

A CHARACTERIZATION OF HABITATS
AND
FISH AND WILDLIFE MANAGEMENT OPPORTUNITIES
AT
CYPRESS BAYOU BASIN, TEXAS AND LOUISIANA

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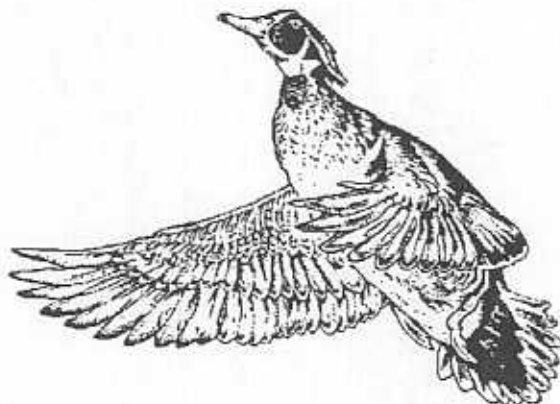
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EXECUTIVE SUMMARY

This document summarizes information collected by FWS on the fish and wildlife resources of the Cypress watershed over the past decade during the course of various land and water resource project investigations. FWS studies have concentrated primarily on identifying and characterizing the structural components of the habitats and quantifying the value of the habitats to representative wildlife species using various habitat assessment methodologies. Emphasis has been placed on the evaluation of bottomland hardwood forests and wetlands, since these habitat types often are the most threatened by development and provide the highest resource values to fish and wildlife within the watershed.

This report also provides some preliminary recommendations on fish and wildlife management measures which should be considered during future detailed planning within the basin. These measures range from preservation of the highest quality natural resources to restoration of degraded habitats. In addition, many opportunities are available to private landowners, agencies, and conservation organizations for the enhancement of existing fish and wildlife habitats within the watershed, thereby contributing to the overall quality of the natural resource base while providing additional opportunities for the public to enjoy those resources.

ACKNOWLEDGEMENTS

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A Characterization of Habitats
and
Fish and Wildlife Management Opportunities
at
Cypress Bayou Basin, Texas and Louisiana

INTRODUCTION

During Fiscal Year 1994, the Fort Worth District U.S. Army Corps of Engineers (Corps) initiated environmental resource investigations within the Cypress Bayou Basin, Texas and Louisiana. These studies, which are being conducted in cooperation with the Texas Parks and Wildlife Department (TPWD), U.S. Fish and Wildlife Service (FWS), National Biological Service (NBS), and other public and private entities, are in response to Congressional and public requests for a watershed approach in the evaluation of water and land resources within the basin. Studies are continuing into Fiscal Year 1995, and will culminate in the preparation of a Reconnaissance Report by the Corps discussing environmental resource problems and opportunities and identifying recommendations for future action by governmental agencies and local citizens. Some of the major areas which are being addressed in the Corps' watershed management study include water quality, vegetation and land use cover-types, recreation, natural and cultural resources protection and enhancement, environmental education, and environmentally sustainable development.

The purpose of this report is to provide a characterization of the fish and wildlife resources which occur within the Cypress Bayou Basin, especially those associated with the bottomland hardwoods and wetlands of the Caddo Lake ecosystem. Fish and wildlife protection and management recommendations for the watershed have also been identified where possible. It is hoped that these recommendations will be utilized by governmental agencies, community organizations, and private landowners for the conservation and improvement of the area's bountiful natural resources. This report is intended to supplement the more comprehensive watershed management study and the various detailed inventories/surveys currently being conducted by TPWD.

STUDY AREA

The current watershed study involves the entire drainage of the Cypress Bayou Basin upstream of and including Caddo Lake in northeast Texas. This area encompasses approximately 6,000 square miles in 11 Texas counties and one Louisiana parish (Figure 1). Major tributaries of the basin include Big Cypress Bayou, Little Cypress Bayou, Black Cypress Bayou, James Bayou, and Frazier Creek.

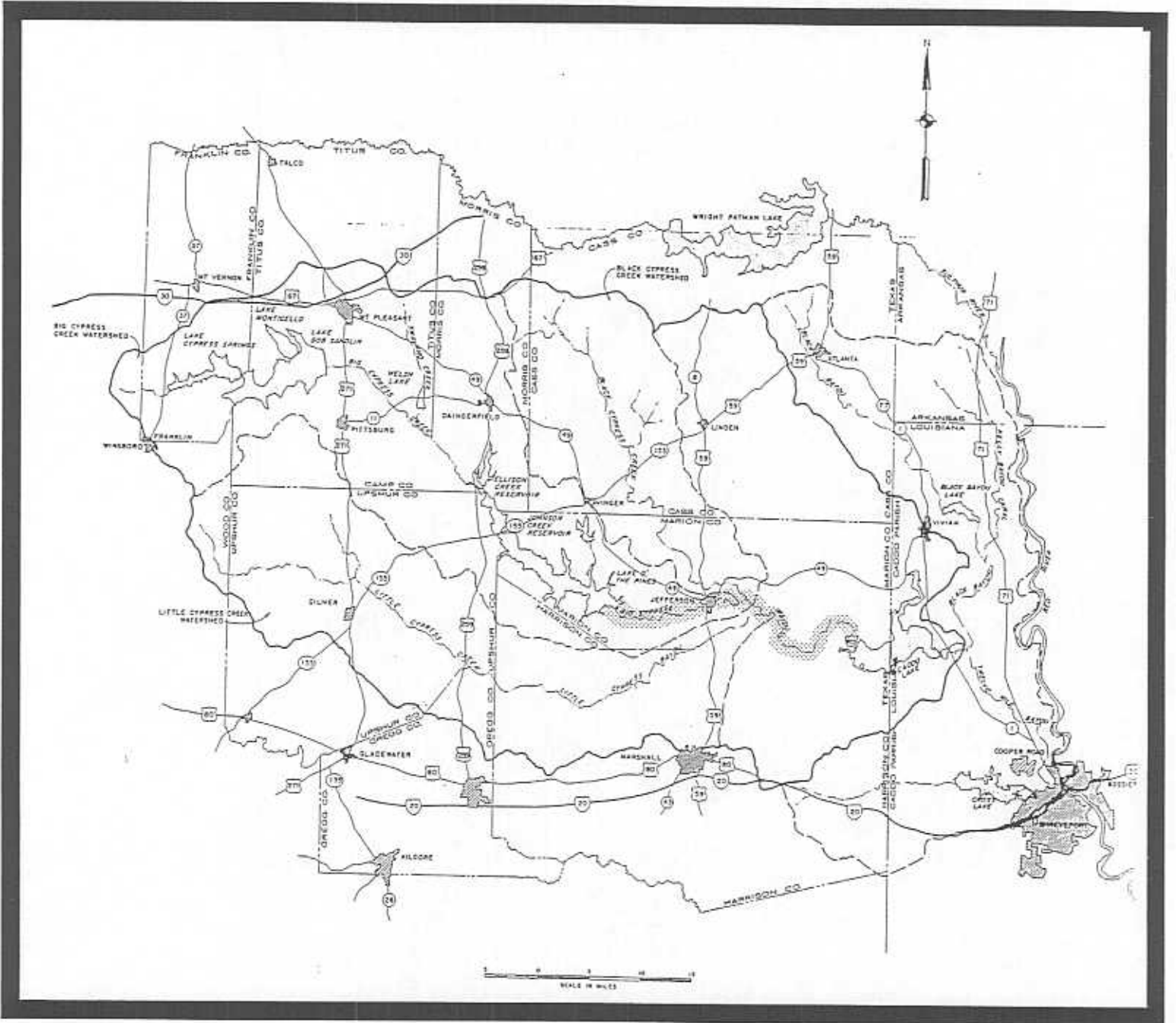


Figure 1. Cypress Bayou Basin Watershed Study Area.

Major reservoirs are located only on the Big Cypress Bayou drainage and include Lake O'the Pines, Bob Sandlin, Cypress Springs, and Monticello. Several smaller reservoirs, including Welsh, Ellison Creek, Barnes Creek, and Johnson Creek, occur on tributaries to Big Cypress Bayou.

Climate of the Cypress Bayou Basin is generally subtropical with hot, humid summers and relatively mild winters. Precipitation averages about 45 inches per year with most of this normally occurring in the spring and winter months. Topography of the watershed is irregular, rolling, hilly uplands dissected by broad, flat floodplains and terraces. Elevations range from approximately 160 feet mean sea level (msl) to 600 feet msl.

The majority of the Cypress Bayou watershed occurs within the Pineywoods ecological region of Texas and Louisiana, with only the extreme western portion occurring in the Post Oak Savannah ecological region (Gould 1975). Soils are mostly sandy or sandy loams with clays common in the floodplains. The Pineywoods were historically dominated by pine-hardwood forest; however, human intervention has dissected the once contiguous forest into a patchwork of different land uses. Currently, the principal land uses include soft and hardwood timber, cattle, and hay production. Oil and gas production, as well as homesite developments, have also contributed heavily to the reduction of forested lands in the basin.

The western portion of the basin in the Post Oak Savannah ecological region is characterized by a slightly drier climate, sandier soils, and a shift to more mesic vegetation typical of the deciduous forest and true prairie associations. Native woody vegetation in this portion of the watershed is dominated by post oak-blackjack oak/elm woodlands in the uplands, interspersed with clearings dominated by native tall grasses or introduced forage grasses. A small amount of agricultural land, consisting primarily of small grains and truck crops, also occurs in this portion of the watershed.

WILDLIFE HABITAT CHARACTERIZATION

Field investigations by the FWS over the past several years have identified 12 primary habitat types utilized by wildlife in the Cypress Bayou watershed. Each of these habitat types may have two or more sub-types, or vegetative associations; however, it is extremely difficult to distinguish between these sub-types on a watershed basis due to limitations in mapping technology, the large area involved, and the excessive amount of field verification required to delineate the associations. Most vegetative associations are generally mapped on a tract-by-tract or smaller area basis because of these difficulties. Since most of the vegetative associations, or sub-types, provide similar functional

habitat values to wildlife species, they are generally aggregated into homogeneous cover-types for wildlife habitat characterization studies. TPWD is currently working on a more detailed delineation of vegetation cover-types using Geographic Information System (GIS) technology.

Table 1 lists the 12 general wildlife habitat cover-types delineated for the Cypress Bayou watershed and discussed in this report. Habitats are identified using a traditional classification scheme, but wetland cover-types have been cross referenced to the FWS's National Wetlands Inventory (NWI) classification system where appropriate (Cowardin et al. 1979).

Table 1. Wildlife habitat cover-types in the Cypress Bayou Basin, Texas and Louisiana.

TRADITIONAL CLASSIFICATION	NWI CLASSIFICATION
Wooded (cypress) swamp	Palustrine forested wetland
Shrub swamp	Palustrine shrub-scrub wetland
Marsh	Palustrine emergent wetland
Vegetated, open water	Lacustrine littoral aquatic bed
River/stream	Riverine
Bottomland hardwood forest	Palustrine forested wetland*
Upland hardwood forest	-
Mixed pine-hardwood forest	-
Pine plantation	-
Shrubland/regeneration	-
Grassland	-
Cropland	-

* Depending upon vegetation composition, soils, and hydrological characteristics, many bottomland hardwood forests may also be classified as wetlands.

Information provided in this report has been developed from previous FWS investigations on Little Cypress Reservoir (1986-1988), Shreveport to Daingerfield Reach of the Red River Waterway Navigation Study (1991-1994), and the current Cypress Bayou Watershed Management Study (1994-1995). In the aggregate, these studies have collected data on approximately 272 sample plots in the Cypress Bayou watershed, most of which are high priority forested and wetland sites. General information on the habitats and wildlife of the Cypress Basin has also been identified and discussed by TPWD (Campo 1986).

A list of common vegetation species observed in each cover type is provided in Appendix A. This list is not a comprehensive checklist of plants for the watershed but is meant to provide a general characterization of the type of vegetation which occurs in the representative habitat cover-types. In addition, photographs of representative cover-types have been provided in Appendix B. These photographs provide a relatively good visual reference of the vegetative composition and structure of the major habitat types within the watershed.

Wooded Swamp. Wooded swamps, or palustrine forested wetlands, consist almost entirely of dense baldcypress stands which are permanently or semi-permanently flooded. The majority of the baldcypress swamps are located in or adjacent to Caddo Lake and its primary tributaries' floodplains, although isolated stands of baldcypress occur in other low-lying sites throughout the watershed. This habitat cover-type is the most notable natural feature of Caddo Lake, which is known for its vast baldcypress stands draped with Spanish moss.

Overstory in this cover-type is dominated by baldcypress, with overcup oaks only occasionally occurring within the canopy of the semi-permanently flooded sites. Mid and understory woody vegetation on the shallow flooded sites, where present, is dominated by stands of swamp privet, buttonbush and water elm. The most common emergent herbaceous species observed in the wooded swamps included smartweed, lizard's tail, arrowhead, and various sedges.

An analysis of the major structural components of the baldcypress swamp community indicates that it provides very good habitat conditions for wildlife (Table 2). On the average, canopy cover of the baldcypress was approximately 70 percent(%), and contained about 8 trees per acre with diameters at breast height (dbh) of at least 20 inches. Understory shrub and herbaceous cover was also sufficient (17 and 26%, respectively) to provide refuge, perch sites, food, and building materials for a variety of wetland species. In addition, the baldcypress swamps contain numerous cavities and snags which provide important nesting and denning sites for birds and small mammals (Figure 2). Logs, stumps, deadfall, and other vegetative debris are also very abundant in the

wetlands and provide escape and reproductive cover for numerous reptiles, amphibians, and small mammals.



Figure 2. Cavities in baldcypress tree.

The overall quality and condition of the baldcypress stands is a direct result of the water management practices currently being practiced within the basin. According to Klimas (1987), the effects of stabilized water levels in Caddo Lake appears to have resulted in denser stands of younger, smaller trees at higher elevations, while producing a decline in older, larger trees at lower elevations. Additional research is now being conducted by NBS to further evaluate the status and trends of the baldcypress swamp community of Caddo Lake.

Shrub Swamp. This wetland cover-type is limited in scope in the Cypress watershed. It consists primarily of previously forested sites which have been cleared and are permanently or frequently flooded or sites which remain too wet for hardwood overstory species to become established. Dominant shrubs in these sites include buttonbush, swamp privet, and water elm. Other species commonly occurring in this cover-type are river birch, water hickory, and several sapling trees such as baldcypress, overcup oak, sweetgum, and persimmon. Deeper sites are generally dominated by buttonbush with a progressive transition to water elm, river birch, baldcypress, and the oaks on higher elevation sites. Such a relationship has previously been documented for an east Texas wetland community by Weller (1989).

Table 2. Structural habitat composition of baldcypress (wooded) swamps in the Cypress Bayou watershed.

<u>Habitat Component</u>	<u>Avg. Value</u>	<u>Range of Values</u>
Overstory canopy closure (%)	70	15 - 85
Trees > 20 in. dbh (no./ac)	8	0 - 20
Trees in 1-6 in. dbh size class (%)	22	1 - 69
Shrub canopy cover (%)	17	1 - 55
Height of shrub canopy (ft)	8.25	7 - 12
Emergent herbaceous canopy cover (%)	26	1 - 75
Total emergent and submergent vegetation cover (%)	37	1 - 100
Stumps or logs > 7 in. dbh (no./ac)	37	0 - 70
Water surface covered by logs, trees, or overhanging vegetation (%)	34	10 - 90
Potential nest cavities (no./ac)	10	0 - 35
Snags > 10 in. dbh	4	0 - 10
Snags > 15 in. dbh	2	0 - 5
dbh of snags > 15 in.	22	17 - 24

Table 3 provides some of the common structural attributes of the shrub wetland community within the Cypress watershed. Shrub canopy cover averaged about 75% on the sample plots and attained a height of approximately 8 feet. Herbaceous cover on the plots averaged 36% and consisted of a variety of sedges, rushes, smartweed, and other emergent plants. Floating and submersed aquatic plants (e.g., water primrose, American lotus, duckweed, etc.) were common in the shrub wetlands containing permanent water. Overall, the diversity and abundance of plant materials in the shrub wetlands make them excellent wildlife habitats. They are especially valuable to the wood duck for brood-rearing habitat and to reptiles and amphibians. Enough large overstory trees were present in or near the shrub wetlands to provide potential nesting cavities for birds and small mammals; however, the number of cavities in this cover-type is limited compared to the forested habitats.

Table 3. Structural habitat composition of shrub swamps in the Cypress Bayou watershed.

<u>Habitat Component</u>	<u>Avg. Value</u>	<u>Range of Values</u>
Tree canopy closure (%)	22	5 - 48
Trees in 1-6 in. dbh size class (%)	73	50 - 90
Shrub canopy cover (%)	75	70 - 80
Height of shrub canopy (ft)	8	6 - 10
Emergent herbaceous canopy cover (%)	36	20 - 50
Water surface covered by logs, trees, or overhanging vegetation (%)	68	50 - 75
Potential nest cavities (no./ac)	2.5	0 - 5
Refuge sites (no./ac)	20	5 - 30

Marsh. Marsh, or emergent wetlands, in the Cypress watershed are also primarily restricted to cleared or open sites that are permanently or semi-permanently flooded. This cover-type, which is dominated by herbaceous vegetation, is commonly located in stream floodplains which have been cleared of woody vegetation and the shallow, open water areas of lakes and ponds within the basin. Emergent vegetation has reestablished on much of the spoil material placed along the various boat canals within Caddo Lake.

Predominant vegetation species occurring in this cover-type include emergents such as smartweed, cattail, maidencane, southern wildrice, and sedges, as well as numerous floating and submersed species such as American lotus, water primrose, spatterdock, arrowhead, elodea, and coontail. An occasional large baldcypress or shrub (buttonbush) may occur in or near the cover-type but it is usually not a dominant feature.

Canopy cover of emergent vegetation averaged approximately 78% in the sample plots and attained an average height of about 11 inches. This coverage and composition of desirable food-producing wetland plants makes the marshes a highly productive foraging site for wetland species, especially waterfowl, wading birds, and small mammals. The large number of refuge sites, consisting of debris piles, logs, etc., also provides abundant cover for species utilizing this cover-type.



Vegetated, Open Water. This wetland cover-type is comprised of the heavily vegetated open water areas of Caddo Lake and the other lakes and ponded areas of the basin. The cover-type is generally restricted to the littoral zones of these water bodies, since sunlight penetration determines the extent of plant growth in the water column. Due to its shallowness, virtually all of Caddo Lake, especially in its upper end, is dominated by floating or submersed vegetation at the peak of the growing season. This vegetation provides extremely important cover and food for waterfowl, shorebirds, and fish. Some key vegetation species occurring in the open water sites include spatterdock, American lotus, pondweed, hydrilla, elodea, coontail, fanwort, and duckweed.

River/stream. The river and stream systems of the Cypress watershed provide a very diversified and productive habitat for fish and wildlife. The streams are characterized by low gradient, slow draining, floodplains that are heavily vegetated. Low-lying sections of the floodplain adjacent to the main channel of the stream often consist of a series of overflow swales, ridges, islands, and sloughs or backwater areas. The riverine portion of the floodplain itself consists of that segment of the stream from cutbank to cutbank. A diversity of plants adapted to continual or occasional flooding occurs within this zone.

Common woody vegetation species occurring within the riverine system include baldcypress, overcup oak, cottonwood, water elm, green ash, black willow, buttonbush, and swamp privet. These species, along with flood debris and occasional steep bare riverbanks, provide good habitat for wildlife. The instream cover provided by logs, debris, and tree limbs is especially important as

fish habitat (FWS 1984). Riverine habitats in the study area upstream of Caddo Lake are closely associated with the bottomland hardwood forests of the floodplain, while downstream of Caddo Lake along Twelvemile Bayou, riverine habitats are much more distinct due to a highly incised channel with steep banks and more mesic vegetation.

Bottomland Hardwood Forest. Several bottomland hardwood forest types occur within the basin, the most prevalent being the water oak/willow oak, overcup oak, and the elm/sugarberry associations. The water oak/willow oak association appears to be the most common bottomland hardwood forest type in the lower reaches of the basin with elm/sugarberry dominating the headwater regions of the watershed.

Overstory species commonly occurring in the water oak/willow oak association include water, willow, overcup and southern red oaks, sweetgum, blackgum, and green ash. The most common mid and understory woody species include water elm, winged elm, red mulberry, American hornbeam, red maple, and deciduous holly.

Some flats within the floodplain subject to frequent and prolonged inundation are characterized by large stands of overcup oak. Vegetation species which most commonly occur with overcup oak on these sites include baldcypress, blackgum, water hickory, river birch, and green ash. Little shrub cover is usually present in these areas due to extensive and prolonged flooding, the saturated nature of the soil, and dense overstory canopy which inhibits understory growth.

Tree species most often associated with the elm/sugarberry vegetation type include American and winged elm, sugarberry, sweetgum, southern red oak, white oak, boxelder, and persimmon. Understory shrub species most prevalent include deciduous holly, various hawthorns, waxmyrtle, and buttonbush.

All of the bottomland hardwoods discussed above are characterized by a diversity of vines and herbaceous species. The most common woody vines include various species of greenbriars, wild grape, rattan, poison ivy, Virginia creeper, dewberry, and Japanese honeysuckle. The most abundant herbaceous plants noted in the bottomlands were smartweed, lizard's tail, false nettle, inland seaots, and various sedges.

Bottomland hardwoods are the most productive wildlife habitats within the Cypress Bayou watershed. As noted in Table 4, the bottomland hardwoods are dominated by overstory species, such as the oaks, that produce abundant mast (i.e., acorns) for wildlife food. The bottomland hardwoods are also structurally diverse and provide abundant undergrowth, cavities, snags, burrows, and other

refuge sites for wildlife escape and nesting cover. On the average, most bottomland hardwoods within the Cypress watershed provide very good to excellent food and cover conditions for a variety of forest wildlife species. They are especially valuable to wildlife species that have restrictive habitat requirements, such as neotropical songbirds which need large unbroken tracts of mature hardwood timber to meet their specific reproductive requirements (Dickson 1988).

Table 4. Structural habitat composition of bottomland hardwood forests in the Cypress Bayou watershed.

<u>Habitat Component</u>	<u>Avg. Value</u>	<u>Range of Values</u>
Overstory canopy closure (%)	80	13 - 100
Canopy closure of mast producers > 6 in. dbh (%)	72	0 - 100
Height of overstory trees (ft)	80	35 - 105
dbh of overstory trees (in)	16	7 - 29
Shrub canopy cover (%)	26	0 - 90
Herbaceous canopy cover (%)	10	0 - 88
Snags > 10 in. dbh (no./ac)	6	0 - 20
Snags < 10 in. dbh (no./ac)	10	0 - 45
Potential nest cavities (no./ac)	7	0 - 30
Refuge sites (no./ac)	15	0 - 60



Upland Hardwood Forest. This vegetation cover-type is most often found in the western portions of the watershed within the Post Oak Savannah ecological region. It normally occurs on the well-drained, sandy soils of upland sites. Dominant overstory vegetation consists of post oak and blackjack oak, with hickory and loblolly pine occasionally present. Overstory canopy cover averaged approximately 93% on the limited sites evaluated, and about 74% of the total canopy was mast-producers greater than 6 inches dbh. Overall shrub canopy cover was 54%. The density of the overstory and shrub canopy resulted in average herbaceous covers of less than 1% due to the heavy shading of the ground layer. The understory shrub community consists primarily of species such as yaupon, deciduous holly, American beautyberry, sumac, and various hawthorns which are adapted to the sandier, drier soils of the uplands.

Where present in the watershed, upland hardwood forests provide an important wildlife habitat and are particularly important to the white-tailed deer and fox squirrel populations of east Texas. Snags, cavities, logs, and other structural components are relatively abundant in this cover-type, although they were limited on some of the individual sample plots. Most upland hardwood sites have been converted to pine plantation or pastureland and thus currently occupy little land area within the watershed.

Mixed Pine-Hardwood Forest. Mixed pine-hardwood forest is the most extensive forested cover-type in the Cypress watershed. Individual sites may range from pine dominated to hardwood dominated, depending upon timber management practices which have been applied to the site. In the Cypress watershed, most upland forested sites are dominated by loblolly pine with a few hardwoods in the overstory and midstory. Hardwoods associated with sites in the eastern portion of the watershed include species such as water and willow oak, sweetgum, blackgum, red maple, southern red oak, sugarberry, and hickory. In the western portions of the basin, primary associated species include post oak, southern red oak, sweetgum, winged elm, and sugarberry. Shrub and ground cover on all sites consists of numerous plants beneficial to wildlife, including American beautyberry, yaupon, deciduous holly, farkleberry, dogwood, sumac, greenbriar, wild grape, poison ivy, Japanese honeysuckle, dewberry, and peppervine.

On the average, sample plots for this cover-type indicated an overstory canopy closure of approximately 66% with only 28% of the canopy comprised of deciduous hardwood species (Table 5).

Table 5. Structural habitat composition of mixed pine-hardwood forests in the Cypress Bayou watershed.

<u>Habitat Component</u>	<u>Avg. Value</u>	<u>Range of Values</u>
Overstory canopy closure (%)	66	10 - 100
Canopy closure of deciduous trees in stand (%)	28	0 - 70
Canopy closure of mast producers > 6 in. dbh (%)	19	0 - 65
Height of overstory trees (ft)	72	30 - 105
dbh of overstory trees (in)	14	7 - 37
Shrub canopy cover (%)	49	9 - 95
Herbaceous canopy cover (%)	13	1 - 45
Snags > 10 in. dbh (no./ac)	3	0 - 20
Snags < 10 in. dbh (no./ac)	10	0 - 60

Height of the overstory trees in the pine-hardwood forests averaged 72 feet, and they attained an average dbh of 14 inches. Structurally, this cover type is relatively diverse and contains abundant snags, cavities, and a well-developed shrub and herbaceous understory component. The mixed pine-hardwood forests of the Cypress watershed provide a valuable wildlife resource, especially when interspersed with adjacent tracts of bottomland hardwoods.

Pine Plantation. This cover-type is dominated by maturing loblolly pine greater than 16.5 feet in height which has been reestablished on sites previously occupied by mixed pine-hardwoods, upland hardwoods, or bottomland hardwoods prior to logging. Most of the pine sites evaluated were relatively open canopied, when compared to the other forest types, due to the lack of deciduous trees in the overstory. Average canopy cover was only 34% with about 3% deciduous species (Table 6). The most common hardwood species present in the pine plantations included sweetgum and hickory, while sumac was the most common understory shrub.

Shrubland/regeneration. Shrublands within the Cypress watershed are almost entirely the early successional stage of pine plantations which have been established on mixed pine-hardwood

sites following clearcut operations. Shrub and herbaceous cover is high on these sites because of site disturbance and their open aspect which favors early successional grasses, forbs, and brush species. Shrub and herbaceous canopy cover averaged 63% and 57%, respectively, for the sites evaluated (Table 6). Prevalent woody vegetation on these regeneration sites includes saplings of loblolly pine, sweetgum, water and willow oak and hickory; sumac; buttonbush; and thickets of greenbriar and dewberry. Doveweed, sunflower, goldenrod, partridge pea, and tickclover are common herbaceous components of these sites.

Shrublands, or early successional pine plantations, provide abundant cover and food for a variety of wildlife species due to the high plant diversity and productivity of the habitat. However, as the pine matures it quickly out-competes more desirable deciduous species and reduces understory cover. This is clearly illustrated in Table 6, which shows that regeneration sites have high shrub and herbaceous canopy covers, but as the pine matures into the forest stage, shrub cover is nearly halved.

Table 6. Structural habitat composition of pine plantation and shrub regeneration lands in the Cypress Bayou Basin watershed.

<u>Habitat Component</u>	<u>Avg. Value</u>	<u>Range of Values</u>
<u>PINE PLANTATION</u>		
Overstory canopy closure (%)	34	16 - 45
Canopy closure of deciduous trees in stand (%)	3	0 - 5
Height of overstory trees (ft)	53	35 - 90
dbh of overstory trees (in)	10	5 - 15
Shrub canopy cover (%)	37	25 - 50
Snags > 10 in. dbh (no./ac)	2	0 - 5
Snags < 10 in. dbh (no./ac)	8	5 - 15
<u>SHRUBLAND/REGENERATION</u>		
Shrub canopy cover (%)	63	30 - 95
Herbaceous canopy cover (%)	57	10 - 100
Potential refuge sites (no./ac)	15	5 - 40

Grassland. Two general types of grasslands occur within the watershed: pastureland and native grasslands. Pasturelands represent the bulk of this habitat cover-type and consist mainly of introduced or improved grass and legume species for cattle grazing and hay production. The most common pasture species in this region are coastal and common bermudagrass, bahiagrass, dallisgrass, lovegrass, and ryegrass. Various clovers, lespedezas, and vetches are also included for forage production in many improved pastures. Native grasslands are limited in scope within the watershed and are composed principally of bluestems (big, little, and broomsedge), Indiangrass, switchgrass, and various panicums and paspalums. Native grasslands are most often found on clearcut sites which have not been planted in pines or reseeded with improved herbaceous species. These sites if left unmanaged will generally revert to a shrub or early successional forest stage.

Cropland. Croplands are not abundant in the study area of the Cypress watershed. When present, they consist primarily of small grains (e.g., wheat, oats, barley), forage sorghums, soybeans, and truck crops such as watermelons, corn, and other vegetables. There are also some peach and pecan orchards in the watershed which may be classified as croplands. Agricultural lands are important to wildlife mainly as a food source, although some species may use this cover-type for escape or reproductive cover, especially when weedy and brushy edges are associated with adjacent cover-types.

WILDLIFE COMMUNITY HABITAT VALUES

Information has been collected on the overall value of the habitat cover-types discussed above to representative wildlife species during previous and current water resource investigations. Quantification of habitat values has been accomplished using the FWS's *Habitat Evaluation Procedures* (HEP) (FWS 1980), and most recently, the draft version of a *Bottomland Hardwood Community Model* developed jointly by the FWS and Corps' Waterways Experiment Station (Schroeder et al. 1992). These models provide a numerical expression (habitat suitability index, HSI) of wildlife habitat quality on a 0 - 1.0 scale, where 0 represents no suitable habitat value and 1.0 represents optimum habitat conditions for representative wildlife species. Wildlife species are selected which represent the various cover and feeding niches available within the habitat, such as the overstory, understory and ground layers, thus providing a representation of the overall quality of the site to a variety of wildlife (Figure 3). In the case of the *Bottomland Hardwood Community Model*, the numerical rating represents the overall quality of the community directly rather than indirectly through the use of representative indicator species.



Figure 3. Beavers are an important evaluation species for wetland habitats.

Recent investigations have concentrated on bottomland hardwood forests and wetlands of the Cypress Basin, since these cover-types are the most productive and critical wildlife habitats within the study area. The following information summarizes the results of the HEP and the bottomland community model for these habitat types within the Cypress watershed. Quantitative information on the quality of upland habitat cover-types is also provided where available.

Wetland Wildlife Habitat Values. Bottomland hardwoods in the Cypress watershed have been evaluated using both traditional HEP and the community model. HEP analyses were conducted primarily along the mainstem of Big Cypress Bayou in Texas, Caddo Lake, and Twelvemile Bayou in Louisiana during evaluation of the Red River Navigation Project in 1991. Numerous sites were also evaluated with HEP in the Little Cypress and Big Cypress watersheds during studies on the Little Cypress Reservoir project during the mid-1980's. The community model was applied during summer and fall of 1994 at numerous bottomland hardwood locations throughout the watershed, including most major and secondary tributaries to Caddo Lake and floodplain lands within Caddo Lake itself. Other wetland cover-types (i.e., wooded swamp, shrub swamp, marsh, and riverine) were evaluated only during the Red River Navigation and Little Cypress Reservoir studies. No additional data have been collected on these cover-types during the current watershed investigation.

However, HEP data will be gathered for project planning purposes should any feasible alternatives be identified for further study in the watershed management project.

Table 7 summarizes the habitat values of wetland cover-types in the Cypress watershed to representative wildlife species. This data indicates that the wetlands provide good to excellent habitat for a variety of wildlife species, with average HSI's ranging from 0.71 to 0.90. This is primarily due to the high food production of the wetlands, especially acorn mast, fruiting shrubs and invertebrates, and the abundant cover provided to the species by cavities, snags, logs, deadfall, and other habitat structural elements (Figure 4).



Figure 4. Great egret utilizing wetlands of Caddo Lake.

Community analysis of the bottomland hardwoods confirms that these factors, expressed as tree and structure components, are important in determining the habitat quality of bottomlands. However, the hydrology of bottomland hardwoods is the key factor influencing its productivity and habitat quality (Table 8). Among other things, flooding of the bottomlands promotes the growth of high quality vegetation through the input of moisture and nutrients and creates a variety of microhabitats and structure through changing the topography of the floodplain. This relationship between bottomland

hardwood species and the hydrologic environment is well established in the scientific literature and has been previously reviewed and documented for the basin by TPWD during studies on Little Cypress Bayou (Hayes 1987).

Due to the direct relationship of bottomland hardwoods and the hydrologic regime, it is obvious that bottomlands are extremely important for a variety of ecological functions other than just wildlife habitat. Some of the more prominent functions of bottomlands besides habitat include floodpeak reduction, water storage and groundwater recharge, and water quality improvement. These functions have been identified and discussed in detail in several excellent publications, including Wharton et al. (1982), McMahan and Frye (1987), and Wilkinson et al. (1987).

It should also be noted that the overall HSI obtained for bottomland hardwoods using the community model (0.82, Table 8) compares very favorably with the average HSI of all evaluation species using the traditional HEP analysis (0.84, Table 7). Therefore, the community model data suggest that the evaluation species selected for the HEP adequately represent the bottomland hardwood forest community. Likewise, the data also suggest that the *Bottomland Hardwood Community Model* may be useful for habitat evaluations in lieu of HEP. This could be very beneficial on some bottomland hardwood studies since HEP is more data intensive and time consuming to apply in the field than the community model.



Table 7. Habitat Suitability Indices (HSI) for bottomland hardwood and wetland wildlife evaluation species in the Cypress watershed.

EVALUATION SPECIES	Habitat Cover-Types*				
	BOTTOMLAND HARDWOODS	WOODED SWAMP	SHRUB SWAMP	MARSH	RIVER
Wood duck	0.78	0.87	0.98	0.98	
Hairy woodpecker	0.87				
Barred owl	0.89				
Carolina chickadee	0.87				
Gray squirrel	0.97				
Raccoon	0.80		1.0	0.70	0.58
Swamp rabbit	0.72		0.58		
Green heron		0.95	0.95	0.95	
Pileated woodpecker		0.57			
Beaver		1.0	1.0		
Mink		0.75	0.90		
Slider turtle		0.20			0.60
Belted kingfisher					0.96
AVERAGE HSI	0.84	0.72	0.90	0.88	0.71

*Vegetated, open water wetland cover-type was not evaluated as a wildlife habitat.

Table 8. Habitat Suitability Indices for the bottomland hardwood forest community of Cypress Watershed.

Habitat Structural Component	Suitability Index
Tree Layer	0.77
Hydrology	0.91
Additional Structure	0.78
Community HSI	0.82

Upland Wildlife Habitat Values. During previous studies within the watershed, HEP data was also collected on the value of upland habitats to various wildlife indicator species. The habitat suitability indices (HSI's) for these wildlife species are provided by cover-type in Table 9.

Table 9. Habitat Suitability Indices for upland wildlife evaluation species in the Cypress watershed.

EVALUATION SPECIES	Habitat Cover-Types					
	PINE-HARDWOOD	PINE	UPLAND HARDWOOD	SHRUB	GRASS	CROP
Hairy woodpecker	0.85	0.63	0.15			
Barred owl	0.65	0.62	0.76			
Carolina chickadee	0.78	0.47				
Fox squirrel	0.50		0.22			
White-tail deer			0.68			
Eastern cottontail				1.0	0.95	0.60
Eastern woodrat				1.0		
Eastern meadowlark					0.63	
Scissortail flycatcher						1.0
AVERAGE HSI	0.70	0.57	0.45	1.0	0.79	0.80

Habitat conditions for upland species generally ranged from good to excellent, with overall HSI's averaging 0.45 for upland hardwoods to 1.0 for shrublands. It is believed that the overall habitat quality of upland hardwoods is higher than indicated, since the small sample size evaluated for this cover-type introduced error into the HSI calculations. For example, the small size of the sample plots (1/10th acre) and the limited number of upland hardwood plots evaluated (4) did not accurately portray the availability of large snags necessary for the hairy woodpecker, thus it received an HSI rating of 0.15. A modified sampling

regime would be necessary to more accurately depict the true value of this habitat cover-type.

FISH AND WILDLIFE MANAGEMENT OPPORTUNITIES

Numerous opportunities have been identified for the preservation, restoration, and enhancement of fish and wildlife resources during past and current studies within the Cypress Bayou watershed. The following narrative discusses specific opportunities which should be considered by federal, state, and local governmental agencies, private landowners, and other interested parties for the protection of these resource values. Where possible, specific examples are provided to illustrate the types of measures and locations of areas which would benefit from restoration or enhancement activities.

Habitat Preservation. In 1985, the FWS developed a land protection plan for the bottomland hardwoods of Texas and Oklahoma (FWS 1985a). The purpose of this plan was to present a combination of alternative actions to preserve as much as possible the remaining high quality bottomland habitats still present in eastern Texas and Oklahoma in order to help conserve important breeding and wintering populations of wood ducks and mallards. This protection plan drew upon previous surveys and inventories as well as specific contract studies conducted within the states. In east Texas, approximately 75 bottomland areas were identified for consideration of which four were located in the Cypress Bayou Basin.



The final concept plan for the Texas Bottomland Hardwood Preservation Program was completed by FWS in May 1985 (FWS 1985b). The concept plan discussed in detail the biological characteristics and threats to each bottomland site and provided a discussion on options available for their protection. The four major areas identified for consideration in the Cypress watershed included portions of Caddo Lake, Big Cypress Bayou, Little Cypress Bayou, and Black Cypress Bayou. These areas were recognized for the quality of their bottomland hardwoods and their value to waterfowl populations. Subsequent evaluations in 1990, in response to the Emergency Wetlands Resources Act, reaffirmed the quality of these habitats for acquisition consideration (FWS 1990).

A map and information on each of these four bottomland areas are included in Appendix C. It should be recognized that the maps for

these areas are general in nature and should be used only for an approximate location of the bottomland site. Each area could easily be expanded or reduced depending upon the specific characteristics of individual tracts and land use changes which have occurred since initial development of the maps. When originally developed, the maps were intended for planning purposes only in order to guide land protection efforts within the east Texas region.

It should also be noted that many other high quality sites, besides those discussed above and presented in Appendix C, occur within the watershed. Examples include the bottomlands of upper Little Cypress Bayou east of Gilmer in the vicinity of State Highways 154 and 155 and the bottoms of Harrison Bayou within Longhorn Army Ammunition Plant at Karnack, Texas. Detailed information on these and other comparable sites has not been developed to date, although cooperative studies are now being conducted by government, educational, and private parties at Harrison Bayou (Burkett, pers. communication).

Except for Caddo Lake, the lack of funds and other priorities have prevented acquisition and/or other preservation efforts within the identified bottomland areas. TPWD, with the assistance of the Texas Nature Conservancy and funding obtained from the North American Wetland Conservation Council, acquired approximately 7,500 acres at Caddo Lake in October 1992 (Figure 5). This area, because of its unique and highly productive wetland habitats, has also been recognized by the FWS as a Resource Category 1 habitat pursuant to its *Mitigation Policy* and as a *Wetland of International Importance* under provisions of the Ramsar Convention (FWS 1993a,1993b). Future preservation efforts within the Cypress Basin will depend upon many factors, especially the availability of funds and local community's cooperation and acceptance of longterm conservation efforts by Federal and State agencies.

Habitat Restoration. Most habitat restoration in the Cypress watershed would involve two main categories of activities: hydrologic manipulation and revegetation. Hydrological restoration would typically include measures such as restoring higher flood flows in the bayous and creeks, increasing the duration and frequency of floodplain saturation, maintaining or improving base streamflows, or similar measures. Revegetation would consist primarily of the replanting or management of previously impacted bottomlands for hardwood timber production.

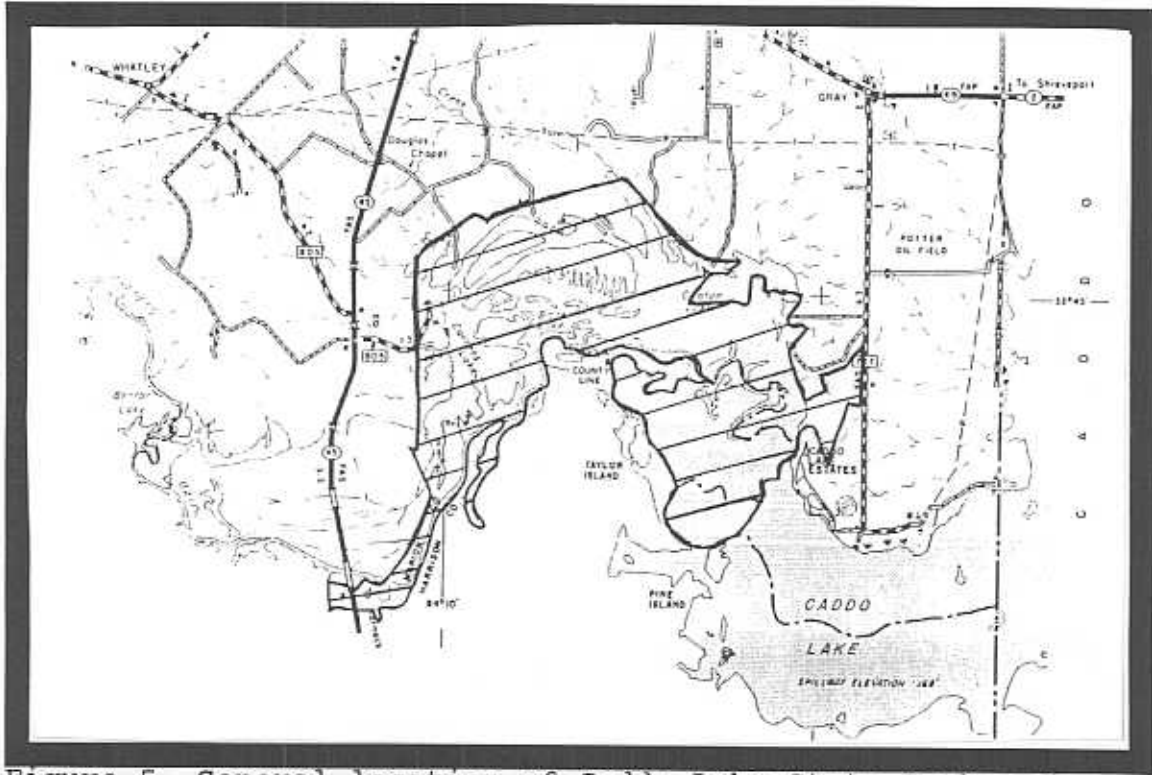


Figure 5. General location of Caddo Lake State Park and Wildlife Management Area.

Hydrology. The natural hydrology of the watershed's floodplain has been greatly affected through the construction of flood control and water supply reservoirs, primarily within the Big Cypress drainage. Reservoir development has resulted in reduced magnitude, frequency, and duration of peak flows downstream of the structures, and in some cases, shifted the seasonal timing of peak flows. As an example, operational discharges from Lake O'the Pines are now restricted to a maximum of approximately 3,000 cubic feet per second (cfs), whereas prior to construction of the reservoir, flood flows within Cypress Bayou had exceeded 57,000 cfs (USGS 1993). In addition, peak flows downstream of the reservoir now occur most often in the late winter months rather than spring due to the reservoir operation schedule.

These factors have influenced the productivity of the floodplains by reducing overbank flows and altering the seasonal water needs of the vegetation. Computer simulation of the hydrological conditions which would occur in Little Cypress Bayou with construction of Little Cypress Reservoir confirmed that the reservoir would eliminate most of the overbank, flushing flows required to maintain the swamps and bottomland hardwood forests of the floodplain, and that project was not even designed with flood control purposes in

mind (Hayes 1987). Hydrologic modifications to the floodplain have also allowed increased human development due to the reduced potential for flooding. Improved access to low sites for timber harvest, pasture development, and gas and oil production have been the most common impacts.

A reduction in overbank flooding also lowers water table elevations in the floodplain's backwaters and contributes to deterioration of natural terraces and berms deposited by the stream during periods of high discharge and sediment transport. In some instances, it appears that landowners have taken advantage of the reduced flood elevations to breach natural bank levees and assist in the drainage of backwater sloughs (Figure 6). It should be noted, however, that these same breaches offer excellent potential for improving and maintaining water levels in the backwater sloughs if structurally modified.



Figure 6. Breach of natural stream bank levee, Big Cypress Bayou, Texas.

As previously noted, our evaluations of the bottomland hardwoods of the Cypress Basin indicate that the hydrologic regime of a site is the key factor influencing its overall habitat value (Table 8). Therefore, any restoration of bottomlands must consider restoring and maintaining favorable hydrologic conditions, if the hydrology of the site has been previously modified in a significant manner.

Structural features which have potential for hydrologic restoration at individual sites within the watershed include, but are not necessarily limited to, ditch plugs, levees, weirs, flashboard risers, or similar water control devices. The application of a specific measure would depend upon site conditions, management objectives, cost, operation and management requirements, etc.

One of the most effective hydrological restoration measures which could be applied within the Cypress watershed would be the modification of water releases from Lake O'the Pines. Preliminary observations indicate that discharges of approximately 1,500 - 2,000 cfs would supply off-channel sloughs, backwaters, and oxbows with sufficient seasonal water to promote the growth of desirable vegetation and improve habitat for fish and wildlife species. These sites should receive ample water in late winter/early spring to ensure optimum growth conditions of wetland plants, and again in late fall/early winter after leaf drop to provide improved foraging habitat, especially for waterfowl and wading birds (Figure 7). Higher water levels in the spring months would also improve fish spawning and nursery areas along the bayou. Optimum conditions could be achieved if higher seasonal discharges were implemented in combination with structural features, thus enabling water levels to be maintained for greater periods of time and providing more management flexibility.



Revegetation. Due to hydrologic modifications of the Cypress floodplain, numerous bottomland areas have been harvested for their timber. Many of these areas have been converted to introduced grasses for hay and cattle production, while some of the higher elevation bottomlands have been converted to pine plantation. These sites offer potential for bottomland hardwood forest restoration, either through the replanting of hardwood trees or vegetative manipulation to release production of desirable mast producers. Species which

should be emphasized during restoration of bottomlands include hard and soft mast producers such as the oaks, hickories, pecans, and fruiting shrubs due to their food value. An excellent reference concerning bottomland hardwood restoration is currently being developed by the Southern Science Center of the National Biological Service (Allen et al. 1993).

Numerous sites have been identified within the Cypress watershed which would benefit from revegetation and/or improvement of their hydrologic conditions. Some of these sites are noted in Appendix D. These sites have been identified using aerial reconnaissance, aerial photography, topographic and wetlands maps, and limited field inspections. It should be emphasized that these sites have not been evaluated in detail or discussed with the individual

landowners, but are provided in this report only to illustrate areas where fish and wildlife resources could benefit from increased habitat management activities. Since fish and wildlife management opportunities are abundant within the watershed, it is incumbent upon government to work cooperatively with private landowners, local communities, and organizations to identify and implement cost effective measures which are a benefit to the people as well as to the wildlife of the Cypress watershed.



Figure 7. Flooded bottomland hardwood site which provides optimum habitat for waterfowl and other wetland-dependent species.

Partners for Wildlife Program. *Partners for Wildlife* is a program of the FWS designed to improve and protect fish and wildlife resources on private lands and to cultivate a sense of stewardship for these resources. It involves technical and financial assistance to private landowners, local governments, educational institutions, or other non-federal entities while leaving land in private ownership. This program was instituted with the FWS's recognition that the future of the Nation's fish and wildlife resources is directly dependent upon the quality, quantity, and distribution of suitable habitat on private lands. History has shown that these lands face the greatest threat of loss or degradation, however, they also provide the greatest potential for restoration and protection.

The Arlington Field Office is actively working with landowners in the Cypress Bayou watershed to restore and protect valuable fish and wildlife habitats. Currently, seven *Partners for Wildlife* projects have either been completed or planned in Harrison County, with two projects underway for Marion County. Beginning in Fiscal Year 1995, some of these projects are being cooperatively developed with the U.S. Bureau of Reclamation as part of the comprehensive Federal water resource studies being conducted in the watershed.

Detailed information on each site and its location within the watershed is provided in Appendix E. To date, most of these projects have involved restoration of wetland hydrology on site through construction of diversion levees and water-level control structures (Figure 8). Additional habitat enhancement features as discussed below have also been incorporated into the project where appropriate.



Figure 8. *Partners for Wildlife* wetland restoration site, Harrison County, Texas.

Habitat Enhancement. Opportunities to improve or enhance fish and wildlife habitats within the watershed are virtually unlimited. Enhancement features are being implemented on *Partners for Wildlife* and Federal project restoration sites throughout east Texas, including the Cypress watershed, and could be easily and economically utilized at other sites proposed by agencies, private landowners, and the conservation community.

As noted previously, one of the most important factors affecting the productivity and diversity of fish and wildlife habitats which occur in the floodplain is its hydrologic condition. Restoration of natural stream bank levees and overbank flood flows are the most desirable ways to restore the productivity of a floodplain; however, due to the lack of control of these factors (especially overbank flooding), water control devices are often used to capture and hold water in the floodplain. Devices that permit manipulations of the water level, such as flashboard risers and screw valves, are especially beneficial since the habitat can be managed for optimum vegetation production and the seasonal needs of target wildlife species (Figure 9).

One drawback of these structures is that they require more maintenance than simple ditch plugs, weirs, or levees, thus development of an individual site will depend upon its specific physical, hydrologic, and biological characteristics and the objectives of the manager. An example



Figure 9. Flashboard riser used for water level management of restored wetlands.

of a site which could benefit from some level of water control is Site 2, Appendix D. This area contains several oxbows, small tributaries, and backwaters which could be enhanced through the restoration and management of water elevations within the floodplain.

Another habitat enhancement measure which is commonly utilized on managed wetland sites in east Texas is the wood duck nest box (Figure 10). Nest boxes are usually provided at sites which have no, or a limited amount of, natural cavities for wood duck nesting production.

Sites in the watershed which are particularly suited to the use of nest boxes are the shrub wetlands and marshes which normally lack a sufficient number of cavities but have ideal brood-rearing and feeding conditions for wood ducks. Texas Parks and Wildlife Department has an existing nest box program for wood ducks, as well as non-game bird boxes. Boxes and management information are available free of charge to cooperating landowners, by contacting the local Department wildlife biologist.



Figure 10. Wood duck nest box.

Many other fish and wildlife enhancement measures are available which could prove beneficial within the Cypress watershed. These include vegetation management techniques to improve the availability and production of hardwoods or other preferred food-producing plants; protection of existing snags, deadfall, or other microhabitats; construction of potholes as permanent water retention structures in the floodplain; food plot development; or similar measures which would add to the value of the habitat. Activities which would protect or provide snags and cavities are especially important for the welfare and nesting production of forest-dwelling birds (Conner 1978).

Riverine habitats could be enhanced for fish by measures such as improved access to backwater spawning sites, creation of gravel spawning beds, preservation and/or development of instream cover, and improved flows and water quality (Crance 1988).

Selection of viable enhancement measures would depend upon overall habitat management goals, site characteristics, costs, and above all the willingness and ability of the wildlife manager to operate and maintain any structural features that might be constructed.

Institutional Measures. A discussion of opportunities for fish and wildlife management would not be complete without mentioning some major institutional measures which should be considered for the protection of important habitats. From a resource management standpoint, the best situation is fee acquisition. Acquisition of land permits government agencies or private conservation organizations to protect resources that might otherwise be under pressure for development if left in the private sector. Acquisition also allows more freedom in implementing habitat management features that might not be economically feasible to private landowners. The drawback is that land acquisition is very expensive and often controversial, thus it is usually reserved for only the highest quality sites.

Conservation easements offer an alternative to fee acquisition, since they leave the land in private ownership while restricting certain types of development. This type of action is usually less expensive than acquisition, but may not always offer a comparable level of wildlife protection/management benefits. Conservation easements are normally acquired from "willing landowners" who often use the land as they have always done as long as it does not conflict with fish and wildlife conservation goals. This method is often valuable when management objectives are to try and protect large areas, or when fee acquisition may not be acceptable to the public.

Voluntary programs such as the Conservation Reserve Program (CRP) and Wetlands Reserve Program (WRP) offer payments to landowners for restoring and protecting valuable upland and wetland wildlife

habitats. These programs require either conservation agreements or long term easements on the part of the landowner. Specific information on these programs is available through the National Resources Conservation Service (formerly known as the Soil Conservation Service), Agricultural Stabilization and Conservation Service, or local conservation districts.

Regulatory programs are the least popular means for implementing habitat protection or restoration measures; however, they are often the only viable means of protecting important fish and wildlife resources since there simply is not enough public funding available to acquire fee title, conservation easements, or enroll landowners into all voluntary conservation programs. Examples of regulatory programs which are often used to protect important fish and wildlife resources include Section 10/404 of the Clean Water Act, State water rights permits, and local land use zoning regulations. Regulatory programs are essentially based on the Public Trust Doctrine, which holds that publicly-owned resources, such as fish and wildlife, water resources, etc., are entrusted to all people of the State and should be protected for the public good. Development actions which have the potential to impact publicly-owned fish and wildlife resources generally are expected to avoid or mitigate the impacts based on the expected level of damage to the resource.

Finally, the key to any successful program to protect or manage fish and wildlife resources is education. Numerous programs now exist at the Federal, State, and local level for education of the public on the values of fish and wildlife conservation, and it is extremely important that these and other programs continue to be funded at an acceptable level. In this regard, the community initiatives identified by Texas Parks and Wildlife Department and Congressman Chapman which target education and research training assistance needs, promotion of ecotourism, visitor information, and natural resource protection within the watershed are extremely important to the overall success of the watershed management study and should continue to receive priority consideration for funding.

SUMMARY AND CONCLUSIONS

This document summarizes information collected by FWS on the fish and wildlife resources of the Cypress watershed over the past decade during the course of various federal land and water resource project investigations. FWS studies have concentrated primarily on identifying and characterizing the structural components of the habitats and quantifying the value of the habitats to representative wildlife species using various habitat assessment methodologies.

This report also provides some preliminary recommendations on fish and wildlife management measures which should be considered during future detailed planning within the basin. These measures range

from preservation of the highest quality natural resources to restoration of degraded habitats. In addition, many opportunities are available to private landowners, agencies, and conservation organizations for the enhancement of existing fish and wildlife habitats, thereby contributing to the overall quality of fish and wildlife populations while providing additional opportunities for the public to enjoy those resources.

Fortunately for the basin's natural resources, most of the recent development projects which have been evaluated have not been constructed, thus many of the unique and valuable habitats of the basin have been spared significant adverse impacts. However, economic pressures will continue to mount for either public or private development of the natural resource base of the watershed, and data on the quality of resources will be necessary for natural resource managers and local officials to make informed decisions. Hopefully, the information and suggestions provided in this report, and the data currently being gathered by TPWD, Corps, Bureau of Reclamation, Caddo Lake Scholars and other parties, will contribute to the wise use and development of the Cypress watershed's natural resources.



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APPENDIX A

COMMON VEGETATION SPECIES OBSERVED IN HEP/BLH COMMUNITY
MODEL SAMPLE PLOTS

1. Wooded Swamp

baldcypress, *Taxodium distichum*
overcup oak, *Quercus lyrata*
persimmon, *Diospyros virginiana*
water locust, *Gleditsia aquatica*
water elm, *Planera aquatica*
swamp privet, *Forestiera acuminata*
buttonbush, *Cephalanthus occidentalis*
smartweed, *Polygonum spp.*
lizard tail, *Saururus cernuus*
arrowhead, *Sagittaria spp.*
snowbell, *Styrax americana*
sedges, *Carex spp.*
dayflower, *Commelina sp.*
St. Johnswort, *Hypericum sp.*
ferns

2. Shrub Swamp

baldcypress
overcup oak
sweetgum, *Liquidambar styraciflua*
water hickory (bitter pecan), *Carya aquatica*
river birch, *Betula nigra*
persimmon
water elm
swamp privet
buttonbush
sedges

3. Marsh

baldcypress
buttonbush
sedges
rushes, *Juncus spp.*
smartweed
maidencane, *Panicum hemitomon*
cattail, *Typha latifolia*
Southern wildrice (giant cutgrass), *Zizaniopsis miliacea*
American lotus, *Nelumbo lutea*
spatterdock, *Nuphar luteum*
frogbit, *Limnobium spongia*
water primrose, *Ludwigia spp.*
duckweed, *Lemna spp.*
coontail, *Ceratophyllum demersum*
chara, *Chara spp.*
hydrilla, *Hydrilla verticillata*
elodea, *Elodea canadensis*

4. Vegetated, Open Water

American lotus
spatterdock
pondweed, *Potamogeton* spp.
duckweed
fanwort, *Cabomba caroliniana*
coontail
elodea
hydrilla

5. Riverine/Stream

baldcypress
water hickory
overcup oak
water oak, *Quercus nigra*
willow oak, *Quercus phellos*
green ash, *Fraxinus pennsylvanica*
American elm, *Ulmus americana*
water elm
sweetgum
cottonwood, *Populus deltoides*
sycamore, *Platanus occidentalis*
black willow, *Salix nigra*
Bois d'Arc (osage orange), *Maclura pomifera*
persimmon
boxelder, *Acer negundo*
black locust, *Robina pseudo-acacia*
honey locust, *Gleditsia triacanthos*
sugarberry, *Celtis laevigata*
soapberry, *Sapindus drummondii*
Hercule's club, *Xanthoxylum clava-herculis*
eastern redcedar, *Juniperus virginiana*
swamp privet
water tupelo, *Nyssa aquatica*
buttonbush
hawthorn, *Crataegus* spp.
sesbania, *Sesbania* spp.
greenbriar, *Smilax* spp.
peppervine, *Ampelopsis arborea*
wild grape, *Vitis* spp.
cocklebur, *Xanthium chinense*
pigweed, *Amaranthus* spp.
smartweed
Hibiscus, *Hibiscus* sp.
sedges
spikesedge, *Eleocharis* spp.
water primrose
heliotrope, *Heliotropium* sp.
toothcup, *Rotala ramosior*
panicgrass, *Panicum* spp.

6. Bottomland Hardwood Forest

water oak
willow oak
overcup oak
southern red oak, *Quercus falcata falcata*
cherrybark oak, *Quercus falcata pagodaefolia*
white oak, *Quercus alba*
post oak, *Quercus stellata*
baldcypress
black gum, *Nyssa sylvatica*
water hickory
mockernut hickory, *Carya tomentosa*
sweetgum
green ash
water elm
American elm
winged elm, *Ulmus alata*
slippery elm, *Ulmus rubra*
basswood, *Tilia caroliniana*
red mulberry, *Morus rubra*
loblolly pine, *Pinus taeda*
river birch
red maple, *Acer rubrum*
boxelder
sugarberry
persimmon
water locust
black locust
hophornbeam, *Ostrya virginiana*
American hornbeam, *Carpinus caroliniana*
gum bumelia, *Bumelia sp.*
chinkapin, *Castanea sp.*
waxmyrtle, *Myrica cerifera*
swamp privet
buttonbush
hawthorns
buckeye, *Aesculus glabra*
fringetree, *Chionanthus virginica*
sweetleaf, *Symplocos tinctoria*
American holly, *Ilex opaca*
deciduous holly, *Ilex decidua*
American beautyberry, *Callicarpa americana*
greenbriar
dewberry
Virginia creeper, *Parthenocissus quinquefolia*
poison ivy, *Rhus radicans*
Japanese honeysuckle, *Lonicera japonica*
wild grape
rattan vine (Alabama supplejack), *Berchemia scandens*
peppervine
inland seaoats, *Chasmanthium spp.*
sedges

smartweed
panicgrasses
burhead
elephantfoot, *Elephantopus sp.*
lizard tail
false nettle, *Boehmeria sp.*
sugarcane plumegrass, *Erianthus giganteus*

7. Upland Hardwood Forest

Post oak
Blackjack oak, *Quercus marilandica*
loblolly pine
hickory
yaupon, *Ilex vomitoria*
deciduous holly
American beautyberry
sumac, *Rhus spp.*
hawthorn
farkleberry, *Vaccinium arboreum*
rattan vine
greenbriar
dewberry, *Rubus sp.*
wild grape

8. Mixed Pine-Hardwood Forest

loblolly pine
sweetgum
southern red oak
cherrybark oak
white oak
willow oak
water oak
post oak
sugarberry
hickory
black gum
red maple
green ash
dogwood, *Cornus sp.*
eastern redcedar
winged elm
chinkapin
American hornbeam
red mulberry
American beautyberry
sumac
coralberry, *Symphoricarpus orbiculatus*
waxmyrtle
farkleberry
yaupon

deciduous holly
black cherry, *Prunus serotina*
sweetleaf
peppervine
poison ivy
dewberry
Japanese honeysuckle
greenbriar
wild grape

9. Pine Plantation

loblolly pine
sweetgum
hickory
sumac
dewberry
greenbriar

10. Shrubland/Regeneration

loblolly pine
sweetgum
willow oak
water oak
hickory
buttonbush
sumac
dewberry
greenbriar
tickclover, *Desmodium spp.*
partridge pea, *Cassia fasciculata*
doveweed, *Croton spp.*
sunflower, *Helianthus spp.*
goldenrod, *Solidago sp.*
ragweed, *Ambrosia spp.*

11. Grassland

common and coastal bermudagrass, *Cynodon dactylon*
dallisgrass, *Paspalum dilatatum*
bahiagrass, *Paspalum notatum*
lovegrass, *Eragrostis spp.*
ryegrass, *Lolium perenne*
big bluestem, *Andropogon gerardii*
broomsedge bluestem, *Andropogon virginicus*
little bluestem, *Schizachyrium scoparium*
Indiangrass, *Sorghastrum elliottii*
switchgrass, *Panicum virgatum*
panicgrasses
foxtail, *Setaria spp.*
doveweed

ragweed
dogfennel, *Anthemis cotula*
lespedezas, *Lespedeza* spp.
clovers, *Trifolium* spp.
vetch, *Vicia* spp.
Illinois bundleflower, *Desmanthus illinoensis*
greenbriar
dewberry
sensitive briar, *Schrankia* sp.

12. Cropland

cotton, *Gossypium hirsutum*
grain sorghum, *Sorghum* spp.
wheat, *Triticum aestivum*
barley, *Hordeum vulgare*
oats, *Avena sativa*
corn, *Zea mays*
peanuts, *Arachis hypogaea*
soybeans, *Glycine max*
watermelons, *Citrullus vulgaris*
Johnsongrass, *Sorghum halepense*
pigweed
giant ragweed, *Ambrosia trifida*
pecan orchards
peach orchards

APPENDIX B
PHOTOGRAPHS OF WILDLIFE HABITAT COVER-TYPES
IN THE
CYPRESS BAYOU WATERSHED



Wooded (baldcypress) swamp habitat cover-type.



Shrub swamp cover type dominated by water elm/buttonbush.



Marsh on Caddo Lake dredged material dominated by cattail and maidencane.



Marsh dominated by sedges, water primrose, and other emergents.



Vegetated, open water habitat cover-type of Caddo Lake.



Riverine habitat of Little Cypress Bayou.



Bottomland hardwood forest - willow oak dominant overstory species.



Bottomland hardwood forest - overcup oak flat.



Upland hardwood forest cover-type.



Mixed pine-hardwood forest cover-type.



Pine plantation cover-type.



Shrubland/regeneration cover-type.



Grassland dominated by native grasses.



Grassland consisting of introduced pasture grasses used for hay production.

APPENDIX C

**PRIORITY BOTTOMLAND HARDWOOD PRESERVATION SITES
IN THE
CYPRESS BAYOU WATERSHED**

NAME OF AREA: Caddo Lake
COUNTY(s): Marion, Harrison
RIVER BASIN: Cypress
TOTAL ACRES: 12,800

SITE I.D.: C-4

LATITUDE/LONGITUDE: 32°43'-46'/94°05'-10'
QUAD REFERENCE: Smithland, Karnack, Trees,
Potters Point -7.5'

1. Habitat Types (by Percent):

Open Water -	13%
Aquatic Beds -	1%
Broad- & Narrow-leaf Deciduous Bottomland Forest: Temporarily Inundated -	10%
Needle- & Broad-leaf Deciduous Hardwood Bottomland Forest: Seasonally Inundated (i.e., Cypress-Tupelo) -	21%
Shrub Swamp -	2%
Marshes (Emergent and Persistent Vegetation) -	1%
Other (Agriculture, Pine, Upland, etc.) -	53%

2. Waterfowl Value (High, Medium, Low):

A. Wintering - Medium	B. Production - High to Medium
-----------------------	--------------------------------

3. Hydrological Regime: Favorable. Stable water levels for long period of time. The only large, natural lake in the State of Texas (natural logjam dam has been upgraded by Corps of Engineers). Fed by Big Cypress, Black Cypress, and Little Cypress. Numerous tributaries and sloughs.

4. Value to Engangered Species or State Species of Special Concern: Yes, American alligators and probably several other species.

5. Special Rocognition Species Values (High, Medium, Low):

White-tailed Deer - High	Squirrels - High
Furbearers - High	Turkey - High to Medium
Colonial Waterbirds - Medium to High	Raptors - High
Other Migratory Birds - High	

6. Development Needs (High, Medium, Low): Low

7. Facilitate Administration of Similar Management Units: Yes, Caddo State Park, Texas Parks and Wildlife Department Wildlife Management Area, natural Area on Longhorn Army Ammunition Plant, and Corps of Engineers lands on Caddo Lake.

8. Ownership (Number by Category and Acreage):

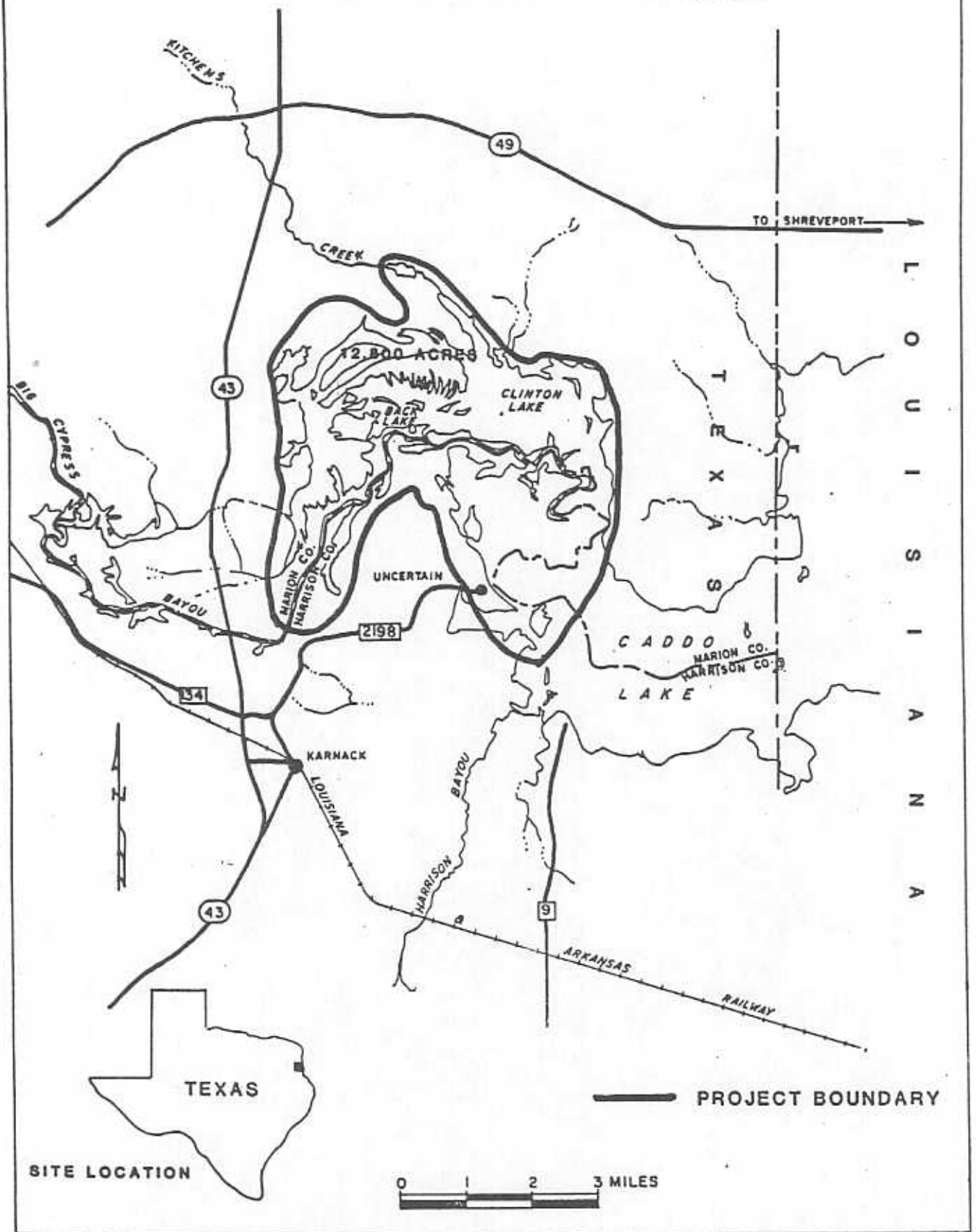
Approx. 5* Private	- _____ acres	*A few other small owners, but majority owned by five owners.
1 State	- _____ acres	
Federal	- _____ acres	
Total Ownerships	- 28,272 acres	

9. Degree and Type of Threat to Habitat (Imminent, Near-Term, Far-Term, Protected): Near-Term. Clearing for development. Small portion protected by Texas Parks and Wildlife Department.

10. Comments: Cypress swamps are dominant vegetation type. Other bottomlands contain willow, water, and overcup oak, and sweetgum. Marshes and shrub swamps are also present. More uplands are present on this area than others. Sources of additional information - University of Texas at Austin (1977) and Walker (1983).

CADDO LAKE

MARION & HARRISON COUNTIES, TEXAS



NAME OF AREA: Black Cypress Creek
COUNTY(s): Cass, Marion
RIVER BASIN: Cypress
TOTAL ACRES: 12,800

SITE I.D.: C-1

LATITUDE/LONGITUDE: 32°50'-58'/94°23'-29'
QUAD REFERENCE: Kellyville, Cunningham Creek -7.5'

1. Habitat Types (by Percent):

Open Water -	2%
Aquatic Beds -	1%
Broad- & Narrow-leaf Deciduous Bottomland Forest: Temporarily Inundated -	57%
Needle- & Broad-leaf Deciduous Hardwood Bottomland Forest: Seasonally Inundated (i.e., Cypress-Tupelo) -	8%
Shrub Swamp -	2%
Marshes (Emergent and Persistent Vegetation) -	1%
Other (Agriculture, Pine, Upland, etc.) -	30%

2. Waterfowl Value (High, Medium, Low):

A. Wintering - High	B. Production - High
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3. Hydrological Regime: Very Favorable. No upstream reservoirs, numerous tributaries, and sloughs. Frequent flooding. Beavers present.

4. Value to Endangered Species or State Species of Special Concern: Yes, American alligators and probably several other species; formerly black bear.

5. Special Recognition Species Values (High, Medium, Low):

White-tailed Deer	- High
Furbearers	- High
Squirrel	- High
Turkey	- High to Medium
Raptors	- High
Colonial Waterbirds	- Medium to High
Other Migratory Birds	- High

6. Development Needs (High, Medium, Low): Low

7. Facilitate Administration of Similar Management Units: No

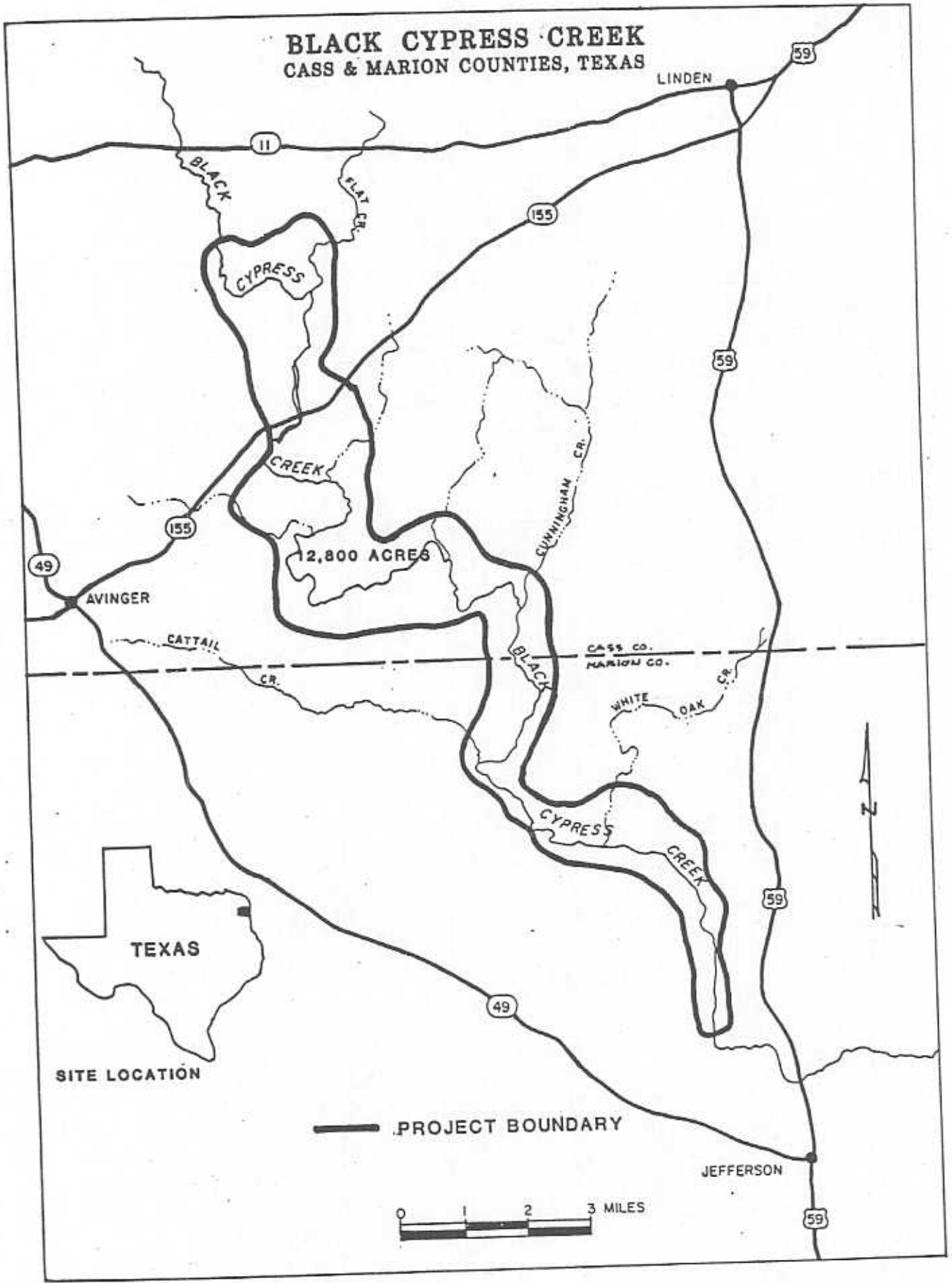
8. Ownership (Number by Category and Acreage):

*2+ Private - _____ acres	*Other small ownerships, but majority owned by two timber companies
_____ State - _____ acres	
_____ Federal - _____ acres	
Total _____ 2+ Ownerships - _____ acres	

9. Degree and Type of Threat to Habitat (Imminent, Near-Term, Far-Term, Protected): Near-Term. Reservoir projects, timber production, and development.

10. Comments: Area is very diverse with high quality water oak, willow oak, overcup oak, and red oak mixed with sweetgum, black gum, river birch, ironwood, and mayhaw. Several significant cypress stands also.

BLACK CYPRESS CREEK CASS & MARION COUNTIES, TEXAS



NAME OF AREA: Big Cypress Bayou
COUNTY(s): Marion, Harrison
RIVER BASIN: Cypress
TOTAL ACRES: 5,350

SITE I.D.: C-3

LATITUDE/LONGITUDE: 32°43'-46'/94°08'-15'
QUAD REFERENCE: Karnack, Woodlawn -7.5'

1. Habitat Types (by Percent):

Open Water -	4%
Aquatic Beds -	1%
Broad- & Narrow-leaf Deciduous Bottomland Forest: Temporarily Inundated -	13%
Needle- & Broad-leaf Deciduous Hardwood Bottomland Forest: Seasonally Inundated (i.e., Cypress-Tupelo) -	45%
Shrub Swamp -	1%
Marshes (Emergent and Persistent Vegetation) -	1%
Other (Agriculture, Pine, Upland, etc.) -	35%

2. Waterfowl Value (High, Medium, Low):
A. Wintering - Medium B. Production - Medium

3. Hydrological Regime: Less favorable than other portions of the system (i.e., downstream from Lake O'The Pines and at headwaters of Caddo Lake). However, does have major tributaries (Black Cypress and Little Cypress) feeding into site just upstream of project area.

4. Value to Endangered Species or State Species of Special Concern: Yes, American alligator.

5. Special Recognition Species:

White-tailed Deer	- Medium
Furbearers	- High
Squirrels	- High
Turkey	- Probably medium to low
Raptors	- Medium
Colonial Waterbirds	- Medium
Other Migratory Birds	- High

6. Development Needs (High, Medium, Low): Medium

7. Facilitate Administration of Similar Management Units: Yes, Caddo Lake State Park, other Texas Parks and Wildlife Department lands on Caddo Lake, natural area on Longhorn Army Ammunition Plant, and Corps of Engineers lands on Caddo Lake.

8. Ownership (Number by Category and Acreage):

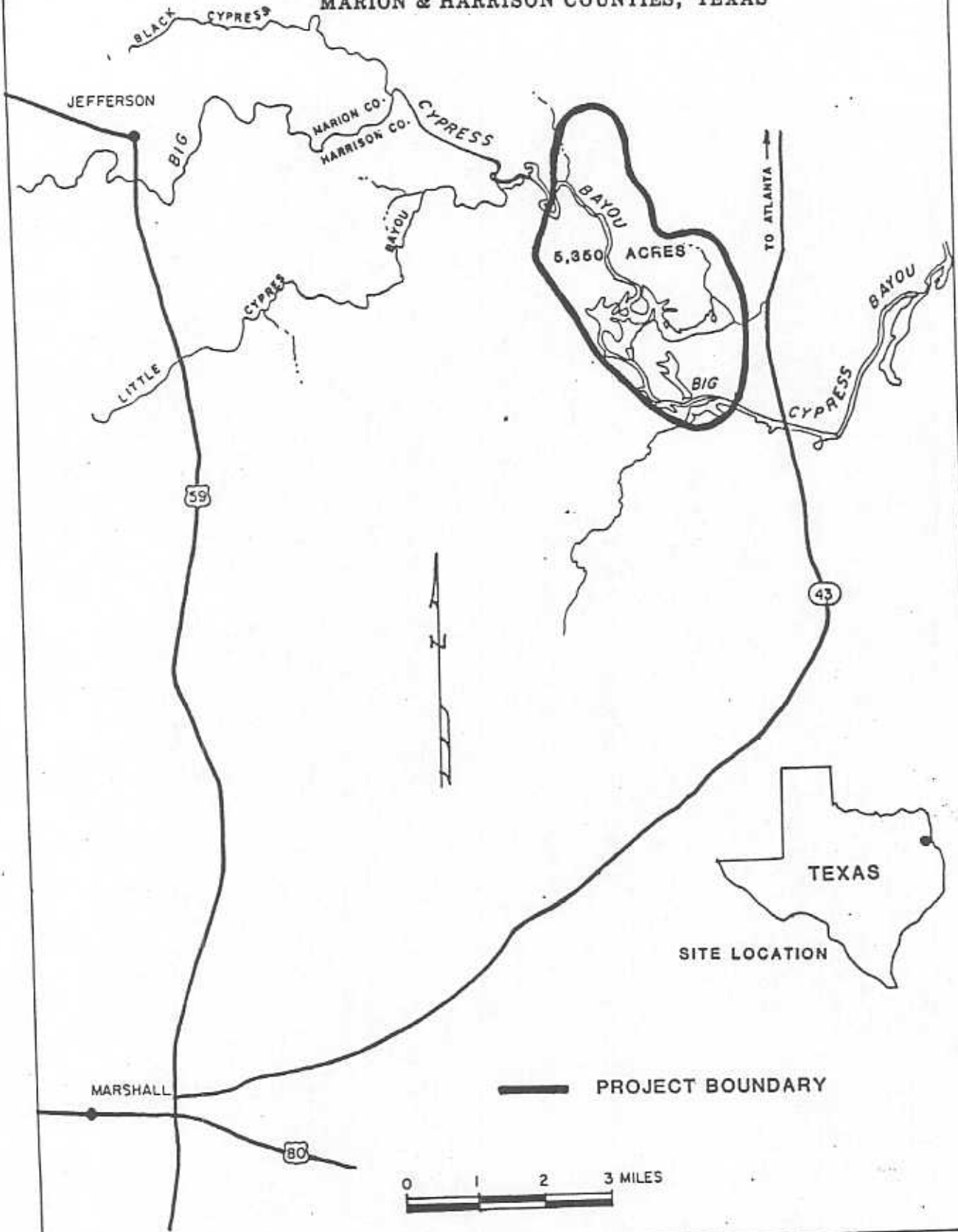
— Private	-	_____	acres
— State	-	_____	acres
— Federal	-	_____	acres
Total	—	_____	Ownerships - _____ acres

9. Degree and Type of Threat to Habitat (Imminent, Near-Term, Far-Term, Protected): Near-Term. Increased clearing for development.

10. Comments: More highly modified (due to homesite development) than other Cypress System sites.

BIG CYPRESS BAYOU

MARION & HARRISON COUNTIES, TEXAS



NAME OF AREA: Little Cypress Bayou
COUNTY(s): Marion, Harrison
RIVER BASIN: Cypress
TOTAL ACRES: 5,452

SITE I.D.: C-2

LATITUDE/LONGITUDE: 32°37'-43'/94°21'-27'
QUAD REFERENCE: Woodlawn, Marshall -7.5'

1. Habitat Types (by Percent):

Open Water -	4%
Aquatic Beds -	1%
Broad- & Narrow-leaf Deciduous Bottomland Forest: Temporarily Inundated -	64%
Needle- & Broad-leaf Deciduous Hardwood Bottomland Forest: Seasonally Inundated (i.e., Cypress-Tupelo) -	3%
Shrub Swamp -	1%
Marshes (Emergent and Persistent Vegetation) -	2%
Other (Agriculture, Pine, Upland, etc.) -	25%

2. Waterfowl Value (High, Medium, Low):
A. Wintering - Medium B. Production - Medium

3. Hydrological Regime: Favorable. Probably is regularly flooded. Several major tributaries and sloughs.

4. Value to Endangered Species or State Species of Special Concern: Yes, American alligator and possibly others.

5. Special Recognition Species Values (High, Medium, Low):

White-tailed Deer	- High
Furbearers	- High
Squirrels	- High
Turkey	- Medium
Raptors	- Medium
Colonial Waterbirds	- Medium
Other Migratory Birds	- High

6. Development Needs (High, Medium, Low): Low

7. Facilitate Administration of Similar Mangement Units: No

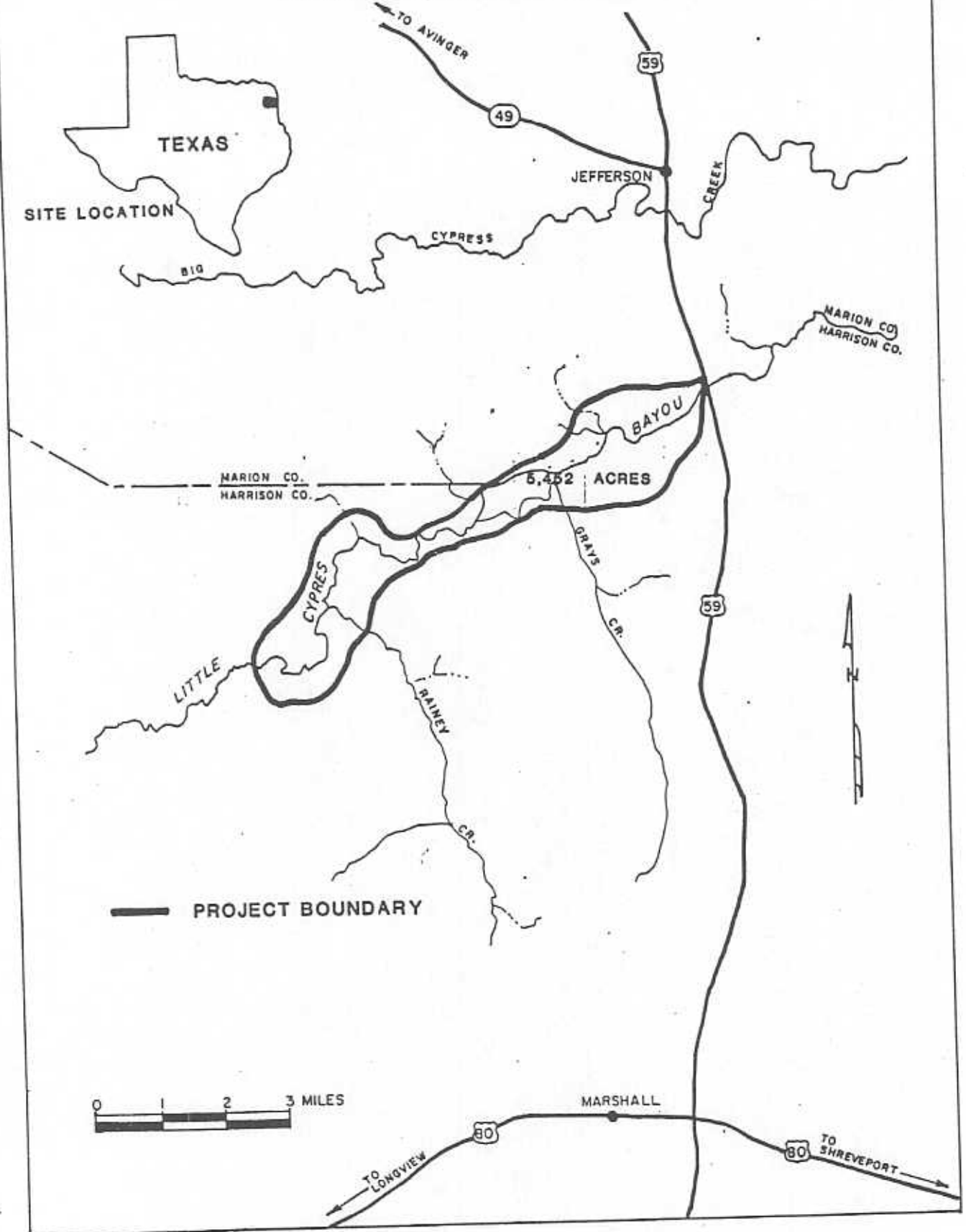
8. Owership (Number by Category and Acreage):

Private	-	_____	acres
State	-	_____	acres
Federal	-	_____	acres
Total	_____	_____	acres

9. Degree and Type of Threat to Habitat (Imminent, Near-Term, Far-Term, Protected): Near-Term. Increased clearing for development and pasture. Possible reservoir project.

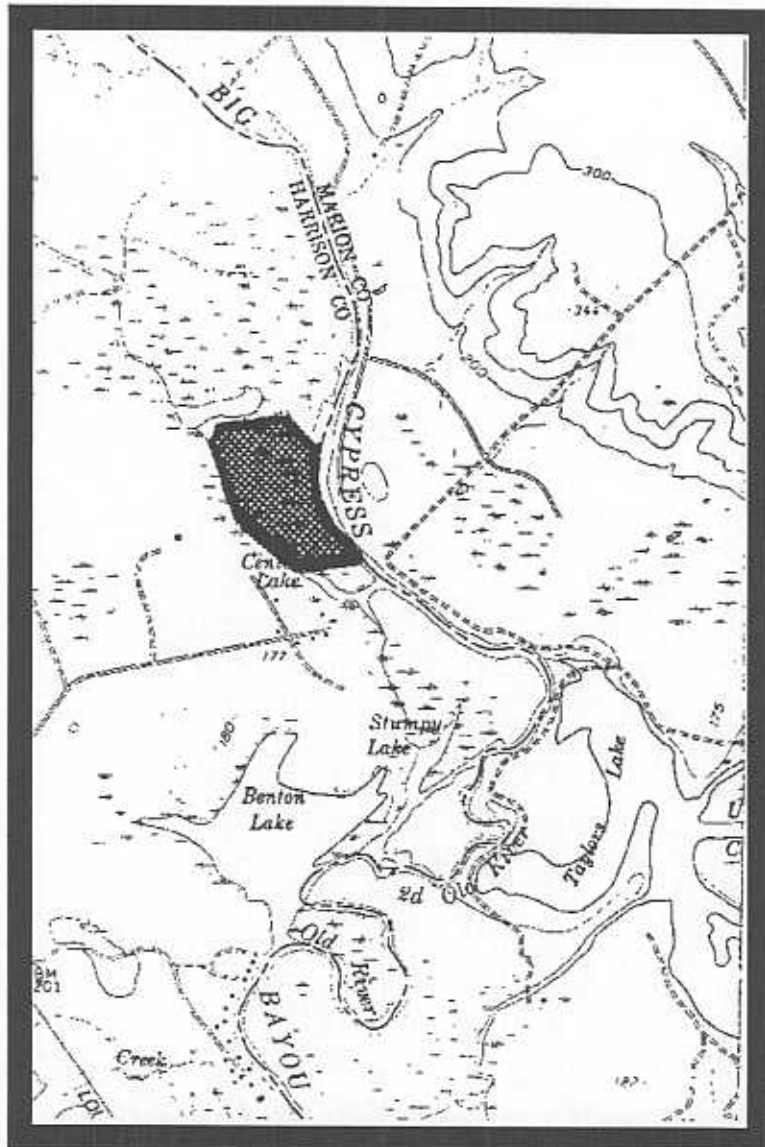
10. Comments: Area highly variable (good to poor quality). Very narrow bottomlands.

LITTLE CYPRESS BAYOU HARRISON & MARION COUNTIES, TEXAS

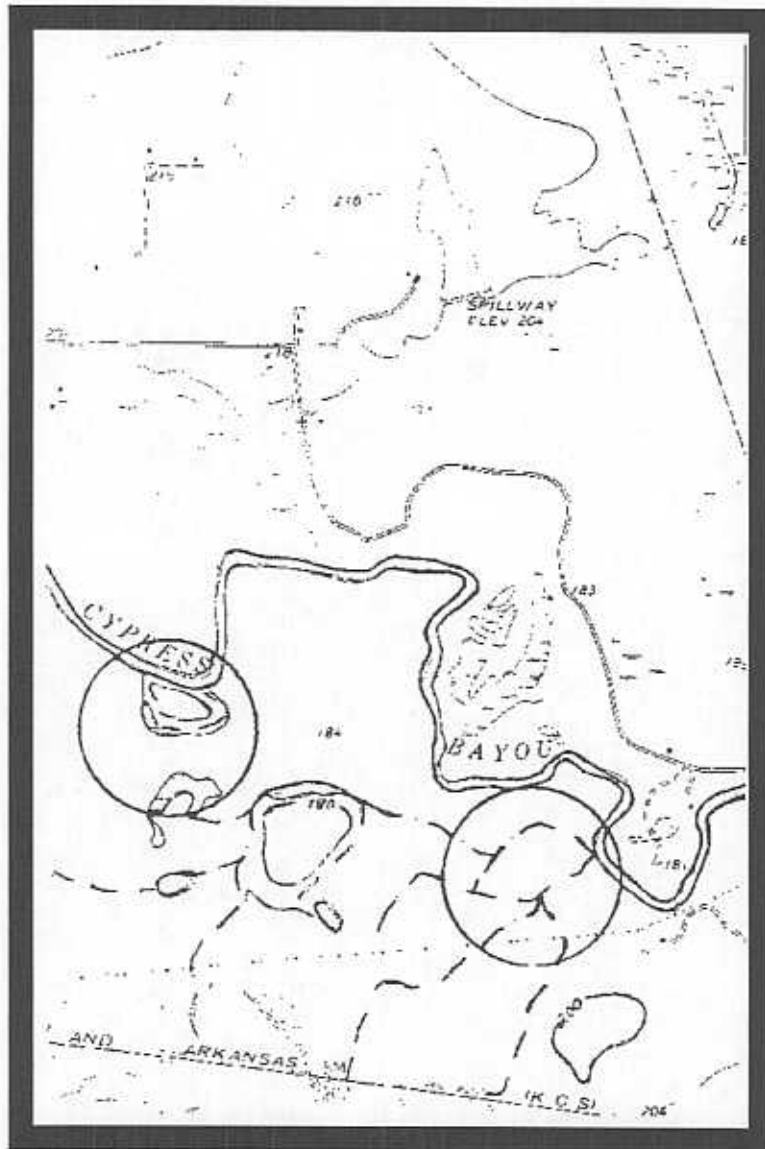


APPENDIX D

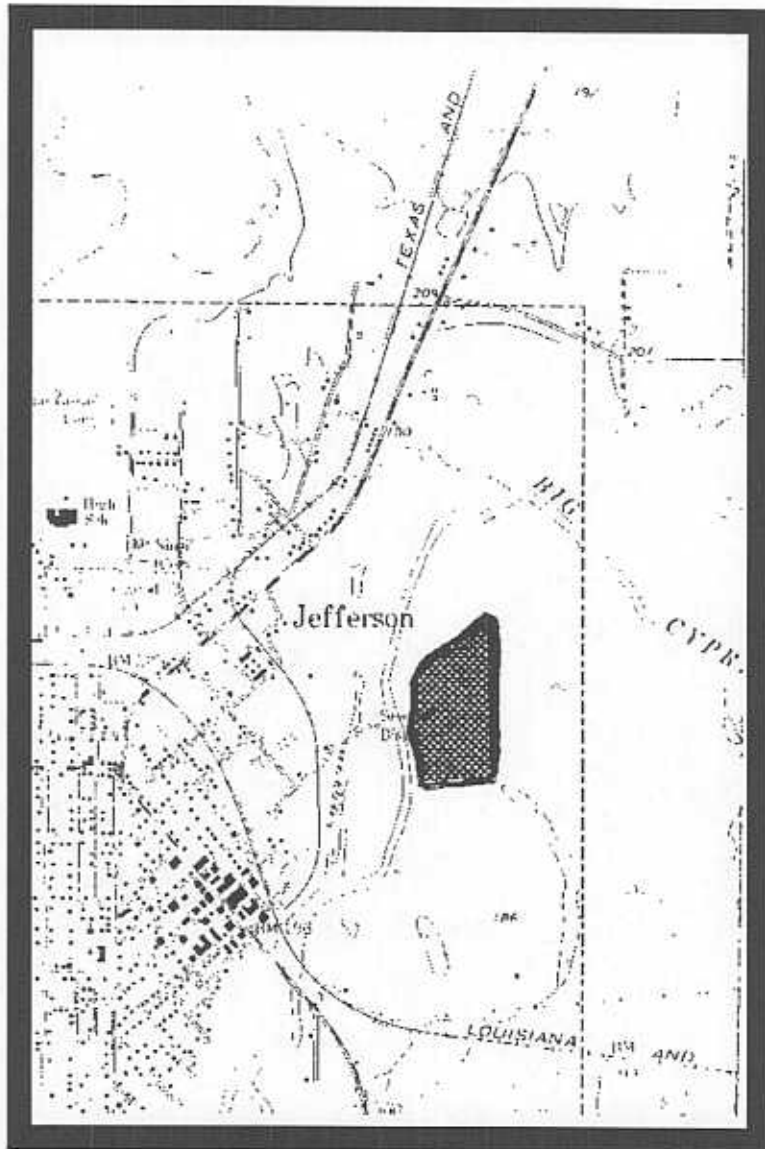
**REPRESENTATIVE SITES WITHIN THE CYPRESS WATERSHED
OFFERING RESTORATION/ENHANCEMENT POTENTIAL**



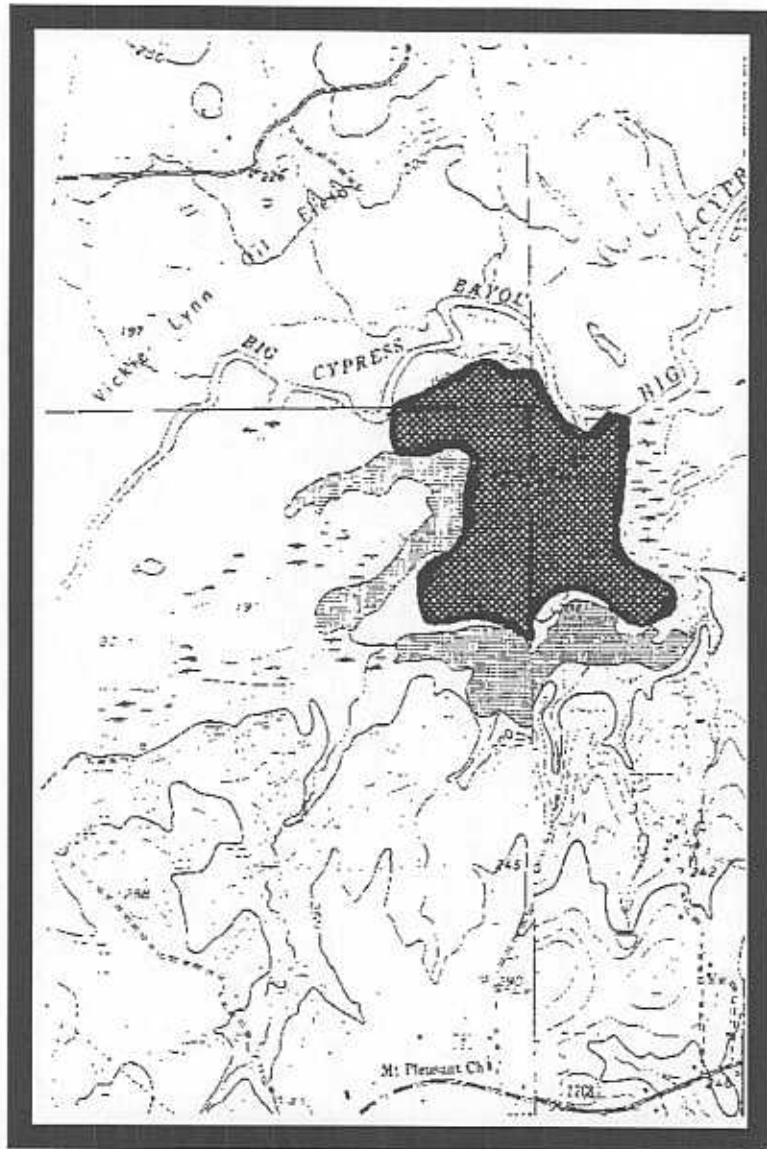
Site 1. Clearcut bottomland hardwoods adjacent to Big Cypress Bayou, north of Centel Lake.



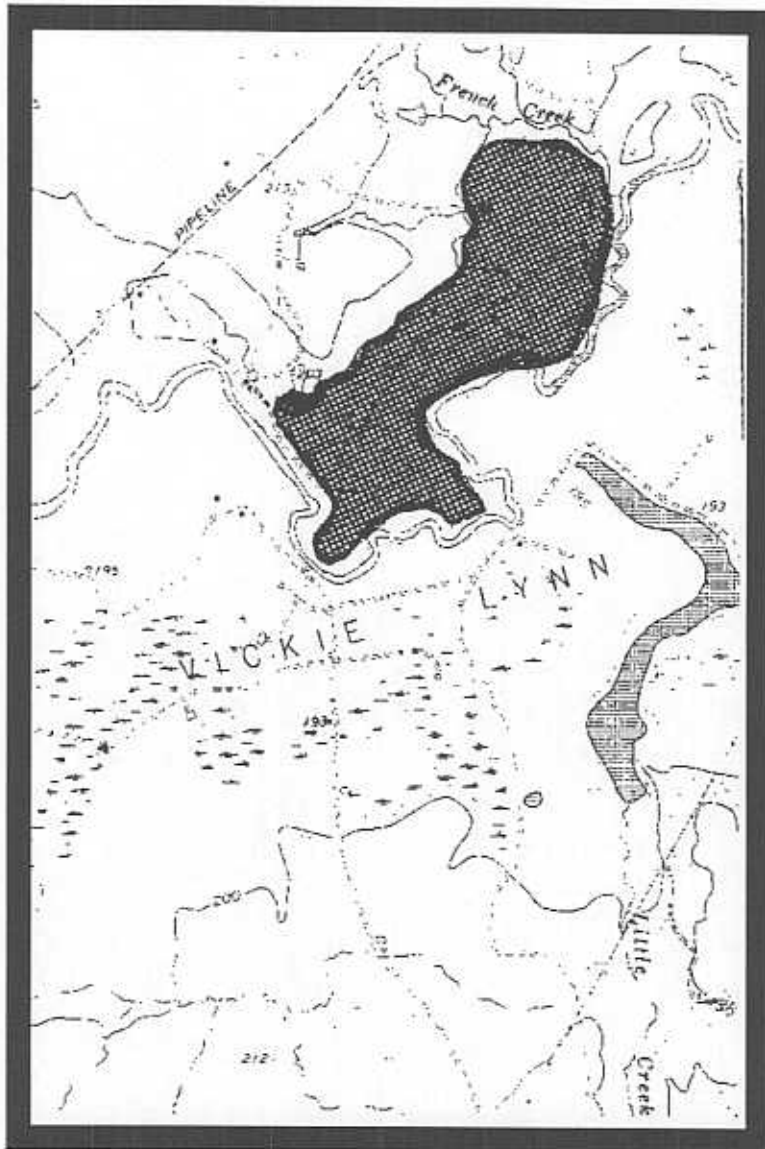
Site 2. Oxbows, sloughs, and tributaries to Big Cypress Bayou between Jefferson and confluence of Black Cypress Bayou.



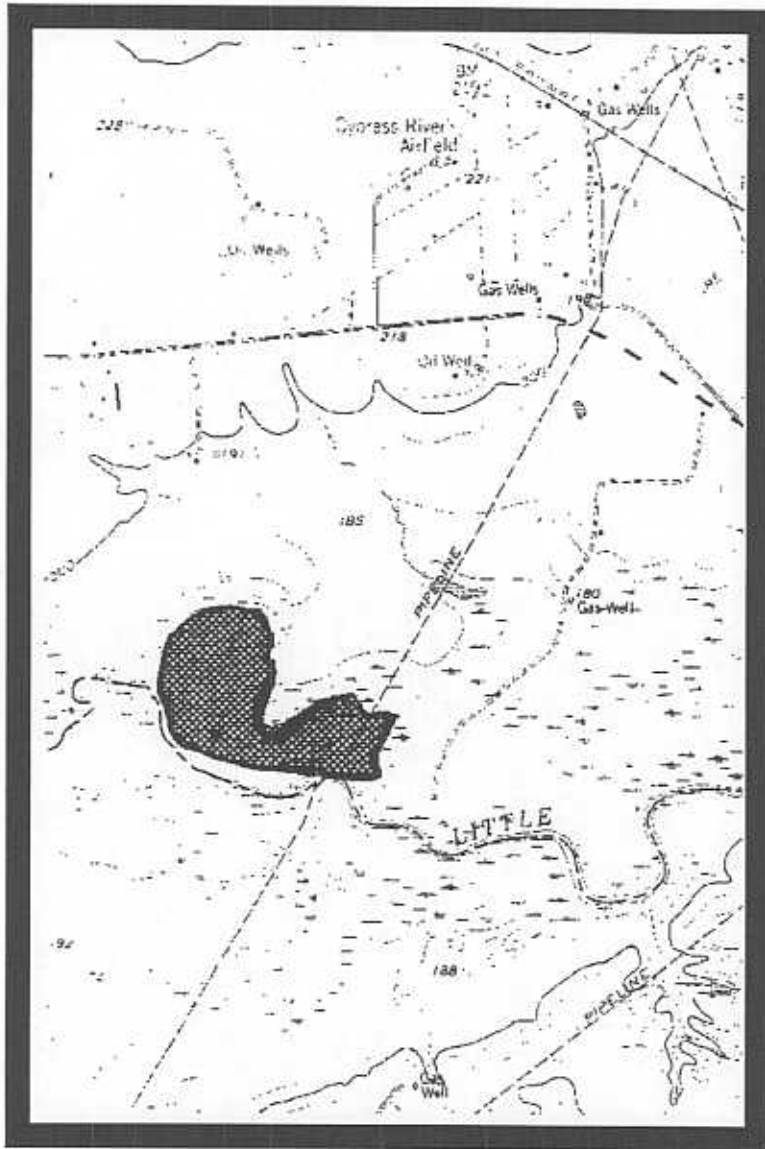
Site 3. Clearcut bottomland hardwood and pine-hardwood forests at Jefferson.



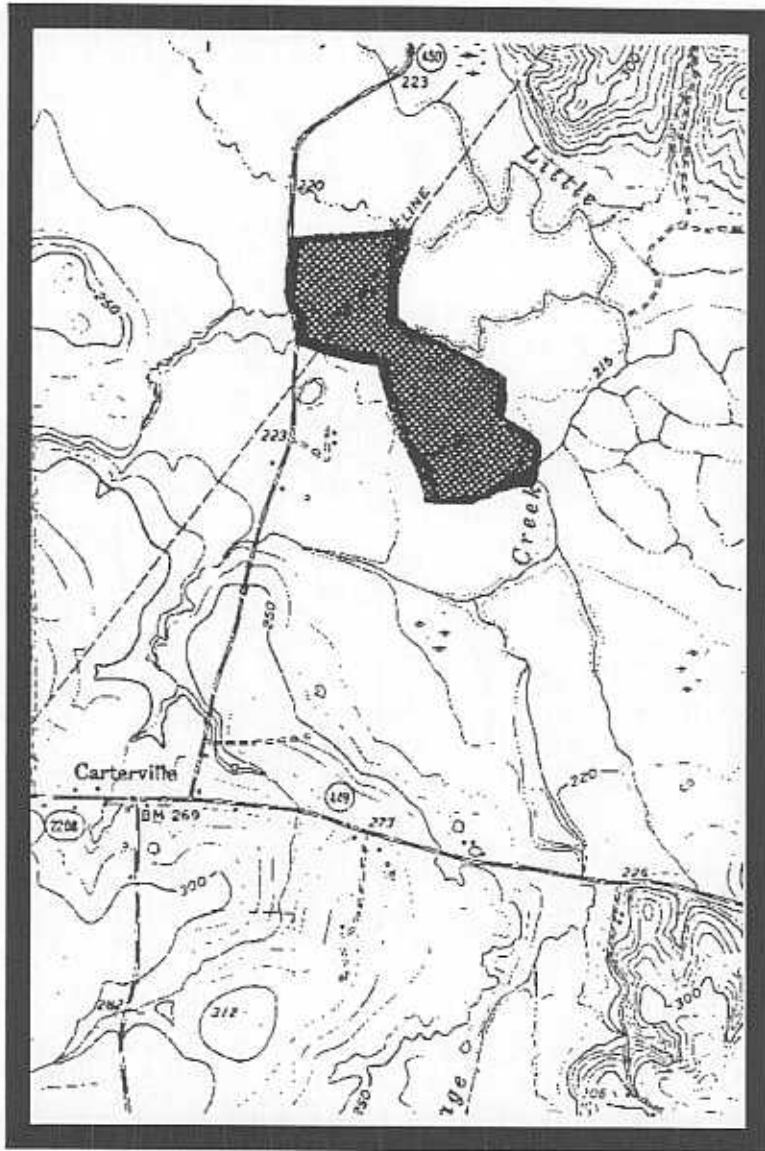
Site 4. Clearcut and pastureland sites between Big Cypress Bayou and oxbow lakes, southwest of Jefferson.



Site 5. Clearcut bottomlands and pine-hardwoods, north of Big Cypress Bayou at French Creek.



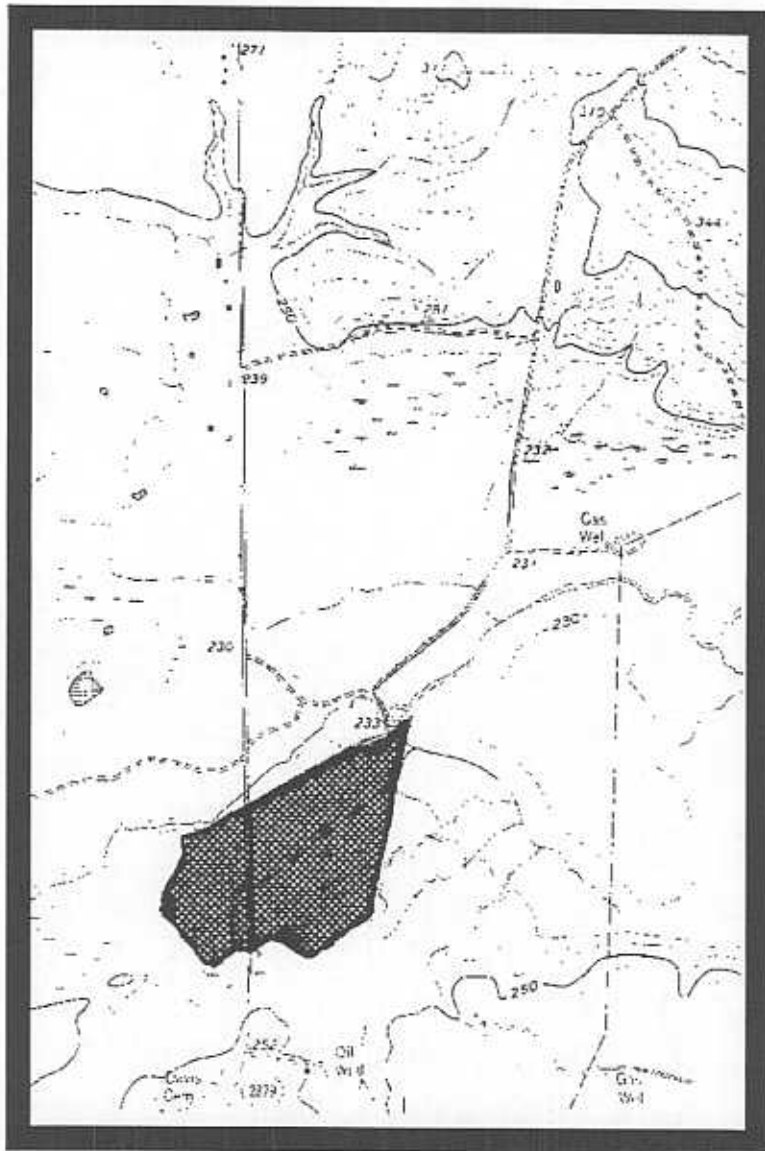
Site 6. Clearcut bottomlands, north of Little Cypress Bayou near Highway 134.



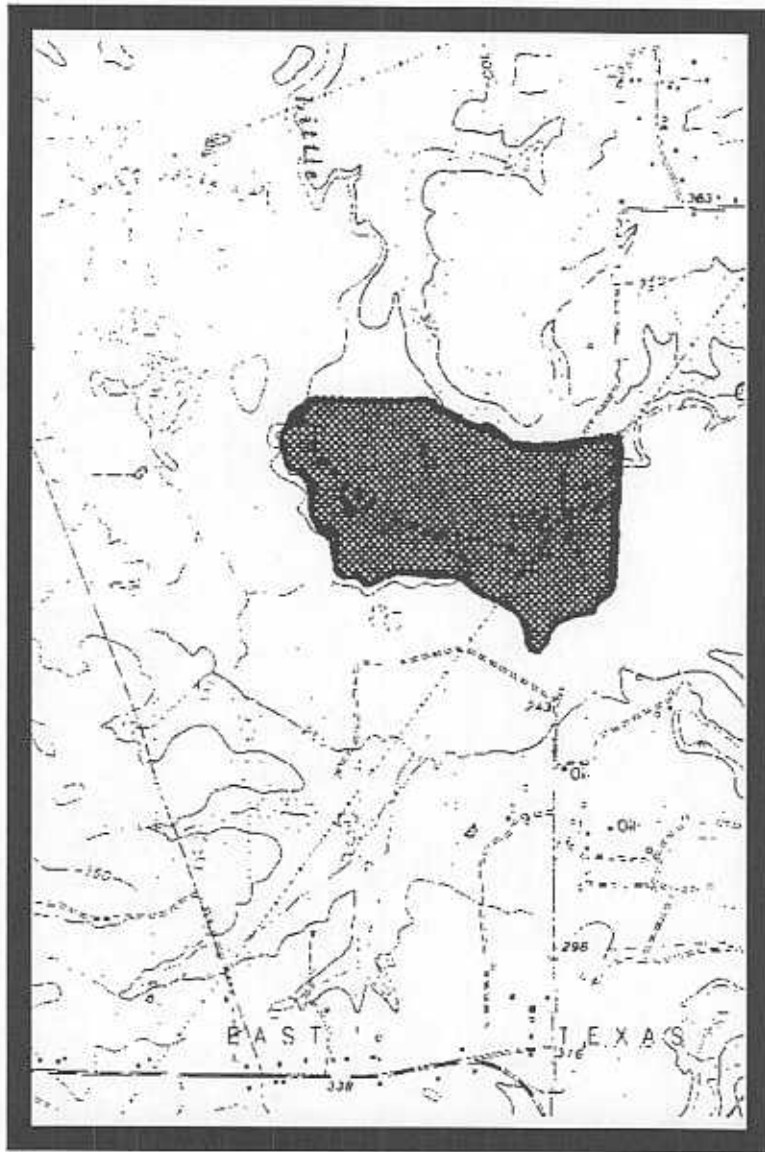
Site 7. Clearcut bottomlands and pasture sites, south of Little Cypress Bayou at Highway 450.



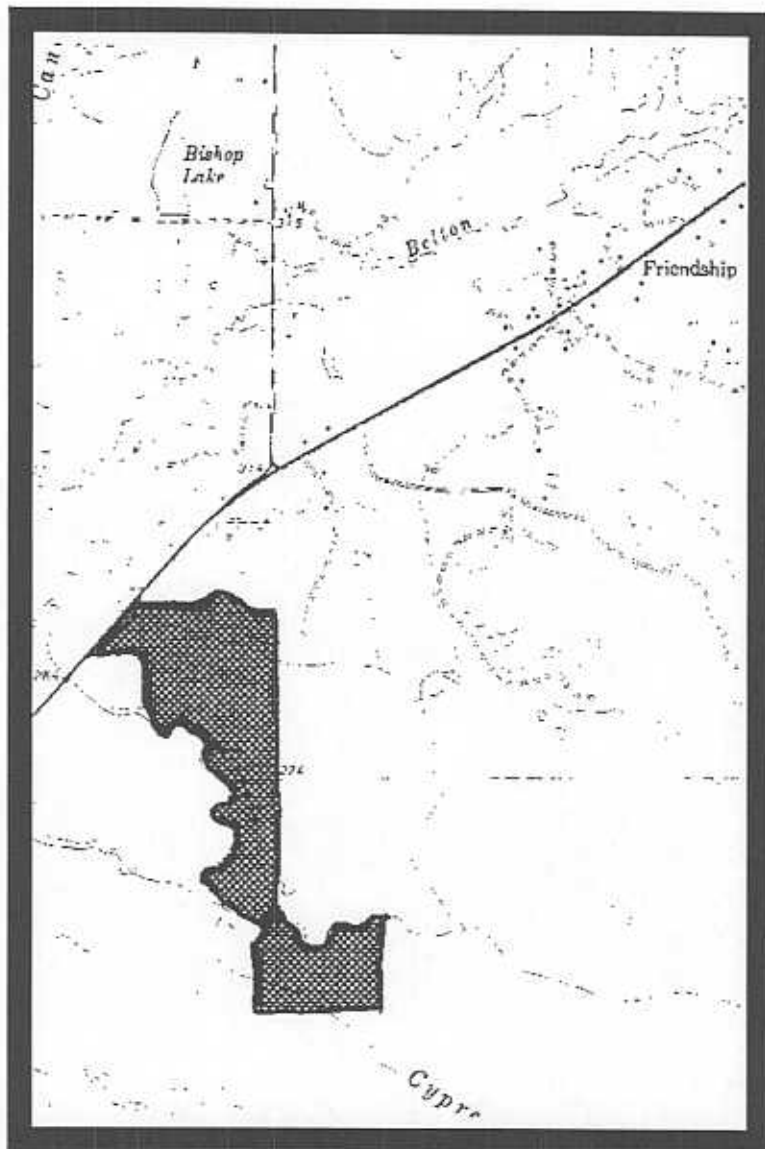
Site 8. Bottomland site between Little Cypress Bayou and Moccasin Creek.



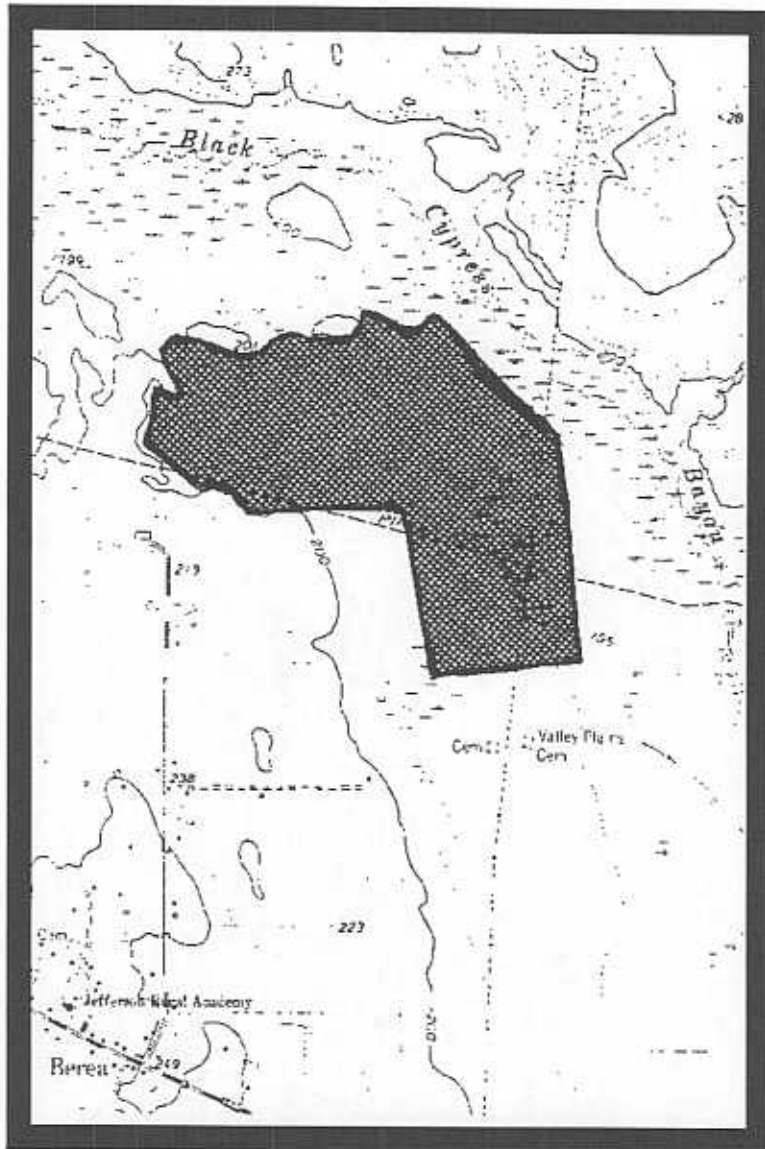
Site 9. Bottomlands along Little Cypress Bayou at Highway 2879.



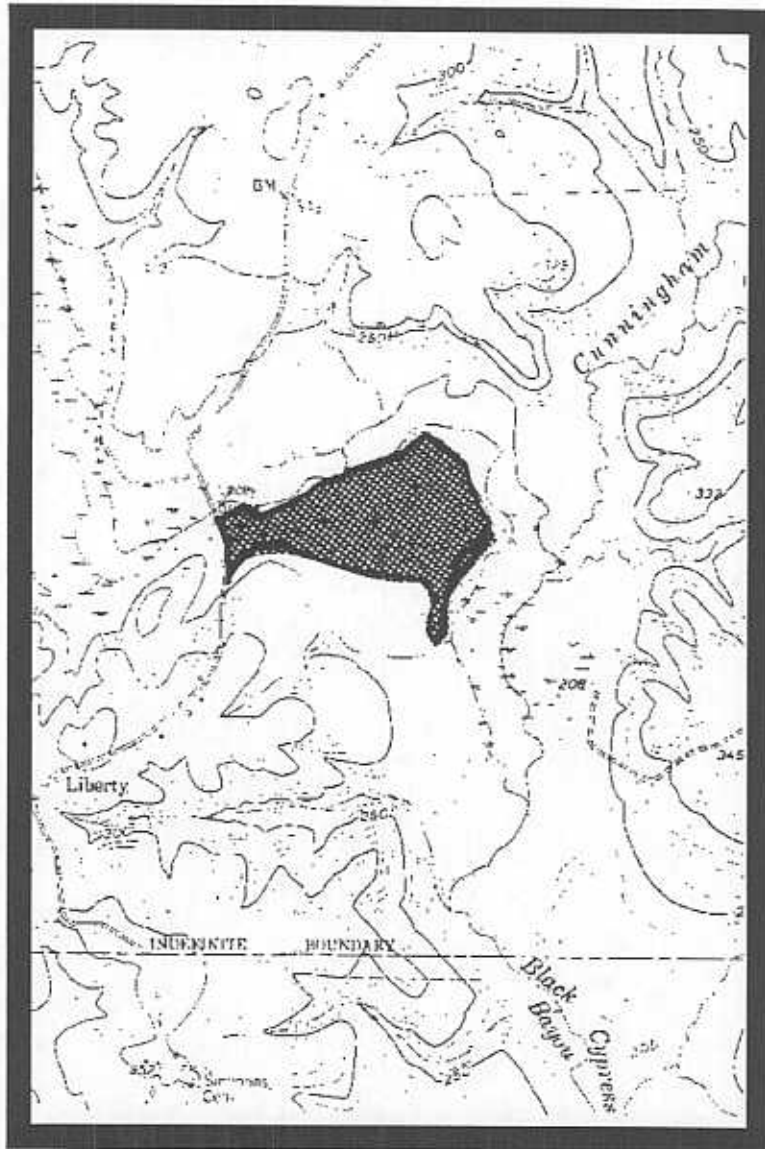
Site 10. Bottomland site on Little Cypress Bayou, west of Highway 259.



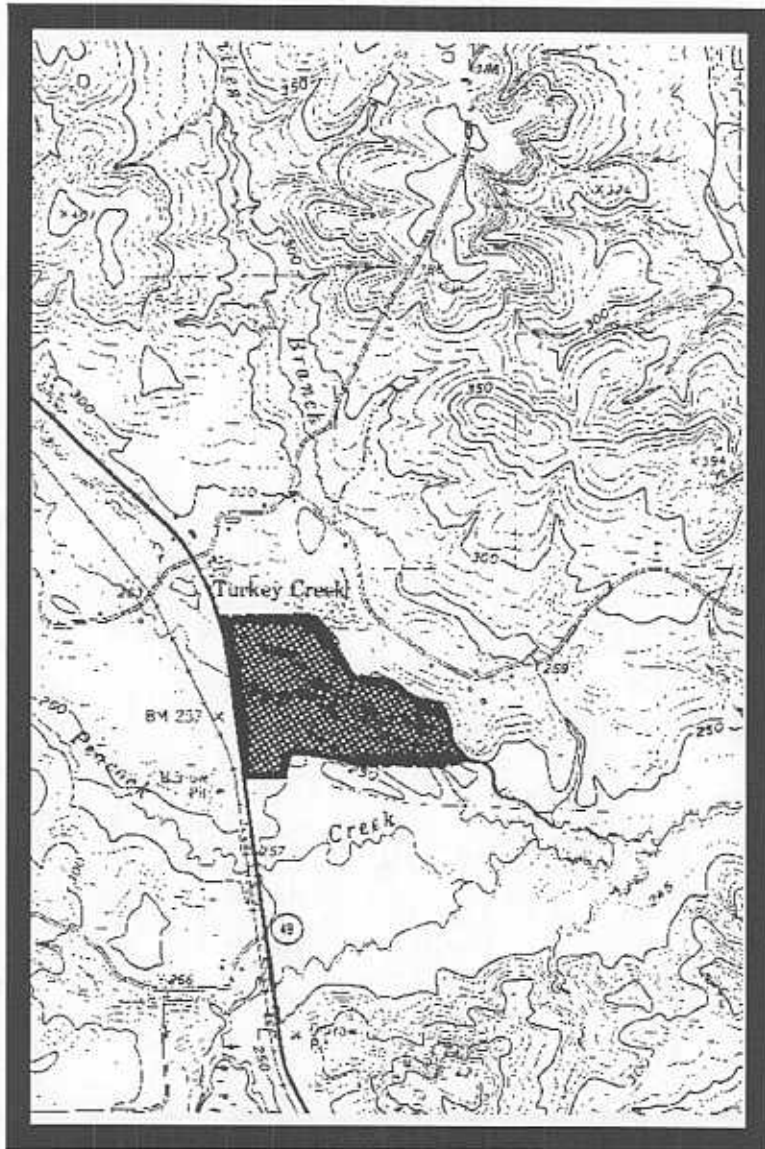
Site 11. Clearcut bottomlands and pasture sites along Little Cypress Bayou, south of Highway 155, northeast of Gilmer.



Site 12. Bottomland and pasture sites, south of Black Cypress Bayou, north of Berea.



Site 13. Bottomland and pasture sites along Black Cypress Bayou at Cunningham Creek.



Site 14. Cleared bottomlands and pasture sites along Turkey Creek, east of Highway 49, north of Avinger.

APPENDIX E
PARTNERS FOR WILDLIFE PROJECTS
WITHIN THE
CYPRESS WATERSHED

Partners For Wildlife
Restoration Sites
in the
Cypress Bayou Basin Watershed, Texas

Property or Site Name: Mac Abney Project Date: January 10, 1995

Location (county, sub-basin, stream, etc.; attach county map noting exact location of site):

Harrison County - Designated as No. 1 on attached county map.

Restoration Measures Installed:

Installed two (2) diversion levees with water-level control devices to control depth and duration of impoundment. Structures will impound no more than 4.5 feet of water at maximum depth. Water will be drawn down seasonally to promote hydrophytic vegetation. Some permanent water will remain, unless evaporated, to provide semi-permanent to permanent water for endemic wildlife.

Total Project Size: 87 acres

Total Project Cost: \$12,857

Total Length of Partners Agreement: 20 years

Project Status (complete, under construction, planning, etc.):
Complete

Additional Comments (if any):

Partners For Wildlife
Restoration Sites
in the
Cypress Bayou Basin Watershed, Texas

Property or Site Name: Glen Brown Project Date: January 10, 1995

Location (County, sub-basin, stream, etc.; attach county map noting exact location of site):

Harrison County - Designated as No. 2 on attached county map.

Restoration Measures Installed:

Installed two (2) diversion levees with water-level control devices to control depth and duration of impoundment for greentree reservoirs. Structures will impound no more than 3 feet of water at maximum depth. Water will be drawn down seasonally to promote hydrophytic vegetation. Some permanent water will remain, unless evaporated, to provide semi-permanent to permanent water for endemic wildlife.

An additional greentree reservoir is planned for downstream area. This project will involve similar measures. Specifics are unknown but are in planning stage.

Total Project Size: 45 acres in two existing greentree reservoirs; Unknown for additional greentree reservoir.

Total Project Cost: \$10,691 for existing project; Unknown for additional greentree reservoir.

Total Length of Partners Agreement: 20 years for existing agreement. This agreement will be amended to add the new project feature.

Project Status (complete, under construction, planning, etc.):
First two greentree reservoirs complete; newly planned project in planning stage.

Additional Comments (if any):

Partners For Wildlife
Restoration Sites
in the
Cypress Bayou Basin Watershed, Texas

Property or Site Name: Charles Bibb Date: January 10, 1995

Location (County, sub-basin, stream, etc.; attach county map noting exact location of site):
Harrison County - Designated as No. 3 on attached county map.

Restoration Measures Installed:

Installed one (1) diversion levee with water-level control device to control depth and duration of impoundment. Structures will impound no more than 2 feet of water at maximum depth. Water will be drawn down seasonally to promote hydrophytic vegetation and protect woody vegetation existing on site. Some permanent water will remain, unless evaporated, to provide semi-permanent to permanent water for endemic wildlife.

Total Project Size: 51 acres

Total Project Cost: \$3,758

Total Length of Partners Agreement: 30 years

Project Status (complete, under construction, planning, etc.):
Under Construction

Additional Comments (if any):

Partners For Wildlife
Restoration Sites
in the
Cypress Bayou Basin Watershed, Texas

Property or Site Name: Ken Carlile Date: January 10, 1995

Location (County, sub-basin, stream, etc.; attach county map noting exact location of site):
Harrison County - Designated as No. 4 on attached county map.

Restoration Measures Installed:

Installed one (1) diversion levee with water-level control device to control depth and duration of impoundment. Structures will impound no more than 4 feet of water at maximum depth. Water will be drawn down seasonally to promote hydrophytic vegetation and protect woody vegetation existing on site. Some permanent water will remain, unless evaporated, to provide semi-permanent to permanent water for endemic wildlife.

Total Project Size: 46 acres

Total Project Cost: \$3,540

Total Length of Partners Agreement: 30 years

Project Status (complete, under construction, planning, etc.):
Complete

Additional Comments (if any):

Partners For Wildlife
Restoration Sites
in the
Cypress Bayou Basin Watershed, Texas

Property or Site Name: Newton Dorsett Date: January 10, 1995

Location (County, sub-basin, stream, etc.; attach county map noting exact location of site):
Harrison County - Designated as No. 5 on attached county map.

Restoration Measures Installed:

Installed two (2) diversion levees with water-level control devices to control depth and duration of impoundment. Structures will impound no more than 4 feet of water at maximum depth. Water will be drawn down seasonally to promote hydrophytic vegetation and protect woody vegetation existing on site. Some permanent water will remain, unless evaporated, to provide semi-permanent to permanent water for endemic wildlife.

Total Project Size: 39 acres

Total Project Cost: \$5,416

Total Length of Partners Agreement: 25 years

Project Status (complete, under construction, planning, etc.):
Complete

Additional Comments (if any):

Partners For Wildlife
Restoration Sites
in the
Cypress Bayou Basin Watershed, Texas

Property or Site Name: Jim Harris Date: January 10, 1995

Location (County, sub-basin, stream, etc.; attach county map noting exact location of site):
Harrison County - Designated as No. 6 on attached county map.

Restoration Measures Installed:

Unknown at this time. In Planning Phase.

Total Project Size:

Unknown at this time. Anticipate approximately 50 - 75 acres.

Total Project Cost: Unknown at this time.

Total Length of Partners Agreement: Unknown at this time.

Project Status (complete, under construction, planning, etc.):
In Planning Phase.

Additional Comments (if any):

Partners For Wildlife
Restoration Sites
in the
Cypress Bayou Basin Watershed, Texas

Property or Site Name: Karnack ISD Date: January 10, 1995

Location (County, sub-basin, stream, etc.; attach county map noting exact location of site):
Harrison County - Designated as No. 7 on attached county map.

Restoration Measures Installed:

Unknown at this time. In Planning Phase.

Total Project Size:

Unknown at this time. Anticipate approximately 1 acre to be used as an outdoor classroom.

Total Project Cost: Unknown at this time.

Total Length of Partners Agreement: Unknown at this time.

Project Status (complete, under construction, planning, etc.):
In Planning Phase.

Additional Comments (if any):

1. U.S. HIGHWAY 101
 2. U.S. HIGHWAY 103
 3. U.S. HIGHWAY 105
 4. U.S. HIGHWAY 107
 5. U.S. HIGHWAY 109
 6. U.S. HIGHWAY 111
 7. U.S. HIGHWAY 113
 8. U.S. HIGHWAY 115
 9. U.S. HIGHWAY 117
 10. U.S. HIGHWAY 119
 11. U.S. HIGHWAY 121
 12. U.S. HIGHWAY 123
 13. U.S. HIGHWAY 125
 14. U.S. HIGHWAY 127
 15. U.S. HIGHWAY 129
 16. U.S. HIGHWAY 131
 17. U.S. HIGHWAY 133
 18. U.S. HIGHWAY 135
 19. U.S. HIGHWAY 137
 20. U.S. HIGHWAY 139
 21. U.S. HIGHWAY 141
 22. U.S. HIGHWAY 143
 23. U.S. HIGHWAY 145
 24. U.S. HIGHWAY 147
 25. U.S. HIGHWAY 149
 26. U.S. HIGHWAY 151
 27. U.S. HIGHWAY 153
 28. U.S. HIGHWAY 155
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 30. U.S. HIGHWAY 159
 31. U.S. HIGHWAY 161
 32. U.S. HIGHWAY 163
 33. U.S. HIGHWAY 165
 34. U.S. HIGHWAY 167
 35. U.S. HIGHWAY 169
 36. U.S. HIGHWAY 171
 37. U.S. HIGHWAY 173
 38. U.S. HIGHWAY 175
 39. U.S. HIGHWAY 177
 40. U.S. HIGHWAY 179
 41. U.S. HIGHWAY 181
 42. U.S. HIGHWAY 183
 43. U.S. HIGHWAY 185
 44. U.S. HIGHWAY 187
 45. U.S. HIGHWAY 189
 46. U.S. HIGHWAY 191
 47. U.S. HIGHWAY 193
 48. U.S. HIGHWAY 195
 49. U.S. HIGHWAY 197
 50. U.S. HIGHWAY 199



**GENERAL HIGHWAY MAP
 HARRISON COUNTY
 TEXAS**

PREPARED BY THE
 TEXAS DEPARTMENT OF TRANSPORTATION
 TRANSPORTATION PLANNING
 AND PROGRAMMING DIVISION

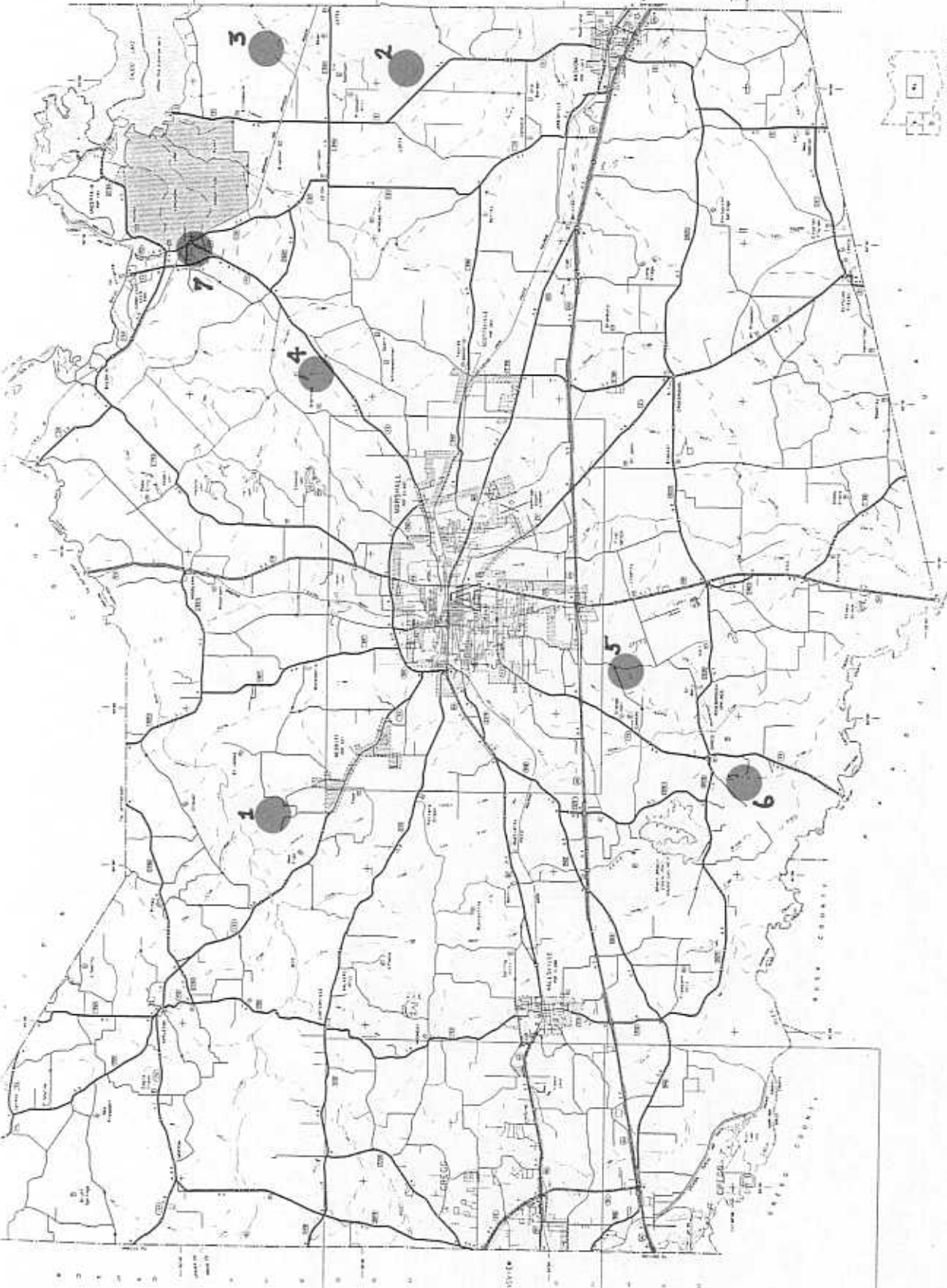
IN COOPERATION WITH THE
 U.S. DEPARTMENT OF TRANSPORTATION
 FEDERAL HIGHWAY ADMINISTRATION

SCALE: 1" = 10 MILES
 10000
 0 10 20 30 40 50 60 70 80 90 100

THIS GENERAL MAP
 PREPARED BY THE TEXAS DEPARTMENT OF TRANSPORTATION
 TRANSPORTATION PLANNING AND PROGRAMMING DIVISION
 IN COOPERATION WITH THE U.S. DEPARTMENT OF TRANSPORTATION
 FEDERAL HIGHWAY ADMINISTRATION

THE GENERAL MAP IS FOR INFORMATIONAL PURPOSES ONLY.
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 THE TEXAS DEPARTMENT OF TRANSPORTATION AND THE FEDERAL HIGHWAY
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Partners For Wildlife
Restoration Sites
in the
Cypress Bayou Basin Watershed, Texas

Property or Site Name: Pete Hochenedel Date: January 10, 1995

Location (County, sub-basin, stream, etc.; attach county map noting exact location of site):

Marion County - Designated as No. 1 on attached county map.

Restoration Measures Installed:

Installed two (2) diversion levees with water-level control devices to control depth and duration of impoundment. Structures will impound no more than 3.5 feet of water at maximum depth. Water will be drawn down seasonally to promote hydrophytic vegetation. Some permanent water will remain, unless evaporated, to provide semi-permanent to permanent water for endemic wildlife.

Total Project Size: 47 acres

Total Project Cost: \$4,600

Total Length of Partners Agreement: 20 years

Project Status (complete, under construction, planning, etc.):
Complete

Additional Comments (if any):

Partners For Wildlife
Restoration Sites
in the
Cypress Bayou Basin Watershed, Texas

Property or Site Name: Marshall Jones Date: January 10, 1995

Location (County, sub-basin, stream, etc.; attach county map noting exact location of site):

Marion County - Designated as No. 2 on attached county map.

Restoration Measures Installed:

Unknown at this time. It is anticipated that existing, failed structure will be rebuilt to accommodate drawdown pipe with water-level control valve.

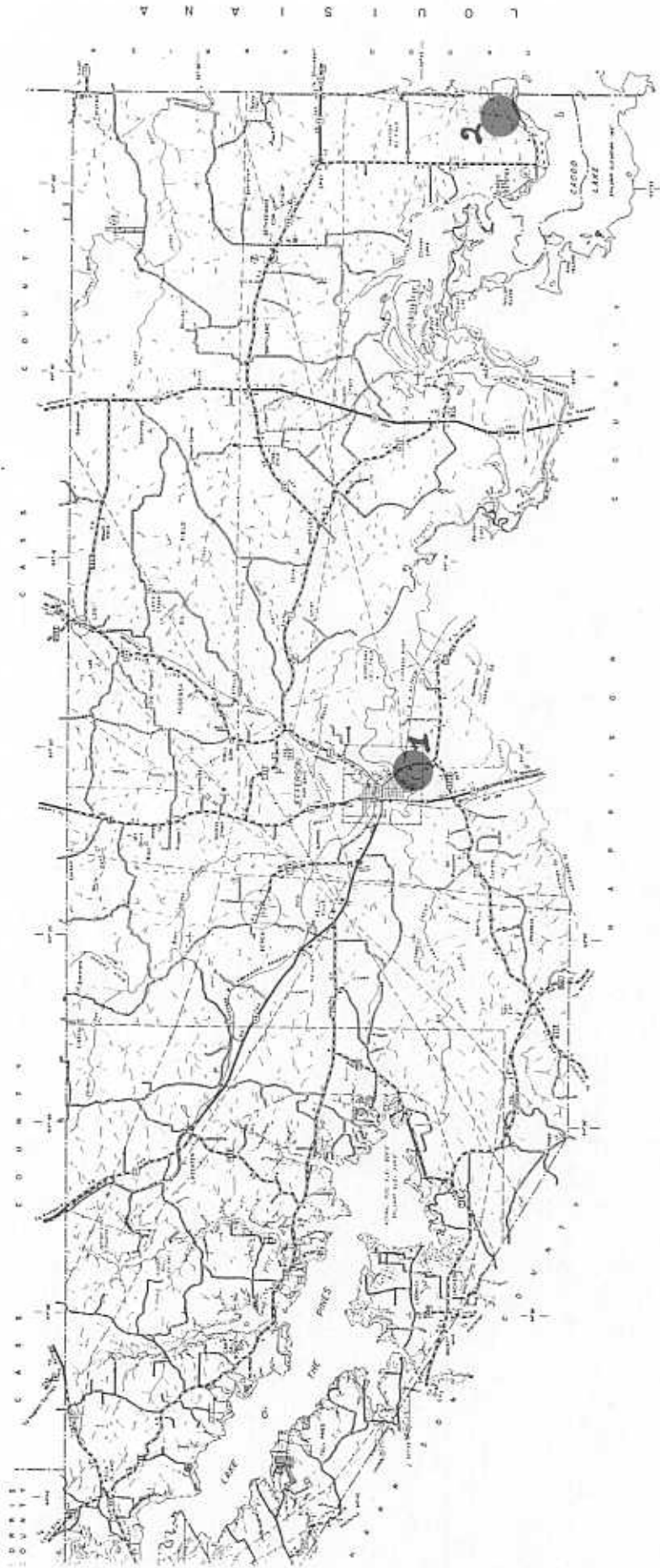
Total Project Size: We anticipate controlling hydrology on approximately 200 acres. Actual size unknown at this time.

Total Project Cost: Unknown at this time.

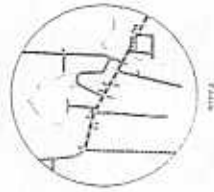
Total Length of Partners Agreement: Unknown at this time.

Project Status (complete, under construction, planning, etc.):
In Planning Phase

Additional Comments (if any):



GENERAL HIGHWAY MAP
 MARION COUNTY
 TEXAS
 DIVISION OF HIGHWAYS
 STATE DEPARTMENT OF HIGHWAYS



LEGEND
 [Symbol] [Symbol] [Symbol]
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 [Symbol] [Symbol] [Symbol]