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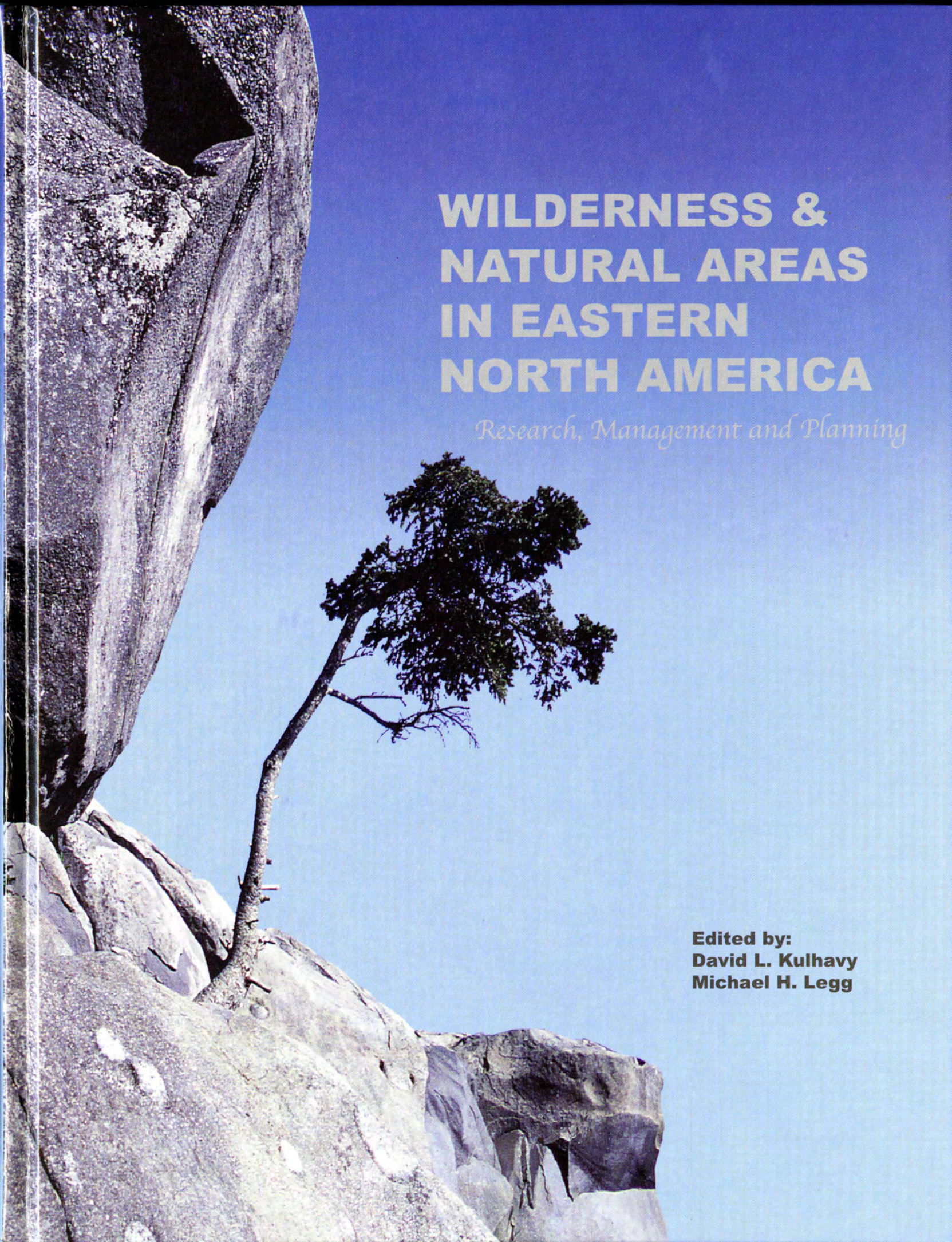
Laurence C. Walker
Stephen F. Austin State University

Thomas Brantley

Virginia Burkett



WILDERNESS & NATURAL AREAS IN EASTERN NORTH AMERICA

Research, Management and Planning

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Characterization of an Old-Growth Bottomland Hardwood Wetland Forest in Northeast Texas: Harrison Bayou

Laurence C. Walker, Arthur Temple College of Forestry, Stephen F. Austin State University, Nacogdoches, TX
Thomas Brantley, Thiokol Corporation Longhorn Army Ammunition Plant, Marshall, TX
Virginia R. Burkett, National Wetlands Research Center, National Biological Service, Lafayette, LA

Abstract: Most wetland losses in the southern region over the past 200 years have occurred in bottomland hardwood forests. By 1980 the original extent of palustrine bottomland in Texas had been reduced by 63%, from roughly 16 to 6 million acres. Additional losses have occurred during more recent years as a result of conversion to agriculture and timber harvests; these factors and the need to supply new hardwood chip mills in the region pose a potential threat to the remaining hardwood resource. The Harrison Bayou watershed in northeast Texas contains one of the few relatively undisturbed bottomland hardwood wetland forests in the State. Harrison Bayou is part of the Caddo Lake wetlands complex, most of which was designated a Wetland of International Importance under the Ramsar Treaty in October of 1993. Caddo Lake State Park is one of fifteen "Ramsar" wetlands in the United States; it is the only wetland with this designation in the State of Texas. Harrison Bayou is an important component of the Caddo Lake watershed; it represents a model bottomland hardwood wetland in both structure and ecological function. Three major forest cover types illustrate the diversity of the 600-hectare bottomland hardwood/baldcypress forest at Harrison Bayou. Comparison of wetland forest extent and species composition in 1977 with 1993 revealed very little change in wetland forest community structure.
Keywords: natural area, bottomland hardwoods, Caddo Lake, Longhorn Army AmmunitionPlant, wetlands, Harrison Bayou, baldcypress, forested wetland, old-growth forest

In 1977, Laurence Walker, Tom Brantley and several faculty members from Stephen F. Austin State University conducted vegetation and wildlife surveys of the bottomland hardwood forest and baldcypress swamp of the Longhorn Army Ammunition Plant along Harrison Bayou. At the time, the U.S. Army was considering designating the area as a "special management area". Though no official action was taken regarding the designation, the area has been set aside from logging and development activities. During October-December, 1993, Brantley and Virginia Burkett re-surveyed the vegetation type map of the area that was produced by Walker and Brantley in 1977, with the aid of low-altitude, 1:600-scale aerial photographs taken in 1990. Additional photography of the area was acquired and interpreted by the National Biological Service in January, 1994. Some changes in forest cover were observed in 1993-1994 and are reported herein.

Much of this report is based upon the original unpublished survey and report prepared by Walker and Brantley. It is primarily descriptive in nature because of the survey methodology used in 1977. This report characterizes the ecology of this unique wetland system. It documents the type and extent of one of the few remaining "old-growth" bottomland hardwood forests in the south.

BACKGROUND

The United States has lost approximately

one half of the wetland acreage that existed in the lower 48 States prior to European settlement. The Department of Interior's National Wetlands Inventory estimated that, on average, over 60 acres of wetlands were lost every hour in the lower 48 states during the 200-year timespan between the 1780's and the 1980's (Dahl, 1990). Losses have been particularly acute in the southern region, where more than 85% of U.S. wetland losses have occurred since the 1970's. Most of these recent wetland losses have occurred in bottomland hardwood forests. By 1980, the original extent of bottomland hardwood wetland forests in Texas had been reduced by 63%, from roughly 16 to 6 million acres (Frye, 1986).

One of the few undisturbed bottomland hardwood stands in the East Texas pine-hardwood region is a 120-hectare tract of palustrine wetland along Harrison Bayou, not far from its outlet into Caddo Lake in Northeast Texas (Fig. 1). That old growth stand joins several other tracts of bottomland hardwoods and southern baldcypress (*Taxodium distichum*), totaling roughly 440 hectares, most of which was high-graded or otherwise harvested in the early 1900's.

The National Wetlands Inventory has classified the bottomland hardwood forest and baldcypress swamp of Harrison Bayou as palustrine wetland, following the criteria set forth by Cowardin and others (Cowardin et al., 1979). All habitats that are classified and mapped as wetlands by the National Wetlands Inventory are defined by plants (hydrophytes), soils (hydric soils) and frequency of flooding. Palustrine wetland systems include those non-tidal wetlands that are dominated by trees, shrubs, persistent emergent vegetation, emergent mosses and lichens where salinity due to oceanic salts is less than 0.5 parts per thousand (Cowardin et al., 1979).

The forest is located within the boundaries of the Longhorn Army Ammunition Plant, which is scheduled for partial decommissioning during the next five years. The U.S. Army's facility manager, Thiokol Corporation, has managed the Harrison Bayou tract as an unofficial "special management area" since the mid-1970's. The unusual character of the forest vegetation, especially the old growth portion, suggests that the Harrison Bayou wetland area has not been altered by silvicultural harvests and most other uses. The Harrison Bayou tract could be transferred to another federal or state agency or sold for private use when the Ammunition Plant is decommissioned by the Department of Defense.

In 1993 the U.S. Fish and Wildlife Service classified the wetlands that fringe Caddo Lake as "Category 1" wetlands for the purposes of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), which grants the Fish and Wildlife Service review authority over all dredge and fill activities that are permitted by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency. In the spring of 1993 the Texas Parks and Wildlife Department and the U.S. Department of Interior nominated Caddo Lake State Park as a Wetland of International Importance under the Ramsar Treaty. In October of 1993 Caddo Lake State Park became the United States' thirteenth "Ramsar" wetland.

SITE HISTORY AND CHARACTERIZATION

The old-growth wetland forest along Harrison Bayou was not logged in the late 1800's and early 1900's, when large tracts of other bottomland hardwoods in the region were harvested, because of its inaccessibility and the commercial isolation of the merchantable species growing there. Old stream channels, now forming small oxbow lakes, and frequent high water made felling, skidding and transport difficult. In 1942 the federal government purchased the land for the Longhorn Ordinance Works (now called the Longhorn Army Ammunition Plant) from T. J. Taylor (the father of Lady Bird Johnson) and other families. Prior to acquisition, however, large tracts of upland forest and some of the bottomland hardwood forest on the Ammunition Plant property were "cut very heavy, removing most of the merchantable trees" (Longhorn Army Ammunition Plant, 1977).

Based upon the age class of standing timber and the presence of stumps and logging debris, it appears that approximately two hundred hectares of bottomland hardwoods and pine along Harrison Bayou were logged between 1900 and 1920. Another hundred more hectares were cutover between 1920 and 1941. Fig. 1 depicts the location of the hardwood forest tracts along Harrison Bayou that have not been harvested and appear to be remnants of the virgin forest that once occupied the bottomlands of the Cypress Bayou/Caddo Lake watershed. In 1969 the U.S. Army adopted a Comprehensive Natural Resources Management

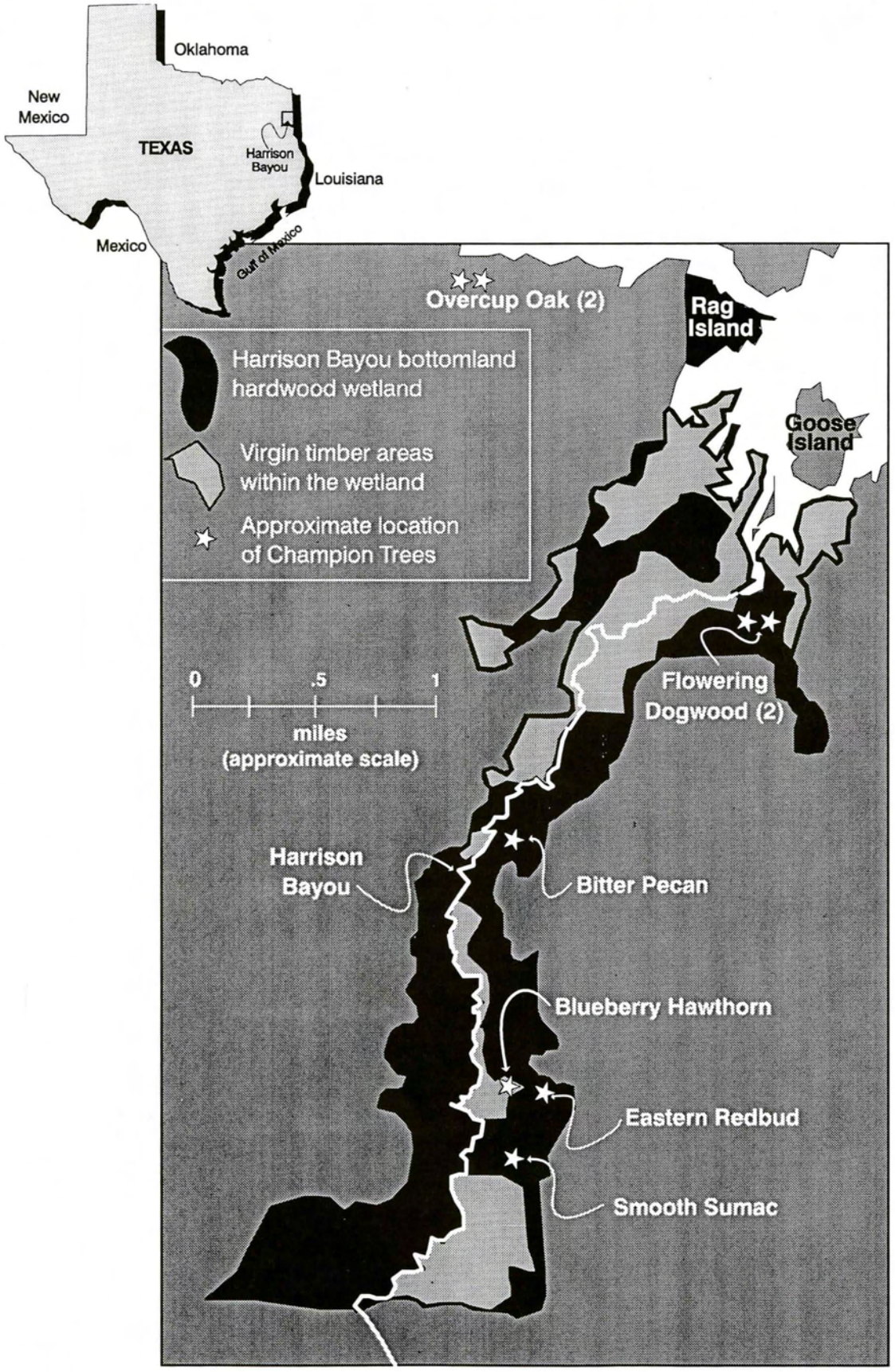

Fig. 1. General locale of Harrison Bayou and location of "old growth" forests.

Plan for the area, which included forest, fish and wildlife management, as well and grounds maintenance and pest control. As originally adopted, the Plan would have allowed the selective harvest of timber in the Harrison Bayou bottom. Through the efforts of the Texas Parks and Wildlife Department, the unique nature of the hardwood stands along Harrison Bayou were recognized and harvesting schedules were altered in 1973.

Water levels and vegetation communities of Harrison Bayou and other streams draining into Caddo Lake are determined by water levels in Caddo Lake. According to numerous historians and U.S. Army Corps of Engineers records, the water level of Caddo Lake during the early 1800's was two or more meters higher than its current level (U.S. Army Corps of Engineers, 1983). The higher water levels in Caddo Lake between the late 1700's and 1830 have been attributed to a natural logjam on the Red River. The logjam was formed by cottonwood trees and other debris from the eroding banks of the River; the so-called "great raft" was more that a hundred miles long and was solid enough for people to traverse on horseback. Evidence of these stable high water levels is exhibited by the presence of large baldcypress trees with fluted buttresses, such as those found in the open water edges of Caddo Lake, at "off site" locations extending far into the higher elevations of oak and pine habitat.

In the 1830's Captain Henry Shreve broke up the raft with a snag boat that sawed through the logs as it moved upstream. In 1873 the U.S. Army Corps of Engineers removed the logjam with explosives and snagboats (U. S. Army Corps of Engineers 1993).

A dam was constructed by the U.S. Army Corps of Engineers in 1914 (U.S. Army Corps of Engineers, 1983; Klimas, 1987) to restore Caddo Lake water levels to a height that would permit navigation, a use that had developed during the 30- to 50-year period that the logjam existed on the Red River. In 1913-14 a team of ecologists, geologists and surveyors from the U.S. Department of Interior investigated the water bottoms and sloughs of Caddo lake to reconstruct the history of the Lake to determine the ownership of the oil reserves. Based upon the state of decay of bottomland hardwood stumps in the lake bottom and other relic features, the DOI team concluded that the lake was formed in 1777. Other historical accounts from the Caddo Indians and John Sibley, an early resident of Natchitoches, LA, place the lake's formation closer to 1800 (U.S. Army Corps of Engineers, 1993).

The lowering of the water level in Caddo Lake after the logjam was removed in 1873 resulted in the emergence of the present-day Harrison Bayou wetland. The succession of forest types discussed in subsequent sections was, and still is, heavily influenced by water levels and man's activities in Caddo Lake. Harrison Bayou is a secondary stream. It has never been significant for transportation or settlement, probably as a result of the high variation in water levels. Those who lived near it hunted, fished, grazed their hogs and cattle, and cut timber. Because of the series of unlikely circumstances alluded to above, the Harrison Bayou bottom has not been available for these pursuits. Had the stands of valuable hardwood and baldcypress timber been located in Louisiana or eastward, they likely would have been harvested in the "cut-out-and-get-out" days before 1900. In Northeast Texas, forests were subject to cutting pressures at a later date. Thus this inaccessible virgin remnant was preserved until the Government took it over during World War II. Now the Harrison Bayou wetland is a relic, an example of what the vegetation of many small stream courses was like before they were harvested or inundated for reservoirs.

Harrison County, locale of the Bayou, covers about 2260 square kilometers and drains into Sabine and Red River tributaries, among which are the Big and Little Cypress bayous that spread to form Caddo Lake. Overflow water from Caddo Lake and Harrison Bayou may cover the Bayou for a depth of one meter or more for long periods in winter. The Lake, eventually emptying into the Red River, drains 7161 square kilometers; its size is estimated at 10,850 ha. Specifically, the site is in the eastern part of the Ammunition Plant property, Northeast of Karnack, west of Farm Road 9 and Big Lake Camp near the mouth of Harrison Bayou, and on the north edge of Harrison County in East Texas. Elevation ranges from 45 to 50 m above mean sea level.

Climate

Climate of the Caddo Lake region is humid subtropical. The growing season is about 240 days. Annual precipitation averages 115 cm, and critical droughts are frequent. Annual tallies have measured from less than 93 cm to more than 175 cm. A few less than 50 days a year

have thunderstorms. These for the most-part occur while the forest is in full foliage; hence raindrop impact does minimal damage to the soil. Rain interception by tree crowns and trunks may reduce direct precipitation by 25 percent during any one growing season. This intensifies evaporation loss and the seasonal distribution of rainfall so that the region is drier than other climatic indicators might suggest. Lightning strikes from electrical storms often kill trees, though they rarely start forest fires in this area.

Soils

Soils of the Harrison Bayou area fall into two main groups, fluvatile soils of floodplains and corresponding soils of wind-modified terraces (Golden et al., 1994). The current landscape of the area probably formed about 11 to 14 thousand years ago during the Holocene glacial retreat. Ocean levels changed and streams cut deeper into the geological strata. This area may have been exposed to a desert type climate for a few hundred years. During this time the wind blew soil materials into mounds on the terrace areas and the stream bottoms were partially refilled. The alluvial soils are generally wet and receive deposition from annual flooding. During periods of intense cultivation, varied sediments were deposited in large quantities on the bottomland areas. This created loamy to sandy natural levees and clayey depressions in the landscape. The terrace soils are old alluvial materials modified by wind forming a mounded landscape. Much of the Harrison Bayou area is characterized by small depressions and broad flats, interspersed with mounds about 1 to 1.5 m in height and 15 to 35 m in diameter.

Two main soils of the floodplain in this region are Socagee and Mathiston soils. Socagee soils have a grayish brown silty clay loam surface over a grayish clay loam. Taxonomic classification places these soils in the fine-silty family of siliceous, thermic Typic Fluvaquents. Mathiston soils have a brownish silt loam surface over a grayish silt loam. Mathiston soils are classified in the fine-silty family of siliceous, thermic, Aeric Fluvaquents. The most important soil of the terraces in the area is the Scottsville soil. This soil has brown, very fine sandy loam surface layer over a yellowish loam subsoil. Taxonomic classification places this soil in the fine-loamy over clayey family of siliceous, thermic, Glossaquic Paledalfs (Personal communication, Raymond Dolezel, USDA Soil Conservation Service, Lufkin, TX, March, 1993).

Due to the degree of wetness, texture and chemical characteristics the undisturbed alluvial soils are covered with hardwoods. In contrasts, the terrace soils nearby are capable of supporting pine hardwood forest types. Isolated areas of the bottomland have salinization problems. These areas commonly known as "salt licks" form a whitish crust when dry. Once denuded it is difficult to reestablish vegetation on these soils.

Archaeology

Evidence of man in the area include the small pieces of Indian pottery rather readily found in the soil on a bluff immediately adjacent to Harrison Bayou. Projectile points are not uncommon. The Caddo tribe, long dominating the region, was good at crafting implements, even though flint had to be brought from the mountains to the north. One collection in the local area is reported to have more than twelve thousand points and pieces. Although most mounds in this area were formed from wind activity (e.g., Loess), Indian-made hillocks, some of which are called "pimple mounds", occur in the Caddo country and adjacent to the Lake. These probably were built by Indians to avoid inundation by high water, just as current-day fishermen build weekend cottages on stilts. Indians may have mined clay from the area for making pottery. If so, this could help to explain the presence of some openings in the forest canopy for which there is no other apparent cause.

A few faint, abandoned wagon roads can still be found near Harrison Bayou. One section of the old Port Caddo/Swanson's Landing road that dates back to the 1800's is easily located on western side of Harrison Bayou (Fig. 2).

GENERAL DESCRIPTION OF TWO BROAD FOREST TYPES

The vegetation of Harrison Bayou and surrounding lands is typical of the forest that once extended from East Texas to the mid-Atlantic Seaboard. Two broad silvical regimes predominate in the wetland area: bottomland hardwood and southern baldcypress. Although the principal vegetation, and certainly the most obvious, is arboreal, a diverse understory of grasses, shrubs, and vines also occurs.

This section broadly outlines the species composition and ecology of bottomland and

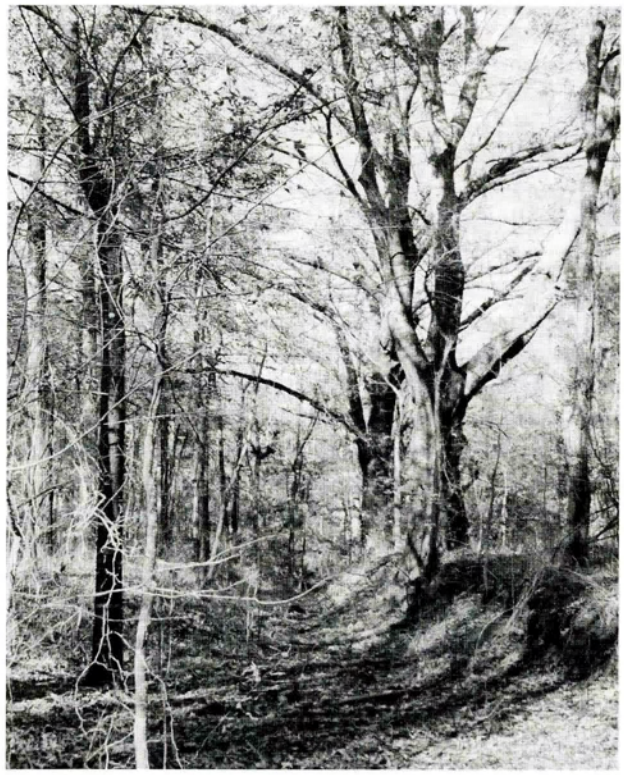

Fig. 2. Photo of the old Port Caddo/ Swanson's Landing wagon road (Oct. 1993).

swamp sites that are typical of the South and the Harrison Bayou area. It also discusses physiographic limitations and injurious agents likely to influence the old growth forest along this watercourse. A broad narrative is provided to assist those concerned with setting aside natural areas in developing some perspective on the uniqueness of this site and the probability of the site remaining as it now appears.

Bottomland Hardwoods

Bottomland hardwood forests occupy about 30 million acres and contain about one-third of the hardwood volume in the southern region. Typical species along rivers are eastern cottonwood (*Populus deltoides*) and willows (*Salix* spp.), grading away from the streamsides into stands of sweetgum (*Liquidambar styraciflua*), water oak (*Quercus nigra*), white oak (*Quercus alba*), or green ash (*Fraxinus pennsylvanica*). Mixed stands on the ridges (i.e.slight rises of a few cm to 1 m above a surrounding flat) may be predominantly white, southern red (Quercus falcata), water oak, hickories (*Carya* spp.), sweetgum, blackgum (*Nyssa sylvatica*), and water tupelo (*Nyssa aquatica*).

Southern baldcypress is often found along with hardwoods in bottomlands where water is too deep for competitive species. It generally occurs in pure, dense, evenaged stands. Where isolated baldcypress trees are found mixed with predominately hardwood forests, a change in the hydrology of the site, such as channel alteration, during the life of the stand has probably occurred.

Regeneration of bottomland hardwoods is difficult to obtain where coarse, loose, sandy soils are at the surface or just below a thin veneer of fine material. In such soils, especially where occurring between natural levees, the water table in summer is likely to be too deep to enable delivery of the moisture by capillarity through the sand. Other difficult sites are those with plastic clay, as on the low flats, and the hardpan and silty clay basins of the terraces. There, because moisture and aeration are unfavorable for many kinds of trees, willow oak (*Quercus phellos*) may occur as the principal species.

Baldcypress

Southern baldcypress, an ecological pioneer, becomes established when water is low during relatively dry seasons. A saturated, but not inundated, seedbed is essential for seed germination. Seedlings must grow fast enough to maintain some portion of their foliage above floodwaters for most of the growing season. Baldcypress does not compete well with bottomland hardwood species in drained soils so periodic flooding and the resulting reduction in competition is generally considered necessary for baldcypress regeneration. Because of these exacting requirements, baldcypress often occurs in pure even aged stands with 30 to 50 years between cohorts (Walker, 1967).

Seeds are produced annually, but abundant seed production occurs every 3 to 5 years (U.S. Department of Agriculture, 1974). The seeds are not preferred by wildlife due to their thick, horny seed coats; however, squirrels eat some seeds and often hasten the release of cones (Wilhite and Toliver, 1990). In October or November, the ripe seeds may be scattered by floodwaters, the most important means of seed dissemination (Schneider and Sharitz, 1988). Germination, in the spring, is usually poor except in seedbeds of sphagnum moss and soft wet muck.

Baldcypress is one of the few conifer species that sprouts, however, the shoots from cutover stumps are usually unsatisfactory for

regenerating a forest. The strongest sprouts are generally produced from stumps of young trees, but trees 60-200 years old may produce healthy sprouts. However, the long-term survival is generally poor and the resulting stems are often poorly shaped (U.S. Department of Agriculture, Forest Service, 1965). Sprouts grow faster than seedlings, and on occasion may compete effectively. Following harvest, baldcypress sites are frequently captured by sweetgum, Nuttall oak (*Quercus nuttallii*), willow oak, and red maple (*Acer rubrum*).

The present forest that occupies most of the flooded area of Caddo lake and the northern end of Harrison Bayou is a pure stand of baldcypress (Fig. 3). In 1993 Bob Keeland of the National Biological Service's National Wetlands Research Center collected cores from Caddo Lake baldcypress trees and crossdated them using a method that allowed discrimination of missing, locally absent and false rings that are common in this species. Most of the trees on Caddo Lake, especially those on the numerous small islands appear to be approximately 90-100 years old. These tress probably became established after the Corps of Engineers lowered water levels in the Red River during the late 1800's. Many trees in the western portion of the lake, however, are much older. A large number of trees are older than 250 years and two in the Willowson's Woodyard area are greater than 350 years in age (Bob Keeland, personal communication, October 22, 1993).

Fig. 3. Baldcypress forest at the mouth of Harrison Bayou on Caddo Lake.

The oldest documented baldcypress stand in the South is located along the Black River, a tributary of Cape Fear River in southeastern North Carolina. Living baldcypress trees ranging up to 1700 years old have been discovered at this site (Stahle et al., 1988). In southern Louisiana and Mississippi living baldcypress trees up to 1300 years old have been found along the Pearl River drainage. Such ancient trees are rare, but it is not uncommon to find baldcypress stands that are hundreds of years old (Frey, 1954; Walker, 1963; Stahle et al., 1992).

The total acreage of baldcypress stands throughout the southeast was dramatically reduced during a period of extensive logging in the early 1900's (Conner, 1988). Many of the cutover lands were not replanted due to difficulty of planting in such wet areas and many restored areas have now been destroyed by nutria (*Myocastor coypus*). Most second growth stands are now less than 100 years old (U.S. Department of Agriculture, Forest Service, 1960).

Two of the most picturesque and intriguing features of baldcypress tress are the buttressed trunks and knees (Brown and Montz, 1986). Buttressing of the lower stem of baldcypress is a common result of water level fluctuation, and is formed in response to the air-water surface moving up and down the tree. An interaction between ethylene and auxin produced by the tree has been suggested as the causative agent (Yamamoto, 1992).

In periodically flooded areas where the soil surface is occasionally exposed during the growing season and flood levels are quite high, the buttress will be the widest at the soil surface and taper to about the mean high water level. The buttressing of most trees in a stand will end at about the same height and the stems will assume a more gradual taper above the buttress. Normally, unbuttressed trunks or only slight swelling occurs on trees not subjected to periods of high water.

The most unique feature of baldcypress trees are the knees produced along many of their roots. Like buttresses, these organs grow in response to fluctuations of the air-water interface. A likely explanation of the knee's function involves mechanical support of the tree, especially in soft, organic soils. Baldcypress trees have been shown to be very tolerant of hurricane force winds (Duever and McCollom, 1993). Wind resistance is indicative of efficient anchorage, especially in view of the numerous shallow-rooted hardwood species that are easily uprooted by hurricanes. Baldcypress trees have deep descending roots at the base of the stems and, in addition, the knees have a dense mat of roots similar to that of the main stem (Mattoon, 1915). Such a dense and deep penetrating root system provides the necessary anchorage for

these trees to proliferate in southeastern coastal areas where they are commonly subjected to hurricane-force winds.

Injurious agents

Much decay in bottomland hardwood forests and baldcypress swamps is attributed to fire. Fire-wounded trees, regardless of species, are likely to contain rot. Fire wounds allow fungi to enter the stems which may, over a long period of time, destroy trees. Although injuries as small as 1 or 2 cm in diameter will allow fungal entry and later destruction of the lower portion of the tree, wounds less than 5 cm in width are generally not important points of infection. Up to 4 years may be required for rot to reach the heartwood but, once there, spread is rapid. The interior of a tree at its base may be totally consumed in the 15 to 20 years required for fire scars to heal. High temperature and high humidity, typical of southern bottomlands, encourage spread of decay.

Beavers (*Castor canadensis*) are a frequent source of damage to mature bottomland hardwoods in this region. Partial girdling results in a wound subject to attack by decay-causing fungi. Decay may be as deep as 10 cm after 6 years in ash trees and 8 years in sweetgum. Wounds extending more than one-quarter of the way around the circumference indicate a strong probability of mortality within 10 years. An examination of 1983 and 1990 1:660-scale black and white photography maintained by the Harrison County Soil and Water Conservation District Office in 1983 and 1989 shows the development of a 13.3 hectare beaver pond on the southeastern corner of the wetland (Fig/ 4). The area was a mixed oak-baldcypress-sweetgum forest in 1977. Today it is a baldcypress/emergent marsh wetland with many dead hardwoods (Fig. 5).

Grazing of domestic livestock has been detrimental to bottomland hardwood forests. Cattle trample reproduction, browse valuable stems, and compact soil. The soft floor of many bottomland forests, especially border areas of reeds and swamps, discourages cattle encroachment. Cattle were commonly grazed in the Harrison Bayou area until 1955; since then they have been excluded.

Free oxygen is considered the limiting factor in the germination of bottomland hardwood seeds in flooded sites. Inundation for up to one month does not appear to reduce germinative capacity unless seeds are covered too deeply by sediment. Consequently, normal seasonal flooding is not a major cause of selective regeneration among species until after germination. But, in frequently inundated areas, production of great quantities of seeds is essential to offset the hazards of submergence.

The forest tent caterpillar (*Malacosoma disstria*) defoliates tupelo, blackgum, sweetgum, willow oak/overcup oak, and river birch (*Betula nigra*) in southern bottomlands. Larvae spin cocoons in early May; moths are in flight 2 weeks later. By June, defoliated trees may put on new leaves, but this foliage will be smaller and sparser than normal. Natural checks on tent caterpillars may stop outbreaks, but occasionally trees are killed.

Baldcypress is notably less susceptible than bottomland hardwoods to insect damage. The most serious pest is the cypress leaf beetle (*Systena marginalis*) that causes foliage to discolor in mid-summer. Damage is done by small (less than 5 mm length), flattened, dull yellowish-tan adults. The insects do not remain on trees more than three days, and leaves are not totally consumed, but turn red within a few days after attack. Heavy feeding is evidenced by linear gouges that seldom pierce both leaf surfaces. Defoliation reduces growth and vigor, enabling secondary pests to further weaken and kill trees. On an occasional basis the cypress looper (*Anacamptodes pergracilis*) has resulted in severe defoliation in baldcypress in Texas and Louisiana. Fruit tree leaf-roller (*Archips argyrospila*) infestations have been observed in southern Louisiana since 1983, and are particularly detrimental to baldcypress saplings (Goyer and Lenhard, 1988).

Baldcypress stands are relatively free of fungi infections. "Pecky cypress", however, results from infection by *Stereum taxodii*. The fungus probably enters the crown and works downward in the heartwood. Damage, characterized by cavities which eventually occur throughout the heartwood of a tree, can be serious on older stems.

Swamp rabbits (*Silvilagus aquaticus*) may be a serious problem in young baldcypress stands. They clip seedlings above ground, making a smooth-angle cut. Damage occurs only on non-flooded sites. Clipped stems generally resprout, but the short shoots are killed when inundated. Nutria, introduced from South America in the 1930s, uproot seedlings, eat bark from tap roots and, in some cases, consume whole roots. Damage occurs on

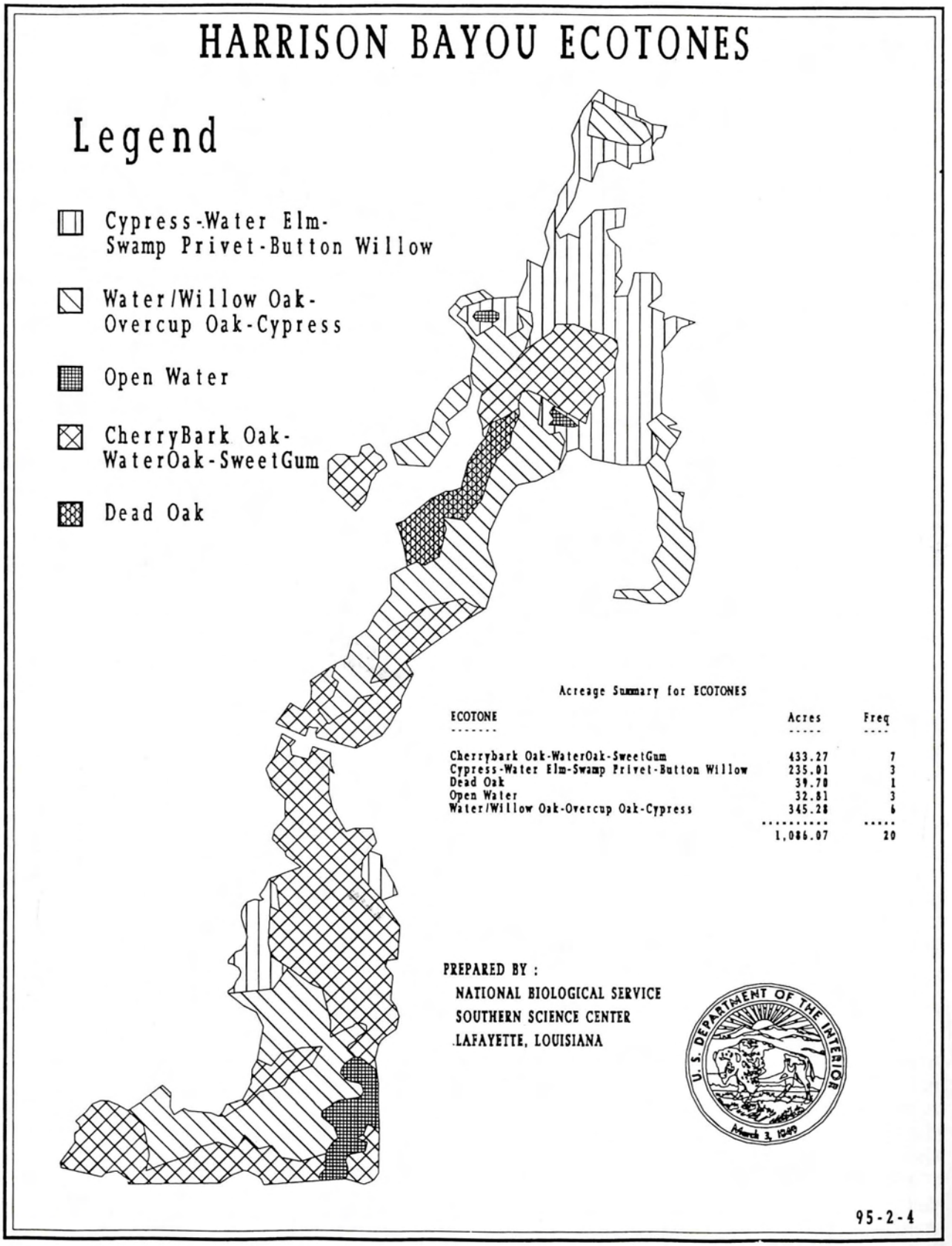

Fig. 4. Wetland boundary and major cover forest types or ecotones in the Harrison Bayou area.

Fig. 5. Hardwood forest damaged by beaver in the southeastern corner of the Harrison Bayou wetland.

flooded sites first and then on adjacent non-flooded areas. In contrast to swamp rabbit injury, the cut is rough and at an angle of about 45 degrees. As seedlings are carried back to the water to be eaten, sections of debarked roots and seedling tops are found strewn upon the surface of the pond (Blair and Langlinais 1960).

Floods overtopping baldcypress seedlings during their first year for more than three weeks can cause mortality. While it is detrimental for plant tips to be submerged for briefer periods after trees are in leaf, death may not result. Sometimes stems re-leaf in late summer after being inundated for several months during the growing season. Warm water and deep deposits of silt and clay sediments, along with oxygen deficiency, contribute to poor survival of submerged seedlings.

Although set aside from most of man's activities at the ammunition plant, one small area of the Harrison Bayou tract may have been damaged when several large rockets were fired in the direction of the forest around 1990. Some trees in this westcentral section of the Harrison Bayou wetland are dead and others appear to be severely stressed (Fig. 4). The damaged area is approximately 15 ha in size and is dominated by water, willow and overcup oaks.

COVER TYPES IN THE HARRISON BAYOU FOREST

Twelve different wetland forest plant communities were identified at the Harrison Bayou site when it was considered for designation as a special management area in 1977. These are now aggregated and mapped as three major cover types or ecotones of the Harrison Bayou wetland (Fig. 4). Other exceptionally large trees found in the area include a persimmon (*Diospyros virginiana*), water elm, overcup oak (*Quercus lyrata*), water locust (*Gleditsia aquatica*), hawthorn (*Crataegus* spp.), and two state champions (as determined by the Texas Forest Service), a water hickory (Carya aquatica) and a flowering dogwood (*Cornus flora*) (Fig. 1).

I. Cherrybark oak-Water oak-Sweetgum

The cherrybark oak (*Quercus falcata* var. *pagodaefolia*)-water oak-sweetgum forest-cover type extends over about 175 hectares, in flat bottoms that are slightly higher in elevation than sites that are more typified by the presence of either baldcypress or overcup oak. Cherrybark oak often reach heights of 30 to 40 m and diameters of 1 to 2 m, which classes them among the largest of the southern oaks (Harlow and Harrar, 1941). Because of the high quality of the wood, these trees are among the most valuable of the region. *Quercus falcata* var. *luecophylla* occurs on the same sites and is difficult to distinguish from the *pagodaefolia* variety. For both, Caddo Lake is the western edge of the range.

The soil of this forest type generally has a clay loam surface which overlies a clay zone, beginning at a depth of 15 cm. At 45 cm, the soil is dense and hard when dry. Bright redoximorphic concentrations in a gray matrix indicates hydric conditions at depths of 50 cm. These soils remain moist most of the time due to wicking from the water table, even after periods of relatively low rainfall.

Quality of forest sites may be described by a Site Index, which is the average total height of the dominant and codominant trees at age 50 years. The Site Index of the Harrison Bayou area is about 100 for sweetgum and cherrybark oak. Average increment growth of sweetgum is typically about 10 rings per cm, regularly, for a radius of 25 cm (the length of the increment borer used). Diameter growth is slow in contrast to that in second-growth managed bottomland hardwood stands. This may be due to the effect of close spacing in these natural stands.

Stems of the species named range from seedlings to 100 cm dbh, the average being about 40 cm. Heights of 30 m are common, such trees having 12 m of relatively clear bole. Baldcypress occurs only as isolated trees or in small groups along the stream channel and in sloughs. Other species found in this type include osage-orange (*Maclura pomifera*) and deciduous holly (*Ilex decidua*).

II. Overcup Oak-Water/Willow Oak-Baldcypress

A moist flat zone astride Harrison Bayou is principally characterized by overcup oak. However, water oak, willow oak and shumard oak (*Quercus shumardii*) are other important components. Site index for shumard oak is probably more than 80, although reliable tabular data are lacking. Current growth rate is slow and steady; 8 rings to a cm of radius. Heights of 30 m are not uncommon. The understory is so sparse that one may see 100 m or more through the forest. Baldcypress trees occur in abundance at the Bayou edge, with many knees protruding from the water. This forest type occupies approximately 140 ha, which is about 10 percent of the Harrison Bayou wetland.

The soil surface in this type is typically 0.3 m above the water in Harrison Bayou. Soil characteristics are directly related to the water that flows over the land. The surface layer is clay loam to clay at a depth of 2-3 cm. A hardpan occurs at 45-50 cm. Crumb to clod structure is found to that depth. No mottling occurs in the top 20 cm, indicating good drainage. Organic matter content is high in the top 5cm, forming an Al horizon.

One overcup oak measured 137 cm dbh and 37 m tall. It is the third largest known tree of this species in Texas. Many large overcup oaks in the "old growth" tracts of Harrison Bayou are dying. It appears that the overcup oak-type is converted to cherrybark oak-sweetgum if the soil moisture is consistently lowered for a duration of several years.

III. Baldcypress-Water Elm-Swamp Privet

The forest at the mouth of Harrison Bayou is characterized by a dense, homogeneous growth of baldcypress. Moving away from the lakeshore, water elm (*Planera aquatica*) and swamp privet (*Forestiera acuminata*) become significant. One stand of this type also contains one of the largest know water locust stems. It measures 115 cm in circumference, 20-21 m tall, and has a crown diameter of over 11 m. The soil has a rich organic layer in the 5-cm thick Al horizon, though the litter layer is, by early August, almost entirely decomposed. There is 10 cm zone of reddish-blue mottling. From 15 to 25 cm, the clay is bright yellow (suggesting hydration of the iron coatings on the silt and clay particles) and permeated with various shades of red, and some blue. At 45 cm, the soil is almost solid blue-gray (without mottling), indicating reduction of the iron in the soil, often associated with waterlogging.

This soil is the most "gumbo-like" of the locale. Drainage is poor. The many baldcypress trees here are directly related to the presence of water that often, and for long periods, stands on the land. Baldcypress trees show 6 to 8 rings per cm in trees of 35 cm diameter. Heights are about 23 m. For the broadleaf stems, heights are usually about 20 m. These poorly formed, fairly dense stands of baldcypress are often called pond cypress, a colloquialism; they are not the variety *ascendens*, found elsewhere in cutover southern swamps and bottomlands.

Most of the undisturbed "old growth" forest tracts in the area belong to this cover type (Fig. 1), which accounts for approximately 25 percent of the total area of the Harrison Bayou wetland.

Summary

Over 80 percent of the original bottomland hardwood forests in the South have been lost due to man's activities. Much of what remains is fragmented and degraded, and the few remaining undisturbed tracts are of great ecological and societal significance. An overview is given of bottomland hardwood and baldcypress forests, the two broad silvical regimes to which most southern wetland forests belong. Three major cover types illustrate the diversity of the bottomland hardwoods and baldcypress vegetation in a relatively-undisturbed wetland forest adjacent to Harrison Bayou as it feeds into Caddo Lake in Northeast Texas. These are cherrybark oak-water oak-sweetgum, overcup oak-water/willow oak-baldcypress and baldcypress-water elm-swamp privet. Harrison Bayou represents a model southern bottomland hardwood wetland in both structure and ecological function. For a variety of reasons stated, the virgin hardwoods and second growth forests that still occur in this area have changed very little since 1977.

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