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A Joint Program for Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing

Renewable Resources Inventory

6. April 1981

SUMMARY REPORT

USE AND APPLICABILITY OF THE VEGETATION COMPONENT OF THE NATIONAL SITE CLASSIFICATION SYSTEM

3. C. A. Clark

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16. Abstract

A classification was made of existing vegetation on a site in Sumter National Forest, South Carolina, using high altitude aerial infrared photography. The classification was done within the framework of the National Site Classification System to determine if this system could be used in the heterogeneously forested Southeastern United States where it had not previously been used. Hopefully this system, with provisions for making modifications as needed, will be implemented by all agencies involved in renewable resource assessments and inventories so as to effect national uniformity in ecological classification.

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SUMMARY REPORT
USE AND APPLICABILITY OF THE VEGETATION COMPONENT OF THE NATIONAL SITE CLASSIFICATION SYSTEM

Job Order 72-532

This report describes activities of the Renewable Resources Inventory project of the AgRISTARS program.

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LOCKHEED ENGINEERING AND MANAGEMENT SERVICES COMPANY, INC.

Under Contract NAS 9-15800

For

Earth Resources Research Divisions
Space and Life Sciences Directorate
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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PREFACE

Use of the vegetation component of the National Site Classification System for Renewable Resource Assessments provided a classification of existing vegetation on a site located in South Carolina for purposes of using the hierarchical categories of the classification system to test applicability to heterogeneous forested areas of Southeastern United States.

In the past ten years a great deal of work has been done on the development of a national and international land classification system, one which will allow uniform application in inventory, assessment, and program planning on a world-wide basis. The latest recommended system was used in classifying the study site in South Carolina.

The specific objective of this study was to test the applicability of the vegetation component of the National Site Classification System in classifying a heterogeneous forested area in Sumter National Forest, Union County, South Carolina, using high altitude aerial infrared photography and ground truth.

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ABBREVIATIONS

BLM	Bureau of Land Management
CIR	Color-infrared
NASA	National Aeronautics and Space Administration
NSCS	National Site Classification System
RNLCS	Recommended National Land Classification System
RPA	Resources Planning Act
SCS	Soil Conservation Service
UNESCO	United Nations Education, Scientific and Cultural Organization
USDA	United States Department of Agriculture
USGS	United States Geological Survey

1. INTRODUCTION

1.1 BACKGROUND

Attempts to ecologically classify forests and rangelands of the United States began at least as early as 1916 (refs. 1, 2, 3, and 4). The work of Clements and Weaver provided the theory, terminology, and impetus for subsequent efforts at ecological classification. Early efforts at classification attempted to describe vegetation from several vantage points: on the basis of species diversity, growth form and physiognomy, spatial structure, dominance, relative abundance, trophic structure and productivity, temporal development, and environmental relationships. This led to a disparate array of incompatible classification systems; these systems were, by and large, theoretical attempts by academicians to describe natural systems. Little emphasis was given to practical applications. Only relatively recently have attempts been made to establish new schemes for use in practical areas of forestry, range, and land management.

In the past decade, more complete and more accurate inventories of renewable natural resources have become an absolute necessity. The United States Department of Agriculture (USDA) Forest Service oversees the management of approximately 197 million acres of federal forest and rangeland and has been tasked with this management since its inception in 1902 (ref. 5). In addition, the USDA Forest Service has been designated as the agency responsible for overseeing the implementation of the Resources Planning Act (RPA) of 1974 as amended by the Forest Management Act of 1976. One of the requirements of the RPA is a complete inventorying of all forest lands beginning in 1980 and repeating every ten years thereafter. Also, in 1977, Congress passed the Soil and Water Resources Conservation Act (RCA). This act directs the Secretary of Agriculture to conduct a continuing appraisal of the status and condition of soil, water, and related resources. The appraisal is to be updated every 5 years and will report on the status and condition of soil resources and related resources -- wetlands, riparian vegetation, fish and wildlife habitat, windbreaks, organic residue, recreation, etc.

This mandate for development and application of an aggregate resources inventory and evaluation system from which to make periodic regional, interregional, and national assessments to the state of the Nation's natural renewable resources makes a uniformly useful, compatible ecological classification system necessary. The classification system should also be useable with remote sensing data, i.e., aerial photography and Landsat satellite data with the understanding that only the higher vegetation categories of Formation Class, Subclass, Group, Formation, and Subformation could be determined using remote sensing. This can be done with remote sensing on the basis of current vegetation only.

1.2 CLASSIFICATION SYSTEMS

In 1971, acting upon recommendations of a Washington Office Special Committee, the Chief of the USDA Forest Service established an interdisciplinary Task Force to establish a classification system for the Pacific Northwest. The system, called ECOCLASS (ref. 6), presented a system based upon natural vegetation, land, and water components. ECOCLASS was ecologically based since the lowest levels of the classification were developed from natural phenomena found on the ground. A hierarchy of increasing generality was developed for each system for ease in deriving regional summaries. Problems were encountered with this system, however. Each of the component systems and the hierarchy developed under each were not entirely pure in the sense of relating to a vegetation system, a land system, or an aquatic system. At various levels in the hierarchies, some individual categories were hybrids representing integrated classes either within or between the systems. Therefore, changes were made to clarify the confusion:

Habitat Type was deleted from the vegetation system as was Community Type. The land system was separated into two classification systems, Landform and Soils. This work was presented as Modified ECOCLASS (ref. 7). Some aspects of Modified ECOCLASS proved to be unacceptable also, and a charge was issued by Chief John R. McGuire, USDA Forest Service, to make recommendations on a land classification system to be used in the 1979 Renewable Resource Assessment and to make recommendations on a land classification system to be used in the 1989 Assessment. A study group to make these recommendations was appointed by Chief McGuire, and an interagency agreement was signed June 6, 1978. The study group was to be led by Richard S. Driscoll as chairman, Marvin C. Meier, and John W. Russell, all of the USDA Forest Service. This group presented a draft of the Recommended National Land Classification System for Renewable Resource Assessments (RNLCS) in 1978 (ref. 8). This system has four components: vegetation, soil, landform, and water. Climate was included as a criterion for separating the vegetation and soil components. The underlying principle of the component classification is to deal initially with each component as an entity, defining and describing the classes on the basis of primary characteristics. These characteristics are based on principal properties of the components, much in the same way plants and animals are classified taxonomically. The proposed classification allows data to be cross-referenced among components or aggregated vertically. This provides flexibility for national, regional, state, or local resource assessments and appraisals for program or project planning and management decisions. The basic categories of the RNLCS are given in table 1-1.

TABLE 1-1.— CLASSIFICATION HIERARCHY

Vegetation System	Soil System	Landform System	Aquatic System
Formation Class	Order	Realm	Order
Formation Subclass	Suborder	Major Division	Class
Formation Group	Great Group	Province	Family
Formation	Subgroup	Section	Type Association
Subformation	Family	Region	Type
Series	Series	District	⋮
Association	Phase	Area	Others as needed
⋮	⋮	Zone	
Others as needed	Others as needed	Locale	
		⋮	
		Others as needed	

The framework for the vegetation system is that presented by the United Nations Education, Scientific and Cultural Organization (UNESCO) Standing Committee on Classification and Mapping of Vegetation on a World Basis (ref. 9). The classification is based primarily on foliar cover and height of vegetation and is related to altitudinal, latitudinal, and climatic constraints. The lowest levels of the classification (Subformation, Series, and Association) are directly comparable to the vegetation classification system used by the Bureau of Land Management (BLM), Forest Service, Soil Conservation Service (SCS), Bureau of Indian Affairs, and several other agencies for renewable resource inventory and assessment/appraisal.

In the Formation Class, the highest class, there are five classes based on the physiognomy and general stature of the vegetation. The five classes are 1) closed forest, 2) woodland, 3) scrub, 4) dwarf scrub and related communities, and 5) herbaceous vegetation.

There are 19 Formation Subclasses. Separations at this level are based mainly on such characteristics as evergreen, deciduous, xeromorphic, hydromorphic, and temperature requirements.

There are 53 currently defined Formation Groups. Separations are made primarily on the basis of generalized climatic modifiers, i.e., tropical, subtropical, drought tolerance, and heat tolerance.

The 166 Formations include such names as eastern broadleaf forests, central grasslands, western grasslands, and western needleleaf forests.

The Subformation level, as defined in the UNESCO system, had only 79 units in the world but provided for expansion. Subformations are often recognized by major genera of the plant community with such designations as pine-Douglas-fir forest, grama-needlegrass-wheatgrass grasslands, beech-maple forest, and southern mixed forest.

The Series level includes additional specificity of physiognomy and structure of the vegetation. Series are usually characterized by an individual climax dominant species such as ponderosa pine, loblolly pine, maple, big sagebrush, blue grama, bluebunch wheatgrass, and cordgrass.

Associations are subdivisions of the Series level of classification. The Association is a kind of plant community of definite composition, presenting a uniform appearance and growing in uniform habitat conditions (ref. 10). The criteria for classifications of plant associations are normally based on the climax species dominants within the major structured plant life forms of the community.

Phases are subdivisions of the Association Class which may be used to separate vegetation units by factors that are not part of the classification criteria. Phases may be used on a local level to identify variation in production, size classes, cover percent, etc. Phases are not to be a part of the taxonomy in the classification.

1.3 CURRENT STATUS OF RECOMMENDED NATIONAL LAND CLASSIFICATION SYSTEM

In January 1979 a technical work group on classification consisting of three members from each of five agencies met to evaluate the RNLCS. These agencies are the USDA Forest Service, SCS, BLM, Fish and Wildlife Service, and U.S. Geological Survey (USGS). The group was assembled under the auspices of the Five Agency Agreement, which was designed to coordinate inventory and classification activities.

The RNLCS was evaluated in terms of its usefulness in making site specific inventories and national and regional resource assessments. The component approach of RNLCS was generally accepted by all agencies. The soil component was accepted as presented with provisions for refinements as the need arises. The vegetation component was accepted on the condition that UNESCO terminology be simplified, that the lower two elements be more developed taxonomically, and that a means be developed for relating current vegetation to potential natural vegetation. The five-agency work group agreed that the aquatic and the landform components needed major work. This would include a detailed analysis to determine the usefulness of these two components. It was agreed that development of the aquatic component have priority over development of the landform component. Also, most agencies agreed that the landform component could be subordinate to the soil and vegetation components until it is fully developed. The work group identified the need for further evaluation of the relationships of the component classification system to present mapping procedures, sampling techniques, and component integration. This should facilitate coordination of the system with ongoing inventory and assessment activities. It was agreed that inventory data and analysis processes used by the five agencies should be translatable into the agreed upon segments of the RNLCS in order to miximize technology transfer and data exchange.

The latest revision, "The National Site Classification System - Status and Plans," was released on May 2, 1980. This manuscript was prepared in response to a request made by the heads of the five cooperating agencies. A number of clarifications, changes, and additions were made. One needed change is the inclusion of percentage foliar cover as a decision rule in each of the five Formation Classes of vegetation. The main element of the vegetation classification from Formation Class to Association is foliar cover. Percentages of foliar cover have been included as follows:

- Closed Forest - Foliar cover over 60 percent by tree canopy
- Woodland - Foliar cover of over 25 but less than 61 percent at maturity
- Shrub - Over 25 percent of the foliar cover is composed of woody perennial plants generally with multiple stems 0.5 to 4 meters at maturity with or without a tree component
- Dwarf-shrub and Related Communities - Over 25 percent foliar cover of multiple stemmed woody perennial plants rarely exceeding 0.5 meter in height with or without a tree component at maturity
- Herbaceous Vegetation - Tree or shrub component cannot exceed 25 percent foliar cover at maturity.

It is stated in this revision, National Site Classification System (NSCS), that the vegetation component is based on potential or climax vegetation and that current vegetation will be recognized as a seral state of the potential vegetation. Since climax vegetation may not be present in all areas, five possible ways of determining climax vegetation are listed. It is stated that soil series (or phases of series when applicable) need to be known in all vegetation classification procedures if the current vegetation community is to be placed in the correct potential plant association. The authors further state that "the soil series (or phase) is the actual link between current and potential vegetation," (ref. 12, p. 49).

Examples of classification of vegetation are given. In these examples potential vegetation is listed for each level in the classification hierarchy. Also listed parallel to potential vegetation is the current vegetation. Thus, the relationship of potential natural, or climax, vegetation to current vegetation is readily discernible at each level in the classification.

In compliance with the requests made by the five agencies, the Series vegetation class and the Association vegetation class are defined and discussed in detail. The Series is a grouping of Associations that have a common climax dominant species. Series is based upon structure including such phenomena as height, branching habit, size of stems, size of crowns, thickness and density of canopy, layering and depth, and spacing and stratification of root systems. The plant species that is exerting the most influence on the plant community due to its structural features is considered the dominant species. The Series class is given the name of that climax dominant species. The Association vegetation class is a distinctive dominant plant species assemblage that occurs on characteristics topography and soils.

Associations are named by the dominant species in the life-form layers present. The order in which the dominants are listed in the Association name reflects the order of species dominants by life-form.

To aid in simplifying UNESCO terminology a glossary is appended to the NSCS. In addition to the Glossary, some terminology used by UNESCO has been revised to more understandable language in an attempt to make the classification more useable.

Since development of national correlation procedures was one of the items requested by the five agencies, the NSCS includes an appendix devoted to addressing this issue. A proposed vegetation correlation process is presented. It involves developing criteria for identifying and naming plant communities, using a standard format for descriptions, and then working toward correlation and national uniformity from a local or field correlation to state and regional correlation to national correlation. Three alternatives for correlation at a national and regional level are given. It is recommended by the five-agency work group that one agency be assigned leadership and responsibility for correlation. This would require cooperative agreements and memoranda of understanding between the lead and cooperating agencies spelling out the role of each agency. The lead agency would need a full-time correlation staff at national and regional levels. Cooperating agencies would need full or part-time correlators at state and intermediate levels.

These revisions and inclusions make the NSCS a great improvement over earlier drafts. The foliar cover percentages aid in classification at higher levels, and the discussions, instructions, and examples will make classification at the lower levels easier, more accurate, and more uniform. Detailed discussions of climax versus potential vegetation should resolve the controversy and eventually allow for extrapolation from current vegetation and ancillary data to potential natural vegetation.

2. PROBLEM STATEMENT

2.1 QUESTION ADDRESSED

The NSCS was developed in the Northwestern United States for renewable natural resources that are configured quite differently from those in the Southeastern United States. The question of its applicability to heterogeneous forested sites was raised. Therefore, the question to be addressed by this study was, "how workable is the vegetation component of the NSCS in a heterogeneous forested area of the Southeastern United States?"

2.2 OBJECTIVE

The objective of this study was to test the applicability of the vegetation component of the NSCS in classifying a heterogeneous forested area in the Southeastern United States.

3. PROCEDURE

3.1 SITE SELECTION

A study site was selected in Union County, South Carolina (fig. 3-1). The site selected was the Whitmire North, South Carolina, USGS 7-1/2 minute quadrangle (fig. 3-2). Factors influencing site selection included availability of aerial color infrared (CIR) photography, locale within a national forest, and botanical diversity.

3.2 AERIAL PHOTOGRAPHY

Optical bar aerial CIR photography of the site was exposed at a nominal scale of 1:32,500 by the National Aeronautics and Space Administration (NASA) for the Forest Service in May 1979. Large format aerial CIR photography (approximate scale of 1:25,000) was located and obtained from the USDA Forest Service in March 1980. This photography was exposed on 14 June 1978. The site in Sumter National Forest proved to be a complex, heterogeneous forested area in contrast to the more homogeneous northwest where ECOCLASS, Modified ECOCLASS, and the NSCS were originally developed. This South Carolina site offered the contrast and species diversity needed to test the NSCS in the Southeastern United States.

3.3 FIELD VERIFICATION

The 7 May 1979 aerial CIR optical bar photography, scale 1:32,500, was obtained for the site. Photographic enlargements (2x) were made for use as field prints. These were taken into the study site, and field notations, observations, and plant species names were noted on plastic protectors and directly onto the field prints. Fifty sample areas were selected, numbered on the quadrangle sheet and field prints, and visited to identify dominant plant species. In addition to notations on the quadrangle sheet and field prints, pertinent information, including species names, was recorded on

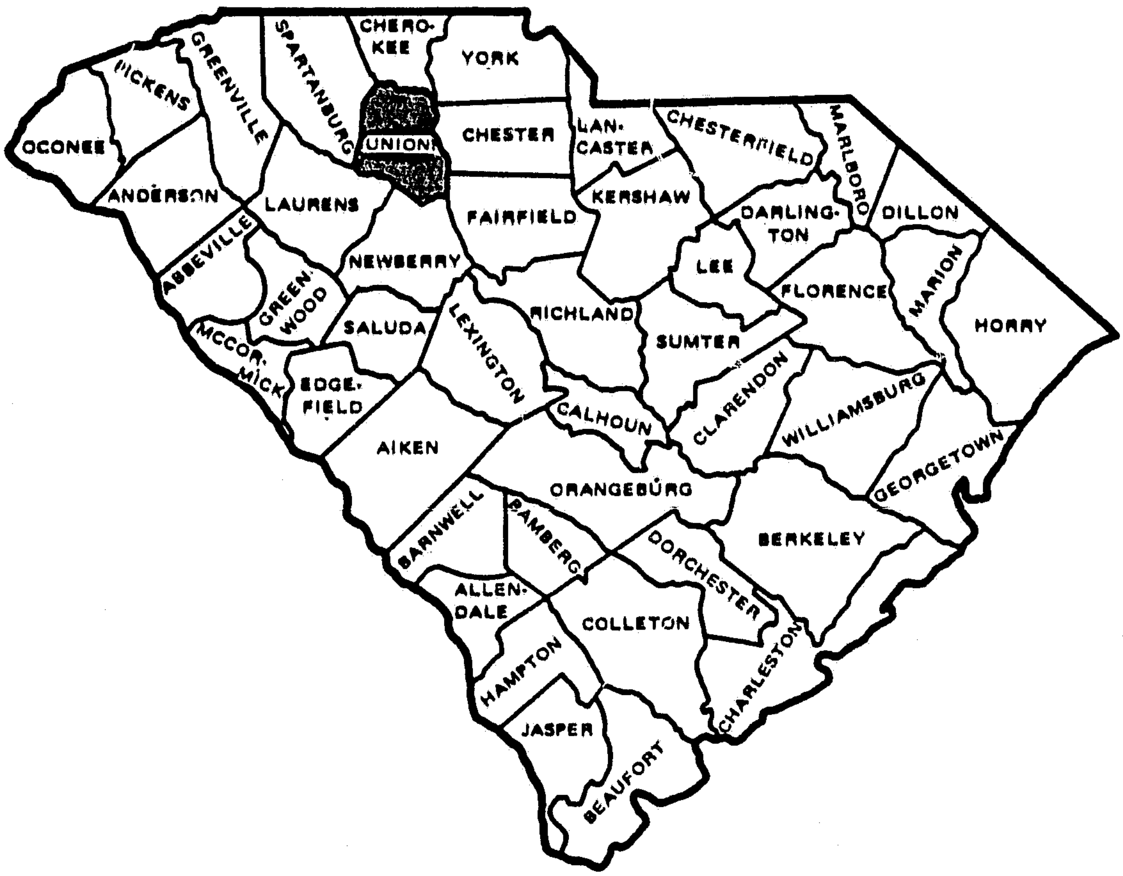

Figure 3-1.– Location of Union County, South Carolina

ORIGINAL PAGE IS
OF POOR QUALITY

Figure 3-2.— Whitmire North quadrangle, South Carolina

tape using a portable tape recorder. With the aerial CIR film and magnification, extrapolations were made for areas not actually visited. Crown closure was determined from aerial photography.

3.4 MOSAIC OF SITE

Using the aerial CIR optical bar photography, a 1:24,000-scale mosaic of the study site was made (fig. 3-3). A negative of the USGS quadrangle sheet was made and a clear overlay printed (fig. 3-2). Negatives and prints were made from the optical bar photography and 12 to 18 control points were selected on each frame of photography. The control points were pinpricked on each frame, and the rectification was made on an E4 Wild rectifier by projecting the selected points onto a base map and by determining the angle of the tip and tilt of each frame.

It was originally thought that the vegetation overlay could best be made from a rectified, 1:24,000-scale mosaic of the site. However, determining the accuracy of the mosaic is extremely difficult and essentially impossible due to the geometry of the panoramic optical bar camera. Distortion increases as distance from nadir increases. Major distortions are also caused by variations in terrain and angle of the airplane. The distortion in each frame varies differently. Therefore, the mosaic is somewhat accurate for small areas but does not meet the USGS standards of accuracy overall. Also, the poor quality of the original CIR film made it impossible to delineate the vegetation polygons from the photographic prints making up the mosaic.

3.5 VEGETATION MAP

A mylar overlay with delineations of vegetation polygons was made from the optical bar photography (fig. 3-4). The numbers identifying the vegetation polygons on this vegetation map are listed in table 3-1, the vegetation classification. Although this smaller scale map will not directly overlay the quadrangle

Figure 3-3.- Reduction of mosaic of study site (original scale 1:24,000) made from optical bar photography

MAP LEGEND

1 Water

2 Loblolly pine

3 Loblolly pine-shortleaf pine-sweetgum-Southern red oak-yellow poplar-post oak-white oak

4 Sweetgum-black oak-Northern red oak-post oak-scarlet oak-Southern red oak-white oak-yellow poplar-sugarberry-American elm

5 Loblolly pine-post oak-shortleaf pine-Southern red oak-sweetgum-white oak-yellow poplar

6 Crop-improved pasture

7 Black willow-Eastern cottonwood-green ash-loblolly pine-red maple-sycamore-sweetgum-Virginia pine-water oak-white ash-willow ash-yellow poplar-hickory

8 Cut over-regenerating loblolly pine-loblolly pine-shortleaf pine

12 Recent cut over-herbacuous vegetation

Figure 3-4.- Map of vegetation polygons.

TABLE 3-1.– VEGETATION CLASSIFICATION IN UNION COUNTY, SOUTH CAROLINA

Map code	Formation class	Formation subclass	Formation group	Formation	Series*
2	Closed forest	Mainly evergreen forest	Tropical and subtropical needle-leaved forest	Tropical and subtropical lowland submontane evergreen needle-leaved forest	Loblolly pine**
3	Closed forest	Mainly deciduous forest	Cold-deciduous forest with evergreen trees admixed	Cold-deciduous forest with evergreen needle-leaved trees	Loblolly pine-sweetgum-shortleaf pine-Southern red oak-yellow poplar-post oak-white oak
4	Closed forest	Mainly deciduous forest	Cold-deciduous forest without evergreen trees	Mainly broad-leaved deciduous	Sweetgum-black oak Northern red oak-post oak-scarlet oak-Southern red oak-white oak-yellow poplar-sugarberry-American elm
6	Herbaceous vegetation	Short grassland	Meadows, pasture, or related grassland	Intensively grazed	Bermuda grass-paspalum ***
7	Closed forest	Mainly deciduous forest	Cold-deciduous forest with evergreen trees admixed	Cold-deciduous forest with evergreen needle-leaved trees	Black willow-Eastern cottonwood-green ash-loblolly pine-red maple-sycamore-sweetgum-Virginia pine-water oak-white ash-willow ash-yellow poplar-hickory
8	Woodland	Mainly evergreen woodland	Evergreen needle-leaved woodland	Evergreen needle-leaved woodland with rounded crowns	Loblolly pine-short leaf pine

TABLE 3-1.- Concluded

Map code	Formation class	Formation subclass	Formation group	Formation	Series*
12	Herbaceous vegetation	Forb vegetation	Low forb community	Mainly perennial flowering forbs and grasses	Bitterweed-Bermuda Grass****
12	Herbaceous vegetation	Forb vegetation	Low forb community	Mainly perennial flowering forbs and grasses	Bermuda grass-dewberry-dwarf sumac-goldenrod ****

*In Union County climax vegetation has not been precisely defined and is not included in the soil survey nor in this study.
**Having become naturalized in this area, loblolly pine is in a stable seral state.
***These pasture lands are in a stable seral state due to management practices.
****The herbaceous vegetation represents a seral state in recent cut-over areas with succession moving toward loblolly pine due to management practices and resistance to Southern bark beetle.

sheet nor the mosaic, comparisons can be made. The vegetation delineations are quite detailed, and accuracy was checked against the USDA Forest Service compartment type maps and the soil survey.

3.6 SOILS

Soils information was taken from the 1975 soil survey of Laurens and Union Counties, South Carolina (ref. 11). Figure 3-5 is a soils map of the study site. Soils, percent slope, and "native vegetation" are presented in table 3-2. A Series vegetation class description of the loblolly pine Series is given in table 3-3. Series class descriptions can be done with all Series listed in table 3-1 since the climatic, topographic, and soils data would be the same for all Series listed.

SOIL ASSOCIATIONS

NEARLY LEVEL SOILS THAT ARE MEDIUM OR SLIGHTLY ACID IN SOME LAYER, ON FLOOD PLAINS

1 Cartecay-Toccoa association: Somewhat poorly drained to well-drained soils that are mostly sandy loam throughout

2 Enoree-Chewacla-Wehadkee association: Poorly drained and somewhat poorly drained soils that are mostly sandy clay loam and loam throughout

MOSTLY GENTLY SLOPING TO STRONGLY SLOPING SOILS THAT ARE STRONGLY ACID IN PART OF THE SUBSOIL, ON UPLANDS

3 Cecil-Appling association: Well-drained, deep soils that are brownish to red, firm clay in the main part of the subsoil; on narrow to broad ridges

4 Hiwassee-Cecil association: Well-drained, deep soils that are dark-red to red, firm clay in the main part of the subsoil; on medium to broad ridges

5 Durham-Appling-Cecil association: Well-drained, deep soils that are brownish to red, friable to firm sandy clay loam to clay in the main part of the subsoil; on medium ridges

6 Madison-Cecil association: Well-drained, moderately deep to deep soils that are red, friable to firm clay loam to clay in the main part of the subsoil; on irregular ridges and short side slopes

MOSTLY GENTLY SLOPING TO STRONGLY SLOPING SOILS THAT ARE SLIGHTLY ACID OR NEUTRAL IN THE SUBSOIL, ON UPLANDS

7 Enon-Wilkes-Iredell association: Well-drained to somewhat poorly drained, shallow to deep soils that are mainly brownish, firm to extremely firm clay loam to clay in the subsoil; on narrow and medium ridges and irregular side slopes

8 Cataula-Enon association: Well-drained, moderately deep to deep soils that are mainly brownish to red, firm to very firm clay loam to clay in the subsoil; on narrow to medium ridges and side slopes

MOSTLY STRONGLY SLOPING TO STEEP SOILS THAT ARE STRONGLY ACID IN PART OF THE SUBSOIL, ON UPLANDS

9 Madison-Pacolet-Cecil association: Well-drained, moderately deep to deep soils that are mainly yellowish-red to red, friable to firm clay loam to clay in the subsoil; on narrow ridges and side slopes

10 Madison-Pacolet-Louisburg association: Well-drained to excessively drained, shallow to deep soils that are mainly red to yellowish brown, friable to firm sandy clay loam to clay in the subsoil; on narrow ridges and side slopes

11 Wilkes-Pacolet-Enon association: Well-drained, shallow to deep soils that are mainly yellowish brown, strong brown, or red, friable to very firm sandy clay loam to clay in the subsoil; on irregular ridges and side slopes

Figure 3-5.– Soils map including the study site

TABLE 3-2.- SOIL SERIES, PERCENT SLOPE, AND "NATIVE VEGETATION" FOUND IN THE STUDY SITE

Soil	Slope, %	Native vegetation
Appling: ApB, ApC	2-6, 6-10	Mixed hardwood and pine forest and an understory of vines, briers, and grasses.
Buncombe: Bu	Bottomland	Birch, elm, and sycamore trees and an understory of vines and briers.
Cartecay: Ca	Nearly level	Mixed hardwoods and an understory of vines, grasses, and canes.
Cataula: CeB2, CeC2, CDB2, CdC2	2-6, 6-10 2-6, 6-10	Oak, elm, gum, pine, and some red cedar and an understory of vines, briers, and grasses.
Cecil: CmB2 ClB, ClD	2-6 2-6, 10-15	Mixed hardwood and pine forest and an understory of briers and grasses.
Durham: DvB, DvC	2-6, 6-10	Oak, hickory, and pine trees and an understory of vines, briers, and grasses.
Enon: EnB, EnC, EnD, EnE	2-6, 6-10, 10-15, 15-25	Oak, gum, elm, red cedar, and pine and an understory of briers, vines, and grasses.
Hiwassee: HyB2, HyC2, HyD2	2-6, 6-10, 10-15	Oak, hickory, dogwood, sourwood, holly, red cedar, and pine and an understory of branbles, shrubs, briers, vines, and grasses.

TABLE 3-2.- Concluded

HwB, HwC2, HwD2	2-6, 6-10, 10-15	
Madison and Pacolet soils: MhF, MdC, MdD	15-40, 6-10, 10-15	Oak, hickory, maple, elm, and pine and an understory of shrubs, briers, vines, and grasses.
Madison: MeB2, MeD2 MdC, MdD	2-6, 10-15 6-10, 10-15	Oak, hickory, maple, elm, and pine and an understory of shrubs, briers, vines, and grasses.
Mecklenburg: MkC	6-10	Oak, hickory, red cedar, and pine and an understory of shrubs, vines, briers, and grasses.
Wehadkee-Chewacla complex: Wc	Nearly level	Gum, water oak, ash, elm, and alder with understory of shrubs, briers, vines, and grasses.

TABLE 3-3.— SERIES VEGETATION CLASS DESCRIPTION

Series name	Climate	Soils	Topography	Plant name
Loblolly pine	Mean temperature ranges from a high of 73°F to a low of 50°F. Mean annual precipitation is 45.1 inches.*	Refer to table 3-2 where all soil series for this site are listed	Gentle to steep, 2 to 40 percent, slopes ranging between 300 to 550 feet.*	Loblolly pine

*This information is the same for all Series listed in table 3-1 since the study site is small in size.

4. RESULTS

4.1 VEGETATION DELINEATION

The overlay with delineated vegetation and land use polygons (fig. 3-4) was made at the same scale as the optical bar photography (1:32,500). The numbers identifying polygons on the vegetation map correspond to Series and are listed on the vegetation classification (table 3-1). These polygons are compatible with, but not identical with, the soil and vegetation delineations on the Soil Survey maps. The polygon delineations were also compared with the Forest Service compartment maps (forest types). The forest types and the Series defined in this study are in agreement. This classification is also in agreement with the general classification of potential natural vegetation by Küchler (ref. 13) of oak-hickory-pine forest for this area. The present classification, however, is much more detailed than Küchler's.

4.2 VEGETATION CLASSIFICATION

The vegetation classification was completed only through Series level because of limited funding for field work and because of the controversy of existing vegetation versus potential natural, or climax, vegetation. The Association vegetation class is "a distinctive dominant plant species assemblage that occurs on characteristic topography and soil(s) and is recognizable on the ground by its characteristics flora and dominant species" (ref. 12, p. 31). A complete listing of all plant species including annual forbs is desirable at the Association level. Such detail requires seasonal on-the-ground observation and sampling. It was not possible to spend the time required to get that amount of on-the-ground detail for this study. This, coupled with the controversy of existing versus potential natural vegetation and the lack of published potential natural vegetation for this area, was sufficient to justify classification of this site through Series level only.

Since field time was limited for this study, it was not possible for the author to determine potential natural vegetation of the site. In an effort to obtain this information, Dr. Eugene P. Odum, Athens, Georgia, and Dr. Rebecca Shiritz, Aiken, South Carolina, (refs. 14 and 15) were contacted. They have worked with the vegetation and ecology of the Piedmont, South Carolina, and they agreed that the dryer upland areas would have a potential of oak-hickory-pine while the lower regions would also include a broadleaf deciduous (magnolia-bay) constituent. The "native vegetation" listed for each soil series in the Soil Survey (ref. 11) may be the most nearly correct with reference to climax vegetation. Küchler (ref. 13) gave oak-hickory-pine as the potential natural vegetation of this region.

The climax vegetation of Southeastern United States is very difficult to determine definitively because of the high level of disturbance occurring for such a long period of time. This disturbance is expected to continue, and it seems questionable whether or not potential natural vegetation can ever be correctly determined for the area.

It is suggested that the classification should have a two-level approach, i.e. current vegetation <u>and</u> potential natural vegetation. As illustrated in the examples in the NSCS, current vegetation should be listed and classification done on the basis of that information until potential natural vegetation is known. When potential becomes available, it should be added and any necessary changes in classification should be made. If the vegetation information is handled in this manner, much of the controversy and many of the problems will be solved.

The classification of vegetation done in this study is presented in table 3-1. Loblolly pine (<u>Pinus</u> <u>taeda</u>) was introduced to this area for timber production. It has become established there, and since it has some increased resistance to southern bark beetle infestation, it appears to be replacing shortleaf pine (P. echinata). Since loblolly pine is naturalized in this area, it is listed with the understanding that it is in a stable seral state.

Foliar cover and size of trees are the criteria used for separating Closed Forest from Woodlands at the highest level of the classification hierarchy, the Formation Class. Foliar cover and tree size were extrapolated using the information obtained on the ground in conjunction with the aerial CIR photography. All forests in the site, except managed timber forests, agricultural areas, and cut-over areas, have at least 70 percent foliar cover. Also, except for regenerating loblolly pine forests, all forest trees are at least 4 meters tall. The only areas that could be classified as woodlands are managed areas and so could only be considered woodlands on the basis of current vegetation.

Formation Classes of shrubs and dwarf-shrubs were not detected in this study site. There is an understory of shrubs in some forests but the percentage foliar cover is less than the prescribed 25 percent.

In this densely vegetated, heterogeneous study site, the large number of intermingled three species make it totally impractical to determine which single species is dominant or even which two species are co-dominant. Therefore, in this classification, Series are named on the basis of multiple species dominants, although it is recommended by Merkel et al. that Series be characterized by an individual climax dominant species.

The sites with predominantly herbaceous vegetation occur in cut-over timbering areas, cropland, and improved pasture. Since these are managed for timbering (loblolly pine), crops, and improved pasture, it is unlikely that they will ever develop to climax or potential natural vegetation. Therefore, these areas of herbaceous vegetation are considered seral states.

The vegetation classification is presented in table 3-1. Table 3-2 gives a Series class description. For other Series descriptions, Series names may be taken from table 3-1, and climate, soils, and topography remain the same. Manual of the Vascular Flora of the Carolinas (ref. 15) was used as the standard for plant names. Scientific and common names of plant species are listed in the appendix.

5. DISCUSSION

The objective of this study was to test the applicability of the vegetation component of the NSCS in classifying the vegetation of a heterogeneously forested area. Since the study began, the Classification System has undergone two revisions, the last of which included significant discussions, improvements, and clarifications. The vegetation classification presented in this summary report was revised from the first classification done in 1979 to incorporate changes suggested in the May 1980 revision.

Potential natural vegetation is not defined for this area except on a very broad, more or less conjectural basis. Until more efficient and more uniform methods are developed for determining potential or climax vegetation in areas where it is not known, existing vegetation should be listed with space for potential vegetation to be added as the information becomes available. Current vegetation is an essential data layer to be used in conjunction with the other components (soil, landform, and water) to determine climax vegetation. However, in classifying areas which are managed for something other than climax vegetation, an explanation should be given discussing the status of the seral state. The UNESCO system specifically states that agricultural vegetation is excluded from the classification System.

In heterogeneous areas such as the site in South Carolina where it is not feasible to determine a dominant species or even two co-dominants, the Series was designated by the dominant species names separated by a hyphen. This can be rather long and cumbersome. Examples of these long lists of species dominants can be seen in table 3-1, under Series.

Considering the original question, then, "How workable is the vegetation component of the NSCS in a heterogeneous forested area of Southeastern United States," the answer is that the heterogeneous vegetation found in Southeastern United States can be classified using the revised UNESCO International Classification and Mapping of Vegetation at least on the basis of current vegetation. More indepth study and correlation of current vegetation with soils, landform, water, and other data could perhaps result in a fairly accurate determination of climax vegetation in areas where it is not known. The revised UNESCO System as incorporated into the NSCS is general enough at the higher levels and specific enough at the lower levels to accommodate densely forested, heterogeneous areas as well as the larger, more homogeneous regions of the Pacific Northwest.

The major problem, then, is that of existing vegetation versus potential natural vegetation. If the suggestions given above are followed, the system is useable and will accommodate potential natural vegetation when that information becomes available.

6. RECOMMENDATIONS

In spite of the aforementioned shortcomings and others which will become apparent as use increases, the revised vegetation component as adopted from the UNESCO System is far superior to the earlier attempts at uniform vegetation classification. Based on the results of this study, this system with provisions for modifications as needed should prove satisfactory, especially if a method is developed to effectively handle current vegetation as well as climax vegetation.

The lowest levels of the NSCS are comparable to the vegetation classification systems used by the Forest Service, BLM, SCS, Bureau of Indian Affairs, and other agencies. Therefore, making existing data conform to this system would be no great task. As new data is added and compiled, the transition could be made. Since the soil component is already widely used, its adoption will be no problem. As the system is adopted nationally it can be modified and improved to fit varying situations. As soon as a national system is implemented, we can establish stable data bases to aid in inventorying, assessing, and managing the Nation's renewable natural resources.

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APPENDIX A

COMMON AND SCIENTIFIC NAMES OF PLANT SPECIES

American elm	*Ulmus americana*
Bermuda grass	*Cynodon dactylon*
Bitterweed	*Helenium amarum*
Black oak	*Quercus velutina*
Black willow	*Salix nigra*
Dewberry	*Rubus trivialis*
Dwarf sumac	*Rhus copallina*
Eastern cottonwood	*Populus deltoides*
Goldenrod	*Solidago* spp.
Green ash	*Fraxinus* sp.
Hickory	*Carya* spp.
Loblolly pine	*Pinus taeda*
Northern red oak	*Quercus rubra* var. *borealis*
Paspalum	*Paspalum* spp.
Post oak	*Quercus stellata*
Red maple	*Acer rubrum*
Scarlet oak	*Quercus coccinea*
Shortleaf pine	*Pinus echinata*
Southern red oak	*Quercus falcata*
Sugarberry	*Celtis laevigata*
Sweetgum	*Liquidambar styraciflua*
Sycamore	*Platanus occidentalis*
Virginia pine	*Pinus virginiana*

Water oak	<u>Quercus nigra</u>
White ash	<u>Fraxinus americana</u>
White oak	<u>Quercus alba</u>
Willow ash	<u>Fraxinus</u> sp.
Yellow poplar	<u>Liriodendron tulipifera</u>