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Soil Studies Educational Unit and Soil Reconnaissance Survey of Piney Woods Conservation Center

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by

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INTRODUCTION

The demand for environmental education has been progressively increasing in the last 30 years. With expanding leisure time, and increasing personal income, millions of Americans are seeking the outdoor environment (Steiner, 1933; Kraus, 1971; Kaplan, 1972; Murphy, 1975). Yet many of these people lack the basic attitudes and skills to fully appreciate the outdoor learning experience. Progressive school administrators recognize the need for a school program that can equip youth with the requirements needed to enrich their lives so they can understand and better enjoy the outdoor environment (Smith et al, 1963; Leonard, 1968; Murphy, 1975; Hammerman and Hammerman, 1980).

Outdoor education is not a new idea or trend. In the early 1930's two federal agencies were formed to handle the large number of young people who had no place in school or at work. The National Youth Association and the Civilian Conservation Corp; not only gave youth something constructive to do but were new ventures into the field of outdoor education (Smith, 1957). The National Youth Association and the Civilian Conservation Corp no longer exist and, although outdoor education has been gaining interest throughout the years, a survey done in the late 1970's found only 781 (11%)

of the nation's 7,143 school districts (with enrollment of 1,000 or more) had outdoor education programs large enough to employ a staff person at least half-time (National Education Association, 1970; National School Public Relations Association, 1971).

In East Texas only the Houston Independent School District and the Tyler Independent School District operate outdoor education programs. The City of Tyler operates one of the oldest outdoor education camps in the nation, Camp Tyler (Smith et al, 1963; Hammerman and Hammerman, 1980). The City of Houston operates Camp Olympia, a cooperative of all the school districts (Gregory et al, 1979).

In many school systems without outdoor education programs individual teachers have developed environmental or nature units that best fit the needs of their students. A coordinated effort is needed to unite all schools and develop an operational environmental education center where East Texas youths may learn necessary skills needed to participate in the natural environment.

The proposed Piney Woods Conservation Center (PWCC), now in its' conceptual stages, would ideally fit the needs of educational systems in East Texas. Stephen F. Austin State University, as the leading educational institution in this area can and should provide the experience and expertise needed to facilitate the proposed center (Stephen F. Austin State University, 1982).

This study presents a program in soils that is one portion of the total environmental education program to be developed for the PWCC. This programs expects to help promote understanding of the soil as a basic component of the environment.

The primary objective of the soil studies educational unit is to train teachers at the middle school level. This study unit will:

1. Familiarize teachers with a variety of soils,
2. Present physical differences in soil properties,
3. Present processes of soil horizon formation,
4. Consider the effects that soils have on vegetation,
5. Integrate all of the above into an effective, teaching unit.

The base data for this study is from a reconnaissance soil survey of the PWCC. Soil interpretations from the reconnaissance survey are integrated into the soil studies educational unit.

LITERATURE REVIEW

Environmental Education

According to Sharp and Partridge (1947); Smith (1970); Hammerman and Hammerman (1980); the origin of outdoor education is not related to any specific time or event. Some writers have traced the initial beginning to the time of Socrates, Plato, even Christ. Other writers have given credit to events in other historical times as the beginning of outdoor education (Gibson, 1936; Bennett, 1972; Goering, 1972; Hammerman and Hammerman, 1980).

Most writers and educators agree outdoor education was first recognized as a educational field in the 1930's. The fifty years following the 30's are divided into periods of 10 years. These periods follow significant events in the development of outdoor education. The 1930-1939, were known as the Period of Inception for the new outdoor education field. Before this period, the outdoors was used as a educational setting but many of the environmental problems; air pollution, soil erosion, land mismanagement, were not yet recognized (Smith, 1957; Donaldson and Goering, 1968; Smith, 1970; Hammerman and Hammerman, 1980).

The following ten years (1940-1951) were known as the period of Experimentation. This period was characterized by the beginning of community school camp programs such as Camp Tyler which was designed as a year round outdoor lab (Smith et al, 1963; Smith, 1970; Donaldson and Swan, 1979; Hammerman and Hammerman, 1980).

The Period of Standardization, 1952-1960, closely identified outdoor programs with school courses. During this time, changes in nomenclature from school camps to outdoor school and outdoor labs occurred (National Education Association, 1970; Smith, 1970; Donaldson and Swan, 1979; Hammerman and Hammerman, 1980).

The Period of Resurgence 1960-1962, characterized the development and passage of the Elementary and Secondary Education Act of 1965. Purpose of the act was to strenghten and improve education quality and education opportunities in public schools (Lewis, 1975; Donaldson and Swan, 1979; Hammerman and Hammerman, 1980).

During the Period of New Directions, 1970-1979, Senator Gaylord Nelson introduced Earth Day, on April 22, 1970, as a means of making environmental issue part of the nation's politics. Senator Nelson also co-sponsored the Environmental Education Act signed by President Nixon on October 30, 1970. The Environmental Education Act is a means of incorporating environmental learning into the educational system (Anonymous, 1972; Brezina and Overmyer, 1974; National School Public Relations Association, 1971; Hammerman and Hammerman, 1980). This period was characterized by new directions into Adventure Education and Environmental Education. Adventure Education teaches experiences of self discovery and uses challenges in a wilderness as the teaching medium. Environmental education develops knowledge and appreciation of the environment and man's relationship to environment (Brezina and Overmyer, 1974; Staley, 1979; Hammerman and Hammerman, 1980).

Outdoor education, conservation education and environmental education are program titles that vary with grade level (National Education Association, 1970). At times, portions of all three are identical, but at other times they vary. However, the educational aims of the three kinds of programs are highly similar if again not identical (Donaldson and Swan, 1979). Stephen F. Austin State University School of Forestry (1980) subdivides environmental education into areas of specialization based on the following:

1) Outdoor education - teaching of regular classroom subjects in an outdoor setting
2) Outdoor Recreation - teaching of physical leisure time activities in outdoor settings
3) Conservation education - teaching about the physical environment in the outdoors (Concepts of ecology and natural resources)

In 1970 the National Education Association conducted a nationwide study of environmental education programs given at all grade levels, from pre-kindergarden through adult education. More than half (57.7%) of the programs were concentrated in grades 5-7. Thus, the majority of exposure to environmental education programs occurs during a very limited time span in most school systems. The actual time involved in these programs is also limited with the medium number of pupil classroom days in a environmental program varying from 10 days at the elementary level; 12 days at the middle school level to 20 days at the high school level.

Of the total environmental and applied science programs, conservation (as a area of specialization within the environmental and applied sciences) showed the greatest concentration of interest amoung all other school programs. According to Stapp (1965) this interest in conservation is an indication of the need to meet the conservation challenge by educating youth to become aroused, informed citizens who will take active roles in local, state, national and international issues. The content of this Thesis best fits into the area of conservation education.

Soils

Knowledge of soils was quite general before the United States Soil Survey began in 1899 and the body of knowledge was based on experience and observations (over the centuries by farmers rather than experimentation). In the 19th century, information about soils gained through agriculture, chemistry, geology and biology was just beginning to be used. Not until the Soil Survey became established did these separate fields become coordinated (USDA, 1937).

Soils are recognized as individual bodies on the surface of the earth that have depth, shape and a genetic history. A soil has characteristics that collectively make it an integrated, dynamic natural body. The Soil Survey Manual (USDA, 1937) identifies these characteristics as resulting from climate, and living material, acting upon the geology, as conditioned by relief over a period of time. A Soil Survey (1) defines the important soil characteristics, (2) classifies the soils into taxonomic units and (3) establishes the soil boundaries on maps or aerial photos (USDA, 1937; Smith and Aandahl, 1957).

Soils generally coincide with visual features on the land surface. For example, some soil types are associated with slopes, crest of ridges, and forest types. All soil mapping is done in the field by soil scientist and the primary reference for soil surveys is the Soil Survey Manual developed by the USDA (1937).

From the soil survey, predictions are made on soil behavior, limitations, capabilities and manipulations. The interpretations benefit the landowner or manager as well as professions in forestry, engineering, agriculture, land use planning and education (Bartelli et al. 1966; Olson, 1981).

Interpretations of a soil survey can be developed for the specific needs of the user. Unfortunately many of the prospective users are not familiar enough with characteristics, terminology and properties to make interpretations for land use. Educational programs are therefore needed to educate and enlighten the public about soils in their area (Simonson, 1974).

One of the earliest agencies to be involved in developing study units in soils was the Soil Conservation Service. A primary function of the SCS (Soil Conservation Service) is promoting the concept of soil conservation. The SCS is concerned with the present population shift from rural to urban concentrations with the resulting dissociation of people from the land (Smith et al. 1963; USDA, 1970). The U.S. Forest Service also holds annual workshops and publishes materials on soil studies in environmental education (USDA, 1977). State Agencies such as the Arizona Cooperative Extension Service (1978); The Delaware State Department of Public Instruction (1973) and Tarleton State University et al (1979) also develop teaching manuals. Most materials and programs, however, have been developed by individual school boards to meet their own local purposes and is generally unavailable to other schools (Montgomery County Public School, 1970; Carter and Mills, 1970; Stahnke et al. 1980).

Most curriculum guides available on soils are very general (material published from federal agencies is generalized for national interest). Information available on curriculum guides with soil study units developed for specific conditions and features important to the development of local soils are often ignored. The availability of information and guides keyed to local observable features is needed to interest teachers in using and working with soils.

METHODS AND PROCEDURES

Study Area

The proposed Piney Woods Conservation Center is located 60 miles southeast of Nacogdoches, Texas in the Angelina National Forest, San Augustine County (See Figure 1). Stephen F. Austin State University, School of Forestry presently holds a special use permit, No. 622, titled Education Center. This special use permit is a "planning permit to allow school of forestry to conduct environmental and outdoor education programs for various groups; develop resource management demonstrations (i.e., soil pits, nature trails, etc.); conduct trail instructional programs and field studies; to determine the feasibility of a regional outdoor education center or facility to serve local school districts in the area, continuing education needs of teachers, and the field needs of the School of Forestry." Permit No. 622 leases use of 60 acres located in the southwest corner of PWCC. A second special use permit will allow access to remaining 2,400 acres of PWCC (See Figure 2). This permit will be transfered to the PWCC from a Field Studies Station located north of Milam, Texas at the end of the leasing period (1985). Both permits were granted to the School of Forestry from the U.S. Forest Service. The Soil

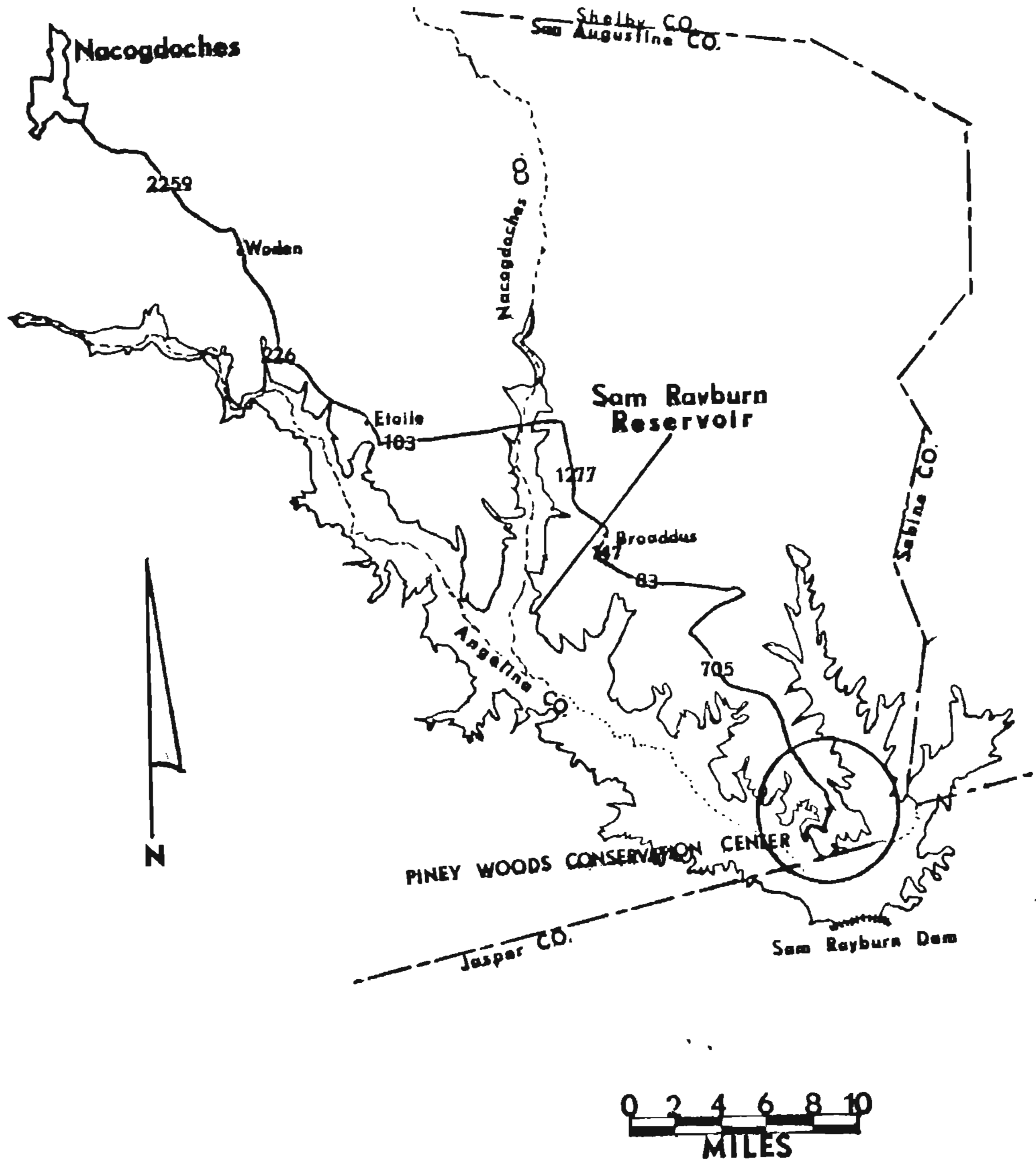


FIGURE 1. LOCATION MAP SAM RAYBURN RESERVOIR

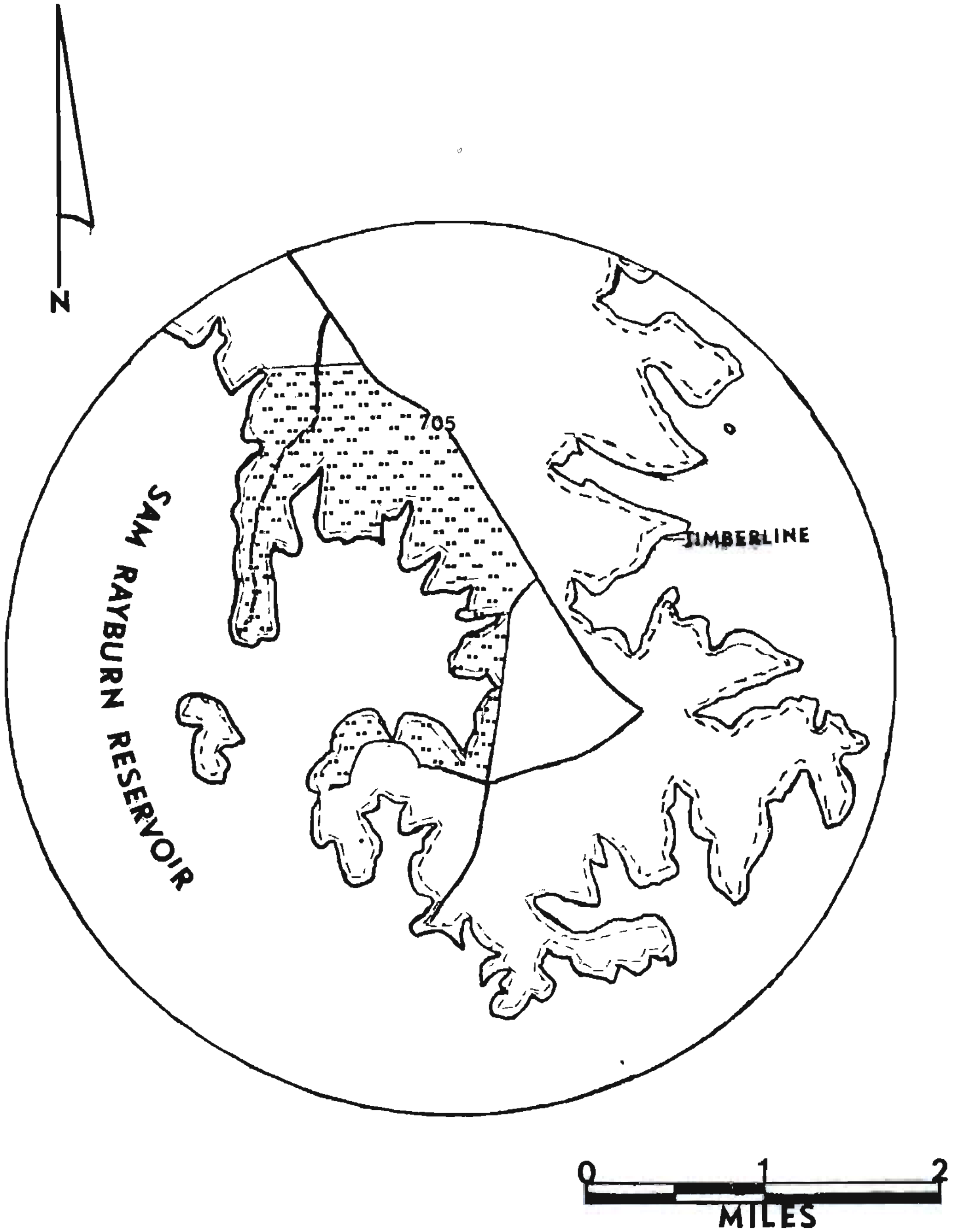


FIGURE 2. LOCATION PINEY WOODS CONSERVATION CENTER

Reconnaissance Survey covered both lease areas, approximately 2,500 acres.

Terrain at the proposed PWCC is level to moderately sloping with elevation differences of 50 feet between lake level and hilltops (Bureau of Economic Geology, 1967).

South and southwest winds from the Gulf of Mexico provide the primary moisture. The 30 year annual precipitation average is 45.96 inches with a mean annual temperature of 66.3 degrees Fahrenheit. Heaviest precipitation is in the spring peaking in April and May. A second period occurs in November and December. The growing season varies from 236 days to 260 days per year (Texas Water Development Board, 1967).

Vegetation consist primarily of a mixed pine hardwood forest. Predominate pine are loblolly (Pinus taeda L.) and shortleaf pine (Pinus echinata Mill.). Predominate hardwoods are sweetgum (Liquidambar stryaciflua L.) and oak (Quercus spp.).

Two geological formations underlying the PWCC site are the Nash Creek and the Yazoo formations. The Nash Creek formation encompasses the southwesterly corner of the PWCC. This formation consist primarily of bentonitic clay interbeded with quartz sand. It is about 60 feet thick. The Yazoo formation outcrops to the north of the Nash Creek and encompasses the remaining land mass of the PWCC. It is clay interbeded with silt and glauconitic sand containing marine mega fossiles and has a thickness of about 200 feet. Both formations form the parent material from which the soils in the area developed (Bureau of Economic Geology, 1967).

Method of Survey

Procedures for the reconnaissance survey are referenced to the Soil Survey Manual (USDA, 1937). The reconnaissance survey was plotted directly on 9 by 9 aerial photos that serve as a base map (aerial photos supplied by USDA, 1975). Photo scale is 1:15,840 or 4 inches to a mile. Aerial photos have 60% overlap in lines of flight and 30% overlap between adjacent flight lines to provide stereoscopic coverage of the area surveyed.

Soil mapping was along transect lines, layed on north compass headings. Transects were staked and marked with flagging at a minimum horizontal distance of 660 feet apart. Lateral transects perpendicular to the main transect lines were necessary at times to determine boundaries of different soils. Auger holes were put in the ground (along the main transect) every 132 feet or whenever visual changes in vegetation and terrain occured. When augering revealed differences in soil types, exposure of the soil profile was necessary for identification and classification. Soil pits were dug for the various soils and a Soil Description Data sheet, SCS-232F, was used to record information on soil pedon (See Appendix for Data sheets).

Acreage for each soil was measured on the photo-map using a planimeter. The planimeter reading in square inches for each soil was totalled and the percentages of each soil in relation to the total area was calculated. Multiplying the percentages of each soil type by the total acreage resulted in the acreage for each individual soil.

RESULTS

Soil Descriptions of PWCC

Soil 1, a Typic Paleudalf, covers approximately 44 acres and is found in the lower southwestern corner of the PWCC (Figure 3). This soil is found on gently sloping convex ridges. The A horizon is a dark grayish brown fine sandy loam about 2 inches thick above a dark yellowish red sandy clay loam subsoil that is extremely firm and hard to penetrate during dry periods. It is well drained and has a high water holding capacity. Overstory vegetation consists primarily of loblolly pine, oak and sweetgum. Soil No. 1 has a high potential for both urban and recreational development and is currently being used as a underdeveloped camping area by local residents.

Soil 2, a Psammentic Paleudalf, covers a relatively small ridge area of less than half an acre. This particular soil is bordered on one side by the Typic Paleudalf and on the other by a Glossic Paleudalf. The A horizon is a dark yellowish brown, fine sandy loam, 57 inches thick, over a sandy loam B. This soil is excessively well drained and has a low water holding capacity. Overstory vegetation consists primarily of loblolly pine with the droughty sandy surface being the main limitation to growth. The potential for urban

FIGURE 3. SOIL RECONNAISSANCE SURVEY

use is high but the sandy surface would be a limiting factor for recreational use.

Soil 3, a Glossic Paleudalf, is a deep gently sloping upland soil covering approximately 42 acres. The A horizon of this soil is a brown to yellowish brown, fine sandy loam about 2 inches thick. The B horizon is a strong brown, sandy clay loam. This soil is well drained and has a high water holding capacity. Overstory vegetation consists primarily of loblolly pine, oak and gum. The low strength of the B horizon to support construction gives this site a medium potential for urban use. Recreation potential on this site is high.

Soil 4, a Typic Hapludult, is a deep soil found on the slopes of major drainages. This soil covers approximately 27 acres and has a dark brown, sandy loam A horizon about 8 inches thick overlying a dark, red clay subsoil with yellowish brown mottles. This soil is moderately well drained and has a medium water holding capacity. The erosion hazard is severe since runoff is rapid. Overstory vegetation consists primarily of assorted hardwoods with some loblolly pine. This soil has a low potential for urban use and a medium potential for recreational use. The main land use limitation is steepness of slope and erosion hazard.

Soils 5 and 5A are both Aeric Glossaqualfs and cover approximately 54 and 803 acres respectively. Differences in vegetation and texture warrents two seperate mapping units. These soils are found on level topography, and have a dark yellowish brown, sandy loam A horizon about 4 inches thick. The B horizons are strong brown to grayish brown with distinct tongueing and mottling throughout. Texture of the B horizons range from a sandy clay loam on site 5A to silty clay on site 5. Overstory vegetation consists primarily of loblolly pine, assorted bottomland hardwoods and on site 5A, a dense understory of briars, dewberry vines and shrubs. Development for recreational and urban use is low due to a high fluctuating water table and high silt content in subsurface horizons on site 5A. Compaction hazard by heavy equipment is high.

Soil 6, an Aquentic Chromudert, is a deep nearly level soil in the southern portion of the PWCC and appears on moderately steep slopes (5-20%) in the northeastern portion. This soil covers the largest area approximately 1212 acres. The surface horizon is a dark grayish brown, clay about 5 inches thick. The subsurface horizons range from a yellowish brown, silty clay to a dense gray clay with red and yellow mottles. It is poorly drained and has a high water holding capacity. The hazard of erosion is severe since runoff is so rapid. Overstory vegetation consists primarily of assorted bottomland hardwoods and loblolly pine. Potential for urban and recreational uses are both low due to high shrink-swell character.

Soil 7, a Vertic Hapludalf, is a deep gently sloping soil that covers approximately 148 acres. The A horizon is a dark grayish brown, sandy loam about 3 inches thick overlying a dark brown, dense clay subsoil with light brown and gray mottles. This soil is somewhat poorly drained and has a medium available water holding capacity. Runoff in steep places is rapid and erosion is severe. Overstory vegetation consists primarily of loblolly and shortleaf pine. The recreation and urban potential for this soil are both low due to erosion hazard and high shrink-swell capacity.

Soil 8, an Aquic Hapludalf, covers approximately 150 acres and is a gently sloping soil with a dark brown, loamy sand A horizon about 2 inches thick. The subsoil is a reddish gray clay mottled brown, gray and yellow. It is moderately well drained and has a high water holding capacity. Overstory vegetation consists primarily of loblolly and shortleaf pine. Urban and recreational potential are both low for this soil. A fluctuating water table in the subsurface horizons is the main limitation to land use.

SOIL STUDIES EDUCATIONAL UNIT

Foreword

The Soil Studies Educational Unit was developed based on a review of literature on current soil studies curriculum guides. Five of the eight soils present at the Piney Woods Conservation Center are discussed in this curriculum guide. These five soils display physical characteristics that are easily observed and studied. Soil descriptions are based on data collected, personal observations and subgroup taxonomy from the Soil Survey of Nacogdoches County, Texas (Dolezel, 1980). Soil classification was verified by Mr. R.C. Dolezel, USDA, Soil Conservation Service, Nacogdoches, Texas.

Introduction

What can be taught with a soil studies educational unit and why should it be taught at all is the first question we should ask ourselves as teachers and educators of today's youth.

Importance of Soils

To answer both questions an understanding of the importance of soil is necessary. Not only is the existance of life dependent on soil, but the quality of that life is dependent on the quality of the soil. The great ancient civilizations of the Summarian and Egyptian people were due to the good soils that developed in the fertile alluvial plains of Mesopotamia and the Nile Valley. Agriculture had its' beginning in these two centers, 7000 years ago. But within a short historical time span these two civilizations created conditions that brought about their downfall. Irrigation and drainage systems were not maintained and soil misuse led to the harmful accumulations of salts. These salts left the soil incapable of supporting life. Seven thousand years later in the "Land flowing with milk and honey" the landscape is all but denuded and great outcrops of rock mark the place where once fertile soil covered the hills. Soil erosion and poor soil management has left this land with barely enough soil to grow a meager crop for existance. Four thousand miles away, the United States of America lost millions of productive farm land in the "dust bowl days" of the 1930's (Lowdermilk, 1975; Brady, 1974).

Since that time,the population of Texas has shifted from primarily rural to urban. Many citizens removed from their rural settings have all but forgotten their kinship with the land. Conservation problems created from this dissociation include air pollution, poor land development and soil erosion.

Many Texas teachers are expressing the need for a resource guide that can be used on specific school sites to help them develop an awareness of the soil conservation issues among the students (Texas Education Agency, 1976).

One of the most direct ways of developing conservation awareness is by providing hands on experiences in an outdoor setting. This Soil Studies Educational Unit is a small but important part of the resource guides to be developed for the PWCC. We rationalize that this unit will familiarize the teacher and student with soil forming processes and properties (Bennett and Schwille, 1970).

Understanding Soils

Once the importance of soil and its' effect on quality of life are understood, then the actual importance of soil to life itself can be answered. The inorganic and organic components of soil supply 13 of the 16 essential chemical nutrients needed by the growing plant. The remaining three (Carbon, Oxygen and Hydrogen) are supplied from the atmosphere.

Soil is one of three basic natural resources (air, water and soil), of the three soil is renewable but only if given enough time. Formation of some soil may take thousands of years for even a few inches; yet, in a matter of minutes the soil may be permanently lost through unwise conservation practices. Proof of this is found all across our world from the countries of the Holy land to the Pacific coast of our own land.

Soil Formation

An important objective of this particular unit is the development of a awareness by the student that soil is a dynamic body undergoing continuous change. This change is caused by several geologic, climatic and bio-chemical phenomena.

All soil is formed from geologic material called parent material. This parent material is acted upon by wind, water and temperature, along with mechanical and bio-chemical weathering. Deposits of this weathered parent material form into soil over a period of time under the action of organisms (Coble et al, 1981).

Large numbers of plant and animal life inhabit the soil. These organisms, both micro and macroscopic in size, have a tremendous effect on the characteristics of the soil. Granulation (structure), permeability, drainage, air movement, organic matter and soil chemistry all are effected by the organism populations. Soil inhabiting plants (bacteria, fungi, algae and molds) and animal life (protozoa, nematodes, earthworms, ants, spiders, etc.) are vital to the conversion of decaying organic matter into inorganic nutrients that are used by growing plants (Kilburn and Thurber, 1970).

Soils are as varied and different as humans are from each other. These differences in soils may range from distinct color and texture variations to more subtle variations of structure and consistence. Students should realize that these differences are caused by varying parent material, different weathering processes, time and relief. The present appearence of the soil does not necessarily dictate the future appearence of the soil. A change in plant community or climate can, over time, change the appearence of the soil (Olson, 1976).

Formation of Soil Horizons

Soil development begins with the weathering of parent material. Successive layers called horizons are formed within the weathered parent material. Formation of the soil horizons depends on soil forming processes. The various combination of processes and the resulting horizons form the genetic background of the soil. There are four major processes involved in the formation of soil horizons. One or more of these processes can be simultaneously active during the formation process (Figure 4).

Addition (of plant matter) is the process that influences the formation of the A horizon. The A horizon is the upper region of the soil normally referred to as the topsoil. The A horizon is formed when micro and macroorganisms aid the process of plant decay and incorporate the decaying material or organic matter into the upper mineral soil. The A horizon is characterized by a dark color caused by the addition and mixture of the black organic matter with the lighter mineral soil.

The process of deletion or loss is normally associated with the formation of the E horizon. Minerals washed downward by the movement of water leave this horizon lighter in color than the above A horizon. This horizon is usually typified by high concentrations of quartz and other resistant minerals. Translocation of soluble minerals and clay particles carried by the downward movement of water, may precipitate out at a lower depth resulting in formation of the B horizon.

The B horizon, usually referred to as the subsoil, is developed from precipitation of soluble minerals and clay being translocated by the water draining downward through the soil. The soils at the PWCC have an easily identifiable B horizon due to the high accumulation of clayey material,

O	Organic Litter horizon formed from micro and macro organisms decaying plant matter. (Transformation)
A	Macro organisms incorporate organic matter from above with mineral soil to form the A horizon. This is topsoil. (Addition)
E	Water movement downward removes organic matter and minerals leaving only the most resistant minerals such as quartz. (Deletion)
B	Clays, minerals and some organic matter precipitate out and form the B horizon. This is the subsoil.(Translocation) Clays also form from Chemical and bio-chemical transformation .
C	The C horizon is presumed to be the parent material. This horizon is little affected by organisms but may be weathered .

FIGURE 4. HYPOTHETICAL SOIL PROFILE

causing the subsoil to have a bright orange to red and gray colors.

Transformation is a chemical process which involves the formation of new minerals or organic compounds. Good examples of this would be the formation of the O horizon, caused by the decomposition of leaf litter or other organic compounds on the surface of the soil, and the development of clay from minerals in the parent material.

The C horizon is usually composed of partially weathered bedrock material that has not been greatly affected by climatic conditions or organisms. This horizon is commonly presumed to be the parent material from which the above horizons have developed (Boul et al, 1980).

Soil Interpretations

Two of the most easily observed physical characteristics of soils, at the PWCC, are texture and color. Texture is the most important physical trait found in soil. Texture regulates such things as rate of water movement, water holding capacity, soil aeration and fertility. Soil texture is the distribution of individual particle sizes. Soils can be classified into texture groups according to the particle size. Soils that are sandy, are loose and feel gritty if they are wet or dry (Figure 5). Soils that are silty often feel soapy when wet and floury when dry. Soils

TEXTURE BY FEEL ANALYSIS

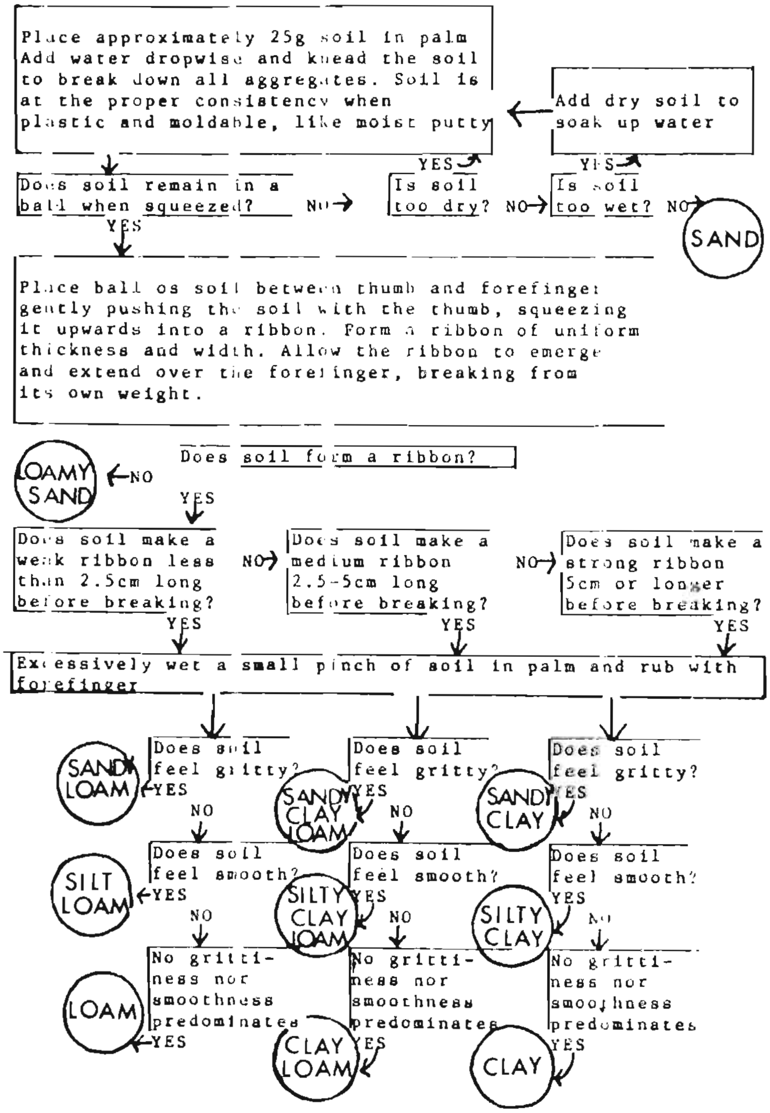
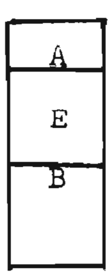


FIGURE 5. INSTRUCTIONAL FLOW DIAGRAM FOR DETERMINING SOIL TEXTURE BY FEEL (Thien, 1979)

that are clayey feel sticky and plastic when wet and hard and cloddy when dry (Foth and Jacobs, 1971).

Color is the most easily observable soil characteristic. The color of the soil can show the student the conditions and processes active during horizon development. For instance, bright colors generally indicate well drained conditions whereas dull colors are due to prolong wetness. Very dark colors, blacks, browns and grays, are usually characteristic of the soil surface and indicate degree of organic matter present in the soil. Dark mineral colors, reds and browns, characterize abundance of iron oxides. A combination of red, yellow and gray colors indicate fluctuating conditions of poor drainage and poor aeration. As drainage improves and allows air to enter the soil, the iron minerals oxidize and turn to red and yellow. When poor drainage increases and soil aeration is at a minimum, the iron reduces and turns to colors of gray. These characteristics, and their effects on plant community and site, will be discussed for the soils used in this unit (Foth, 1978).

Soil 1



0-2 inches, dark grayish brown, sandy loam

2-6 inches, yellowish brown, sandy loam

6 inches plus, yellowish red, sandy clay loam

Soil 1 is dominated by sand particles. These particles give the soil a sandy loam to sandy clay loam texture. Texture of this soil can be easily identified by feeling and touching the soil from each horizon (Figure 5). The soil should feel gritty; closely observe the soil, notice the individual quartz particles that comprise the sand size fraction. The sand found on this site comes from alluvial parent material deposited here by water. Before Sam Rayburn Dam was built, the Angelina River flowed freely within its' banks. The Angelina River is the main water source to Sam Rayburn Reservoir. During periods of high rainfall the Angelina River would overflow its' banks and flood the surrounding area. The receding flood water left deposits of alluvial material carried by the river. These depositions occurred a very long time ago.

This soil has three readily identifiable horizons. The A, E and B horizons. The B horizon contains a higher percentage of clay deposited by the process of translocation. The dark orange color of this horizon is caused by the iron clay which precipitated onto the sand particles.

All mineral soils are composed of various particle sizes. These particle sizes are sand, silt and clay. The sand and clay can be easily observed in the soil but the amount of silt size percentage is much too small to be seen.

This soil is one of the best soils found at the PWCC. Soil scientists make this conclusion after studying all the plants have difficulty reaching the deeper B horizon where the water is held. Only trees with deep root systems have no trouble growing and thriving on this soil. Most of the water is stored in the B, and the A and E horizons have little water. The reason for this is that sand particles are round and large in size. When sand particles touch, like in soil, large spaces are created between the individual particles, water cannot be held in these large spaces or pores because gravity tends to pull the water downward through the large pores. Soils dominated by sand particles posses good drainage, good aeration (air is held in large pores), are easy to cultivate,but hold very little water. Agricultural crops can be grown here if an irrigation system is installed. It is very difficult to install an irrigation system for a forest community because trees do not grow in straight rows unless they are planted. It takes a long time to grow trees and the money spent on watering and on the irrigation system will not be compensated for when the trees are finally ready for harvest. However, one solution to planting young trees would be to plant in furrows. The furrows produced by most farm plows are usually 6-8 inches deep. Planting the young trees in the furrows brings the tree closer to the B horizon. The furrow will also act as a channel for funneling rain water to the young tree. The process of furrowing can provide the young tree with the added edge necessary for it to survive the first few years until the root system grows and reaches the B horizon. Loose, sandy soils located on slopes (such as this soil) tend to be unstable. Buildings constructed on this site would require special foundations to prevent shifting.

Soil 4 *

A	0-8 inches, dark brown, sandy loam
B	8 inches plus, yellowish red, clay

Soil 4 is found on narrow steep slopes leading to major drainageways. The parent material consists of inter-layers of sand and clay sediment.

This is one of the most colorful soils found at the PWCC. A dark brown, sandy loam horizon contrasts sharply with the yellowish red, clayey B horizon. The absence of the E horizon here is one of the identifying characteristics of this soil. Soil 4 has considerable more limitations than the previous two soils. Most of the limitations are caused by the clayey B horizon. The B horizon has a much greater amount of clay than the A horizon. Clay particles, also referred to as colloids, are flat, micalike in shape and microscopic in size. The small size of the clay colloids creates spaces between the clay particle which are also

* Soils will have to be numbered as stops or sites to prevent confusion in the final study unit brochure.

microscopic in size. These microscopic spaces or micropores prevent water from moving through the pores very fast. As a result water drainage is often slow. However, these micropores will hold water longer than the bigger macropores.

Soils dominated by clay colloids have fine texture, are sticky and plastic when wet and hard and cloddy when dry. Have the students feel the B horizon. Is the soil sticky or hard? How has the previous weeks' weather effected the B horizon (has it rained a lot or has it been dry and sunny).

Major limitations caused by the clay on this site are:

1) High concentrations of clay, create wet conditions in the soil. Pines, the major harvest species, prefer drier, sandier sites.

2) Tree root systems need room to grow downward and out (have students dig in the B horizon). Tree root systems have the same difficulty penetrating this horizon, that students have digging in the clay.

3) Since micropores prevent good water drainage downward, the water will stay on the surface longer and run off down-slope eroding valuable topsoil.

<u>Soil 5A</u>

A	0-4 inches, dark yellowish brown, fine sandy loam
E	4-11 inches, yellowish brown, sandy loam
B	11 incnes plus, strong brown sandy clay loam

Soil 5A was formed from old alluvial sediment that was reworked by wind.

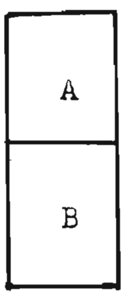
This soil has three major horizons, the A, E and B. The texture on these three horizons range from a sandy loam to a sandy clay loam. The loam term indicates observable fractions of all three particle sizes (sand, silt and clay). However, the sandy term preceding the loam clarifies the sand as the dominant size fraction in this texture. Have the students feel the soil horizons. Can they see or feel the sand, silt and clay (sand will feel gritty, silt will feel floury, and clay will feel plastic).

Notice the spots of color (red, yellow and gray) that mark this soil's profile. These spots of color or mottling are caused by a fluctuating water table. This water moves up during the rainy season and down during the summer (fluctuates) within the soil and reacts with the iron clay mineral to form these spots of color. Soils with a high or fluctuating water table are usually poorly drained and this mottled condition is a result of the poor drainage.

Observe the thickness and variety of vegetation on this site. Everything from pines, hardwoods even briars and other assorted vines and shrubs seem to be thriving on this soil. Why is the vegetation here so much thicker and varied than the vegetation on the previous soils? One reason is the fluctuating water table present in this soil. When it rains a lot, the water will come to the surface so that even small plants and trees have a readily available water supply. After it quits raining for a few days, and the sunshine dries the vegetation and topsoil, the water will move back down to the subsurface horizon (B horizon). This way the plants and trees won't suffocate (most plants and trees do a considerable amount of breathing through their root systems). An available water supply and good aeration provide a very favorable environment for plant growth.

Do you think it would be possible to build on this site? Houses, a basketball court, how about a school? It would be very difficult to build on this soil without doing a lot of special foundation work first. During the rainy season this site could become so wet (water stands on the surface of this soil) that you could float small boats in the water.

<u>Soil 6</u>



0-5 inches, dark grayish brown, clay

5 inches plus, yellowish brown, clay

Soil 6 is one of the most interesting soils found at the PWCC. This soil is derived from calcareous clayey sediment.

It is very difficult to observe more than one horizon of this soil's profile. The entire profile is fairly uniform in color and texture. The texture of this soil is clay. Have the students feel the texture. Notice how sticky and plastic feeling it is. Is it easy to mold and reshape? If it has been dry and droughty the past weeks, perhaps the clay is hard and cloddy.

Look at the pine trees on this site, why are they so crooked? Previously discussed was the fact that clay can hold considerable more water than sand or silt, because of clay's dominance by micropores. The more water that occupies the micropore, the more the clay will swell, until it pushes outward. As the clay becomes drier, and the water in the micropores is evaporated or used, the clay will shrink back. When the clay shrinks and pulls together large cracks are formed in the ground. Topsoil and decaying plant matter will fall into these cracks until it rains again and the clays swell pushing the topsoil and decaying plant matter outward. The result of this continuous alternating wetting and drying is the humpy appearence of the landscape. These small depressions and mounds continuously form, shifting the vegetation on the surface of the soil. Pine trees, which grow away from gravity, are forever trying to straighten up and grow. The soil which is continuously shifting produces the crooked look of the pine trees.

Summary

The five soils discussed in this soil studies unit express physical characteristics of color and texture best. Color and texture were the two physical characteristics discussed because they are easiest to observe. Color and texture are not the only soil characteristics present. Structure, consistence, and horizon boundaries are more subtle and take more experience to differentiate.

Color is a good environmental indicator of site conditions; active soil processes and horizon development can be indicated by color.

Texture is the most important physical characteristic and regulates rate of water movement, water holding capacity, soil aeration and fertility. Texture is the distribution of individual particle sizes, sand, silt and clay. Texture to a degree determines color of the soil. Soils high in iron clays, will be red and orange. Soils with organic matter will be black, brown or gray. Soils high in clay or silts, but found on a wet site, will be gray and black due to reduction of iron clay.

Color and texture were used to make interpretations in the soil unit concerning present site conditions, vegetative growth, and construction or urban development.

The Soil Studies Educational Unit is meant to be used as a field guide. Few diagrams are used in this soil unit as compared to other soil educational units primarily due to the fact that soil mapping unit pedons are exposed and are intended to give hands on experience to the teacher and student in a outdoor setting. Comments from teachers, working and teaching in environmental education, were used in the writing of this unit. Your comments are appreciated.

Glossary

Addition-process by which matter is added to the soil.

Aeration-good supply of oxygen available in pores of soil.

Alluvial-stream deposits made during flood stages.

Calcareous-consisting of or containing calcium carbonates.

Deletion-process which involves losses of material or minerals from soil.

Genetic- soil characteristics formed by alteration of parent material.

Horizon-a layer of uniform soil material.

Irrigation-artificial means of watering the soil.

Mottled-Spots of red, yellow and gray color due to poor drainage.

Parent Material-altered geological material from which the soil is presumed to have formed from.

Pore-minute opening or space between solid soil particles.

Soil Profile-a verticle cut exposing the face and horizons of a soil.

Transformation-chemical process that involves the formation of new minerals or organic compounds.

Translocation-process by which materials or minerals are moved from one horizon and deposited in another soil horizon.

Weathering-process of altering color, texture, composition or form by exposure to natural elements.

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APPENDIX

Field Data Sheets-Soils

SCS Soils-232F
Soil Description

U.S. Department of Agriculture
Soil Conservation Service

Soil type: Alfisol Soil No. 1
Area: San Augustine Co. Date: 3/81 Stop No. 1
Classification: Typic Paleudalf
Location: Angelina National Forest
Vegetation: Loblolly pine, holly, sweetgum, oak
Parent Material: Alluvial
Physiography: top of bluff
Relief: level
Elevation: -----
Slope: 0-2%
Aspect: North
Erosion: None
Permeability: Moderate
Additional Notes:

Horizon	Depth	Color Moist	Texture	Structure	Consistence Moist	Reaction	Boundary
O	1.5-0	Mixed hardwood, pine litter					
A	0-2	dk gr br 10yr4/2	sl	med gran	fr	4.5	sg
E	2-6	yl br 10yr5/4	sl	wk sub A	fr	6.0	sg
B	6+	yl red 5yr5/6	scl	st sub A	fi	4.5	--

SCS Soils-232F
Soil Description

U.S. Department of Agriculture
Soil Conservation Service

Soil type: Alfisol Soil No. 2
Area: San Augustine Co. Date: 3/81 Stop No. 2
Classification: Psammentic Paleudalf
Location: Angelina National Forest
Vegetation: Pine, oak, sweetgum
Parent Material: Alluvial
Physiography: top of bluff
Relief: level
Elevation: -----
Slope: 0-2%
Aspect: North
Erosion: None
Permeability: Rapid
Additional Notes:

Horizon	Depth	Color Moist	Texture	Structure	Consistence Moist	Reaction	Boundary
O	2-0	Mixed pine and Hardwood litter					
A	0-7	dk yl br 10yr4/4	s	gran	l	6.0	sg
E	7-19	yl br 10yr5/4	s	wk sub A	fr	7.0	sg
EB	19-57	yl br 10yr5/8	s	wk sub A	fr	6.5	wg
B	57+	st br 7.5yr5/8	sl	st sub A	fi	5.5	

SCS Soils-232F
Soil Description

U.S. Department of Agriculture
Soil Conservation Service

Soil type: Alfisol — Soil No. 3
Area: San Augustine Co. — Date: 3/81 — Stop No. 3
Classification: Glossic Paleudalf
Location: Angelina National Forest
Vegetation: Pine, sweetgum, oak, holly
Parent Material: loamy sediment
Physiography: top of bluff
Relief: level
Elevation: -----
Slope: 0-2%
Aspect: North
Erosion: none
Permeability: moderate
Additional Notes:

Horizon	Depth	Color Moist	Texture	Structure	Consistence Moist	Reaction	Boundary
O	3-0	Mixed pine, hardwood litter					
A	0-2	br 10yr5/3	sl	wk gran	fr	6.5	sc
E	2-9	yl br 10yr5/4	sl	wk sub A	fr	6.0	sg
EB	9-11	yl br 10yr5/6	sl	wk sub A	fr	5.5	sg
B	11+	str br 7.5yr5/8	scl	st sub A	fi	5.5	--

SCS Soils-232F
Soil Description

U.S. Department of Agriculture
Soil Conservation Service

Soil type: Ultisol — Soil No. 4
Area: San Augustine Co. — Date: 3/81 — Stop No. 4
Classification: Typic Hapludult
Location: Angelina National Forest
Vegetation: oak, sweetgum
Parent Material: stratified loamy and clayey sediment
Physiography: side of slope
Relief:
Elevation: ------
Slope: 2-8%
Aspect: North
Erosion: none
Permeability: slow
Additional Notes:

Horizon	Depth	Color Moist	Texture	Structure	Consistence Moist	Reaction	Boundary
O	2-0	Mixed hardwood litter					
A	0-8	dk br 10yr3/3	sl	wk subA	fr	6.0	sa
B	8+	yl red 5yr4/8	c	med ang	fi	5.0	--

SCS Soils-232F
Soil Description

U.S. Department of Agriculture
Soil Conservation Service

Soil type: Alfisol — Soil No. 5a
Area: San Augustine Co. — Date: 3/81 — Stop No. 5
Classification: Aeric Glossaqualf
Location: Angelina National Forest
Vegetation: pine, oak, briars, dewberry vines
Parent Material: alluvial sediment
Physiography:
Relief: level
Elevation: ----
Slope: 0-3%
Aspect: North
Erosion: none
Permeability: slow
Additional Notes:

Horizon	Depth	Color Moist	Texture	Structure	Consistence Moist	Reaction	Boundary
O	2-0	Mixed hardwood, pine litter					
A	0-4	dk yl br 10yr4/4	fsl	wk sub A	fr	5.5	sg
E	4-11	yl br 10yr5/6	sl	med sub A	fr	6.5	sg
B	11+	str br 7.5yr5/6	scl	st sub A	fi	6.0	--

SCS Soils-232F
Soil Description

U.S. Department of Agriculture
Soil Conservation Service

Soil type: Alfisol — Soil No. 5
Area: San Augusitne Co. — Date: 3/81 — Stop No. 6
Classification: Aeric Glossaqualf
Location: Angelina National Forest
Vegetation: bottomland Hardwood, oak, sweetgum
Parent Material: alluvial
Physiography:
Relief: level
Elevation: -----
Slope: 0%
Aspect: none
Erosion: none
Permeability: slow
Additional Notes:

Horizon	Depth	Color Moist	Texture	Structure	Consistence Moist	Reaction	Boundary
O	3-0	Bottomland Hardwood, pine					
A	0-5	very dk gr br 10yr3/2	fsl	med gran	fr	6.0	sa
E	5-12	br 10yr5/3	sil	med sub A	fr	5.5	sa
B	12+	light br gr 10yr6/2	sic	st sub A	fi	4.5	--

SCS Soils-232F
Soil Description

U.S. Department of Agriculture
Soil Conservation Service

Soil type: Vertisol — Soil No. 6
Area: San Augustine Co. — Date: 3/81 — Stop No. 7
Classification: Aquentic Chromudert
Location: Angelina National Forest
Vegetation: pine,oak sweetgum,willow
Parent Material: Calcareous Clayey sediment
Physiography:
Relief: gilgai
Elevation: -----
Slope: 0-20%
Aspect: North
Erosion: none
Permeability: very slow
Additional Notes:

Horizon	Depth	Color Moist	Texture	Structure	Consistence Moist	Reaction	Boundary
O	.5-0	Bottomland hardwood,pine					
A	0-5	dk gr br 10yr4/2	clay	Ang B	fi	5.5	wg
B	5+	yl br 10yr5/4	clay	Ang B	very fi	5.0	--

SCS Soils-232F
Soil Description

U.S. Department of Agriculture
Soil Conservation Service

Soil type:	Alfisol		Soil No.7
Area:	San Augustine Co.	Date: 3/81	Stop No.8
Classification:	Vertic Hapludalf		
Location:	Angelina National Forest		
Vegetation:	oak,sweetgum,pine,dogwood,holly		
Parent Material:	Calcareous clayey sediment		
Physiography:			
Relief:	gilgai		
Elevation:	------		
Slope:	0-5%		
Aspect:	North		
Erosion:	none		
Permeability:	slow		
Additional Notes:			

Horizon	Depth	Color Moist	Texture	Structure	Consistence Moist	Reaction	Boundary
O	1-0	Mixed	hardwood,pine		litter		
A	0-3	dk br 10yr4/3	sl	wk sub A	fr	6.0	sg
E	3-9	yl br 10yr5/6	sl	med sub A	fr	6.5	wg
B	9+	dk br 7.5yr4/4	sc	st sub A	fi	5.5	--

SCS Soils-232F
Soil Description

U.S. Department of Agriculture
Soil Conservation Service

Soil type: Alfisol — Soil No. 8
Area: San Augustine Co. — Date: 3/81 — Stop No. 9
Classification: Aquic Hapludalf
Location: Angelina National Forest
Vegetation: pine, sweetgum, oak
Parent Material: loamy and clayey sediment
Physiography:
Relief: level
Elevation: ----
Slope: 0-3%
Aspect: north
Erosion: none
Permeability: slow
Additional Notes:

Horizon	Depth	Color Moist	Texture	Structure	Consistence Moist	Reaction	Boundary
O	1-0	Mixed pine, hardwood litter					
A	0-2	7.5yr4/2	ls	wk sub A	fr	5.5	sa
E	2-4	10yr4/2	ls	sub A	fr	5.0	sa
B	4+	5yr5/2	c	st sub A	fi	5.0	--

SOIL STUDIES EDUCATIONAL UNIT AND

SOIL RECONNAISSANCE SURVEY OF

PINEY WOODS CONSERVATION CENTER

APPROVED:

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SOIL STUDIES EDUCATIONAL UNIT AND
SOIL RECONNAISSANCE SURVEY OF
PINEY WOODS CONSERVATION CENTER

by

CONSUELO GARCIA CAMPOS KLOTZ, B.S.F.

Presented to the Faculty of the Graduate School of
Stephen F. Austin State University
In Partial Fulfillment
of the Requirements

For the Degree of
Master of Science in Forestry

STEPHEN F. AUSTIN STATE UNIVERSITY
December, 1982

ABSTRACT

A soil reconnaissance survey was conducted on 2,500 acres adjacent to Sam Rayburn Reservoir, in the Angelina National Forest, San Augustine County; the future site of the proposed Piney Woods Conservation Center.

Data from the soil reconnaissance survey was interpreted and organized into a soil studies educational unit to be used to familiarize teachers with a variety of soils and their properties. Five of the eight soils were integrated into the study unit which is a portion of the total outdoor education and conservation program to be developed for the Piney Woods Conservation Center.

VITA

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