The University of Texas

RESEARCH NOTE 1

1976

A PRELIMINARY STUDY OF BIOLOGIC ASSEMBLAGES OF EAST TEXAS LIGNITE BELT

Melody Holm

BUREAU OF ECONOMIC GEOLOGY
THE UNIVERSITY OF TEXAS, AUSTIN
C. G. Groat, *Acting Director*

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by

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INTRODUCTION

Lignite is a major energy resource in Texas; as the demand for energy resources grows and reserves of oil and gas dwindle, lignite will become the major fuel potential in the State. That lignite which is strippable by present technology occurs in two northeast-trending bands in East Texas (fig. 1); 10.4 billion short tons covering approximately 1 million acres are potentially available for strip mining (Kaiser, 1974).

One of the major environmental problems encountered in utilization of strippable lignite is the disturbance of natural and cultivated plant communities. Therefore, a general survey of the East Texas vegetational regions—the Post Oak Belt and the Pineywoods—was conducted in order to determine the extent and complexity of present biologic assemblages and the manner by which they might be affected by strip mining.

Field work was conducted on a reconnaissance basis in the spring of 1975. County maps, U.S.G.S. 7.5- and 15-minute topographic maps, and 1:250,000-scale geologic maps were used to locate study areas on and adjacent to the Wilcox Group in the Post Oak Belt and Pineywoods region. Different types of areas in both regions were surveyed for dominant woody species. Because of private

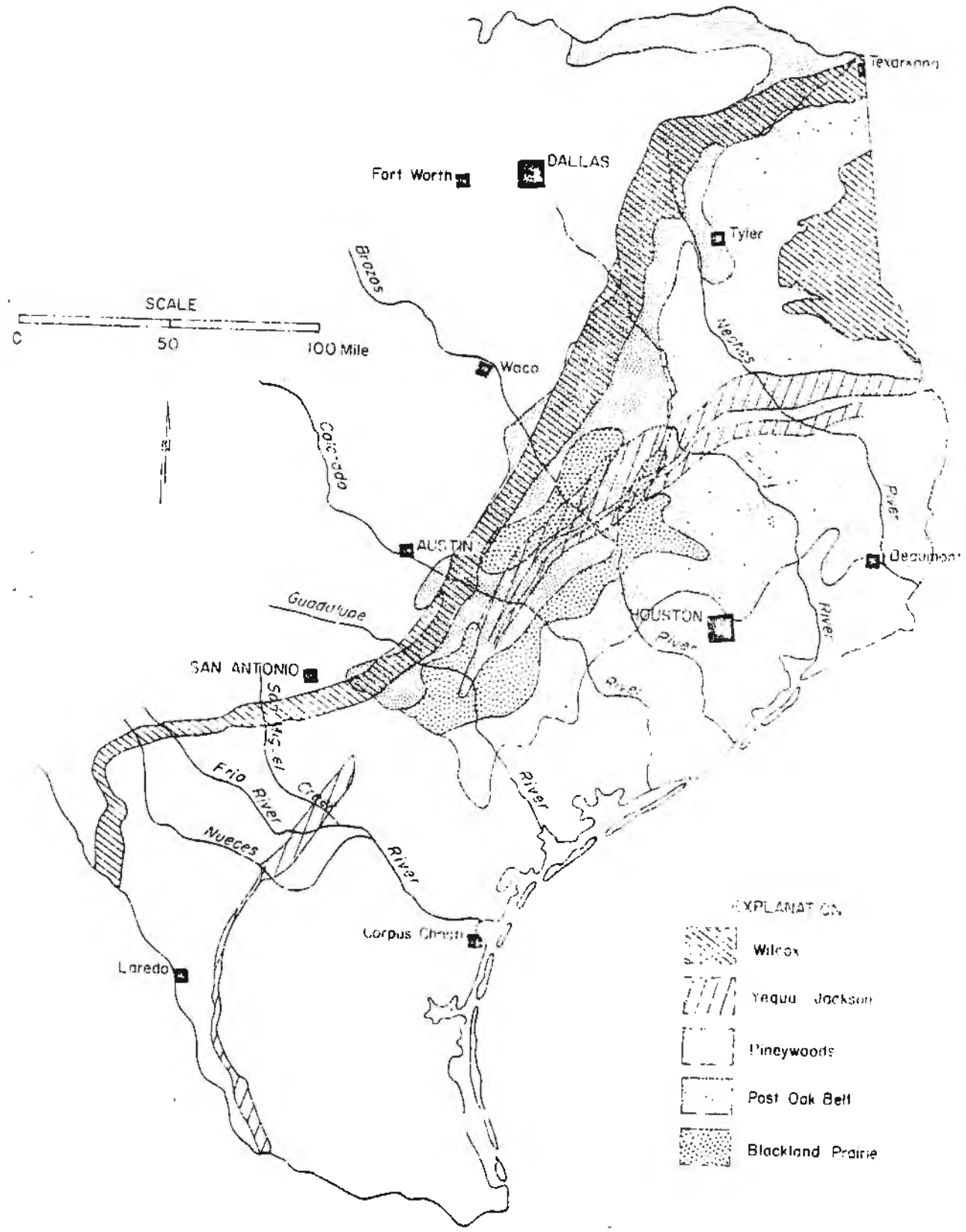

Figure 1. Relationship of strippable lignite in the Wilcox and Yegua-Jackson units (after Kaiser, 1974) and major vegetation regions of East Texas.

ownership of land, access to areas was limited to the open road net; state parks, national forests, and other public lands were utilized as much as possible. Accessible areas were traversed by foot when possible to note the relative abundance of trees, shrubs, and woody vines.

Acknowledgments.--Basic information about the vegetation of the study area was obtained through the Soil Conservation Service, the U. S. Forest Service, and the Texas Parks and Wildlife Department. Various publications, theses, dissertations, and individuals were helpful in offering information formerly obtained about the area. Dr. Ray Hicks, Department of Forestry, Stephen F. Austin State University in Nacogdoches, was extremely helpful in spending time in the field with the author to help familiarize her with Pineywoods woody vegetation. Elizabeth T. Moore supervised preliminary editing and typing. Claudia Farmer drew the figures.

POST OAK BELT

The Post Oak Belt extends north-northeast from Guadalupe, DeWitt, Gonzales, and Goliad Counties in South Texas to Fannin, Lamar, Red River, and Bowie Counties in Northeast Texas. The region includes approximately 8.5 million acres. Its eastern limit borders the Pineywoods region (fig. 1). The topography of the Post Oak Belt is gently rolling to hilly with elevations of 300 to 800 feet above sea level. Its soils are typically light-colored acidic sandy loams or sands on the higher elevations, ranging to darker colored sandy loams and clays, also acidic, in lower areas. Cleared areas are common (fig. 2). Rainfall averages 40 to 45 inches annually, and temperatures are mild during the winter and hot in the summers.

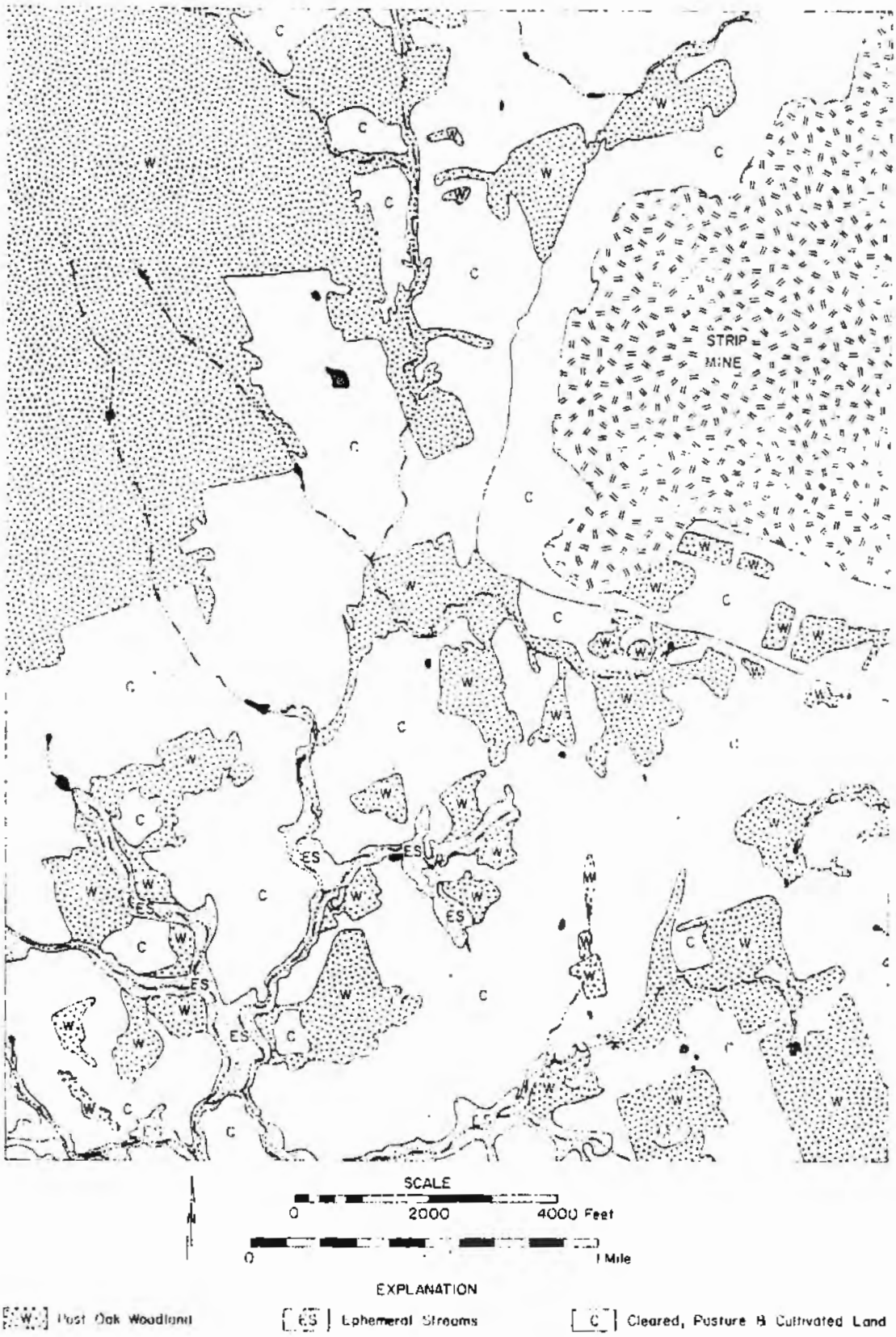

Figure 2. Distribution of vegetation in the Post Oak Belt near the strip mine at Alcoa, Milam County, Texas, and in the Alcoa Lake topographic quadrangle. Solid pattern marks lakes and stock ponds.

Some authors prefer to call this belt of scrub-like oak forest the Post Oak
nnah. Dyksterhuis (1957) defines a savannah as a relatively dry grassland
.ining isolated trees. Historical accounts of different areas in the Post Oak
describe the area as a grassland with scattered large trees (mostly post oak),
underbrush, and extensive open areas (Truett, 1972, from Engeling, 1951).
/er and Clements (1938) described the Cross Timbers as part of the Post Oak
nnah and as part of the oak-hickory forest which is a continuous hardwood
ation extending from northeast Texas to southeast Minnesota. However, they
:e the idea of the oak-hickory forest being a climax biota. They describe the
inant species as post oak and blackjack oak, which usually are not true climax
inants. Some ecologists maintain that the oaks are relicts of a more exten-
forest from a moister climate and are able to maintain themselves by the
rable moisture-holding characteristics of the sandy soil (Weaver and
nents, 1938). The grasses, then, would be the climax dominants. Allen
4) found that the forests of the Navasota River region range from 100 to 150
's in age, supporting the theory of an original grassland. Isolated prairies
3) in the region also support the latter theory.

Agricultural use since the mid-1800's has promoted the growth of the post
forest. Grazing encourages the growth of a woody overstory by destruction
atural communities. Conversion of a grassland to dense woodland also results
n absence of fire as well as overgrazing.

The theory of the natural savannah is also supported by extensive coverage
prairie climax grasses: little bluestem, Indiangrass, switchgrass, purple top
ss, and a grass related to sea oats (Chasmanthium). Deterioration (or distur-
ce) of the climax community is indicated by the increase of such species as

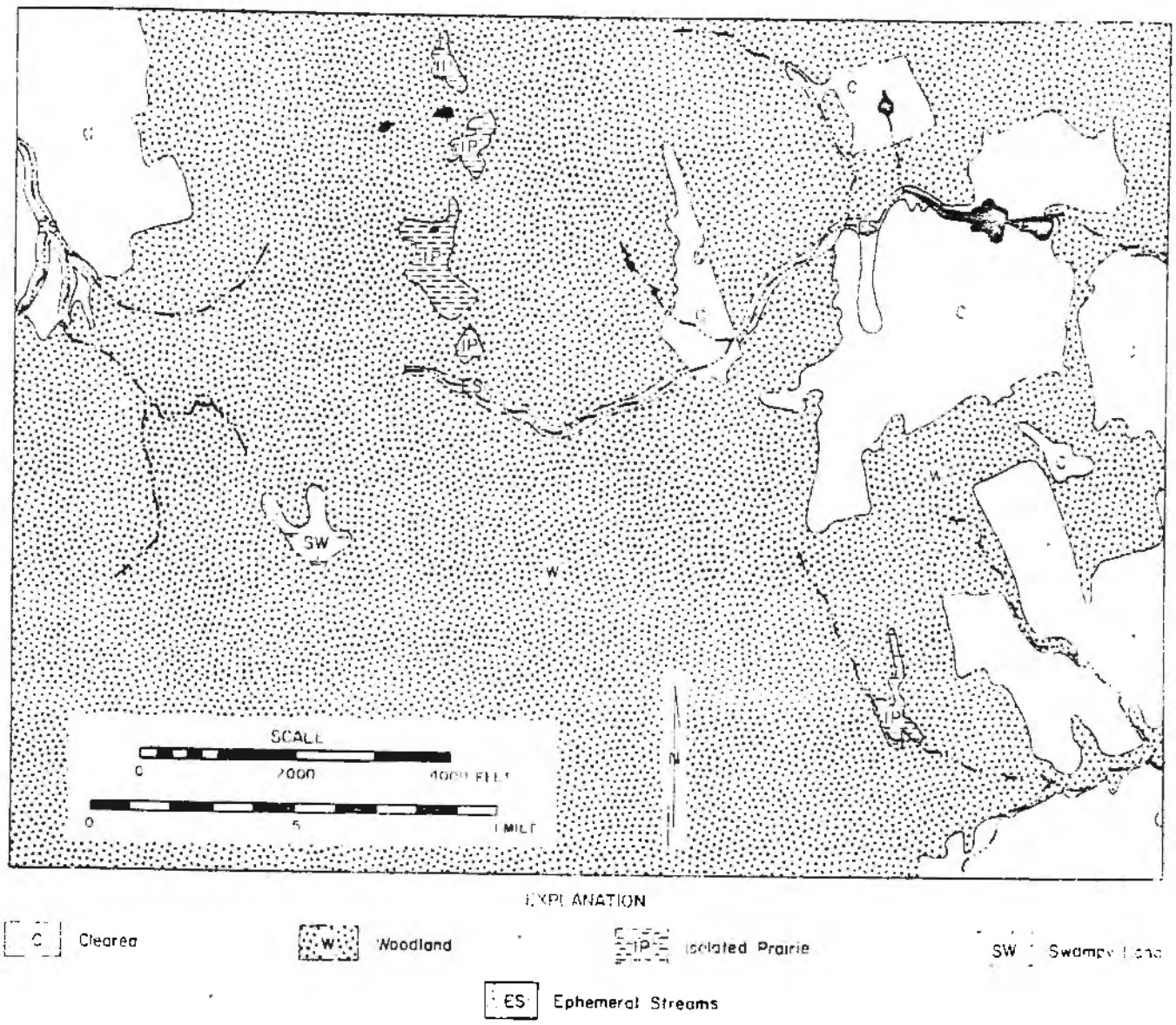

Figure 3. Distribution of vegetation in the Post Oak Belt, showing isolated prairies in wooded areas of the Alcoa Lake topographic quadrangle, Milam County, Texas. Solid pattern marks lakes and stock ponds.

buffalograss and curly mesquite grass and by the invasion of such species as the annual three awns, red lovegrass, broomsedge, splitbeard bluestem, smutgrass, the herbaceous species yankee weed, western ragweed, bull nettle, and the shrubs yaupon and greenbrier.

Study Area

Field observations in the Post Oak Belt were centered on the area north of the Colorado River, particularly in Bastrop, Lee, Milam, and Freestone Counties. Special attention was given to the areas near and adjacent to both the Alcoa strip mine in Milam County and the Texas Utilities Generating Company strip mine in Freestone County. These areas were chosen because of their relation to ongoing mining operations and contrasts in the vegetation of reclaimed and unreclaimed mine spoil.

Most of the land in the Post Oak Belt has been cleared for natural and improved pasture and for some cultivated crops. Much of the wooded area has been grazed by cattle, and present vegetation shows signs of disturbance. Particular attention was given to areas which appeared to be relatively undisturbed. Three different associations of woody species were found in this region: upland, ephemeral stream, and bottomland (fig. 4).

Upland

The upland areas (figs. 3, 4) have relatively dry soils with textures ranging from fine sands to fine sandy clay loams. Dominant overstory species are post oak and blackjack oak with scattered hickory. Sandjack oak is not abundant but appears in some sandy sites. Understory species and shrubs appear in various numbers and density. Very sandy uplands in some places have little or no undergrowth of shrubby species, and the density of the overstory oaks is relatively high.

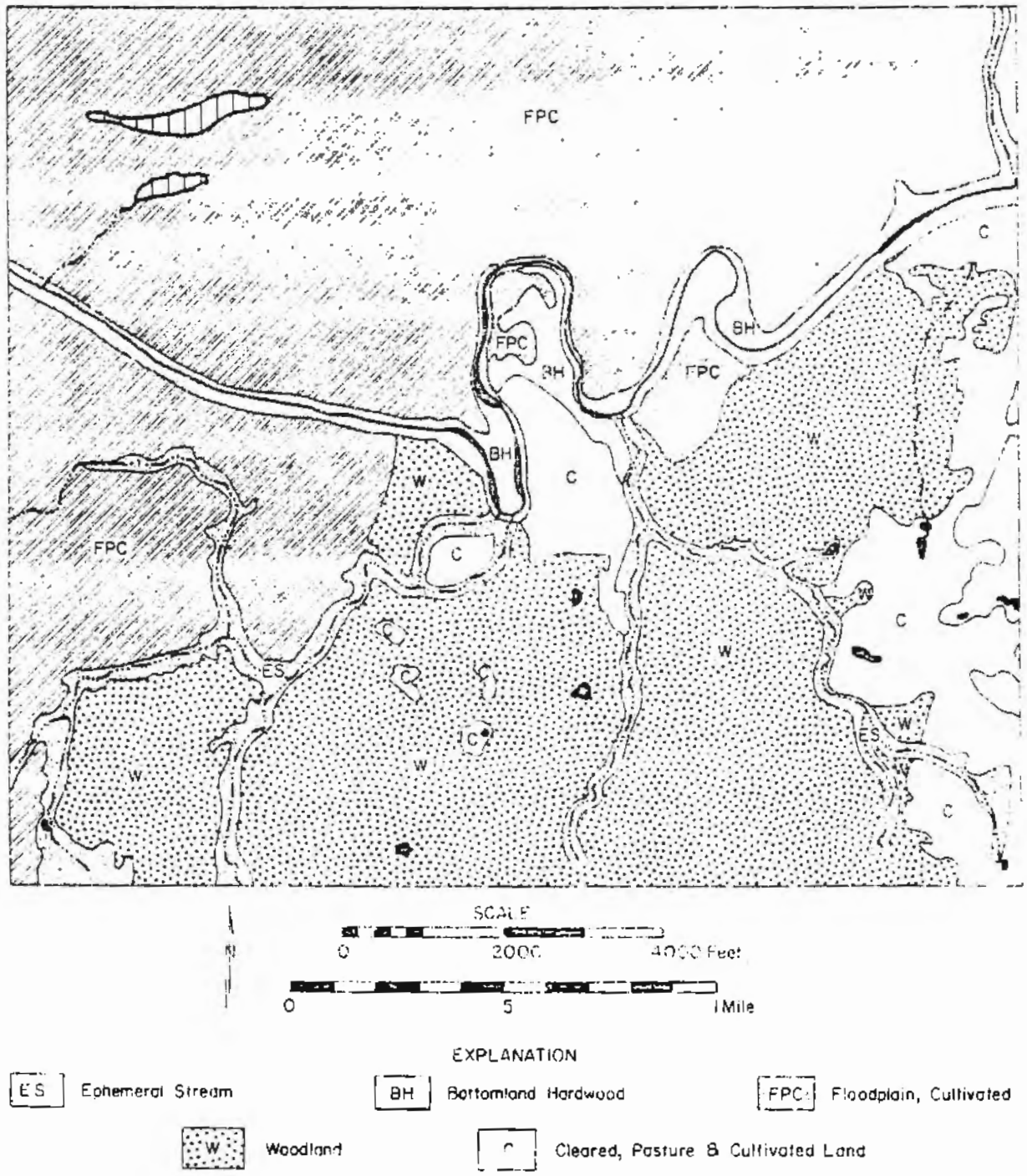

Figure 4. Distribution of vegetation in the Post Oak Belt, showing bottomland hardwoods in the Little River floodplain, Hanover topographic quadrangle, Milam County, Texas. Open vertical lines indicate lakes, and solid patterns mark stock ponds.

The floor of these wooded sites is covered with herbaceous species and grasses. Grazing conditions on these sites are poor; they appear to be undisturbed.

However, undisturbed sites are rare, and more typical areas are those with an open to dense second story and shrub cover. The density and variety of undergrowth differ in accordance with varying degrees of grazing pressure and other factors such as soil characteristics, topography, and availability of water. In more densely vegetated areas, small trees and shrubs are winged elm, yaupon, deciduous holly, American beautyberry, eastern red cedar, sparkleberry, rusty blackhaw, dogwood, hawthorn, and snowberry. Woody vines are an important component in the wooded areas, typically forming dense thickets. Greenbrier and grape are the most prevalent with peppervine, Virginia creeper, and supplejack being common. Trumpet creeper and honeysuckle are found especially along roadsides and woodland edges. Poison ivy is abundant in most areas.

In a few places white ash, gum elastic, black cherry, flatwood plum, skunkbush, and St. Andrew's cross are noteworthy. McCaleb (1954) found that woody species increased in percentage and number as grazing pressure increased from 15 to 5.1-7.5 acres per animal unit (1 cow and 1 calf). At this high-pressure level woody species decreased, probably because of their utilization as forage. The most consistent invaders on such disturbed sites are winged elm, yaupon, and greenbrier, and they form almost impenetrable thickets in many areas. Plum also forms dense thickets in areas which are relatively open, especially in old fields and along roadsides. Willow baccharis is becoming a serious invader in the Post Oak region and is prominent along roads, in disturbed areas, and in old fields, especially where the soil remains moist. Mesquite and some prickly pear are present on clayey soils, typically in great numbers in old cleared fields.

Hackberry and cedar elm are also more abundant on clayey soils. Dewberry is very common in disturbed areas and along roads, usually forming a dense ground cover.

A unique formation dominated by loblolly pine in the southwestern part of the Post Oak Belt, an area called the "Lost Pines," superficially resembles upland vegetation in the Pineywoods. Post oak and blackjack oak are more prevalent in the "Lost Pines," however, than in the true Pineywoods; understory and shrub composition, although possibly less dense, is more like that of the rest of the Post Oak Belt. These loblolly pines occur on high terrace gravels of the Colorado River; this substrate probably has a significant influence over their location. It is thought that these pines constitute a remnant of a once more extensive East Texas evergreen forest left from a moister, cooler climate. Subsequently, they have adapted to slightly drier conditions; it is likely that the soils upon which they grow are a controlling factor of their location.

Ephemeral Streams

Ephemeral stream vegetation (figs. 2, 3, 4) is similar to the upland association with species composition changing gradationally from the upland areas. A difference in vegetational composition is dependent upon both the availability of moisture throughout the year and soil characteristics. Many intermittent streams are dry for a significant period, at which time the vegetation is essentially the same as in upland areas. As soil moisture increases, an increase can be seen in the numbers of dogwood, grape, hackberry, cedar elm, supplejack, and Virginia creeper. Post oak and blackjack oak usually are not present in the immediate vicinity of the stream bed.

Streams which contain water most of the year and which have small floodplains with sandy clay loam soils exhibit vegetational characteristics similar to bottomland areas. If species of oak are present, they are water oak and occasionally red oak. Hackberry and cedar elm are abundant in a common flora of American elm, hickory, mulberry, and ash. Dogwood population increases in moister areas, as does supplejack and Virginia creeper. Other shrubby species found along intermittent streams are buttonbush, American elder, and soapberry. Greenbrier occurs along streams in great abundance, as in the upland areas. Box-elder, black willow (more abundant on wide floodplains), hickory, and occasionally cottonwood also more abundant in wide floodplains are at water's edge. Vegetation along and near these streams is dense, lush, and compositionally complex in its natural state. However, because these areas provide a convenient water source for cattle, they usually cannot be found in their original state.

Bottomland

Bottomland-type vegetation (fig. 4) is found in the floodplains of major streams and rivers and is very similar to that found along intermittent streams which flow throughout much of the year. However, a distinction is made here based on differences in soil characteristics, availability of water, composition of native vegetation, and agricultural uses. The soils are usually clay loams or silty clay loams developed over alluvial sediments; they are commonly less acidic than the upland sandy soils. Bottoms are periodically flooded, moisture is generally available in surficial soils, and the water table is commonly shallow throughout the year. Major overstory species are hackberry, American elm, ash, pecan, hickory, water oak, and cedar elm. Willow and cottonwood are

abundant along water's edge. Smaller trees and shrubs occurring in abundance are box-elder, mulberry, buttonbush, American elder, soapberry, and dogwood. Vines occupy a prominent niche in the understory community and include greenbrier, grape, supplejack, and Virginia creeper. Undisturbed natural communities are not common in the bottomlands of the Post Oak Belt since the fertile soil is desirable for row crops and pastureland. Pecan is a native species valuable for its nut and is found in open areas when cultivated.

Mined Areas

The mined area at Alcoa in Milam County provides an example of severely disturbed land which was abandoned after mining and now supports natural vegetation. Material down to 120 feet is brought to the surface in the process of stripping overburden from the lignite. These unconsolidated sands and clays are piled steeply in rows up to 60 feet high over areas which were mined previously. Slopes in many places approach a maximum angle of repose, and the vegetation has difficulty in establishing rootholds on such unstable surfaces. Erosion is severe and helps in prohibiting rapid plant growth. However, much of the area does support some kind of plant life, especially those older areas of the mine in which native vegetation has had a longer time to recover. Some younger mined areas (to 10 years old) support little or no vegetation. Small herbaceous "weedy" species are the first to come in, establishing themselves in places on even some of the youngest spoil piles. Various species of composites, along with thistle, cocklebur, and other unidentified species are especially prevalent on the older spoil (approximately 20 years old). These areas also support a few species of grasses, the most abundant of which is broomsedge. The grasses are not as common on the slopes as on flatter areas.

Younger spoil does not support the density of grass found in the older areas, though grass is locally present to some degree. Dewberry commonly covers the entire side of a slope and occurs in patches throughout the area. It appears as a major component of the vegetative cover on both old and younger spoil material. Grape is prominent in a select area on 10- to 12-year-old spoil. This latter site is adjacent to a natural woodland, which influences those species which move into the adjacent mined area. The most obvious and abundant woody species, along with dewberry, is willow baccharis, previously described as a serious invader in the Post Oak Belt. This plant is abundant in low moist areas on mine spoil and common on steep slopes and on the tops of spoil piles. Younger areas (10 years old and younger), as well as the older areas, support significant numbers of this species. Rattle bean concentrates in some of the low wet areas on the older spoil (at least 10 years old). This species is found in areas which have been disturbed by such things as overgrazing and construction. Mesquite is seen in only a few spots, none of which are on steep slopes.

Prickly ash appears to take a long time to establish itself. It is found toward the base of old spoil piles (20 years old). Eastern red cedar appears sporadically on the older spoil (15 to 20 years old). It is not abundant but appears to be increasing. Cottonwood grows in isolated stands on the tops of some of the oldest spoil piles. These areas are relatively flat, almost depression-like features and apparently retain sufficient moisture to support growth of cottonwood. Since cottonwood seed is windborne, its presence in these areas seems natural.

Lower depressions on the spoil and open pits retain significant amounts of water. These ponds are not really stagnant nor ridden with algal growth but

support a significant number of aqueous plants, fish life, and waterfowl. The ponds are bordered by willow as well as willow baccharis and various herbaceous species.

A small area (approximately 5 acres) over 40 years old exhibited the great diversity of species found in the region. Species include a significant number of post oak, cedar elm, and pecan, with yaupon, poison ivy, and a dense herbaceous cover. A few mesquite were also noted. This was the first small area to be mined, and it is likely that the lignite was relatively shallow and the topsoil remained near or at the surface, providing a fertile, organic base containing viable seeds. This type area and rare sites left in place by mining operations probably act as source areas for reestablishing native vegetation.

Some recently mined areas at Alcoa are being leveled, fertilized, spread with lime, and seeded with weeping lovegrass and coastal bermuda. Desirable nitrogen-fixing species such as crimson clover and bluebonnets are present in spots throughout the area. The grasses appear to be doing well; however, bare spots occur in places where the slope is somewhat unstable and where drainage patterns are reestablishing themselves. Loblolly pine planted along the road appears to be thriving.

Spoil material at the mine of Texas Utilities Generating Company at Fairfield in Freestone County is reclaimed as soon as stripping operations permit so that erosion and runoff from unstable spoil material is kept at a minimum. The spoil piles are leveled and contoured, drainage patterns are reestablished in their original locations, and soil is fertilized, limed, watered, and sprigged in coastal bermuda and crimson clover. Stream heads and some stream courses are skirted

by stripping procedures in order to preserve diverse vegetational sites as source areas for seed and for wildlife habitats.

One reclaimed area was sprigged in coastal bermuda in 1972. After about 1 year, cattle were allowed to graze in the area, and after 1-1/2 years of grazing, the area was again fertilized. The condition of the cover is good and appears to be comparable in quality to other improved pastures in the area. Honeylocust saplings in this pasture area are thriving, as are white ash, elm, and cottonwood planted near ponds. Willow is coming in naturally along many of the streams.

The results of these reclamation methods provide a good example of the potential for improvement of land disturbed by mining.

PINEYWOODS

The Pineywoods, also known as the Timber Belt and East Texas Forest Region, is the southwestern extension of the pine-hardwood forest of the southeastern United States. The Texas forest covers approximately 15 million acres from the eastern border of the state to the Post Oak Belt, from Bowie County in the north, through Wood and Anderson Counties at its western limit, and to Liberty and Orange Counties in the south (fig. 1). Topography is gently rolling to hilly with elevations ranging from 200 to 500 feet above sea level. Low wet areas are common; there are numerous creeks and rivers, marshes and swamps. Soils are typically acidic, light-colored to dark-gray sands or sandy loams with a low organic content. The sands are usually underlain by clay, with silt and clay content of alluvial soils increasing in the floodplains. Rainfall averages 35 to more than 50 inches annually with high summer temperatures and mild winters. Plant distribution is related to the above two factors: soil and climate.

Some ecologists distinguish two regions within the Timber Belt: the pine orest and the pine-oak forest (Tharp, 1926). The pine forest has its eastern nargin along the Sabine River, with its northern limit in Shelby County, extending vestward to Montgomery, Walker, and Houston Counties and southward to Orange County. Longleaf pine is reported to have covered a vast portion of this region, lmost excluding other trees and shrubs (Tharp, 1926). Now most of the virgin imber is gone. Shortleaf and loblolly pine are found mostly in the northern part f the area, with hardwoods occurring in the bottomlands.

Pine-Oak

The pine-oak forest actually constitutes an ecotone between the pine forest n the east and the oak-hickory forest or Post Oak Belt on the west. This pine- ak ecotone stretches from the Red River to the coastal prairie, encircling the ine forest on the north and west. Loblolly and shortleaf pine are dominant, ith post oak, blackjack oak, and red oak being widespread. Sweetgum is undant, frequently as numerous as pine. Strippable lignite occurs in this ine-oak area.

Timber companies operate in the East Texas pine-hardwood region and, long with ranching, play a vital role in the economy of the region. "Tree farms" an be seen throughout the area, and sites cleared for pasture are common, ough not quite as extensive as in the Post Oak Belt. Areas on the Wilcox Group eem to be cleared and cultivated more extensively than areas on other geologic ubstrates. This may be due, in part, to a higher clay content in the Wilcox nds. Some of the wooded areas have been grazed but not to the extent that reas in the Post Oak Belt have.

Grasses and other herbaceous species, forming an extremely complex association with woody plants, are abundant in the Pineywoods (Correll and Johnston, 1970). Invaders are similar to those of the Post Oak Belt. Complications in plant successional patterns have resulted from the introduction of grasses and legumes, mostly for improved pasture. Correll and Johnston (1970) describe peat moss, present in varying degrees, as being characteristic of pockets of evergreen shrub bogs, open seepage slopes, and cypress-tupelo swamps.

Upland Pine-Oak

Field observations in this region were concentrated north of Nacogdoches through Rusk, Panola, and Shelby Counties to Harrison County. Particular attention was given to the area around Darco, where a small strip mine has been in operation for over 20 years.

Two basic associations of woody species occur in the region: upland pine-oak and bottomland hardwood (fig. 5). Vegetational changes between these two areas are distinct. Streams which are running throughout most of the year are included in the bottomland division; those which are predominantly dry are included in the upland division, both with minor distinctions.

The dry sandy uplands are dominated by shortleaf pine with loblolly pine in moister sites. A second canopy is composed of southern red oak, post oak, and blackjack oak with a more minor occurrence of hickory, blackgum, water oak, sugarberry, and winged elm. Bluejack oak is found on the sandier soils. Sassafras is common on some sites and moves into areas which have been disturbed. American beautyberry, dogwood, rusty blackhaw, hawthorn, yaupon,

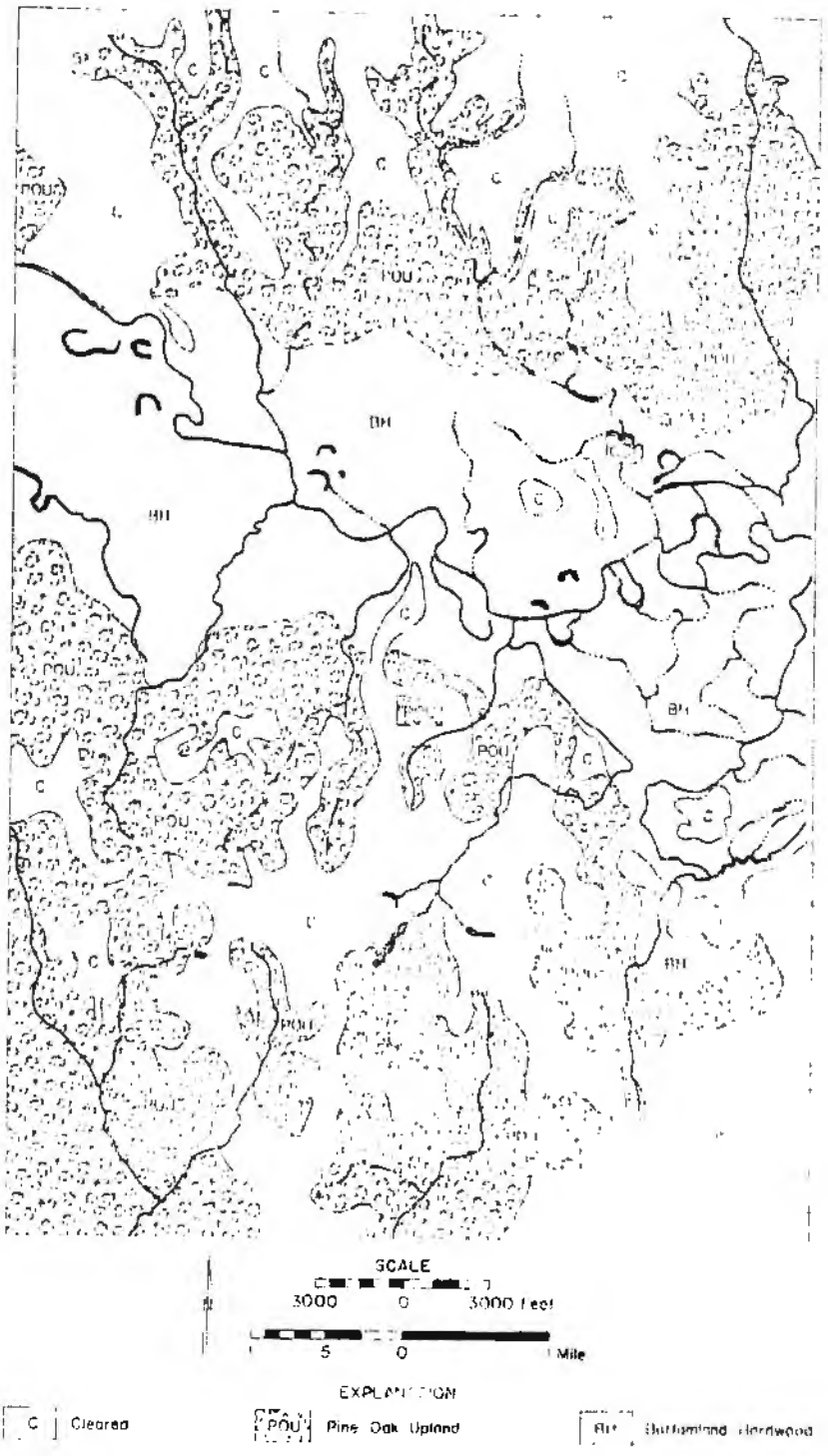

Figure 5. Distribution of vegetation in the Pineywoods along the Sabine River in the Darco topographic quadrangle, Harrison and Panola Counties, Texas. Solid pattern marks standing water bodies.

sumac, sparkleberry, southern bayberry, Hercules' club, and fringetree are common as understory shrubs. Several species of vines are common in dry areas: peppervine, greenbrier (commonly forming dense thickets), supplejack, Carolina jessamine, trumpet creeper, and poison ivy.

Dependent upon the availability and amount of water, streams in upland areas may exhibit some change in vegetational composition. Loblolly pine is dominant in moister areas with sugarberry, winged elm, and white oak becoming more common. American elm is present along with Carolina basswood, red maple, and American hornbeam.

Bottomlands

The bottomlands are typically wet, swampy, low-lying areas, usually near or adjacent to major streams and rivers. They have unique floral assemblages, with only a few of the species found in the dry uplands extending into the wetter areas. The soils in these areas usually have a higher silt and clay content than those of the sandy uplands, which in part may account for vegetational differences. These bottoms generally have not been cleared or grazed. Many of the hardwoods in some places have been taken for their lumber value. Hardwoods are dominant in the bottoms, with the following species being most abundant: swamp chestnut oak, Shumard oak, laurel oak, water hickory, bitternut hickory, shagbark hickory, sweetgum, and sycamore. Beech and ash are common locally. A second story is composed primarily of red maple, American hornbeam, Eastern hophornbeam, American holly, planertree, and magnolia. Understory shrubs in some places do not form as dense a cover in the bottomlands as in the uplands. Several species commonly are seen in wet areas: deciduous holly, snowbell, buttonbush,

arrowwood, willow baccharis, American elder, waxmyrtle, hypericum, dogwood, vaccinium, leatherwood, and scarce poison sumac. Major vines include poison ivy, grape, greenbrier, and supplejack. A few unique species are found adjacent to stream banks, including river birch, black willow, and smooth alder. Cottonwood is found in sites throughout the region.

Mined Area

The area which has been strip-mined near Darco served as an example of the vegetation which moves into a severely disturbed area. Immediate access to the area was not possible; however, an almost complete vegetative cover was evident in the form of shrubby species and some oak, with pine being dominant.

Tharp (1926) discussed succession on burned areas and cutover lands in the pine-oak forest of East Texas. He reported that a burn results in a more open forest and increases the growth of grass and herbage on the floor. Lumbering (cutover) often is followed by fire, which destroys seedlings 5 to 10 years old and seeds at or near the surface. These areas then become ripe for the invasion of more inconspicuous species, the first being grasses: Andropogon spp., Aristida spp., Panicum spp., Paspalum spp. Woody newcomers include sweetgum, post oak, blackjack oak, and waxmyrtle.

Old cultivated fields, abandoned after fertility becomes too low for good economic use, are soon covered with a dense stand of pine, especially in the loblolly area. Two other invaders of old fields are sassafras and persimmon. Observation of succession of species in these areas provides useful information applicable to stripped areas.

CONCLUSIONS

The Post Oak Belt and Pineywoods regions of East Texas are unique and diverse. Soils, topography, and climate have significant influence over vegetative types, with rainfall especially controlling plant distribution. The Pineywoods region is characterized by high rainfall and deep sandy soils with low organic content. These conditions are favorable to the growth of pine, which is the dominant species of the region. As rainfall decreases westward, the pines disappear, and post oak and blackjack oak become the dominant species in the Post Oak Belt.

Reaction to disturbance in the two areas varies according to the characteristics of the respective region. As previously mentioned, pine often takes over old fields in the Pineywoods region, and grasses, herbaceous species, and shrubs move into burned areas. In the Post Oak Belt, a dense cover of shrubs often takes over old fields and disturbed woodlands.

Grasslands and herbaceous species were the first to take over strip-mined areas in both regions, with a few species of shrubs and trees following. In both regions the unconsolidated sands and sandy clays with relatively low acidity and abundant rainfall (the latter especially in the Pineywoods region) make rapid recovery possible after strip mining. Undesirable species in stripped areas can be controlled by good reclamation programs, with the land being especially suited for multiple use and agricultural development. Re-creation of wooded areas on mined land is also possible with proper management over a long period of time. It is economically desirable to reclaim stripped land as illustrated in the discussion of reclaimed and unreclaimed land in the Post Oak Belt. Even though