,187	1,039	1,181	1,462
30–39	1,552	3,000	1,590	1,307	1,432	1,983
40–49	1,889	2,854	2,100	1,615	1,729	2,433
50–59	1,985	—	2,184	1,770	1,923	2,149
60–69	2,171	—	2,165	2,326	2,001	3,028
70–79	2,184	—	2,623	1,749	1,957	4,641
80+	2,209	—	1.651	2,177	2,006	3;811
All classes	1,462	1,144	1,487	1,260	1,524	2,300

[1]Trees 5.0 inches d.b.h. and larger.

forest qualifying as good habitat ranged from 55 percent in Anderson County to only 18 percent in Chesterand Fairfield Counties (table 9).

Previous estimates of the extent of habitat suitable for the red-cockaded woodpecker have been based largely on limited field studies, localized surveys. and generalized forest types. In 1975. a new estimating procedure was developed using RRE data to systematically identify favorable red-cockaded habitat across the entire Southeast. Wildlife experts knowledgeable about habitat requirement3 of the red-cockaded woodpecker provided descriptive information. The following criteria were used to scan computer tapes of recorded plot data: commercial forest land. pine forest types. sawtimber stands, stand age of 40 years or more. and basal area of 20 square feet or more.

Table 6.—Average volume of sawtimber per acre of commercial forest land by stand-age class. by forest types. Piedmont of South Carolina, 1977

Stand-age class (years)	All types	Forest type				
		Pine plantations	Natural pine	Oak-pine	Upland hardwood	Lowland hardwood
	Board feet[1]					
0–9	313	—	405	480	397	—
10–19	1,345	1,802	1,110	1,675	853	2,006
20–29	2,243	3,233	2.281	1,198	1,876	2,109
30–39	3,674	10,890	4,086	2,554	2,925	3,627
40–49	5,166	11,262	6.864	3,947	3,695	6.835
50–59	5,775	—	7,632	4,504	5,053	3,155
60-69	7,276	—	8,374	8,555	5,932	10,494
70–79	7,516	—	10,649	5,512	5,660	21,706
80+	7,940	—	7.057	9,161	6,241	16,093
All classes	3,750	2,072	4,201	3,102	3,659	6,630

[1]International ¼-Inch Rule

Table 7.—Average number of saplings[1] per acre of commercial forest land by stand-age class. by forest types. Piedmont of South Carolina. 1977

Stand-age class (years)	All types	Forest type				
		Pine plantations	Natural pine	Oak-pine	Upland hardwood	Lowland hardwood
	Number					
0–9	487	426	721	492	360	100
10–19	771	535	851	1,044	906	450
20–29	796	318	865	1,129	633	567
30–39	734	400	768	788	730	300
40–49	626	250	627	791	590	300
50–59	643	—	686	621	630	200
60–69	527	—	592	720	522	500
70–79	574	—	525	720	522	500
80+	496	—	533	766	467	333
All classes	664	442	751	743	596	386

[1]Trees 1.0 to 4.9 inches d.b.h

The screening procedure was done in steps. We first identified all sample plots assigned a pine forest type (fig. 5). We sequentially added additional criteria, eliminating plots each time until all the constraints had been imposed. Then, a final map (fig. 6) and statistical table (table 10) were generated.

Habitat variables for the red-cockaded woodpecker are being refined. After these refinements are made, the data can be rescreened for improved estimates of suitable habitat.

For range, we can relate the forage component of the forest resource to broad forest type and stand age. For all forest types, forage yield is high when stands are established and decreases rapidly to age 20 (fig. 7). At this time, the tree

Table 8.—Gray squirrel habitat suitability by stand-age class. by forest type, Piedmont of South Carolina, 1977

Stand-age class (years)	All classes	Forest type			
		Pine plantations	Natural pine	Oak-pine	Hard-wood
	Habitat ranking[1]				
0-9	0.6	0.5	0.6	0.8	0.8
10–19	1.3	1.3	1.2	1.1	1.4
20-29	2.1	1.5	1.6	2.1	2.5
30-39	2.1	2.0	1.8	2.3	2.6
40–49	2.5	—	2.2	2.6	2.7
50-59	2.7	—	2.3	2.7	2.9
60–69	2.7	—	2.4	2.6	2.9
70–79	2.8	—	2.7	2.8	2.8
80+	2.7	—	2.5	2.7	2.8
All classes	2.0	1.0	1.8	2.1	2.5

[1]0 = Unsuited.
1 = Poor
2 = Fair.
3 = Good.

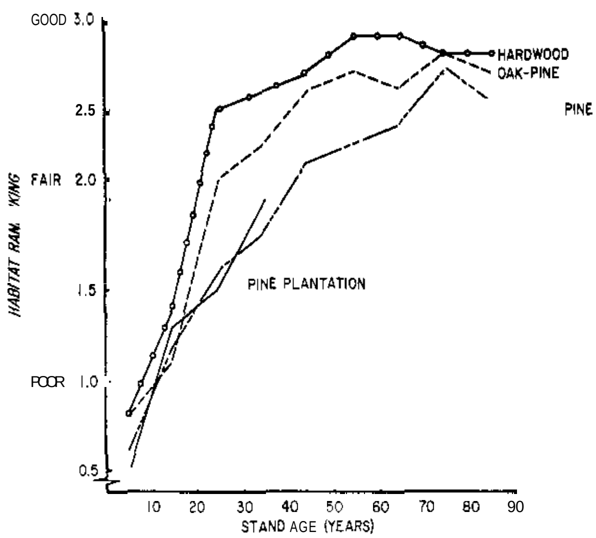


Figure 4.—Gray squirrel habitat suitability, by stand-age class and forest type, Piedmont. South Carolina, 1977.

canopy is usually fully closed and competition for light, moisture, and nutrients is intense. It often remains so until the stand is very old. Forage production in hardwood stands is generally greater than production in pine plantations. For the Survey Unit, hardwood stands experience the highest grazing use (fig. 8). Grazing use is highest in Cherokee County and lowest in McCormick county (table 11).

We think that many characteristics of forest stands will prove important in determining recreational value. One of the items of special interest tallied on each plot is evidence of human recreational use. This evidence included such things as hiking trails, shotgun shells, tree stands, campfire rings, bait containers, trail-bike tire tracks, or other visual evidence of use by people. From this information we can obtain relative estimates of those forest conditions which people seemingly prefer for dispersed outdoor recreation. The information is not intended to measure actual use.

We find that 40 percent of the use by people occurred in two age classes (30 to 39 and 40 to 49 years) (table 12). In addition, 48 percent of all recreational use took place in hardwood stands. 32 percent in natural pine, 16 percent in oak-pine and 4 percent in pine plantations (fig. 9). Spartanburg County had the highest percentage of use and Newberry County the lowest in the Piedmont Unit (table 13).

RRE field crews collected hydrological and soils data that can be used to develop general information about the condition of the resources and to define general trade-offs between various resource management strategies. The following are some examples of analyses that can be made from RRE data.

Average humus and litter depths at various stand ages are shown by forest type in figures 10

Table 9.—Area of commercial forest land and its percentage distribution by habitat quality for gray squirrel, by county, Piedmont of South Carolina. 1977

County	All classes	Quality of squirrel habitat			
		Unsuited	Poor	Fair	Good
	Acres	.... *Percent*			
Abbeville	219,883	7	28	24	41
Anderson	208,201	I	9	35	55
Cherokee	154,802	17	15	31	37
Chester	290,619	10	25	47	18
Edgefield	234,637	18	18	38	26
Fairfield	386,015	8	30	44	18
Greenville	278,448	—	20	28	52
Greenwood	205,672	7	38	33	22
Lancaster	235,604	14	21	29	36
Laurens	305,701	I I	21	37	31
McCormick	206,778	12	21	37	30
Newberry	315,829	4	20	47	29
Oconee	280,294	2	19	37	42
Pickens	209,464	7	18	31	44
Saluda	187,758	8	20	44	28
Spartanburg	271,227	10	20	35	35
Union	272,352	10	23	35	32
York	264,752	2	28	31	39
All counties	4,528,036	8	23	36	33

Table 10.—Area with potential habitat for the red-cockaded woodpecker, by State and ownership class. Southeast

State	All ownerships	National Forest	Other public	Forest industry[1]	Other private
	.... *Thousand acres*				
Florida	320	94	36	76	114
Georgia	885	53	75	130	627
South Carolina	705	151	39	88	427
North Carolina	1,406	32	118	138	1,118
Virginia	478	—	16	135	327
Southeast	3,794	330	284	567	2,613

[1]Includes other private lands under long-term lease

and 11. Figure 10 suggests that topsoil development is slower under planted pine than under other timber types. It is apparent in figure 11 that pine litter accumulates rapidly but decomposes slowly. Hence, topsoil development is slower in pine plantations than in hardwood stands.

In the Piedmont Unit, the highest incidence of soil erosion occurred in Cherokee County and the lowest in Oconee County (**fig. 12** and table 14). Table 15 shows a breakdown of soil-texture classes by county. These data may be valuable in explaining erosion or site productivity.

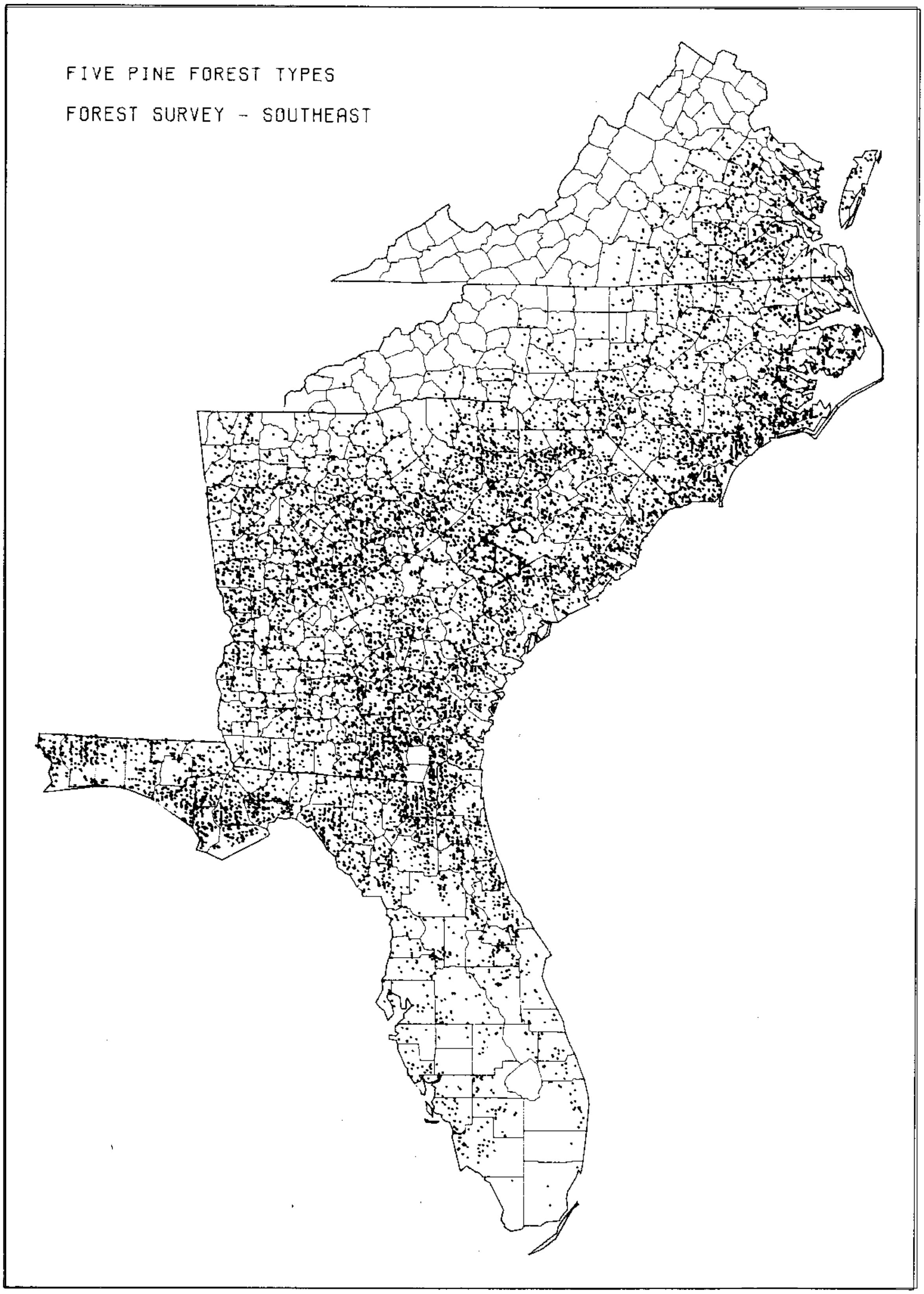


Figure 5.—RRE sample **plots** assigned **a** pine **forest** type, Southeast

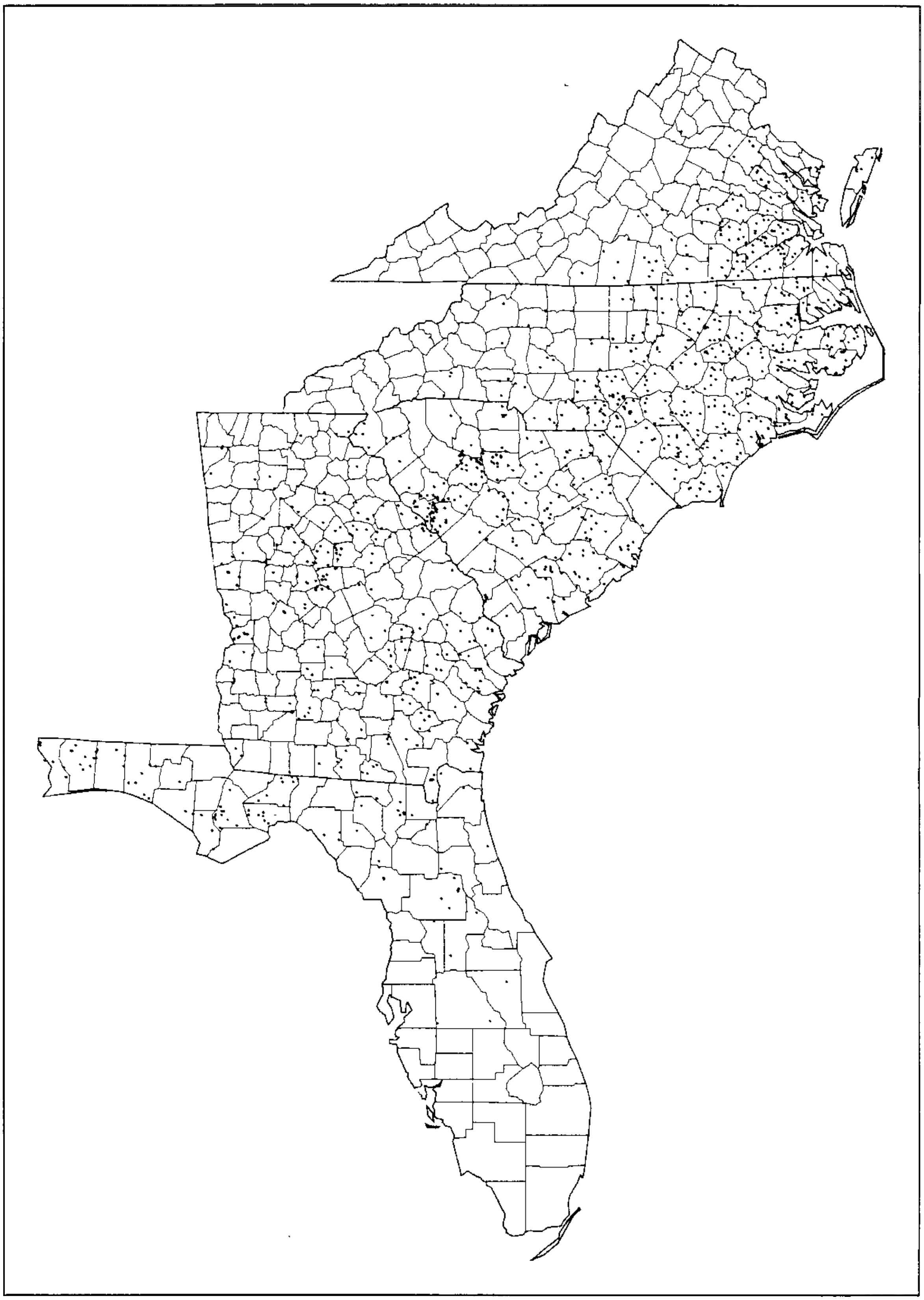


Figure 6. — Potential habitat for the red-cockaded woodpecker. Southeast

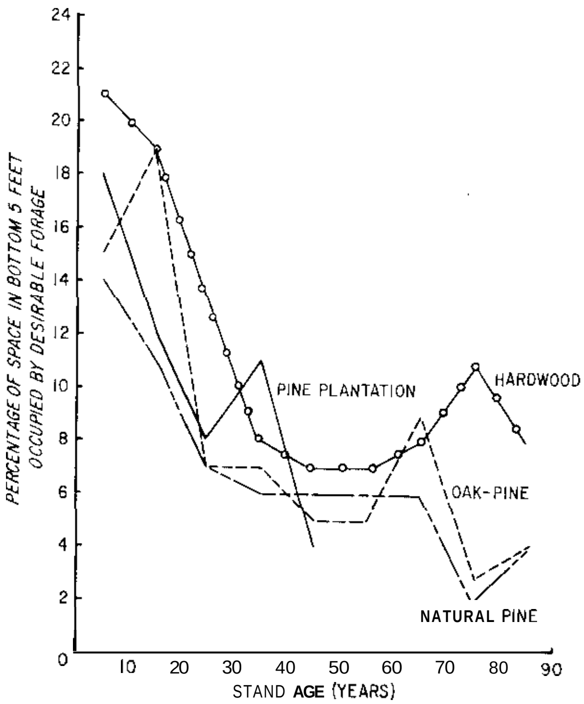


Figure 7.—Percentage of desirable forage, by forest type. by stand age. Piedmont. South Carolina, 1977.

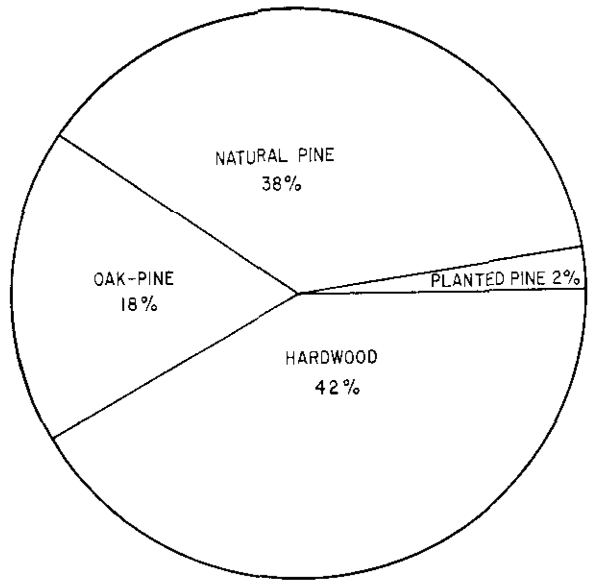


Figure 8.—Percentage of grazed commercial forest land, by forest type, Piedmont of South Carolina. 1977.

Table II.—Area of commercial forest land and its percentage distribution, by grazing intensity and county, Piedmont of South Carolina, 1977

County	All classes	Grazing intensity[1]			
		None	Light	Medium	Heavy
	Acres	...	... *Percent* ...		....
Abbeville	219,883	82	12	6	—
Anderson	208,201	83	10	5	2
Cherokee	154,802	79	15	6	—
Chester	290,619	91	5	4	—
Edgefield	234,637	98	2	—	—
Fairfield	386,015	89	7	3	1
Greenville	278,448	92	4	4	—
Greenwood	205,672	90	8	—	2
Lancaster	235,604	96	2	2	—
Laurens	305,701	87	10	2	1
McCormick	206,778	99	—	1	—
Newberry	315,829	93	3	—	4
Oconee	280,294	97	2	1	—
Pickens	209,464	90	6	4	—
Saluda	187,758	90	2	3	5
Spananburg	271,227	88	7	3	2
Union	272,352	82	14	4	—
York	264,752	85	12	3	—
All counties	4,528,036	90	6	3	1

[1] None = No evidence of grazing.
Light = Less than 35 percent of plants grazed.
Medium = 35 to 70 percent of plants grazed.
Heavy = More than 70 percent of plants grazed.

Table 12.—Use by people, by stand-age class and forest type, Piedmont of South Carolina

Stand-age class (years)	All classes	Forest type			
		Pine plantations	Natural pine	Oak-pine	Hard-wood
	...	....	Percent *use*	......	......
0–9	8	27	7	9	5
10–19	10	48	13	9	5
20–29	18	25	36	16	4
30–39	20	—	19	21	22
40–49	20	—	11	26	27
50–59	16	—	10	10	26
60–69	4	—	4	3	5
70–79	2	—	—	3	2
80+	2	—	0	3	4
All classes	100	100	100	100	100

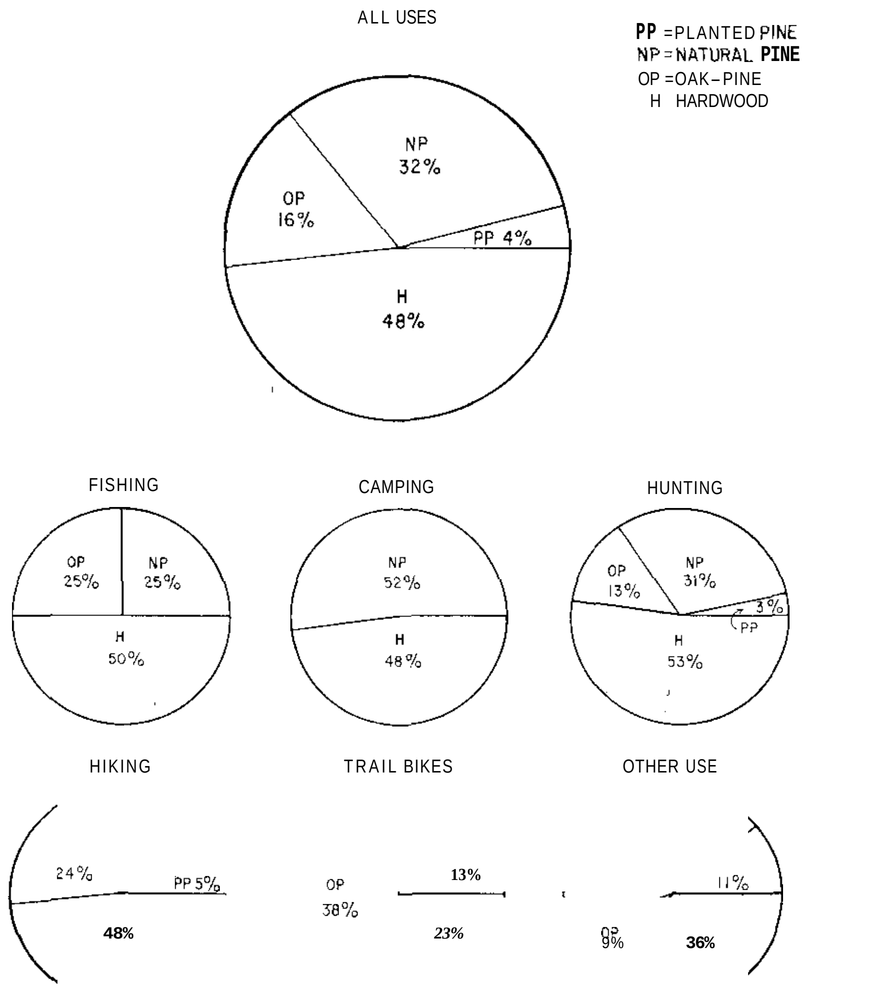


Figure 9. — Distribution of evidence of dispersed outdoor recreation on commercial forest land, by use, by forest type, Piedmont of South Carolina, 1977.

Table 13.—Area of commercial forest land and its percentage distribution of use by people. by county. Piedmont of South Carolina, 1977

County	All classes	No people use	People use
	Acres	.... *Percent*	...
Abbeville	219,883	82	18
Anderson	208,201	58	42
Cherokee	154,802	70	30
Chester	290,619	93	7
Edgefield	234,637	90	10
Fairfield	386,015	88	12
Greenville	278.448	68	32
Greenwood	205,672	86	14
Lancaster	235,604	93	7
Laurens	305.701	76	24
McCormick	206,778	90	10
Newberry	315,829	99	1
Oconee	280,294	78	22
Pickens	209,464	69	31
Saluda	187,758	85	15
Spartanburg	271.227	50	50
Union	272,352	75	25
York	264,752	83	17
All counties	4,528,036	80	20

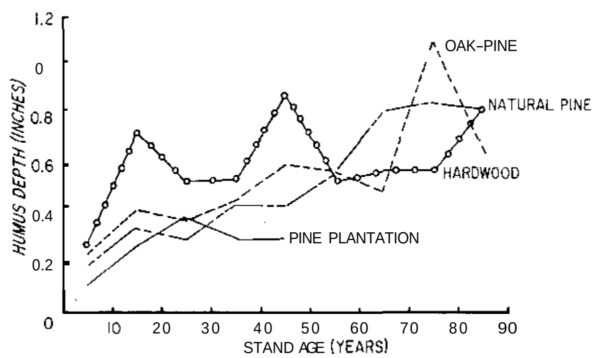


Figure 10.—Average humus depth, by forest type, by stand age. Piedmont of South Carolina. 1977.

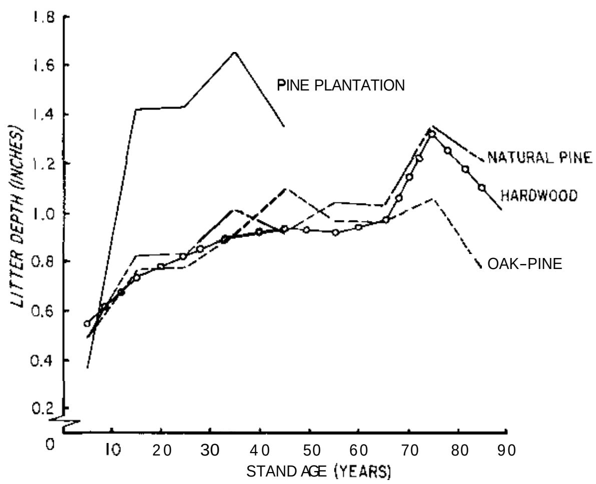


Figure 11.—Average litter depth, by forest type, by stand age, Piedmont of South Carolina, 1977.

Table 16 shows a soil and water risk classification for interpreting potential soil- and water-quality trade-offs. Approximately 1.3 million acres of land need some sort of silvicultural practice during the next 10 years (table 16). These practices are needed to increase timber supply, but what are the risks to soil and water quality? It is apparent from table 16 that the type of silvicultural practice used to take advantage of the opportunity will influence soil and water quality. For example, stand conversion and artificial regeneration with site preparation could be applied on 507,406 acres. If risk class 3 and above were judged unacceptable impacts, intensive site preparation would be acceptable on 328,581 acres and unacceptable on 178,825 acres. For the unacceptable acres, some other regeneration technique with lower risks should be used.

From the standpoint of total wood fiber. the conventional forest inventory measures of grow-

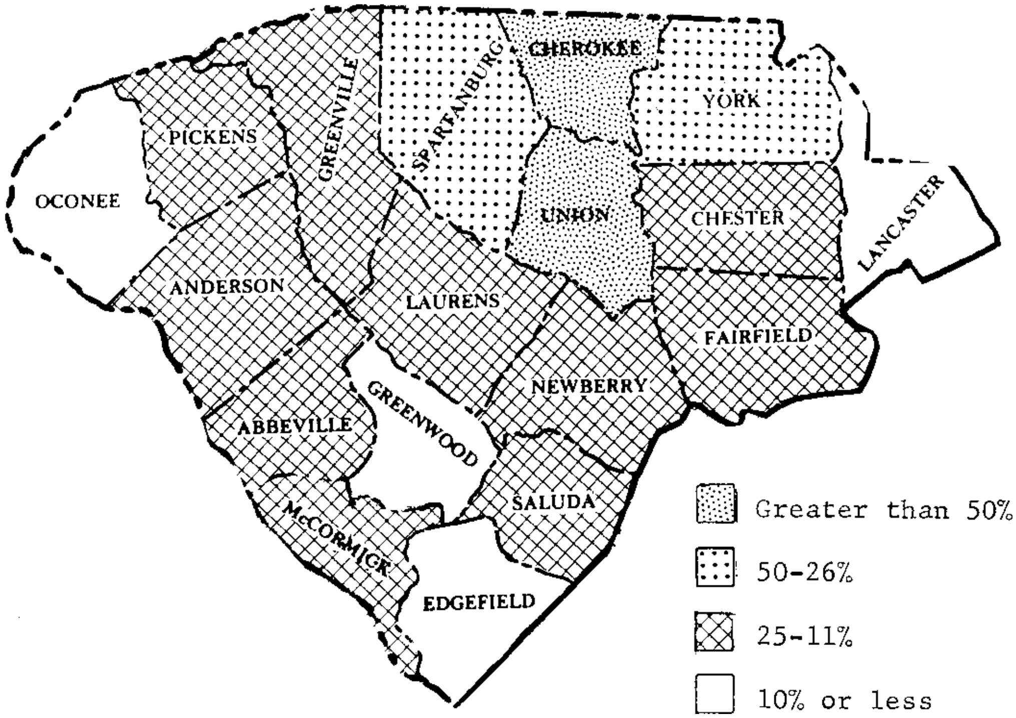


Figure 12.—Proportion of commercial forest with soil erosion, by county. Piedmont of South Carolina, 1977.

Table 14.—Areaof commercial forest land and its percentage distribution by degree of soil erosion, by county, Piedmont of South Carolina, 1977

County	All classes	Degree of soil erosion			
		None	Low	Medium	High
	Acres	....	Percent	....	
Abbeville	219,883	85	8	2	5
Anderson	208,201	83	12	5	—
Cherokee	154,802	38	28	22	12
Chester	290,619	89	9	—	2
Edgefield	234,637	94	2	2	2
Fairfield	386,015	80	17	2	I
Greenville	278,448	81	8	7	4
Greenwood	205,672	94	6	—	—
Lancaster	235,604	90	6	—	4
Laurens	305,701	88	7	3	2
McCormick	206,778	75	I?	9	4
Newberry	315,829	89	10	—	I
Oconee	280,294	95	2	—	3
Pickens	209,464	88	10	—	2
Saluda	187,758	85	15	—	—
Spartanburg	271,227	61	22	10	7
Union	272.352	43	17	18	22
York	264,752	69	19	9	3
All counties	4,528,036	80	12	4	4

Table 15.—Area of commercial forest land and its percentage distribution by soil-texture class, by county, Piedmont of South Carolina. 1977

County	All classes	Soil texture class				
		Sands	Sandy loam	Loam	Clay loam	Clay
	Acres	.... *Percent*				
Abbeville	219,883	4	22	27	27	20
Anderson	208,201	5	28	49	13	5
Cherokee	154,802	3	33	17	35	12
Chester	290,619	2	26	—	57	15
Edgefield	234,637	16	24	46	12	2
Fairfield	386,015	28	31	5	19	17
Greenville	278,448	2	32	53	11	2
Greenwood	205,672	5	21	40	12	22
Lancaster	235,604	9	23	7	40	21
Laurens	305,701	1	32	37	12	18
McCormick	206,778	1	30	27	26	16
Newberry	315,829	27	14	1	46	12
Oconee	280,294	8	43	13	31	5
Pickens	209,464	2	29	55	13	1
Saluda	187.758	12	15	48	25	—
Spartanburg	271,227	5	34	29	22	10
Union	272,352	7	33	40	20	—
York	264.752	—	34	12	46	8
All counties	4,528,036	8	28	28	26	10

ing stock have been rather conservative. They have included the solid-wood content between a 1-foot stump and a minimum 4.0-inch top of only the central stems in selected trees 5.0 inches d.b.h. and over. Substantial volumes in rough and rotten trees, stumps, tops, limbs. and saplings are excluded. With the gradual trend toward closer utilization and renewed interest in the use of wood for fuel, there is a need for inventories of total wood fiber.

Table 17 shows the distribution of total aboveground volume of all trees on commercial forest land. by class and species group, in the Piedmont of South Carolina. Table 18 shows the per-acre distribution of this total volume by stand-age class for major forest types. The largest differences between conventional measures of growing stock and measures of total volume occur in hardwoods. Table 19 shows a more refined distribution of hardwood timber volume by 1-inch d.b.h. classes and class of material. With the accumulation of data from a special volume study conducted as a subsample in conjunction with the ongoing inventory, average tree characteristics can now be developed for each major species in the Region (table 20). The collection of data on the lesser vegetation is still another step toward the ultimate objective—to be able to quantify total biomass within the forests across the range of forest conditions.

The multiresource inventory provides a wealth of information for studying the ecology of various plant species. The frequency of occurrence of a particular species can be related to various forest types, conditions, and species associations. This kind of information helps to identify the environment required for the growth and development of certain species and to study successional changes that occur within a particular plant community over time. Table 21 shows the distribution and ranking of the five most prevalent species or species groups observed within oak-hickory stands in the Piedmont of South Carolina. The species composition within five vegetative layers is compared over time using 20-year-age classes. Table 22 gives the frequency

Table 16.—Area of commercial forest land and its percentage distribution, by soil- and water-quality risk class, by treatment opportunity, Piedmont of South Carolina. 1977

Treatment opportunity	All classes	Soil- and water-quality risk classes[1]				
		1	2	3	4	5
	Acres	.... *Percent*				....
No treatment	3,223,011	25	39	16	18	2
Salvage cut	39,304	41	20	39	—	—
Harvest	209,064	20	32	7	24	17
Commercial thinning	212,896	52	40	4	4	—
Precommercial thinning	32,590	43	28	13	16	—
Cleaning and release	285,150	25	41	16	17	1
Stand conversion	155,948	23	45	14	15	3
Artificial regeneration without site preparation	18,615	64	29	—	7	—
Artificial regeneration after site preparation	351,458	32	31	10	24	3
Total	4,528,036	27	38	14	18	3

Definitions for soil- and water-quality risk classes:

1. During the recovery period of the activity. the water quality impact should be slight (suspended sediment less than 100 milligram\ per liter) and coil erosion less than the rate of new soil development.
2. Water quality during the recovery period of the activity can he impaired (suspended sediment greater than 100 milligrams per liter), but soil erosion should not exceed the rate of new sail development.
3. Water-quality impact can be high and soil erosion can exceed the rate of new soil development during the recovery period of the silvicultural activity.
4. Water-quality impact can be serious and roil erosion can exceed rhr rate of new soil development for 5 to 20 years after treatment.
5. Water-quality impact can be very serious and soil erosion can exceed the rate of new soil development for more than 20 years after treatment.

of occurrence of major species on plots in the oak-hickory type, again by stand-age class.

In multiple-use management, a diversity of conditions must be maintained. The diversity of forest ecosystems must be sufficient to accommodate the production of the desired combination of human benefits. These benefits include coniferous and hardwood timber products, outdoor recreation, solitude, clean water, and habitat for all endemic plants and animals.

In multiresource inventories, one objective is to measure forest diversity in some way. In the South Carolina inventory, crews recorded important items related to forest diversity within a 450-acre circular area around each sample plot on commercial forest: (1) the percentage of forest, and (2) the number of different forest conditions distinguishable on aerial photographs. Table 23 shows the results of the classifications made at 1,019 sample plots in the Piedmont. At 67 percent of the sample locations, more than 75 percent of the surrounding 450-acre area was forested. At 50 percent of the sample locations, three different forest conditions occurred within the surrounding 450-acre area.

Finally, we reemphasize that the analysis of the multiresource inventory data collected in South Carolina is outside the scope of this Paper. In this chapter, we have merely given examples of the sorts of information that were gathered and the ways in which the information might be reported.

Table 17.—Total aboveground volume of all trees on commercial forest land. by class and species group, Piedmont of South Carolina, 1977

Class of volume	All species	Pine	Other softwood	Soft hardwood	Hard hardwood
	.... *Thousand cubic feet*				
Sapling-size trees:					
Growing-stock	824.931	405,015	69,677	160,335	189,904
Non growing-stock	414,452	40,826	10,662	131,144	231,820
Total	1,239,383	445,841	80,339	291,479	421,724
Growing-stock trees:					
Poletimber-size trees					
Stumps	182.900	87,772	2,987	30.255	61,886
Bolewood	2,067,400	1,004,371	34,178	417,164	611,687
Tops and limbs	416,266	242.669	8.258	57.470	107.869
Total	2,666,566	1,334,812	45,423	504,889	781,442
Sawtimber-size trees					
Stumps	189.715	105,335	2,297	40,183	41,900
Saw log portion	3,129,476	1,847,916	40,291	523,660	717,609
Upper-stem portion	428,041	215,224	4,693	78,151	129,973
Tops and limbs	342,845	153,628	3,349	60,748	125,120
Total	4,090,077	2,322,103	50,630	702,742	1,014,602
Rough and rotten trees:					
Stumps	55,782	7,949	411	18.456	28,966
Bolewood	542,794	77,857	4,021	174,598	286,318
Tops and limbs	133,139	18,595	960	53,243	60,341
Total	731,715	104,401	5,392	246.297	375,625
Total. all volume classes	8,727,741	4,207,157	181,784	1,745,407	2,593,393

Table 18.—Average total aboveground volume of wood' per acre of commercial forest land by stand-age class. by forest types, Piedmont of South Carolina, 1977

Stand-age class (years)	All types	Forest type				
		Pine plantations	Natural pine	Oak-pine	Upland hardwood	Lowland hardwood
	Cubic feet					
0–9	390	218	505	464	403	9
10–19	1,271	1,923	1,037	883	841	1,372
20–29	1,791	2,432	1,728	1,604	1,593	2,064
30–39	2,085	3,377	2,131	1,866	1,968	2,383
40–49	2,397	3,181	2,606	2,146	2,235	2,947
50–59	2,503	—	2,686	2,307	2,446	2,530
60–69	2,660	—	2,598	2,807	2,499	3,637
70–79	2,652	—	3,099	2,238	2,395	5,253
80+	2,646	—	1,982	2,630	2,457	4,265
All classes	1,923	1,515	1,976	1,727	1,981	2,767

'Trees 1.0 inches d.b.h. and larger, excluding bark

Table 19.—Average aboveground cubic-foot volume in hardwoods, by d.b.h. class and volume material class, Piedmont of South Carolina, 1977

Diameter class (inches)	'Total aboveground volume	Bole volume'			Crown volume	
		Stump	Saw log portion	Upper stems	Tops	Limbs[2]
	Cubic feet					
1	0.12	0.02	—	—	0.09	0.01
2	.44	.06	—	0.01	.35	.02
3	1.05	.11	—	.12	.78	.04
4	1.85	.20	—	.81	.71	.13
5	2.95	.26	—	1.61	.76	,32
6	5.07	.39	0.02	3.86	.66	.14
7	7.79	.54	.14	5.78	.61	.72
8	9.86	.71	.95	6.97	.65	.58
9	12.13	.90	2.63	6.93	.62	1.05
10	18.47	.87	8.21	7.10	.92	1.37
11	21.74	1.22	11.99	5.80	.86	1.87
12	29.70	1.60	17.38	6.17	1.33	3.22
13	35.56	1.72	23.71	5.26	1.03	3.84
14	43.21	2.02	28.88	6.09	1.02	5.20
15	51.79	2.25	37.58	6.88	1.02	4.06
16	56.55	2.36	42.51	5.94	1.68	4.06
17	65.13	1.72	47.77	9.47	1.05	5.12
18	96.94	3.11	70.51	10.87	4.10	8.35
19	87.47	3.70	64.63	5.45	1.14	12.55
20	101.52	3.58	73.48	8.44	1.38	14.64

[1] Includes both mainstem and fork volume to a4.0-inch top outside bark
[2] Includes limbs **of** all sizes.

Table 20. — Average tree characteristics for loblolly pine in the Southeast

DBH class	Double bark at d.b.h.	Lengths			Cubic-foot volume		Board-foot volume[1]
		Total height	Bole length	Saw log length	Merchantable volume	Total volume	
	Inches	....	*Feet*	....	... *Cubic feet*	...	
5	0.95	39.4	16.9	—	1.76	2.47	—
6	1.06	44.2	24.5	—	3.22	3.95	—
7	1.20	48.2	30.3	—	4.96	5.78	—
8	1.29	53.5	36.9	—	7.40	8.30	—
9	1.40	58.4	42.9	24.6	10.49	11.49	36.3
10	1.49	62.7	47.9	32.9	14.02	15.17	58.7
11	1.62	65.2	50.8	33.2	17.63	18.96	82.6
12	1.70	67.5	53.5	42.5	21.62	23.14	108.9
13	1.76	70.0	56.4	46.6	26.25	27.94	139.6
14	1.85	73.5	60.0	50.5	31.69	33.62	176.2
15	1.92	75.2	62.2	53.5	37.14	39.25	215.5
16	2.03	77.4	63.8	55.7	43.30	45.71	259.6
17	2.06	77.2	63.8	56.1	48.58	51.40	299.3
18	2.18	82.1	68.8	61.0	57.74	60.61	364.4
19	2.27	76.3	63.3	55.9	59.04	63.29	378.1
20	2.40	84.3	70.8	64.0	71.54	75.27	464.4

[1] International ¼-Inch Rule.

Table 21. — Distributionof plant species by age class and vegetative layer for oak-hickory stands, Piedmont of South Carolina, 1977

Vegetative layer	Age class (years)	Ranking of five most prevalent species				
		First	Second	Third	Fourth	Fifth
Overstory (30+ feet)	0–19	Sweetgum	Yellow-poplar	Loblolly pine	Red maple	White oak
	20–39	White oak	Yellow-poplar	Sweetgum	Hickory	Scarlet oak
	40–59	White oak	Yellow-poplar	Sweetgum	Hickory	Southern red oak
	60–79	Yellow-poplar	Sweetgum	Hickory	White oak	Black oak
	80+	Hickory	White oak	Chestnut oak	Sweetgum	Yellow-poplar
Midstory (15–30 feet)	0–19	Sweetgum	Elm	Loblolly pine	Red maple	Water oak
	20–39	White oak	Sweetgum	Hickory	Red maple	Post oak
	40–59	White oak	Hickory	Sweetgum	Red maple	Water oak
	60–79	White oak	Hickory	Red maple	Black oak	Sweetgum
	80+	Hickory	White oak	Hackberry	Beech	Sourwood
Understory (5–15 feet)	0–19	Dogwood	Sweetgum	Redcedar	Elm	Red maple
	20–39	Sweetgum	Dogwood	Hickory	White oak	Honeysuckle
	40–59	Dogwood	Red maple	Hickory	Sweetgum	Blue beech
	60–79	Dogwood	Hickory	Elm	Other shrubs	Red maple
	80+	White oak	Yellow-poplar	Laurel	Dogwood	Blackgum (upland)
Shrub layer (1–5 feet)	0–19	Honeysuckle	Greenbrier	Sweetgum	Blackberry	Dogwood
	20–39	Honeysuckle	Greenbrier	Wild grape	Blackberry	Dogwood
	40–59	Laurel	Red maple	Dogwood	Honeysuckle	Hickory
	60–79	Other shrubs	Switch-cane	Laurel	Honeysuckle	Dogwood
	80+	Laurel	Switch-cane	Red maple	Hickory	Dogwood
Ground layer (0–1 foot)	0–19	Othergrasses	Honeysuckle	Forbs	Blackberry	Greenbrier
	20–39	Honeysuckle	Greenbrier	Poison ivy	Other grasses	Forbs
	40–59	Honeysuckle	Forbs	Wild grape	Other grasses	Greenbrier
	60–79	Forbs	Honeysuckle	Ferns	Other grasses	Poison ivy
	80+	Forbs	Switch-cane	Blueberry	Ferns	Other grasses

Table 22.—Major species of plant groups in the oak-hickory forest type and their frequency of occurrence, by stand-age class, Piedmont of South Carolina, 1977

Plant species	All age classes	Stand-age class				
		0–19	20–39	40–59	60–79	80+
	.... *Percentage of sample locations*					
Honeysuckle	63	70	62	65	53	29
Greenbrier	79	78	82	82	70	71
Sweetgum	70	74	68	71	63	57
Blackberry	38	70	42	27	23	14
Dogwood	80	63	82	84	87	86
Forbs	89	83	85	90	97	100
Redcedar	46	39	53	51	30	14
Elm	44	52	52	40	37	—
Red maple	80	70	70	88	83	57
Loblolly pine	26	41	28	18	33	29
Water oak	37	39	35	41	30	—
White oak	70	37	75	80	73	86
Yellow-poplar	66	52	62	69	83	71
Other grasses	79	81	72	83	73	71
Poison ivy	54	39	60	58	53	57
Wild grape	82	67	87	88	77	43
Hickory	83	52	88	88	97	100
Post oak	34	30	35	38	23	29
Scarlet oak	34	33	30	36	37	43
Laurel	11	6	7	12	23	29
Blue beech	15	7	12	17	27	29
Southern red oak	53	39	60	60	40	14
Ferns	52	48	42	54	60	86
Other shrubs	52	37	48	59	50	57
Switch-cane	11	11	5	11	13	43
Black oak	41	20	40	49	53	29
Blueberry	37	33	38	38	30	43
Blackgum (upland)	56	43	58	60	67	43
Hackberry	6	2	3	7	7	14
Beech	20	4	27	21	20	43
Sourwood	38	28	32	42	47	57
Chestnut oak	10	4	10	8	23	43

Table 23.—Distribution of samples in commercial forest land, by percent forest and number of forest conditions within a 450-acre circular area around the sample location, Piedmont of South Carolina, 1977[1]

Percent forest within 450-acre circular area	Total number of samples	Number of forest conditions within 450-acre area								
		1	2	3	4	5	6	7	8	9
		....	....	....	Number of samples	....	....	....	....	....
1–5	6	1	—	2	3	—	—			—
6–15	4	—	2	1	—	1	—	—	—	—
16–25	15	2	2	4	2	—	4	1	—	—
26–35	21	1	3	12	4	—	1	—	—	—
36–45	24	—	4	9	8	—	2	1	—	—
46–55	58	1	8	29	15	2	2	1	—	—
56–65	97	—	7	46	28	8	3	2	2	1
66–75	112	1	7	56	33	7	6	—	1	1
76–85	204	—	12	113	59	11	4	4	1	—
86–100	478	1	55	237	138	37	5	4	1	—
Total	1,019	7	100	509	290	66	27	13	5	

[1] Intended as one measure of forest diversity and forest habitat interspersion

ANALYSIS OF THE DATA

The multiresource inventory was begun to provide managers and policymakers with information about renewable forest resources other than timber. For this purpose, field data are not nearly enough. The new data must be analyzed and interpreted.

For the first time. foresters, range scientists, wildlife biologists, recreation specialists, ecologists, and others will be able to draw upon a common data base. This does not mean, however, that all needs can be served by a single analysis. Each discipline will want to evaluate benefits from a different perspective.

We can only hope that all the disciplines will start with a common understanding of the basic ecological relationships. The plant communities that occupy forests and rangelands develop in predictable sequences, and certain benefits can be expected from each stage in the sequence. For example, a stand of young hardwood saplings and seedlings offers no immediate timber benefits, but may offer excellent browse for deer. By cutting and regenerating the stand, we reap the timber benefit and renew the deer browse habitat. However, harvesting also eliminates the mast and dens for squirrels. The scope of resource analysis must be expanded to take these ecological relationships into consideration.

DEVELOPMENTS UNDERWAY

Computer modeling is a useful technique for improving resource analysis. We call attention to the DYNAST system developed at the Southeastern Station (Royce 1977). DYNAST consists of three complementary models adapted to different management purposes. The timber model, DYNAST-TM, harmonizes management actions for the production of timber. The optimum benefit model, DYNAST-OB, optimizes a specified benefit such as wilderness experience, recreation, visual appeal, habitat for a specific animal or plant, timber, water, or energy production. The multiple benefit model, DYNAST-MB, harmonizes forest management for multiple benefits.

The DYNAST system is based on the relationship between the benefits produced and the distribution of a forest's stands in different stages of development (called habitats). The continuum of succession must be divided into habitats that are significant for the benefits being considered. The classification will vary for different types of forest and can be modified whenever a new relationship is discovered between a particular age class and a particular benefit.

The multiresource inventory being tested in South Carolina seems to provide an ideal classification of forest habitats for input into the DYNAST models. Plans call for analvses of the

South Carolina data using DYNAST.

Currently, resource analysts with RRE in the Southeast are studying the size and age distributions, species composition, and successional trends among the major forest types in South Carolina. Preliminary findings suggest that with few exceptions land-use patterns and forestry practices are fragmenting the forests into smaller parcels or stands. For example, in the Piedmont Region. about 30 percent of the commercial timberland is broken up into distinct forest conditions of less than 10 acres (Knight 1978). There is also mounting evidence of a strong successional trend from pine to hardwood species.

Other developments underway include analyses of the multiresource data from the standpoints of outdoor recreation and wildlife habitat. The outdoor recreation study has been arranged through a cooperative agreement between RRE and Clemson University (Saunders, Stachoviak, and Howard 1978). The wildlife habitat study has been arranged through a cooperative agreement between RRE and Virginia Polytechnic Institute and State University.

The long-term objective of RRE in the Southeast is to develop and maintain expertise required to fully analyze and integrate all resource elements. For the present, our resource analysts who are most familiar with the data should establish the basic ecological relationships and make the initial interpretations of the findings. This procedure will identify the limitations and proper use of the data. After the basic ecological relationships are established, outside researchers are encouraged to help extend the analysis of the data through both independent and cooperative efforts.

THE FUTURE

We are optimistic about the future of multiresource inventories. We have identified an important task and made good progress toward its completion. As future assessments are planned and additional information needs develop, changes are inevitable. Our goal, therefore, is to maintain the expertise needed to make changes while we are collecting, processing, and analyzing resource information for the Southeast.

IMPROVE EACH NEW INVENTORY STARTED

Southeastern Stater are inventoried in an established sequence. As work in one State nears completion, planning and preliminary inventory work are underway in the next State. In every inventory cycle. however, each State is treated as a new start. Past work is reviewed, procedures are examined, and various changes are made before work is started in the next State. Major changes are usually avoided within a State because inconsistencies in the data within a State would create difficulties in both present and future measurements. We are constantly looking for ways to improve procedures, and we think each new inventory is a little better than the preceding one. By the time a State is revisited, therefore, the accumulated improvements are quite significant.

ESTIMATING FUTURE NEEDS

The frequency of inventories, commonly referred to as the survey cycle, has Huctuated between 8 and 11 years since 1945. If current manpower and sampling intensity are maintained, we will be able to conduct multiresource inventories on an 8-year cycle. Many people argue that the cycle should be reduced to 5 years. Even if this is done, it will take 5 years to uniformly gather a piece of new information across the entire Southeast. To partially offset the timelag between wanting information and having it. the RRE inventory staff tries hard to estimate future needs and to collect data to meet these needs. The record shows that RRE has been fairly successful. For example, biomass studies were initiated in 1963 and the demand for this information has recently intensified. A new class of management-related information, including treatment opportunity, stand history, timber availability, and improved stand age, was added to the inventory in 1970. User interest in this information is now on the increase.

The challenge and risk associated with anticipating future resource-information needs are considerably greater with multiple resources, but so are the potential benefits.

THE 1990 ASSESSMENT

Most of the transition to a multiresource inventory, described in this Paper, was accomplished under stringent deadlines. A response to the RPA was needed; the 1980 Assessment due dates were firm; many separate initiatives already in motion required inventory involvement. Now

that data needs for the 1980 Assessment have largely been satisfied and the South Carolina Pilot Project is nearing completion. it is time to consider what the 1990 Assessment needs will be and how they will be met. Several assumptions can be made in this regard. First. deadlines will be established requiring final data by mid-1988. Further. the Forest Service will want to use the best possible data base. and this base will be shared by various resource uses. We can also speculate that the 1990 Assessment will place much greater emphasis on use interactions and the display of alternatives for mixing and balancing combinations of resource use. If these assumptions hold true, RRE in the Southeast must strengthen both techniques research and resource analysis. and it must conduct multiresource inventories in Florida. Georgia, North Carolina, and Virginia. We expect to complete the initial multiresource inventory of the Southeast by 1984. and to complete a second generation multiresource inventory and remeasurement of South Carolina and Florida by 1988. for use in the 1990 Assessment.

GATHERING ADDITIONAL INFORMATION

A described earlier in this Paper, there are four ways we can gatheradditional resource information. We can collect additional information at each sample, overlay other data, acquire information already compiled in final form, or initiate special studies. The South Carolina Pilot Study placed emphasis on the first method and greatly increased the amount of data collected at both forest and nonforest sample locations. The next phase of increased data collection will involve the remaining methods of gathering additional information.

The key to overlaying independent data sources is to have common geographic locators. Various mapping and computer techniques can be used to merge information from different sources if a compatible coordinate system is used. Past inventories in the Southeast have used an arbitrary coordinate system sensitive to the nearest mile. A study conducted by RRE (Cost 1976) shows that as location accuracy is increased. the cost also increases. A decision to abandon the existing system in favor of a standard, but more expensive. coordinate system will have to be made if RRE inventory data and data from other sources are to be combined.

Many sources of information are available to the resource analyst. Some of these outside sources are completely reliable. some are not. Despite questions of reliability, we must often use outside sources for types of data that we cannot efficiently collect.

The remaining way to gather additional information is through special studies. Such studies are often used when gathering of certain data is too complicated or too time consumingfor regular inventory crews. Special studies may also require expensive. specialized equipment. In these studies, we subsample from the regular inventory plots, or we select an independent sample. New studies will likely be needed to: (1) validate wildlife habitat rankings, (?) develop weight conversion factors for space occupancy stocking estimates. (3) determine average weights per cubic foot for minor tree species, and (4) closely monitor the management actions in harvested pine stands.

REPORTING RESULTS—FUTURE OUTLOOK

We have not yet formulated a strategy for disseminating our results. Perhaps some combination of publications. direct consultation, data transfers, and customized responses will be satisfactory. We really do not know. We do know that when we broadened the scope of our inventories, we also broadened the interested audience. Many of the new users of our results may not yet view us as a source of information. We will continue to look for new ways to make the multiresource inventory as useful and as available as possible. We encourage specialists in ecology, hydrology, outdoor recreation, range, soils, and wildlife to assist and cooperate with RRE in the evaluation and dissemination of the inventory findings.

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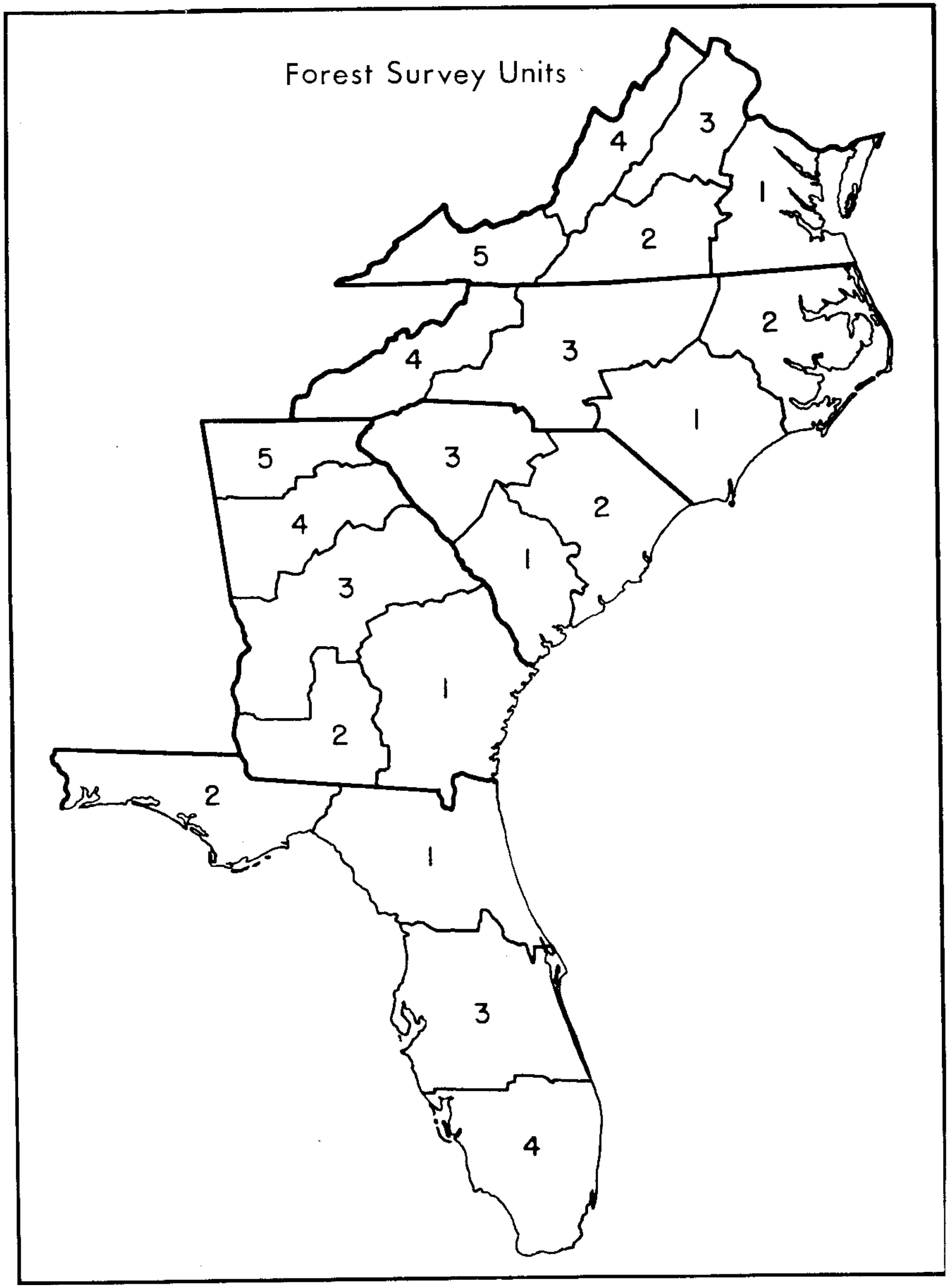
APPENDIX



Forest Survey Units
4
3
1
2
5
2
3
4
1
5
3
2
4
1
3
1
2
2
1
3
4

FORM SE-1, JANUARY 1976 FOREST INVENTORY TREE RECORD CREW:______________ DATE:________________

LOCATION				TREE				TREE QUALITY					SITE			BARK	SIZE		TREE CLASSIFICATION								
STATE	UNIT	COUNTY	LOCATION	POINT NO.	TREE NO.	SPECIES	D.B.H.	LOG GRADE	CROWN RATIO	CROWN CLASS	DAMAGE	TREE CLASS	SITE CLASS	TREE ORIGIN	PHYSIO.CLASS	DOUBLE BARK AT D.B.H.	TOTAL AGE	TOTAL HEIGHT	FORKS	LIMBS	PRODUCT	NUMBER OF SECTIONS	IDENT.8OR9	SURVEY CYCLE	OPTION 1	OPTION 2	OPTION 3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
XX	X	XX	XXX	X	XX	XXX	XXX	X	X	X	XX	X	X	X	XX	XXX	XXX	XXX	X	XX	XX	XX	X	X	XX	XX	XX

TREE SECTIONS									TREE LOGS OR BOLTS												OPTIONAL		
					WORK ZONE	SECTION CULL						UTILIZATION			SWEEP			CROOK					
SECTION NO.	SEC. IDENT.	LOWER D.O.B.	UPPER D.O.B.	SECTION LENGTH	ACC. SEC. LGTHS.	PERCENT CU. FT.	PERCENT BD. FT.	MINOR LIMBS	LOG NUMBER	LOG GRADE	BOLTER LOG	UTILIZ.	PRODUCT	DBLE.BARK TOP OF SECTION	DEPARTURE	LENGTH	D.O.B.	DEPARTURE	LENGTH	D.O.B.	OPTION 1	OPTION 2	OPTION 3
29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
XX	X	XXX	XXX	XXX		XXX	XXX	XX	XX	X	X	X	XX	XXX	XX	XXX	XXX	XX	XX	XXX	XX	XX	XX
01																							
02																							
03																							
04																							
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16																							
17																							
18																							
19																							
20																							

FORM SE-2, March 1977 | FOREST RESOURCES INVENTORY SAMPLE RECORD | Page 1

STATE	UNIT	COUNTY	LOCATION	SAMPLE KIND	DATE OF SURVEY	L.U. PATTERN	OWNERSHIP	LARGE OWNER CODE	STAND ORIGIN	SITE CLASS	PHYSIO. CLASS	STAND AGE	SEED SOURCE	FOREST TYPE	STAND SIZE	SEEDLINGS PER ACRE: SO. Y. PINES	SEEDLINGS PER ACRE: OTHER	STOCK.: NONSTOCK.	STOCK.: INHIB. VEG.	INHIB. CLASS	SLOPE	ASPECT	ACCESSIBILITY	OPERABILITY	SIZE OF FOREST CONDITION
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
XX	X	XX	XXX	X	XXXX	X	XX	XX	X	X	XX	XX	X	XX	XX	XX	XX	X	X	X	X	X	X	X	XX
39																									

PAST TREAT. OR DIST: PRIMARY	PERIOD	SECONDARY	TERTIARY	TREAT. OPPOR.	OLD CLASSIFICATIONS: STAND ORIG.	FOREST TYPE	OWNERSHIP	PAST DIST.	POINTS REMEAS.	INV. POINTS	NO. OF ENTRIES	POINT HISTORY 1	2	3	CRUISER NUMBER	OPEN 1	2	3	4	REMEASUREMENT PERIOD	EXPANSION FACTORS: REMEASUREMENT	VOLU
28	29	30	31	32	33	34	35	36	37	38	39	40			41	42				43	44	45
XX	XX	X	X	X	X	XX	XX	X	X	X	XX	X	X	X	XX	XX	XX	XX	XX	XXX	XXXXX	XXXX

D.B.H. EST. DIST. TO MARK	ENTRY NUMBER	AZIMUTH	DISTANCE	POINT NUMBER	TREE NUMBER	TREE HISTORY	SPECIES	D.B.H.	TREE CLASS	MGT. CLASS	LENGTH	CUBIC CULL PERCENT	CROWN RATIO	CROWN CLASS	DAMAGE	OLD D.B.H.	CRUISER NUMBER	VOL. IDENT.	LIVE TREE CAVITIES	PROSPECTIVE DEN TREES	OPI 5
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
	XX	XXX	XX	X	XX	X	XXX	XXX	X	X	XXX	XX	X	X	XX	XXX	XX	X	XX	X	XX
	01																				
	02																				
	03																				
	04																				
	05																				
	06																				
	07																				
	08																				
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	10																				
	11																				
	12																				
	13																				
	14																				
	15																				
	16																				
	17																				
	18																				
	19																				
	20																				

1 ____ 2 ____ 3 ____ 4 ____ 5 ____ 6 ____ 7 ____ 8 ____ 9 ____ 10 ____

FORM SE-3, MARCH 1977

AREA SAMPLE RECORD

Page _____ of _____

STATE _____ XX

UNIT _____ X

COUNTY _____ XX

COUNTY NAME ____________________

Type of Water/Marsh
1-Fresh
2-Salt

Water Class
1-Lake
2-Stream

Lake Size
1-Less than 1 acre
2-1-5 acres
3-6-10 acres
4-11-15 acres
5-16-20 acres
6-21-21 acres
7-26-30 acres
8-31-11 acres
9-36-40 acres

Stream Width
1-1-30 feet
2-31-110 feet
3-111-190 feet
4-191-270 feet
5-271-350 feet
6-351-430 feet
7-431-510 feet
8-511-590 feet
9-591-660 feet

Sampling Method
Blank - Photo
1- Aerial
2- Ground
3- Deleted

P.I. by _____

Date of P.I. _____

Cruiser Numbers _____, _____, _____, _____

CLUSTER						PHOTO CLASS						SUBSAMPLE FIELD CHECK																PLOTS				
												CLUSTER POINTS																				
SAMPLING METHOD	OLD PHOTO NUMBER	NEW PHOTO NUMBER	OLD PLOT NUMBER	NEW PLOT NUMBER	CLUSTER NUMBER	COMM. FOREST RESER. FOREST 20;50	UNPRODUCTIVE FOREST 40	OTHER MISC. 60	URBAN 67	CENSUS WATER 91	NON-CENSUS WATER 92	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	OLD LAND USE	NEW LAND USE	FRESH/SALT WATER	WATER CLASS	SIZE/WIDTH
X	XXX	XXX	XXX	XXX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	X	X	X

FORM SE-9, MAY 1977 (REVISED)

ECOLOGICAL DIVERSITY PROFILE RECORD

LOCATION						WILDLIFE HABITAT												WATER					RANGE		RECREATION							
																		TYPE			DEPTH											
STATE	UNIT	COUNTY	LOCATION	CRUISER NUMBER	NUMBER OF ENTRIES	BROWSING	TYPE DIVERSITY	MILL RESIDUES	LOGGING SLASH	LITTER & TRASH	GULLIES	HOLES & CAVES	ROCK OUTCROPS	MARSH CONDITIONS	SPANISH MOSS	SNAGS PER ACRE	# OF CAVITIES	STAND	ACRE	POINT 1	ACRE	POINT 1	GRAZING	FENCING	PEOPLE USE	HIKING	HUNTING	CAMPING	FISHING	TRAIL BIKES	OTHER USE	POSTED
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
XX	X	XX	XXX	XX	XX	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	XX	XX	X	X	X	X	X	X	X	X	X	XX
39																																

SOIL								LAND USE IMPACT						MISC.		OPEN														
LITTER DEPTH	HUMUS DEPTH	SOIL TEXTURE	PERCENT BARE GROUND	PERCENT COMPACTION	SOIL STRUCTURE	SLOPE LENGTH	SOIL EROSION	NONFOREST PROXIMITY		ZONE 1	ZONE 2	ZONE 3	PERCENT FOREST	BURN HISTORY	SEASON	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
35	36	37	38	39	40	41	42	43		44	45	46	47	48	49	50														
XX	XXX	X	XX	XX	X	XXX	X	X	X	X	X	X	X	X	X	X	X	X	X	XX	X	X	X	X	XX	X	X	X	X	XX

VEGETATIVE DATA

ENTRY NO.	POINT NO.	HT. ZONE	HEIGHT		ZONE PERCENT	BROAD CLASS		SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES	SPECIES
			FROM	TO		SPECIES	PERCENT										
59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
XX	X	X	XX	XX	XXX	X	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
01																	
02																	
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13																	
14																	
15																	
16																	
17																	
18																	
19																	

CODE	COMMON NAME
	YELLOW PINES
131	Loblolly pine
121	Longleaf pine
126	Pitch pine
128	Pond pine
107	Sand pine
110	Shortleaf pine
111	Slash pine
115	Spruce pine
123	Table-Mt. pine
132	Virginia pine
	OTHER SOFTWOODS
	Atlantic white-cedar
221	Baldcypress
010	Fir
260	Hemlock
241	Northern white-cedar
222	Pondcypress
060	Redcedar
090	Spruce
129	White pine
	SOFT HARDWOODS
950	Basswood
762	Black cherry
694	Blackgum (lowland)
693	Blackgum (upland)
313	Boxelder
330	Buckeye
601	Butternut
740	Cottonwood
651	Cucumbertree
970	Elm
460	Hackberry
555	Loblolly-bay
652	Magnolia
316	Red maple
580	Silverbell (in mts.)
317	Silver maple
653	Sweetbay
611	Sweetgum
731	Sycamore
691	Water tupelo
920	Willow
621	Yellow-poplar
	HARD HARDWOODS
540	Ash
531	Beech
370	Birch (except yellow)
901	Black locust
837	Black oak
602	Black walnut
823	Bur oak
813	Cherrybark oak
832	Chestnut oak
826	Chinkapin oak
491	Dogwood
311	Florida maple
400	Hickory
591	Holly
552	Honeylocust
820	Laurel oak
838	Live oak
680	Mulberry
822	Overcup oak
521	Persimmon (forest grown)
830	Pin oak
835	Post oak
833	Northern red oak
806	Scarlet oak
817	Shingle oak
834	Shumard oak
812	Southern red oak
318	Sugar maple
825	Swamp chestnut oak
804	Swamp white oak
827	Water oak
802	White oak
0il	Willow oak
371	Yellow birch
	MISCELLANEOUS
816	Bear oak
	Blackjack oak
807	Bluejack oak
841	Dwarf live oak
840	Dwarf post oak
819	Turkey oak
899	Other scrub oaks
341	Ailanthus
548	American mt. ash
391	Blue beech
451	Catalpa
310	Chalk maple
421	Chestnut
661	Chinaberry
660	Domestic fruit (apple, etc.)
760	Fire cherry
701	Eastern hophornbeam
319	Mountain maple
692	Ogeechee gum
641	Osage-orange
521	Persimmon (field grown)
722	Planertree (water elm)
721	Redbay
471	Redbud
712	Royal paulownia
931	Sassafras
352	Serviceberry
581	Silverbell (except mts.)
ill	Sourwood
315	Striped maple
999	Other miscellaneous trees

VOLUME DISTRIBUTION

Tree size: Bolts (8')	Logs (16')	Bolt number 1	2	3	4	5	6	7	8	9	10
		Percent of tree volume									
2	1	56	44								
3	1½	41	33	26							
4	2	33	28	22	17						
6	2½	27	23	19	17	14					
7	3	24	21	18	15	12	10				
-	3½	22	19	17	14	12	9	7			
-	4	20	18	15	13	11	9	8	6		
-	5	18	15	13	12	10	9	8	6	5	3

PRIMARY PAST TREATMENT OR DISTURBANCE

00	No treatment or disturbance
01	Harvesting followed by artificial regeneration
02	Harvesting followed by natural regeneration } not seed tree
03	Harvesting without regeneration } not seed tree
04	Commercial thinning
05	Precommercial thinning
06	Cleaning, release, or other intermediate cutting
07	Clearing or other site preparation
08	Girdling or poisoning of undesirable trees
09	Prescribed burning
10	Major drainage efforts
11	Removal of selected trees resulting in high grading
12	Significant damage from wildfire
13	Major man-caused flooding
14	Grazing or other activity that retards or precludes development of understory
15	Turpentining
16	Artificial regeneration after site preparation
17	Artificial regeneration without site preparation
18	Construction of fences, woods roads, fire breaks, trash pits, etc., if such activity has significantly influenced the stand condition
19	Natural regeneration on nonforest land (Sample kind 1 only)
20	Artificial regeneration on nonforest land (Sample kind 1 only)
21	Harvesting leaving seed trees, with satisfactory regeneration
22	Harvesting leaving seed trees, without satisfactory regeneration
23	Salvage cut
24	Significant damage from disease
25	Significant damage from insects
26	Significant damage from weather or other natural destructive agents
99	Other (specify in item 100 under notes)

SECONDARY AND TERTIARY PAST TREATMENT OR DISTURBANCE AND OLD PAST DISTURBANCE CLASSIFICATION

0	None
1	Timber cutting
2	Mechanical site preparation
3	Drainage
4	Prescribed fire
5	Grazing
6	Weather
7	Insects
8	Disease
9	Other

PHYSIOGRAPHIC CLASS

11	High mountain tops and slopes
12	Sand dunes and sand ridges
13	Low mountain tops and dry slopes
14	Sand hills
15	Mountain foothills
10	Other xeric
21	Flatwoods and dry pocosins
22	Rolling uplands
23	Bluffs
24	Mountain saddles and moist slopes
25	Natural stream levees
26	Valley bottoms
27	Mountain coves
28	Narrow stream margins
29	Broad stream margins
20	Other mesic
31	Deep swamps
32	Cypress strands
33	Small drains
34	Cypress ponds
35	Willow heads and strands
36	Bays and wet pocosins
37	Marl flats and forest prairies
30	Other hydric

TROPICALS

984	Australian pine
982	Cajeput-tree
986	Carribean pine
985	Citrus
510	Eucalyptus
940	Mahogany
983	Silk oak
006	Other tropicals
911	Sable palm
910	Other palms

TABLE OF VARIABLE PLOT LIMITING DISTANCE RADII

Slope 0

DBH	Tenths of Inch: 0	1	2	3	4	5	6	7	8	9
	Distance in Feet									
05	07.10	07.24	07.38	07.53	07.67	07.81	07.95	08.09	08.24	08.38
06	08.52	08.66	08.80	08.95	09.09	09.23	09.37	09.51	09.66	09.80
07	09.94	10.08	10.22	10.37	10.51	10.65	10.79	10.93	11.08	11.22
08	11.36	11.50	11.64	11.79	11.93	12.07	12.21	12.35	12.50	12.64
09	12.78	12.92	13.06	13.21	13.35	13.49	13.63	13.77	13.92	14.06
10	14.20	14.34	14.48	14.63	14.77	14.91	15.05	15.20	15.34	15.48
11	15.62	15.76	15.91	16.05	16.19	16.33	16.47	16.62	16.76	16.90
12	17.04	17.18	17.32	17.47	17.61	17.75	17.89	18.04	18.18	18.32
13	18.46	18.60	18.75	18.89	19.03	19.17	19.31	19.46	19.60	19.74
14	19.88	20.02	20.17	20.31	20.45	20.59	20.73	20.88	21.02	21.16
15	21.30	21.44	21.59	21.73	21.87	22.01	22.15	22.30	22.44	22.58
16	22.72	22.86	23.01	23.15	23.29	23.43	23.5.	23.72	23.86	24.00
17	24.14	24.28	24.43	24.57	24.71	24.85	24.99	25.14	25.28	25.42
18	25.56	25.70	25.85	25.99	26.13	26.27	26.41	26.56	26.70	26.84
19	26.98	27.12	27.27	27.41	27.55	27.69	27.83	27.98	28.12	28.26
20	28.40	28.54	28.69	28.83	28.97	29.11	29.25	29.40	29.54	29.68
21	29.82	29.96	30.11	30.25	30.39	30.53	30.67	30.82	30.96	31.10
22	31.24	31.38	31.53	31.67	31.81	31.95	32.09	32.24	32.38	32.52
23	32.66	32.80	32.95	33.09	33.23	33.37	33.51	33.66	33.80	33.94
24	34.08	34.22	34.37	34.51	34.65	34.79	34.93	35.08	35.22	35.36
25	35.50	35.64	35.79	35.93	36.07	36.21	36.35	36.50	36.64	36.78
26	36.92	37.06	37.21	37.35	37.49	37.63	37.77	37.92	38.06	38.20
27	38.34	38.48	38.63	38.77	38.91	39.05	39.19	39.34	39.48	39.62
28	39.76	39.90	40.05	40.19	40.33	40.47	40.61	40.76	40.90	41.04
29	41.18	41.32	41.47	41.61	41.75	41.89	42.03	42.18	42.32	42.46
30	42.60	42.74	42.89	43.03	43.17	43.31	43.45	43.60	43.74	43.88
31	44.02	44.16	44.31	44.45	44.59	44.73	44.87	45.02	45.16	45.30
32	45.44	45.59	45.73	45.87	46.01	46.15	46.30	46.44	46.58	46.72
33	46.86	47.01	47.15	47.29	47.43	47.57	47.72	47.86	48.00	48.14
34	48.28	48.43	48.57	48.71	48.85	48.99	49.14	49.28	49.42	49.56
35	49.70	49.85	49.99	50.13	50.27	50.41	50.56	50.70	50.84	50.98
36	51.12	51.27	51.41	51.55	51.69	51.83	51.98	52.12	52.26	52.40
37	52.54	52.69	52.83	52.97	53.11	53.25	53.40	53.54	53.68	53.87
38	53.96	54.11	54.25	54.39	54.53	54.67	54.82	54.96	55.10	55.24
39	55.38	55.53	55.67	55.81	55.95	56.09	56.24	56.38	56.57	56.66
40	56.80	56.95	57.09	57.23	57.37	57.51	57.66	57.80	57.94	58.08

DAMAGE CODES

00	No damage
10	Insects
20	Other disease
21	Fusiform rust
22	Annosus root rot
23	Littleleaf disease
24	Blister rust
25	Hardwood cankers
26	Branch stubs } 5% cull
27	Top breakage } 5% cull
28	Other basal defects } 5% cull
30	Fire
40	Animal
50	Weather
60	Suppression and stagnation
80	Logging and related
84	Turpentining
90	Form (damaging)
	Saplings only
91	Form (culling)
92	Off site (damaging)
93	Off site (culling)

UTILIZATION

Product known
1 Tree not used
2 Tree bucked for product in place
3 Tree length logging

Product estimated
4 Tree not used
5 Tree bucked for product in place
6 Tree length logging

CAUSE OF DEATH

Timber cut		Mortality	
81	Logging	10	Insects
82	TSI	20	Disease
83	Turpentining	30	Fire
84	Land Clearing	40	Animals
85	Conversion to non-forest or noncommercial forest land	50	Weather
		60	Suppression
		70	Other

PRODUCT

Primary	Secondary	
00	-0	No product
1-	-1	Sawlog
2-	-2	Veneer log or bolt
3-	-3	Cooperage log or bolt
4-	-4	Pulpwood
5-	-5	Piling
6-	-6	Poles
7-	-7	Fencepost
8-	-8	Fuelwood
9-	-9	Miscellaneous prod.

TREE HISTORY

1	Live tree recorded on previous survey or live tree tallied on the 10-point cluster
2	Ingrowth 1.0 inch d.b.h. or larger on smallest fixed plot not recorded on previous survey
3	Live tree on variable plot not recorded on previous survey
5	Salvable dead tree 5.0 inches d.b.h. or larger recorded as a live tree on previous survey
6	Nonsalvable dead tree 1.0 inches d.b.h. or larger recorded as a live tree on previous survey (includes salvable 1.0-4.9 inches)
7	Mortality tree 5.0 inches d.b.h. or larger on the smallest fixed plot not recorded as a live tree on the previous survey (Mortality tree less than 1.0 inches during last survey and now 5.0 inches or larger)
8	Tree removed from commercial forest recorded as live tree on previous survey
9	Tree removed from commercial forest 5.0 inches d.b.h. or larger on the smallest fixed plot not recorded as a live tree on the previous survey (Timber removals less the 1.0 inches during last survey and now 5.0 inches or larger)
0	Stump of dead tree 1.0 inch d.b.h. or larger recorded as a live tree on previous survey and harvested for a product

FOREST TYPE

04	White pine-hemlock
10	Spruce-fir
21	Longleaf pine
22	Slash pine
31	Loblolly pine
32	Shortleaf pine
33	Virginia pine
34	Sand pine
35	Redcedar
36	Pond pine
37	Spruce pine
38	Pitch pine
39	Table-mt. pine
50	Oak-hickory
52	Chestnut oak
57	Southern scrub oak
60	Oak-gum-cypress
70	Elm-ash-cottonwood
80	Maple-beech-birch

PROSPECTIVE DEN TREES

0	No damage
1	Basal defect
2	Top breakage
3	Branch stubs
4	Basal defect and top breakage
5	Basal defect and branch stubs
6	TOP breakage and branch stubs
7	Basal defect, top breakage and branch stubs

CODING SUMMARY, PART I
SOUTH CAROLINA
MARCH 1977

PLOT SIZES

Plot size	Circular (radius in feet)	Square (side in feet)
1	117.75	208.71
1/2 Acre	83.26	147.56
1/5 Acre	52 66	93.34

STAND SIZE

Primary	Secondary	
1-	-1	Sawtimber
2-	-2	Poletimber
3-	-3	Sapling & seedling
40		Nonstocked

LAND USE PATTERN

0 Nonforest

1 Isolated forest less than 10 acres in size and bounded on all sides by nonforest uses

2 Isolated forest between 10 and 50 acres and bounded on all sides by nonforest uses

3 Isolated forest between 50 and 100 acres and bounded sides by nonforest

4 Isolated forest between 100 and 200 acres and bounded on all sides by nonforest uses

5 A long, narrow stringer or strip of forest bounded both sides by nonforest uses

6 Many small, scattered, irregular-shaped forest areas linked by stringers or strips interspersed nonforest

7 Intermixed forest and non-forest of about the same and shapes

8 Scattered blocks of forest loosely related by narrower of forest land

9 Forest areas of over 200 acres

STAND ORIGIN

1 No evidence of seeding or planting.
2 Since last survey trees planted or seeded with acceptable survival
3 Prior to last survey trees planted or seeded with acceptable survival.
4 Since last survey trees planted or seeded without accentable survival
5 Prior to last survey trees planted or seeded without acceptable survival.

HORIZONTAL SLOPE CORRECTION PER 70 FEET OF SLOPE DIST. Percent Slope	Feet added	HORIZONTAL SLOPE CORRECTION PER 100 FEET OF SLOPE DIST. Percent Slope	Feet
	0.1		0.1
10	0.4	10	c.5
15	0.8	15	1.1
20	1.4	20	2.0
25	2.1	25	3.0
30	2.9	30	4.2
35	3.9	35	5.6
40	5.0	40	7.2
45	6.2	45	8.8
50	7.4	50	10.6
55	8.7	55	12.4
60	9.9	60	14.2
65	11.3	65	16.2
70	12.7	70	18.1
80	15.3	80	21.9
90	17.9	90	25.6
100	20.5	100	29 3
110	23.0	110	32.8
120	25.2	120	36.0

TREATMENT OPPORTUNITY

0 No treatment needed
1 Salvage cut
2 Harvest
3 Commercial thinning
4 Precommercial thinning
5 Cleaning, release, or other intermediate cutting
6 Stand conversion
7 Artificial regeneration without preparation
8 Artificial regeneration after site preparation

NUMBER OF TREES REQUIRED FOR 16.7-PERCENT STOCKING BY D.B.H. CLASS

D.b.h.	Size of acre: 1 Acre	1/2
1/2	94	47
1/4	77	39
	57	29
	40	20
10	26	13
12	19	10
14	15	
16	12	
18	10	
20		

1/ - 2 and 4 inch trees occuring in clumps should be counted as 1

STOCKING STANDARDS FOR TREES

Tree size	1 Acre: No. trees full stocking	Percent per tree
Seedling	600	.17
	560	18
	460	.22
	340	.29
	240	.42
10	155	.65
12	115	.87
14	90	1.11
16	72	1.39
18	60	1.67
20+	51	1.96

SEED SOURCE

0 No seed source
1 Yellow pine
2 Other softwood
3 Desirable hardwood seed trees (seetgum, yellow-poplar, water tupelo, lowland blackgum, cherry-bark oak, northern red oak, white oak, swamp chestnut oak, sycamore, or ash
4 Other hardwood seed tree species

MANAGEMENT TREE CLASS

, A tree, part of the manageable stand tree, competing with or in conflict with manageable stand trees
, A miscellaneous tree immaterial to manageable stand trees

ACCESSIBILITY

1 condition is highly accessible using existing roads.
2 Roads could be easily built into the area.
, Roads would be difficult to build into the area.
4 very difficult or impractical to build into the area due to slope, water, or other physical obstacles.

OPERABILITY

: No problem
2 Limited to seasonal use due to water conditions in wet weatner
, Moderate slope (averaging 20-39 percent), irregular terrain, or other ground conditions limiting the type of equipment that could be operated within the forest condition
4 Mixed wet and dry areas within forest condition typical of multi-channeled streams with intermixed dry areas or island.
5 Severe slopes (averaging 40-49 percent), broken terrain, or other adverse ground conditions which drastically limit equipment use.
6 Adverse operating conditions caused by year-round water problems
7 Slopes of 50 percent or more.

INHIBITING VEGETATION CLASS

0 No significant inhibiting vegetation
1 Scattered, small stems, and low heights
2 Scattered, with either large stems or tall heights
3 Scattered, with large stems and tall heights
4 Intermediate density, small stems, and low heights
5 Intermediate density, with either large stems or tall heights
6 Intermediate density, with large stems and tall heights
7 Dense with small stems and low heights
8 Dense with either large stems or tall heights
9 Dense with large stems and tall heights

SLOPE (Percent)

0 0-9
1 10-19
2 20-29
3 30-39
40-49
5 50-59
6 60-69
7 70-79
8 80-89
9 90+

ASPECT (Degrees)

0 No aspect
1 338-22
2 23-67
, 68-112
4 113-157
5 158-202
6 203-247
, 248-292
8 293-337

SECTION IDENT.

0 Stump section
log section, main stem
2 Upper stem section, main it —
, Top section, main stem
4 Saw log section, fork
5 Upper stem section, fork
6 Top section, fork
7 Utilizable limb section
utilizable limb
9 Minor limbs

/

I Po.>* remeasured and new inven taken at same point without sh or substituting.
2 Point remeasured at original location but inventory taken a a shifted location
3 Point remeasured at original location but inventory taker a a substitute point (points 2 a

CROWN RATIO (percent of live crown)

1 0-9
2 10-19
3 20-29
4 30-39
5 40-49
50-59
7 60-69
6 70-79
9 80-89
0 90-99

SAMPLE KIND

1 Sample location center did no qualify as unreserved commer forest land at time of last
2 Sample location center quali unreserved commercial forest at time of last survey and r struction of old plot is pos
3 Sample location center quali unreserved commercial for land at time of last survey reconstruction of old plot i impossible

CROWN CLASS

1 Open grown
2 Dominant
3 Codominant
4 Intermediate
5 Overtopped

D.B.H.	NUMBER OF WELL-SPACED SEED TRE ACRE FOR 10 SQ.FT. OF BASAL AR
	23
10	18
11	15
12	13
13	10
14	
15	
16	
17-18	
19-20	
20+	

LIVE TREE CAVITIES

Location (left digit)
0 None
1 Cavities below d.b.h.
2 Cavities above d.b.h.
3 Cavities below and d b

Number (right digit)
X(1-9)

GROUND LAND USE

20 Commercial forest
40 Unproductive forest
50 Prod forest reserved
61 Cropland
62 Improved pasture
63 Natural rangeland
64 Idle farmland
66 Other farmland, inc. farmsteads
67 Urban and other
68 Marsh
91 Census water
92 Non-census water

OWNER CLASS

11 National Forest
12 BLM
13 Indian
14 Miscel. federal
15 State
16 County and municipal
20 Forest industry
40 Farmer
50 Farmer-owned leased
60 Miscel priv., corporate
70 Miscel. priv., individua
80 Miscel priv., corporate
90 Miscel. priv., individua

SHAPE OF FOREST CONDITION

1 A regular shaped area having customary width-to-length re ship and a normal boundary.
2 A central area having one or protrusions, extensions, or boundary. Sample location central area.
3 A central area having one or protrusions, extensions, or boundary. Sample location the central area.
4 Two or more distinct areas l linked together by strips, or bands of similar forest c Sample location is in the di area.
5 Two or more distinct areas l linked together by strips, s or bands of similar forest c location is not in t distinct area.
6 Strips, stringers, or bands land typical of long narrow margins, narrow cypress stra long bands of reverted land

TREE CLASS

1 Desirable tree
2 Acceptable tree
3 Rough tree
4 Rotten tree

CODING SUMMARY
SOUTH CAROLINA
MARCH 1977

CODE	COMMON NAME
	YELLOW PINES
131	Loblolly pine
121	Longleaf pine
126	Pitch pine
128	Pond pine
107	Sand pine
110	Shortleaf pine
111	Slash pine
115	Spruce pine
123	Table-Mt. pine
132	Virginia pine
	OTHER SOFTWOODS
043	Atlantic white-cedar
221	Baldcypress
010	Fir
260	Hemlock
241	Northern white-cedar
222	Pondcypress
060	Redcedar
090	Spruce
129	White pine
	SOFT HARDWOODS
950	Basswood
762	Black cherry
694	Blackgum (lowland)
693	Blackgum (upland)
313	Boxelder
330	Buckeye
601	Butternut
740	Cottonwood
651	Cucumbertree
970	Elm
460	Hackberry
555	Loblolly-bay
652	Magnolia
316	Red maple
580	Silverbell (in mts.)
317	Silver maple
653	Sweetbay
611	Sweetgum
731	Sycamore
691	Water tupelo
920	Willow
621	Yellow-poplar
	"Am HARDWOODS
540	Ash
531	Beech
370	Birch (except yellow)
901	Black locust
837	Black oak
602	Black walnut
823	Bur oak
813	Cherrybark oak
832	Chestnut oak
826	Chinkapin oak
491	Dogwood
311	Florida maple
400	Hickory
591	Holly
552	Honeylocust
820	Laurel oak
838	Live oak
680	Mulberry
822	Overcup oak
521	Persimmon (forest grown)
830	Pin oak
835	Post oak
833	Northern red oak
806	Scarlet oak
817	Shingle oak
834	Shumard oak
812	Southern red oak
318	Sugar maple
825	Swamp chestnut oak
804	Swamp white oak
827	Water oak
802	White oak
831	Willow oak
371	Yellow birch
	MISCELLANEOUS
816	Bear oak
824	Blackjack oak
807	Bluejack oak
841	Dwarf live oak
840	Dwarf post oak
819	Turkey oak
899	Other scrub oaks
341	Ailanthus
548	American mt. ash
391	Blue beech
451	Catalpa
310	Chalk maple
421	Chestnut
661	Chinaberry
660	Domestic fruit (apple, etc.)
760	Fire cherry
701	Eastern hophornbeam
319	Mountain maple
692	Ogeechee gum
641	Osage-orange
521	Persimmon (field grown)
722	Planertree (water elm)
721	Redbay
471	Redbud
712	Royal paulownia
931	Sassafras
352	Serviceberry
581	Silverbell (except mts.)
711	Sourwood
315	Striped maple
999	Other miscellaneous trees

984	Australian pine
982	Cajeput-tree
986	Carribean pine
985	Citrus
510	Eucalyptus
940	Mahogany
983	Silk oak
006	Other tropicals
911	Sable palm
910	Other palms

CODE	COMMON NAME
	SHRUBS
007	Alder
008	Azalea
009	Bayberry
023	Blackberry
024	Blueberry
026	Bluestem palmetto
027	Brambles
028	Buffalo-nut
029	Chinkapin
032	Devil's-walking-stick
033	Elderberry
034	Gallberry
035	Fetterbush
036	Haw
038	Hawthorn
039	Hazel
044	Horse-sugar
045	Huckleberry
046	Hydrangea
047	Laurel
048	Mangrove
087	Mistletoe
049	Pawpaw
052	Plum
166	Privet
053	Rhododendron
054	Rose
055	Saw-palmetto
056	Spicebush
163	St. Johnswort
057	Strawberry bush
058	Sumac
059	Titi
069	Viburnum
074	Waxmyrtle
075	Witch-hazel
076	Yaupon
077	Other shrubs
	VINES
079	Climbing rose
082	Crossvine
083	Dewberry
084	Greenbrier
085	Honeysuckle
086	Kudzu
088	Poison ivy
089	Rattan
099	Trumpet creeper
133	Virginia creeper
134	Wild grape
135	Yellow jessamine
136	Other vines
	GRASSES AND GRASSLIKES
137	Bahiagrass and other pasture grasses
138	Bluestem, big
139	Bluestem, broomsedge
140	Bluestem, slender
141	Bluestem, creeping
164	Bluestem, little
142	Bristle grass
143	Carpetgrass
144	Cutover muhly
145	Fescue
167	Indiangrass
146	Marsh-grass
147	Panicums
148	Paspalum
149	Reeds
168	Sawgrass
151	Sedges
152	Switchcane
153	Threeawn (wiregrass)
154	Uniolas
155	Other grasses
156	Other grasslikes
	FORBS AND OTHERS
157	Cactus
158	Composites
159	Ferns
161	Legumes
162	Lichens
165	Other forbs
169	Moss

BROAD SPECIES CLASSES

1	Yellow pines
2	Other softwoods
3	Hardwoods (scrub oaks & misc.)
4	Tropicals
5	Shrubs
6	Vines
7	Grasses and grasslikes
8	Forbs & others

BROWSING

0 No browsing
1 Light browsing - difficult to find browse plants on sample. Less than 5 percent of plants grazed.
2 Moderate browsing - frequently find browsing on sample acre
3 Heavy browsing - generally more than 35 percent of plants on the sample acre browsed

MILL RESIDUES

0 None
1 Sawdust piles, slabs, edgings, sawmill structure, or other mill residues

LOGGING SLASH

0 None
1 Logging slash, windthrown trees or broken tops

LITTER AND TRASH

0 None
1 Trash piles, abandoned autos, dumps etc.

GULLIES, RAVINES AND DITCHES

0 None
1 Gullies, ravines or ditches present

HOLES AND CAVES

0 None
1 Holes, burrows, crevices or caves present

ROCK OUTCROPS, ROCK SLIDES AND GRAVEL BEDS

0 None
1 Rock outcrops, rock slides or gravel beds

MARSH CONDITION

0 None
1 5—11 areas of marsh-like conditions or moist seepages occurring within the forest

0 None
1 One or more trees in the forest condition contains Spanish Moss

WATER TYPE

0 None
1 Permanent
2 Temporary

HIKING

0 None
1 Foot trails, trail markers, or blazed trees

HUNTING

0 None
1 Spent shotgun shells, tree stands or other signs of hunting

GRAZING INTENSITY

0 None
1 Light grazing - difficult to find grazed plants on sample. Less than 35 % of plants grazed.
2 Moderate grazing - frequently find grazing on the sample acre. Generally 35 to 70 % of plants are grazed.
3 Heavy grazing - extensive

LIVESTOCK FENCING

0 Not fenced, or inadequate fencing for grazing use
1 Adequate fencing for grazing use

PEOPLE USE

0 No evidence of people use
1 Occasional use
2 Moderate use
3 Intensive use

CAMPING

0 None
1 Campsites, litter or miscellaneous tree cutting

FISHING

0 None
1 Paths along stream bank or lake, bait containers or posted fishing regulations

TRAIL BIKES

0 None
1 Tire impressions in forest condition sampled

OTHER USE

0 None
1 Other significant use of the forest condition

POSTED

0 None
1 Locked gate
2 Keep out
3 No trespassing
4 No hunting
5 No fishing
6 No dumping
7 Other posted signs
8 Owner contact
9 Other evidence

TRAILS

0 None
1 Improved trail
2 Active woods road
3 Unimproved trail
4 Old woods road (include tram roads)
5 Skid trail
6 Game or livestock trail
7 Other road or trail

BURN HISTORY

0 None
1 Burned within past year
2 Burned within past 1-3 years
3 Burned within past 3-10 years
4 Burned beyond 10 years

SEASON OF THE YEAR

1 Growing season
2 Dormant season

SOIL TEXTURE

1 Sands
2 Sandy loams
3 Loams
4 Clay loams
5 Clays

SLOPE LENGTH OR DISTANCE TO WATER IN FEET FROM SAMPLE CENTER

0	No obstruction, no slope, or plot center in primary water
1	1 - 99
2	100 - 199
3	200 - 299
4	300 - 399
5	400 - 499
6	500 - 599
7	600 - 699
8	700 - 799
9	800 +

PROXIMITY
FEET FROM SAMPLE CENTER

0	Adjacent (less than 118 feet)
1	119-150
2	151-200
3	201-250
4	251-300
5	301-400
6	401-500
7	501-600
8	601-700
9	701-833 (first circle)

LAND USE IMPACT AND PRIORITIES

1	Urban buildup
2	Lakes and seashores
3	Rivers and streams
4	Commercial-reserved forest land
5	Agricultural lands
6	Unproductive forest
7	Major highways
8	Other roads
9	Rights-of-way
0	Commercial forest

SOIL STRUCTURE

0 None
1 Blocky
2 Platy

SOIL EROSION

0 None
1 Light - very little sheet erosion
2 Medium - both sheet and rill erosion
3 High - bad rill erosion, gullies

PERCENT FOREST

Percent forest	Code	Number of dot counts (20 dots) 1 position	(40 dots) 2 positions	(60 dots) 3 positions	(80 dots) 4 positions
1-5	0	0-1	0-2	0-3	0-4
6-15	1	2-3	3-6	4-9	5-12
16-25	2	4-5	7-10	10-15	13-20
26-35	3	6-7	11-14	16-21	21-28
36-45	4	8-9	15-18	22-27	29-36
46-55	5	10-11	19-22	28-33	37-44
56-65	6	12-13	23-26	34-39	45-52
66-75	7	14-15	27-30	40-45	53-60
76-85	8	16-17	31-35	46-51	61-68
86-100	9	18-20	35-40	52-60	69-80

ECOLOGICAL DIVERSITY PROFILE RECORD CODING SUMMARY
SOUTH CAROLINA, PART I
MARCH 1977 ***** (REVISED)

PLANT SPECIES:'

Code	Common name	Scientific name
	YELLOW PINES	
131	Loblolly pine	*Pinus taeda*
121	Longleaf pine	*Pinus palustris*
126	Pitch pins	*Pinus rigida*
128	Pond pine	*Pinus serotina*
107	Sand pine	*Pinus clausa*
110	Shortleaf pine	*Pinus echinata*
111	Slash pins	*Pinus elliottii*
115	Spruce pine	*Pinus glabra*
123	Fable-Mountain pine	*Pinus pungens*
132	Virginia pine	*Pinus virginiana*
	OTHER SOFTWOOD	
043	Atlantic while-cedar	*Chamaecyparis thyoides*
221	Baldcypress	*Taxodium distichum* var. *distichum*
010	Fir	*Abies* spp.
260	Eastern hemlock	*Tsuga canadensis*
241	Northern white-cedar	*Thuja occidentalis*
222	Pondcypress	*Taxodium distichum* var. *nutans*
060	Eastern redcedar	*Juniperus virginiana*
090	Spruce	*Picea* spp.
129	Eastern white pine	*Pinus strobus*
	SOFT HARDWOODS	
950	*American* basswood	*Tilia americana*
762	Black cherry	*Prunus serotina*
694	Blackgum (lowland)	*Nyssa sylvatica*
693	Blackgum (upland)	*Nyssa sylvatica*
313	Boxelder	*Acer negundo*
330	Buckeye	*Aesculus* spp.
601	Butternut	*Juglans cinerea*
740	Cottonwood	*Populus* spp.
651	Cucumbertree	*Magnolia acuminata*
970	Elm	*Ulmus* spp.
460	Hackberry	*Celtis occidentalis*
555	Loblolly-bay	*Gordonia lasianthus*
652	Magnolia	*Magnolia* spp.
316	Red maple	*Acer rubrum*
580	Silverbell (in mountains)	*Halesia* spp.
317	Silver maple	*Acer saccharinum*
653	Sweetbay	*Magnolia virginiana*
611	Sweetgum	*Liquidambar styraciflua*
731	American sycamore	*Platanus occidentalis*
691	Water tupelo	*Nyssa aquatica*
920	Willow	*Salix* spp.
621	Yellow-poplar	*Liriodendron tulipifera*
	HARD HARDWOODS	
540	Ash	*Fraxinus* spp
531	American beech	*Fagus grandifolia*
370	Birch (except yellow)	*Betula* spp.
901	Black locust	*Robinia pseudoacacia*
837	Black oak	*Quercus velutina*
602	Black walnut	*Juglans nigra*
823	Bur oak	*Quercus macrocarpa*
813	Cherrybark oak	*Quercus falcata* var. *pagodaefolia*
832	Chestnut oak	*Quercus prinus*
826	Chinkapin oak	*Quercus muehlenbergii*
491	Flowering dogwood	*Cornus florida*

311	Florida maple	*Acer barbatum*
400	Hickory	*Carya* spp.
591	American holly	*Ilex opaca*
552	Honeylocust	*Gleditsia triacanthos*
820	Laurel oak	*Quercus laurifolia*
838	Live oak	*Quercus virginiana*
680	Mulberry	*Morus* spp.
822	Overcup oak	*Quercus lyrata*
521	Common persimmon (forest grown)	*Diospyros virginiana*
830	Pin oak	*Quercus palustris*
835	Port oak	*Quercus stellata*
833	Northern red oak	*Quercus rubra*
806	Scarlet oak	*Quercus coccinea*
817	Shingle oak	*Quercus imbricaria*
834	Shumard oak	*Quercus shumardii*
812	Southern red oak	*Quercus falcata*
318	Sugar maple	*Acer saccharum*
825	Swamp chestnut oak	*Quercus michauxii*
804	Swamp white oak	*Quercus bicolor*
827	Water oak	*Quercus nigra*
802	White oak	*Quercus alba*
831	Willow oak	*Quercus phellos*
371	Yellow birch	*Betula alleghaniensis*

MISCELLANEOUS TREES

816	Bear oak	*Quercus ilicifolia*
824	Blackjack oak	*Quercus marilandica*
807	Bluejack oak	*Quercus incana*
841	Dwarf live oak	*Quercus* spp.
840	Dwarf post oak	*Quercus* spp.
819	Turkey oak	*Quercus laevis*
899	Other scrub oaks	*Quercus* spp.
341	Ailanthus	*Ailanthus* spp.
548	American mountain-ash	*Sorbus americana*
391	American hornbeam	*Carpinus caroliniana*
451	Catalpa	*Catalpa* spp.
310	Chalk maple	*Acer* spp.
421	American chestnut	*Castanea dentata*
661	Chinaberry	*Melia azedarach*
660	Domestic fruit (apple, etc.)	*Malus* spp.
760	Fire cherry	*Prunus* spp.
701	Eastern hophornbeam	*Ostrya virginiana*
319	Mountain maple	*Acer spicatum*
692	Ogeechee tupelo	*Nyssa ogeche*
641	Osage-orange	*Maclura pomifera*
521	Common persimmon (field grown)	*Diospyros virginiana*
722	Planertree (water elm)	*Planera aquatica*
721	Redbay	*Persea borbonia*
471	Eastern redbud	*Cercis canadensis*
712	Royal paulownia	*Paulownia tomentosa*
931	Sassafras	*Sassafras albidum*
352	Serviceberry	*Amelanchier* spp.
581	Carolina silverbell (except mountains)	*Halesia carolina*
711	Sourwood	*Oxydendrum arboreum*
315	Striped maple	*Acer pensylvanicum*
999	Other miscellaneous trees	———

TROPICALS

984	Casuarina	*Casuarina* spp.
982	Cajeput-tree	*Melaleuca leucadendron*
986	Caribbean pine	*Pinus caribaea*
985	Citrus	*Citrus* spp.
510	Eucalyptus	*Eucalyptus* rpp.
940	Mahogany	*Swietenia* spp.
983	Silk-oak	*Grevillea robusta*

006	Other tropicals	———
911	Cabbage palmetto	*Sabal palmetto*
910	Other palms	*Sabal* spp.

SHRUBS

007	Alder	*Alnus* spp.
008	Flame azalea	*Rhododendron calendulaceum*
009	Northern bayberry	*Myrica pensylvanica*
023	Blackberry	*Rubus* spp.
024	Blueberry	*Vaccinium* spp.
026	Bluestem palmetto	*Sabal minor*
027	Brambles	*Rubus* spp.
028	Buffalo-nut	*Pyrularia pubera*
029	Chinkapin	*Castanea* spp.
032	Devil's-walkingstick	*Aralia spinosa*
033	Elderberry	*Sambucus* spp.
034	Gallberry	*Ilex* spp.
035	Fetterbush	*Lyonia lucida*
036	Haw	*Ilex* spp.
038	Hawthorn	*Crataegus* spp.
039	Hazel	*Corylus* cpp.
044	Common sweetleaf	*Symplocos tinctoria*
045	Huckleberry	*Gaylussacia* spp.
046	Hydrangea	*Hydrangea* spp.
047	Mountain-laurel	*Kalmia latifolia*
048	Mangrove	*Rhizophora* spp.
087	Mistletoe	*Phoradendron* spp
049	Pawpaw	*Asimina* spp.
052	Plum	*Prunus* spp.
lhh	Privet	*Ligustrum* spp.
053	Rosebay rhododendron	*Rhododendron maximum*
054	Rose	*Rosa* spp.
055	Saw-palmetto	*Serenoa repens*
056	Spicebush	*Lindera benzoin*
163	St. Johnswort	*Hypericum* spp
057	Strawberry bush	*Euonymus americanus*
058	Sumac	*Rhus* spp.
059	Swamp cyrilla	*Cyrilla racemiflora*
069	Viburnum	*Viburnum* spp.
074	Southern bayberry	*Myrica cerifera*
075	Witch-hazel	*Hamamelis virginiana*
076	Yaupon	*Ilex vomitoria*
077	Other shrubs	———

VINES

079	Climbing rose	*Rosa* spp.
082	Crossvine	*Bignonia capreolata*
083	Dewberry	*Rubus* spp.
084	Greenbrier	*Smilax* spp.
085	Japanese honeysuckle	*Lonicera japonica*
086	Kudzu	*Pueraria lobata*
088	Poison ivy	*Rhus radicans*
089	Rataan	*Berchemia* spp.
099	Trumpet creeper	*Campsis radicans*
133	Virginia creeper	*Parthenocissus quinquefolia*
134	Summer grape	*Vitis aestivalis*
135	Yellow jessamine	*Gelsemium sempervirens*
136	Other vine*	——

GRASSES AND GRASSLIKES

137	Bahiagrass (& other pasture grasses)	*Paspalum notatum*
138	Bluestem, big	*Andropogon gerardi*
139	Bluestem, broomsedge	*Andropogon virginicus*
140	Bluestem, slender	*Andropogon tener*
141	Bluestem, creeping	*Andropogon stolonifer*

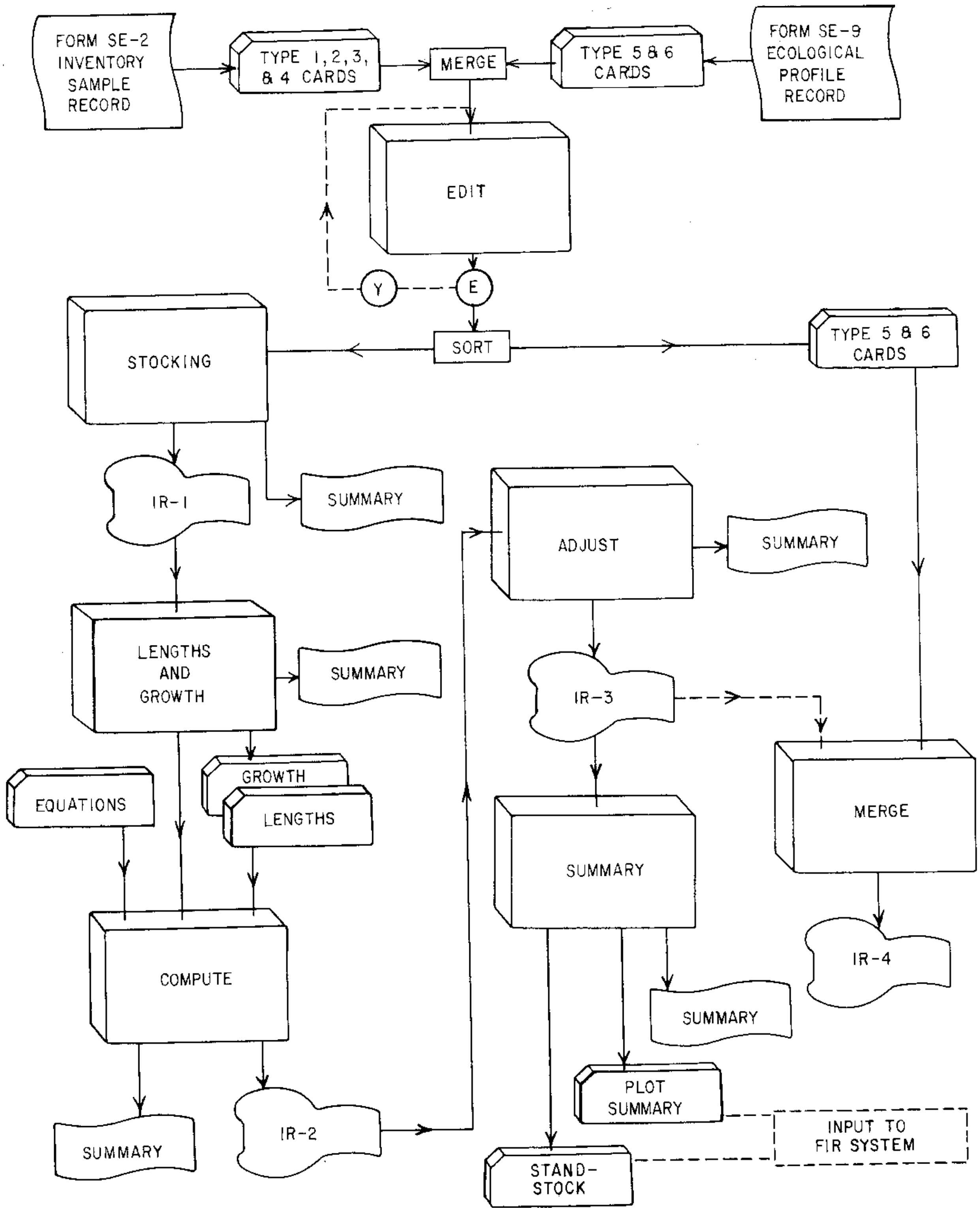
164	Bluestem, little	*Andropogon scoparius*
142	Bristlegrass	*Setaria* spp.
143	Carpetgrass	*Axonopus* spp.
144	Cutover muhly	*Muhlenbergia expansa*
145	Fescue	*Festuca* spp.
167	Indian grass	*Sorghastrum* spp.
146	Marsh-grass	*Spartina* spp.
147	Panicums	*Panicum* spp.
148	Paspalum	*Paspalum* spp.
IJY	Common reed	*Phragmites communis*
168	Saw-grass	*Cladium jamaicense*
151	Sedges	*Cyperus* spp.
152	Switch-cane	*Arundinaria tecta*
153	Pineland three awn (wiregrass)	*Aristida stricta*
154	Uniolas	*Uniola* spp.
155	Other grasses	———
156	Other grasslikes	———

FORBS AND OTHERS

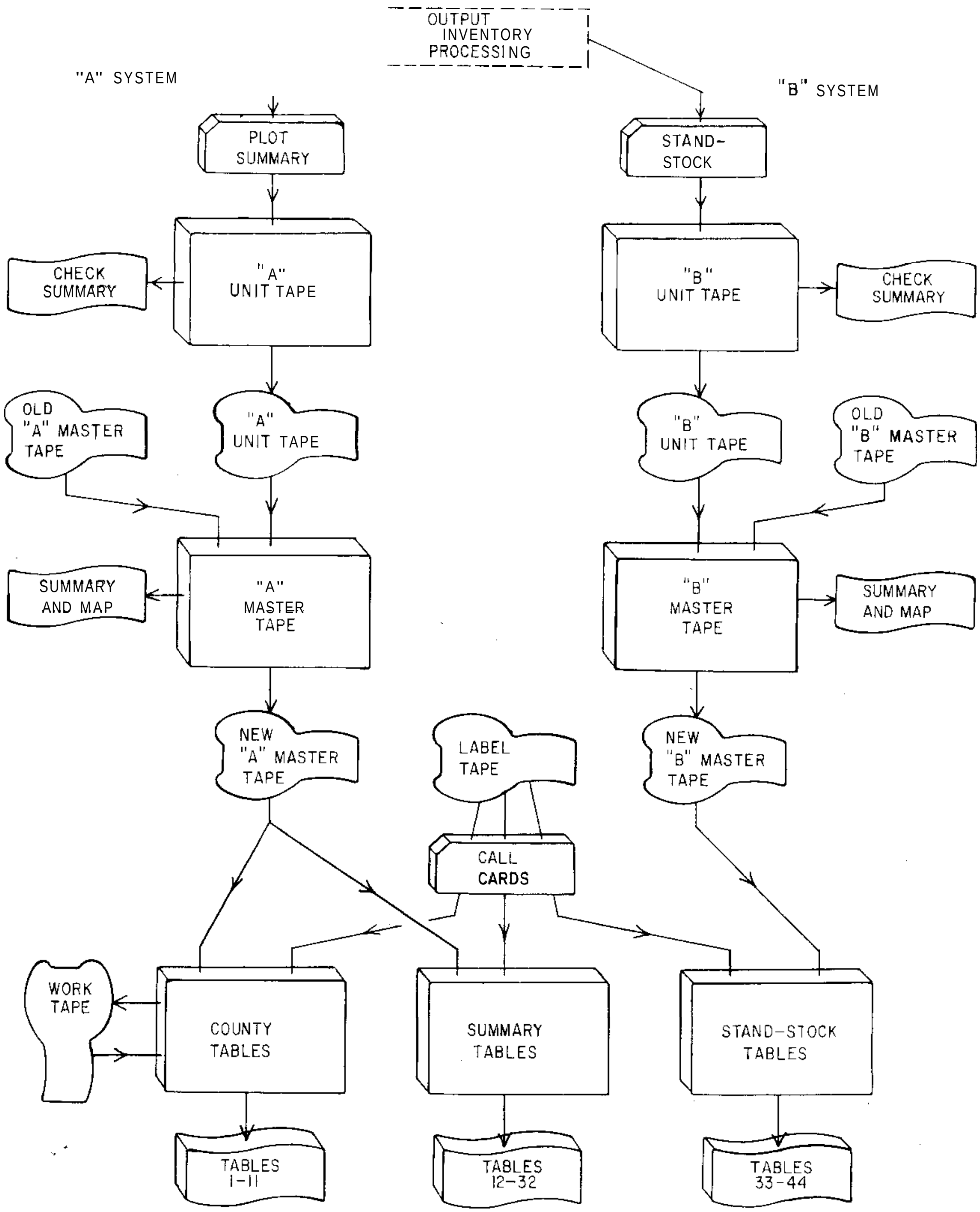
157	Cactus	*Opuntia* spp.
158	Composites	*Compositae*
159	Ferns	*Pteridophyta*
161	Legumes	———
162	Lichens	
165	Forbs	———
169	Mosses	———

[1]Common and scientific names listed according to the following sources: Dean, Blanche Evans. 1968. Trees and shrubs in the heart of Dixie. 246 p. South. Univ. Press, Birmingham, Ala.; Fernald, Merritt Lyndon. 1950. Gray's manual of botany, 8th ed., rewritten and expanded. 1,632 p. Am. Book Co., New York; Kelsey, Harland P., and William A. Dayton, 1942. Standardized plant names. Zded., rev. 675 p. J. Horace McFarland Co., Harrisburg, Pa : Little, Elbert L. Jr. 1953. Check list of native and naturalized trees of the United States (including Alaska). U.S. Drp. Agric. For. Serv., Agric. Handb. 41, 471 p. U.S. Gov. Print. OR., Washington, D.C.: U.S. Department of Agriculture, Forest Service, 1967. Forest Survey handbook. FSH 4813.1. U.S. Dep. Agric., For. Serv., Washington, D. C.: and U.S. Department of Agriculture, Soil Conservation Service. 1965. Important native grasses for range conservation in Florida. 163 p. U.S. Drp. Agric., Soil Conser. Serv., Gainesville, Fia.

INVENTORY PROCESSING SYSTEM



FIR PROCESSING **SYSTEM**



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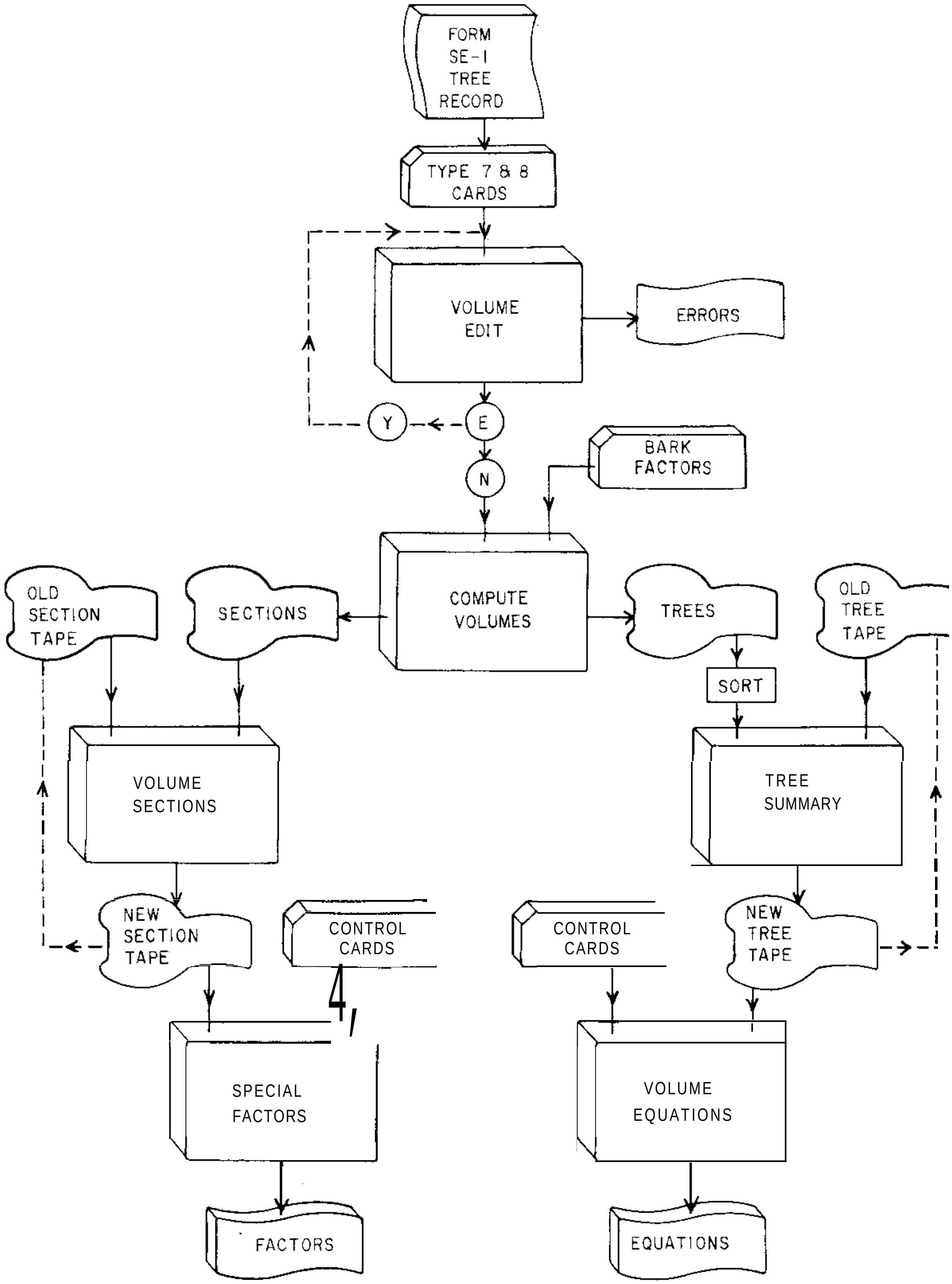

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