



Area Study: Central Texas (Waco) Area

*Evaluation of Selected Natural Resources in Part of the
Central Texas (Waco) Area*



Brazos River at Waco, Texas





**RESOURCE PROTECTION DIVISION:
WATER RESOURCES TEAM**

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Resources in Part of the
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EXECUTIVE SUMMARY

This report is an evaluation of selected natural resources of the Central Texas area. Senate Bill 1 (75th Texas Legislature, 1997) mandated the completion of pending Priority Groundwater Management Area (PGMA) studies that were called for by House Bill 2 (69th Texas Legislature, 1985). The purpose of the PGMA program is to identify and evaluate areas of Texas that are experiencing, or are expected to experience, critical groundwater problems within the 25-year planning horizon. The PGMA process is intended to encourage local and regional governments to address identified groundwater problems and consider appropriate management options.

The Central Texas study area includes parts of the drainage basins of the Colorado River, the Brazos River, and a small portion of the Trinity River. The area includes Bell, Bosque, Brown, Callahan, Comanche, Coryell, Eastland, Erath, Hamilton, Hill, Lampasas, McLennan, Mills, and Somervell counties, as well as portions of Falls, Milam, and Limestone counties; an area of approximately 10,340 square miles. The ecology of the study area today reflects a history of human disturbance including overgrazing, soil erosion, a decline in the water table in some parts of the study area, declining native grasslands, and altered river ecosystems.

The economy of the area consists primarily of agribusiness and mineral production. Agricultural production is extensive and varied. Comanche County is the leading peanut producing county in the state. Erath County is the largest milk producer in the state. Natural resources in the area include oil, gas, sand, gravel, limestone, lime, and clay.

The study area includes the Western Cross Timbers, Mesquite Plains, Live Oak-Mesquite Savanna, Oak Woodlands, Lampasas Cut Plain, Grand Prairie, Eastern Cross Timbers, and the Blackland Prairie natural subregions. Live Oak-Mesquite-Ashe Juniper Parks and Oak-Mesquite-Juniper Parks and Woods, as well as Silver Bluestem-Texas Wintergrass Grassland and Bluestem Grassland are the dominant vegetation types of the study area.

Two major rivers run through the study area. The Brazos River, on the east side of the study area, and the Colorado River on the west side. Two major tributaries to the Brazos River are the Paluxy and the Bosque rivers.

The Paluxy River, from its confluence with the Brazos River to 40 miles upstream, supports a striped bass (*Morone saxatilis*) spawning run. Dinosaur Valley State Park (SP), a unique state holding and a National Natural Landmark (details in the TPWD regional facilities section) is located on the Paluxy River. The Colorado River, between Colorado Bend State Park and Lake Buchanan, supports a white bass (*Morone chrysops*) spawning run and serves as a TPWD collection area.

Within the study area, TPWD operates six state parks (Fig. 6), Dinosaur Valley Sp, Lake Brownwood State Recreation Area (SRA), Lake Whitney SRA, Meridian SP, Mother Neff SP, and a small section of Colorado Bend SP. The state parks require water to operate and provide recreational opportunities to the public, as well as to maintain a healthy fauna and flora.

Evaluation of Selected Natural Resources in Part of the Central Texas (Waco) Area

INTRODUCTION

Purpose

The Texas Natural Resource Conservation Commission (TNRCC), working with the Texas Water Development Board (TWDB) and the Texas Parks and Wildlife Department (TPWD), is charged with identifying Priority Groundwater Management Areas (PGMAs) - areas in Texas that are experiencing, or are expected to experience in the future, critical groundwater problems. The purpose of the PGMA program is to assist local and regional interests in addressing groundwater management issues; including quantity and quality of surface water and groundwater, contamination issues, and land subsidence.

Senate Bill 1 (75th legislature, 1997) mandated the completion of pending PGMA studies that were called for by House Bill 2 (69th Legislature) in 1985. TNRCC and TWDB identified all or parts of the central Texas counties for continued monitoring. The study area was not designated as a critical area for a PGMA study in 1990, but TWDB and TNRCC were to continue monitoring groundwater levels and local groundwater management initiatives. A groundwater study was initiated in 1989 with TNRCC requesting a groundwater resources and availability study from TWDB. TWDB completed the report *Evaluation of Water Resources in Part of Central Texas* (TWDB Report No. 319, Baker et al.) in January 1990.

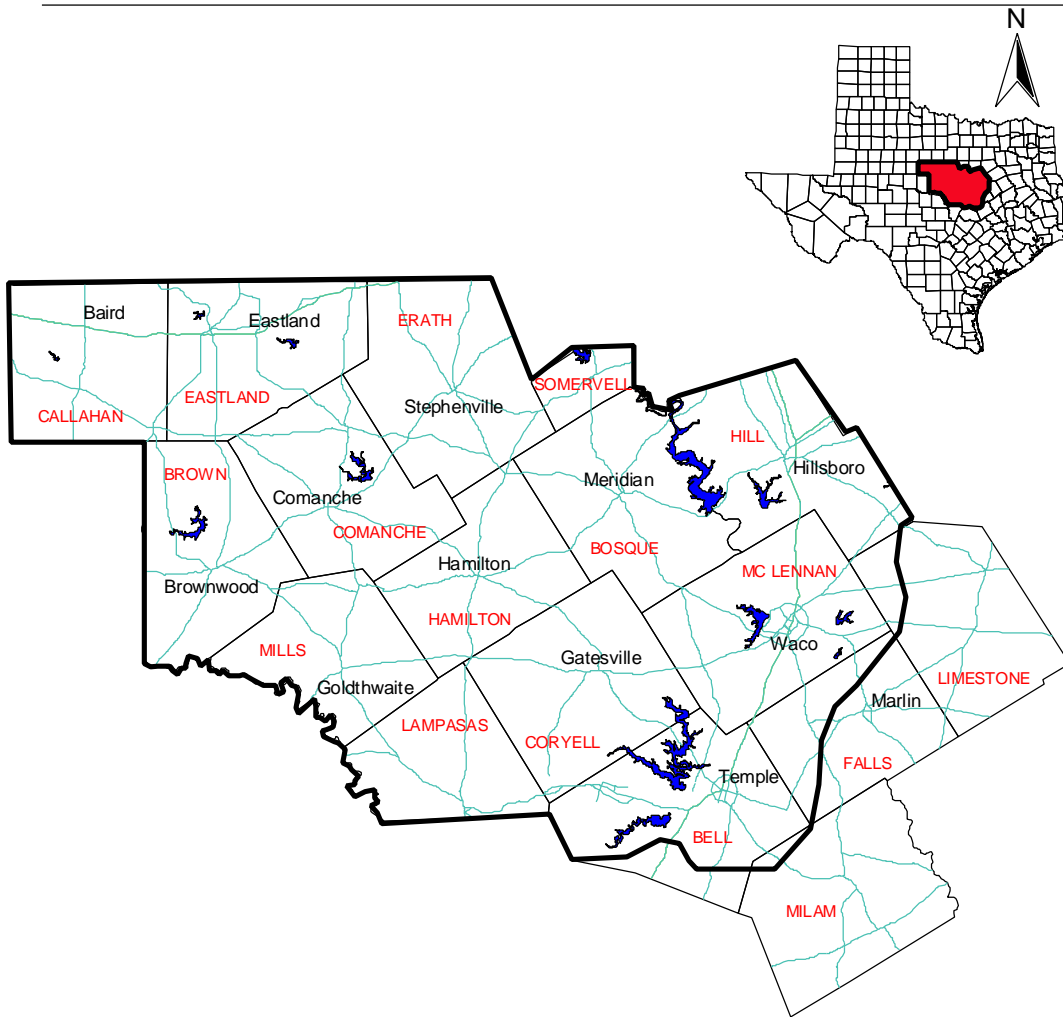
Location and Extent

The Central Texas Alluvium and Paleozoic Outcrop study area, in this report, called the Central Texas (Waco) study area, includes 17 counties: Bell, Bosque, Brown, Callahan, Comanche, Coryell, Eastland, Erath, Hamilton, Hill, Lampasas, McLennan, Mills, and Somervell counties, as well as portions of Falls, Milam, and Limestone counties (Fig. 1). This area is located within the Brazos River, Colorado River, and Trinity River basins, and it covers approximately 10,340 square miles (Baker et al. 1990).

Geography and Ecology

The part of central Texas included in the study area lies within the Coastal Plains and the North Central Plains physiographic provinces (Baker et al. 1990). The study area includes the following natural subregions: Western Cross Timbers, Mesquite Plains, Live Oak-Mesquite Savanna, Oak Woodlands, Lampasas Cut Plain, Grand Prairie, Eastern Cross Timbers, and the Blackland Prairie (LBJ School of Public Affairs 1978; Fig.2).

Figure 1. Map of the Study Area



30 0 30 60 90 Miles

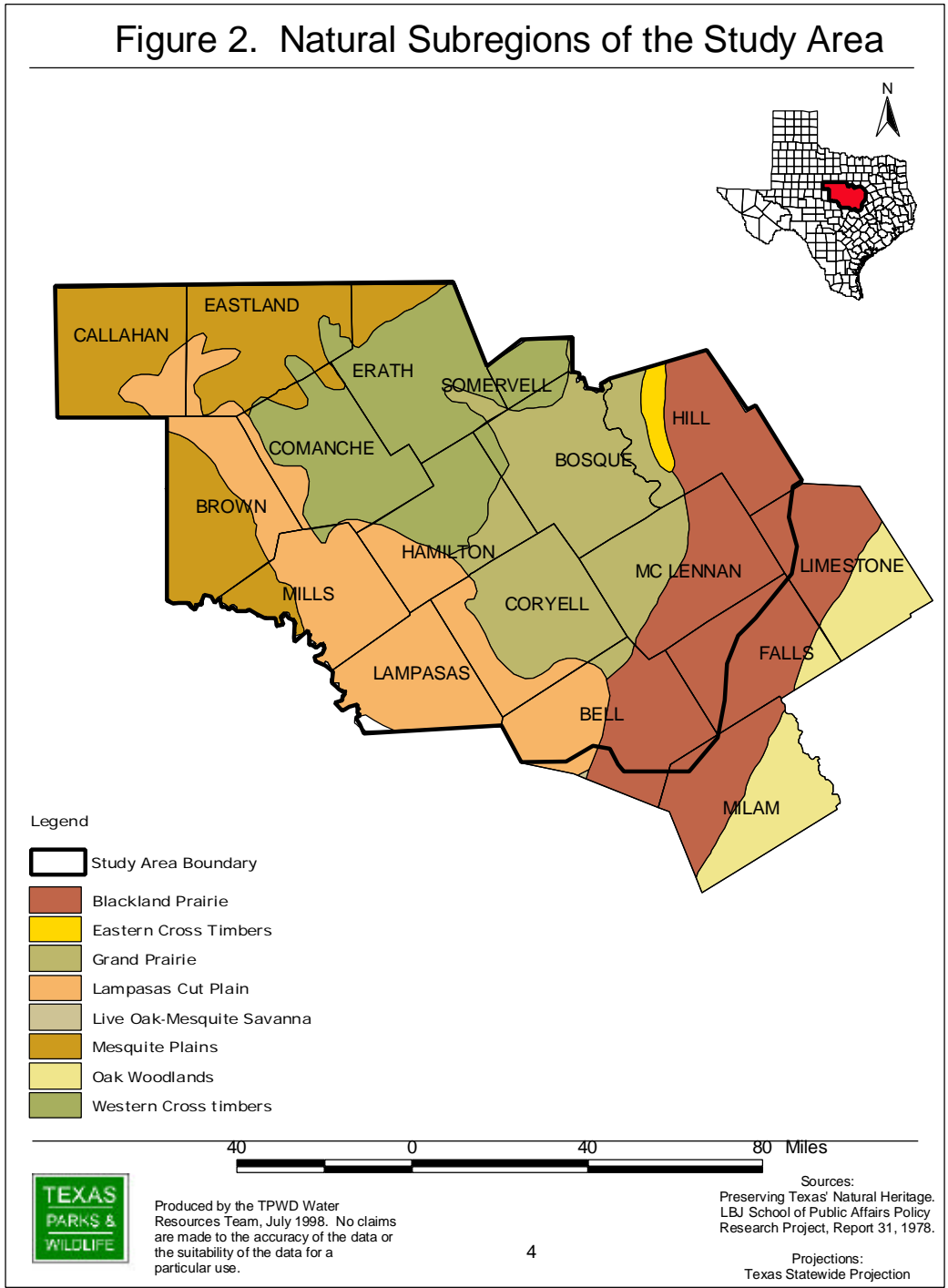


Produced by the TPWD Water Resources Team, July 1998. No claims are made to the accuracy of the data or the suitability of the data for a particular use.

Sources:
TPWD GIS lab archives data 1998.

Projections:
Texas Statewide Projection
(Lambert Conformal Conic)

Figure 2. Natural Subregions of the Study Area



Long hot summers and short mild winters characterize the study area’s weather. The average daily minimum temperature for January ranges from 32°F in the northwest to 39°F in the southeast. The average annual precipitation ranges from about 24 inches per year in the northwest to about 36 inches in the eastern part of the study area.

Population

The exact population of the study area as a whole is not available. The population of counties that are entirely or partially within the study area is given in Table 1.

Table 1. Projections for Population Growth in the Study Area (Texas Water Development Board 1998)

Year ⇒ Locality ↓	1990	2000	2010	2020	2030	2040	2050
Bell	191,088	231,977	254,642	279,238	297,304	308,139	324,850
Bosque	15,125	17,069	19,196	21,542	23,893	25,174	28,142
Brown	34,371	35,189	36,002	36,828	37,065	36,904	36,575
Callahan	11,859	11,860	12,230	12,154	11,889	11,130	10,887
Comanche	13,381	13,188	13,312	13,596	13,957	14,293	14,697
Coryell	64,213	74,511	86,839	101,400	115,585	122,651	129,454
Eastland	18,488	17,940	17,546	17,256	16,557	15,792	14,952
Erath	27,991	31,253	35,036	36,619	37,324	37,714	38,104
Falls	17,712	19,014	19,912	20,963	22,163	23,388	24,644
Hamilton	7,733	7,342	7,247	7,193	6,177	5,864	5,447
Hill	27,146	27,636	28,572	29,881	31,362	32,840	34,417
Lampasas	13,521	16,785	18,317	19,509	20,154	20,820	21,935
Limestone	20,946	22,501	23,500	24,625	25,785	26,814	27,883
McLennan	189,123	219,037	244,417	259,381	275,041	288,276	300,877
Milam	22,946	25,200	26,490	27,631	28,825	29,975	31,072
Mills	4,531	4,774	4,888	5,049	5,154	5,200	5,247
Somervell	5,360	5,849	6,398	6,784	6,852	6,986	7,705

Economy and Land Use

The economy of the area consists primarily of agribusiness, manufacturing, and mineral production (Dallas Morning News 1997). Agricultural production is extensive and varied. Erath County is the largest milk producer in the state, and Comanche County is a major peanut producer (Texas Agricultural Statistics Service 1997). Natural resources in the area include oil, gas, sand, gravel, limestone, lime, and clay.

Fort Hood, one of the largest military establishments in the nation, is located in Bell and Coryell counties. Its military and civilian payroll adds substantially to the local economy.

SELECTED NATURAL RESOURCES*

Vegetation and Soils

The natural regions of Texas were delineated largely on the basis of soil types and major vegetation types. Soils in the Central Texas (Waco) area vary from sandy loam soils in the west; to gray, dark, and alluvial soils centrally; to deep, dark, alkaline, clay soils in the east (Godfrey et al. 1973).

As stated in the introduction, the study area includes the following natural subregions: Western Cross Timbers, Mesquite Plains, Live Oak-Mesquite Savanna, Oak Woodlands, Lampasas Cut Plain, Grand Prairie, Eastern Cross Timbers, and the Blackland Prairie. The scientific names of the plants mentioned in this section are listed in Appendix A (McMahan et al. 1984).

The vegetation map (Figure 3) shows that the Oak-Mesquite-Juniper Parks and Woods type, the Silver Bluestem-Texas Wintergrass Grasslands type, the Bluestem Grasslands type, and the Live Oak-Mesquite-Ashe Juniper Parks type are the dominant or co-dominant types in the study area. The Oak-Mesquite-Juniper Parks and Woods type occurs over the entire study area. Associated species include post oak, ashe juniper, shin oak, Texas oak, blackjack oak, live oak, cedar elm, agarito, soapberry, sumac, hackberry, Texas pricklypear, Mexican persimmon, purple three-awn, hairy grama, Texas grama, sideoats grama, curly mesquite, and Texas wintergrass (McMahan et al. 1984).

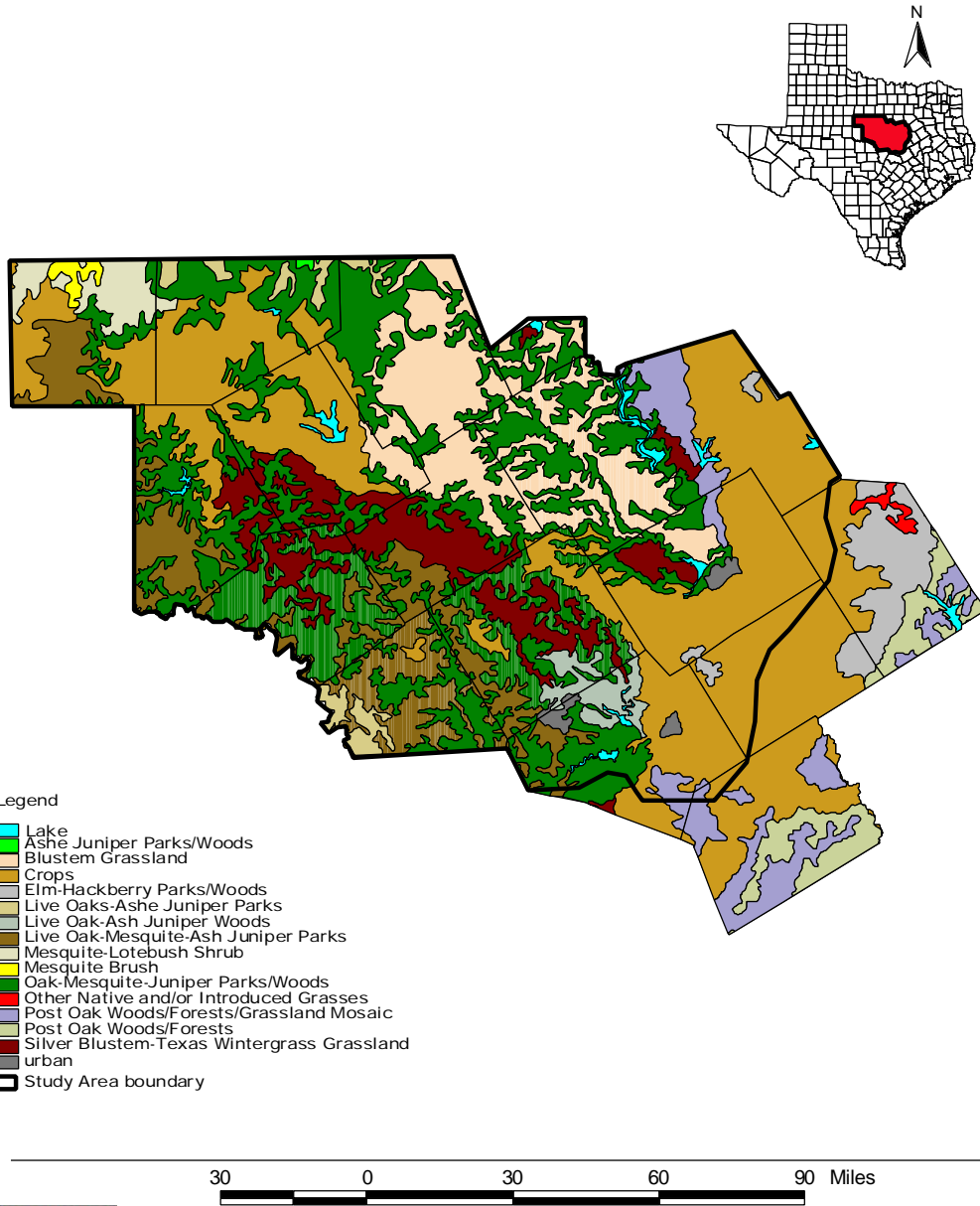
The Silver Bluestem-Texas Wintergrass Grasslands type occurs centrally in the study area. Associated species include little bluestem, sideoats grama, Texas grama, three-awn, hairy grama, tall dropseed, buffalograss, windmillgrass, hairy tridens, tumblegrass, western ragweed, broom snakeweed, Texas bluebonnet, live oak, post oak, and mesquite (McMahan et al. 1984).

The Bluestem Grasslands type occurs extensively in the Western Cross Timbers and Grand Prairie natural subregions in the northcentral part of the study area. Associated species include bushy bluestem, slender bluestem, little bluestem, silver bluestem, three-awn, buffalograss, bermudagrass, brownseed paspalum, single-spike paspalum, smutgrass, sacahuista, windmillgrass, southern dewberry, live oak, mesquite, huisache, baccharis, and Macartney rose (McMahan et al. 1984).

The Live Oak-Mesquite-Ashe Juniper Parks type occurs mostly on level to gently rolling uplands and ridge tops. It is found in the Mesquite Plains and Lampasas Cut Plain subregions within the study area. Associated species include Texas oak, shin oak, cedar elm, netleaf hackberry, flameleaf sumac, agarito, Mexican persimmon, Texas pricklypear, kidneywood, saw greenbriar, Texas wintergrass, little bluestem, curly mesquite, Texas grama, Halls panicum, purple three-awn, hairy tridens, cedar sedge, two-leaved senna, mat euphorbia, and rabbit tobacco (McMahan et al. 1984).

* The fauna and flora described in this report represent those species that are riparian, semi-aquatic, and aquatic, unless otherwise noted.

Figure 3. The Vegetation Types of the Study Area



Produced by the TPWD Water Resources Team, July 1998. No claims are made to the accuracy of the data or the suitability of the data for a particular use.

Source: TPWD GIS lab archives. The vegetation represents a general summary of previously produced larger scale maps. Delineation of the vegetation occurs only where the actual vegetation exhibited adequate resolution for definition.

Springs

The distribution and size, as of 1980, of springs and seeps in the area are given by county in Table 2 (Brune 1981). Flowing springs emphasize the fact that ground and surface water are interconnected. Most springs emanate from the top of the groundwater reservoir, so changes in the water table elevation generally have immediate impact upon spring discharge rates.

Table 2. Distribution and Estimated Size (in 1980) of Springs and Seeps in the Study Area (Brune 1981)

County	Large	Moderately large	Medium	Small	Very small	Seep	Former
Bell	0	1	1	6	1	1	0
Bosque	0	0	0	0	0	0	2
Brown*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Callahan*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Comanche*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Coryell*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Eastland	0	0	0	0	0	0	1
Erath*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fall*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hamilton*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hill*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lampasas	0	2	1	2	0	0	4
Limestone *	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mc Lennan	0	0	0	0	0	0	1
Milam*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mills*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Somervell*	N/A	N/A	N/A	N/A	N/A	N/A	N/A

The numbers above are a reflection of either a spring or a group of springs. * No available records for those counties.

Codes:

Large = 280 to 2,800 cfs

Moderately large = 28 to 280 cfs

Medium = 2.8 to 28 cfs

cfs

Former = no flow or inundated

Small = 0.28 to 2.8 cfs

Very Small = 0.028 to 0.28 cfs

Seep = less than 0.028

Several species of crustaceans have been found living in caves and associated springs in Bell County. As these species can live nowhere else, they will be lost if the springs are allowed to fail (Brune 1981). Springs in the study area emanate from the Edwards and associated limestones, upper Cretaceous Austin chalk, and Quaternary river terrace sand and gravel. The spring waters are chiefly of the calcium bicarbonate type, very hard, fresh, and alkaline (Brune 1981).

Rivers

Two major rivers cross the study area (Fig. 4). The Brazos River on the east side of the study area, and the Colorado River on the west side. Two major tributaries to the Brazos River are the Paluxy and the Bosque rivers.

The Paluxy River, from its confluence with the Brazos River to 40 miles upstream, supports a striped bass (*Morone saxatilis*) spawning run. Also on the Paluxy River is Dinosaur Valley SP, a unique state holding and a national natural landmark (details in the TPWD regional facilities section). The Colorado River, between Colorado Bend State Park and Lake Buchanan, supports a white bass (*Morone chrysops*) spawning run and serves as a TPWD collection area (Bauer et al. 1991).

Fish

The study area rivers and streams support a variety of native and introduced fishes (Table 3). Linam and Kleinsasser (1987) concluded that water quality and habitat in the Bosque River drainage were adequate to support a diverse and healthy fish community. Upstream reaches of the river had lower species richness and index of biotic integrity ratings, probably due to depressed water quality during low flow periods. During low flow periods, stretches of the North Bosque River are effluent dominated. The occurrence of deep pools and the proximity of Lake Waco, both of which serve as refugia during low flow episodes, allow recovery and recruitment in reaches impacted by low flow. The Bosque River supports a significant recreational fishery. Spawning runs of white bass occur in the North Bosque River upstream of Lake Waco.

Table 3. Summary of Fishes Collected from the Bosque River by Hubbs and Strawn* in 1953, Linam and Kleinsasser in 1987, and Jones** in 1998 (Linam and Kleinsasser 1987)

Scientific Name	Common Name	1953	1987	1998
<i>Ameiurus melas</i>	Black bullhead			X
<i>Ameiurus natalis</i>	Yellow bullhead	X	X	X
<i>Campostoma anomalum</i>	Common stoneroller	X	X	X
<i>Carpionodes carpio</i>	River carpsucker			X
<i>Cyprinella lutrensis</i>	Red shiner	X	X	X
<i>Cyprinella venusta</i>	Blacktail shiner	X	X	X
<i>Dorosoma cepedianum</i>	Gizzard shad		X	X
<i>Dorosoma petenense</i>	Threadfin shad		X	
<i>Etheostoma spectabile</i>	Orangethroat darter	X	X	X
<i>Fundulus notatus</i>	Blackstripe topminnow	X	X	X
<i>Gambusia affinis</i>	Western mosquitofish	X	X	X
<i>Ictalurus punctatus</i>	Channel catfish	X	X	X
<i>Lepisosteus osseus</i>	Longnose gar			X
<i>Lepisosteus spatula</i>	Alligator gar			X
<i>Lepomis cyanellus</i>	Green sunfish	X	X	X

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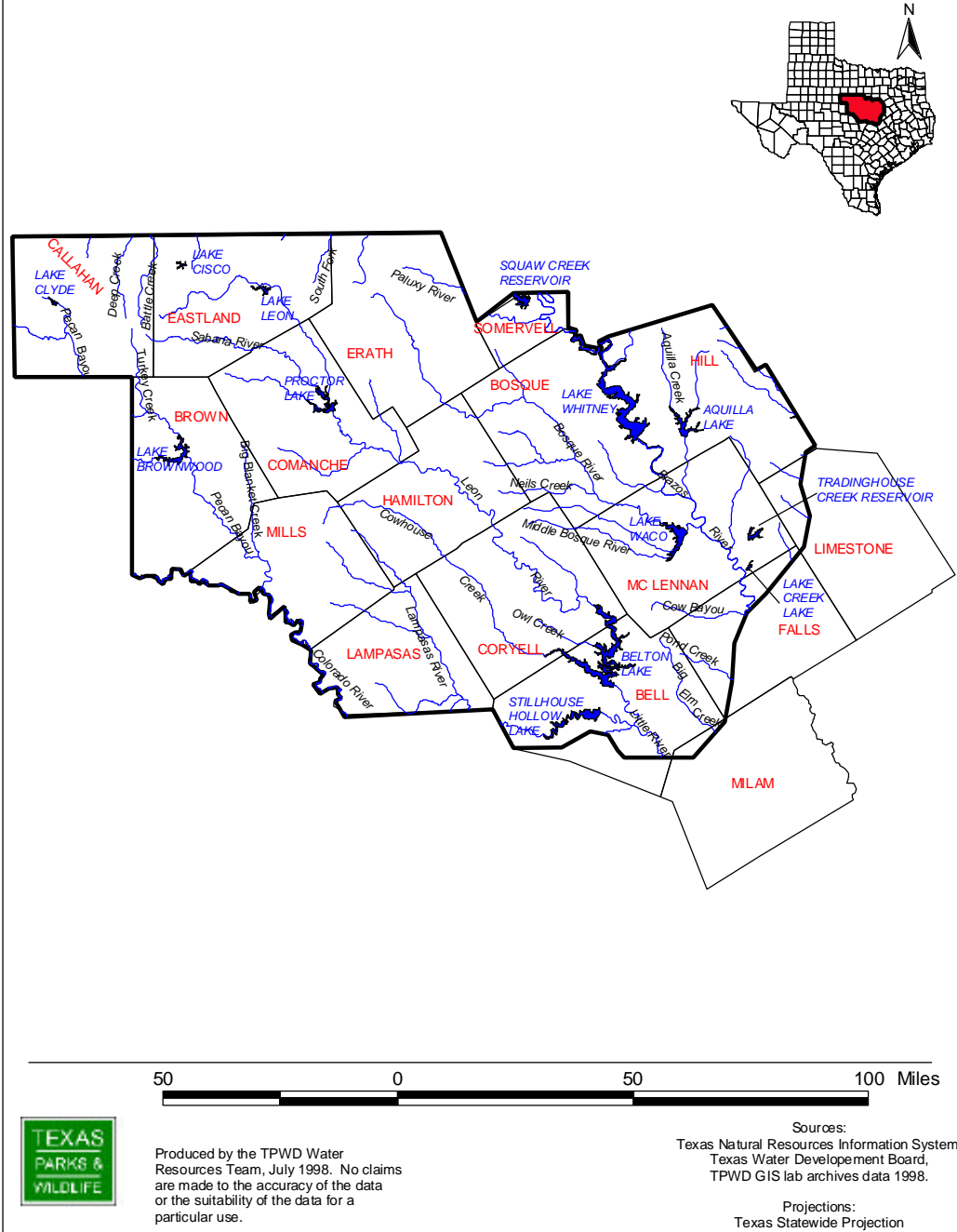
<i>Lepomis gulosus</i>	Warmouth		X	
<i>Lepomis humilis</i>	Orangespotted sunfish		X	
<i>Lepomis macrochirus</i>	Bluegill	X	X	X
<i>Lepomis marginatus</i>	Dollar sunfish		X	
<i>Lepomis megalotis</i>	Longear sunfish	X	X	X
<i>Lepomis microlophus</i>	Redear sunfish		X	
<i>Lepomis punctatus</i>	Spotted sunfish		X	
<i>Menidia beryllina</i>	Inland silverside		X	X
<i>Micropterus punctulatus</i>	Spotted bass	X	X	
<i>Micropterus salmoides</i>	Largemouth bass	X	X	X
<i>Moxostoma congestum</i>	Gray redhorse	X	X	X
<i>Notemigonus crysoleucas</i>	Golden shiner	X		X
<i>Notropis volucellus</i>	Mimic shiner		X	X
<i>Opsopoeodus emiliae</i>	Pugnose minnow		X	X
<i>Percina macrolepida</i>	Bigscale logperch	X	X	X
<i>Percina sciera</i>	Dusky darter	X		
<i>Pimephales promelas</i>	Fathead minnow	X		X
<i>Pimephales vigilax</i>	Bullhead minnow	X	X	X
<i>Pomoxis annularis</i>	White crappie		X	
<i>Pylodictus olivaris</i>	Flathead catfish	X		X

*Unpublished data

**List received from Tim Jones at Tarleton State Institute, Stephenville, Texas.

Two area fish species not listed in Table 3 are reported on the Special Species List (Table 7; Wildlife Diversity Program 1998). They are the Guadalupe bass and the smalleye shiner. The Guadalupe bass is endemic to the streams of the northern and eastern Edwards Plateau including portions of the Brazos, Colorado, Guadalupe, and San Antonio basins. It is also found in small numbers in the lower Colorado River. The Guadalupe bass is the official state fish of Texas (Hubbs et al. 1991). The smalleye shiner is endemic to the middle and upper Brazos River drainage. At present, TPWD does not have more extensive information on the fish species of other streams within the study area.

Figure 4. Water Resources in the Study Area



Birds and Waterfowl

Many species of migrating neotropical songbirds and wintering shorebirds stopover in the study area. They feed and rest along the banks of the Colorado River, the Brazos River, and other water bodies such as the Bosque River, Lake Brownwood, Lake Whitney and Belton Lake, as well as the different creeks within the area. The riparian vegetation that grows along the rivers, streams, and lakes is of special importance to nesting songbirds and raptors, such as the black-capped vireo and the zone-tailed hawk.

The county Special Species Lists (Wildlife Diversity Program 1998) for the study area include 12 birds (Table 7), some of which are riparian, and/or wetland dependent. The distribution of these species by county is shown in Figure 5.

Several of the birds listed in Table 7 occur in the study area only as migrants (peregrine falcon, whooping crane). Migrating peregrines utilize wetlands in the study area because they prey mostly on ducks and shorebirds. Migrating whooping cranes would also use wetlands for feeding and roosting. The golden-cheeked warbler and black-capped vireo are upland nesters on the Edwards Plateau and are found in most of the study area (Figure 5).

Mammals, Amphibians, and Reptiles

There are at least 48 species of mammals (Table 4), amphibians (Table 5), and reptiles (Table 6) that are either aquatic, semi-aquatic, or in some way wetland-dependent, present in the study area. The Salado Springs salamander (Table 5) is listed on the Special Species List (Wildlife Diversity Program 1998). Table 6 includes two reptiles that are listed in the Special Species List: the Brazos water snake and the Texas garter snake. None of the riparian or water dependent mammals in Table 4 are on the Special Species List. Figure 5 shows the distribution of those species listed on the Special Species List.

Table 4. Selected* Mammals of the Study Area (Wildlife Diversity Program 1998)

Scientific Name	Common Name
<i>Castor canadensis</i>	American beaver
<i>Cryptotis parva</i>	Least shrew
<i>Mustela vison</i>	Mink
<i>Myocastor coypus</i>	Nutria
<i>Sylvilagus aquaticus</i>	Swamp rabbit

*mammals that are riparian.

Table 5. Selected Amphibians of the Study Area (Wildlife Diversity Program 1998)

Scientific Name	Common Name
<i>Acris crepitans</i>	Northern cricket frog
<i>Ambystoma texanum</i>	Smallmouth salamander
<i>Ambystoma tigrinum</i>	Tiger salamander
<i>Bufo punctatus</i>	Red-spotted toad
<i>Bufo speciosus</i>	Texas toad
<i>Bufo valliceps</i>	Gulf Coast toad
<i>Bufo woodhousii</i>	Woodhouse's toad
<i>Desmognathus auriculatus</i>	Southern dusky salamander
<i>Eurycea sp 2</i>	Salado Springs salamander
<i>Gastrophryne olivacea</i>	Great Plains narrowmouth toad
<i>Notophthalmus viridescens</i>	Eastern newt
<i>Pseudacris clarkii</i>	Spotted chorus frog
<i>Pseudacris streckeri</i>	Strecker's chorus frog
<i>Pseudacris triseriata</i>	Striped chorus frog
<i>Rana berlandieri</i>	Rio Grande leopard frog
<i>Rana blairi</i>	Plains leopard frog
<i>Rana catesbeiana</i>	Bullfrog
<i>Rana clamitans</i>	Green frog
<i>Rana sphenoccephala</i>	Southern leopard frog
<i>Scaphiopus couchii</i>	Couch's spadefoot
<i>Scaphiopus holbrookii</i>	Eastern spadefoot
<i>Siren intermedia</i>	Lesser siren
<i>Spea multiplicata</i>	New Mexico spadefoot

Table 6. Selected Reptiles of the Study Area (Wildlife Diversity Program 1998; Garrett and Barker 1987)

Scientific Name	Common Name
<i>Agkistrodon contortrix</i>	Copperhead
<i>Agkistrodon piscivorus</i>	Cottonmouth
<i>Alligator mississippiensis</i>	American alligator
<i>Chelydra serpentina</i>	Snapping turtle
<i>Deirochelys reticularia</i>	Chicken turtle
<i>Kinosternon flavescens</i>	Yellow mud turtle
<i>Kinosternon subrubrum</i>	Eastern mud turtle
<i>Nerodia erythrogaster</i>	Plainbelly water snake
<i>Nerodia fasciata</i>	Southern water snake
<i>Nerodia herteri</i>	Brazos water snake
<i>Pseudemys texana</i>	Texas river cooter
<i>Regina grahamii</i>	Graham's crayfish snake
<i>Sternotherus carinatus</i>	Razorback musk turtle
<i>Sternotherus odoratus</i>	Common musk turtle
<i>Thamnophis marcianus</i>	Checkered garter snake
<i>Thamnophis proximus</i>	Western ribbon snake
<i>Thamnophis sirtalis</i>	Common garter snake
<i>Thamnophis sirtalis annectens</i>	Texas garter snake
<i>Trionyx muticus</i>	Smooth softshell
<i>Trionyx spiniferus</i>	Spiny softshell

Table 7. Species** of Special Concern in the Central Texas (Waco) Study Area (Wildlife Diversity Program 1998)

Map code*	Scientific name	Common name	Fed. Status	State Status
AMPHIBIANS				
1	<i>Bufo houstonensis</i>	Houston toad	LE	E
2	<i>Eurycea sp 2</i>	Salado springs salamander		
BIRDS				
3	<i>Buteo albicaudatus</i>	White-tailed hawk		T
4	<i>Buteo albonotatus</i>	Zone-tailed hawk		T
5	<i>Dendroica chrysoparia</i>	Golden-cheeked warbler	LE	E
6	<i>Falco peregrinus</i>	Peregrine falcon	E/SA	
7	<i>Falco peregrinus anatum</i>	American peregrine falcon	LE	E
8	<i>Falco peregrinus tundrius</i>	Arctic peregrine falcon	E/SA	T
9	<i>Grus americana</i>	Whooping crane	LE	E
10	<i>Haliaeetus leucocephalus</i>	Bald eagle	LT	T
11	<i>Mycteria americana</i>	Wood stork		T
12	<i>Plegadis chihi</i>	White-faced ibis		T
13	<i>Sterna antillarum athalassos</i>	Interior least tern	LE	E
14	<i>Vireo atricapillus</i>	Black-capped vireo	LE	E
FISHES				
15	<i>Micropterus treculi</i>	Guadalupe bass		
16	<i>Notropis buccula</i>	Smalleye shiner		
MAMMALS				
17	<i>Canis rufus (extirpated)</i>	Red wolf	LE	E
18	<i>Felis pardalis</i>	Ocelot	LE	E
19	<i>Myotis velifer</i>	Cave myotis bat		
REPTILES				
20	<i>Crotalus horridus</i>	Timber/canebrake rattlesnake		T
21	<i>Nerodia harteri</i>	Brazos water snake		T
22	<i>Nerodia paucimaculata</i>	Concho water snake	LT	T
23	<i>Phrynosoma cornutum</i>	Texas horned lizard		T
24	<i>Thamnophis sirtalis annectens</i>	Texas garter snake		
VASCULAR PLANTS				
25	<i>Argythamnia aphoroides</i>	Hill country wild-mercury		
26	<i>Croton alabamensis var texensis</i>	Texabama croton		
27	<i>Eriocaulon koernickianum</i>	Small-headed pipewort		
28	<i>Spiranthes parksii</i>	Navasota ladies'-tresses	LE	E

* Lookup code for map of Figure 5.

Status Code:

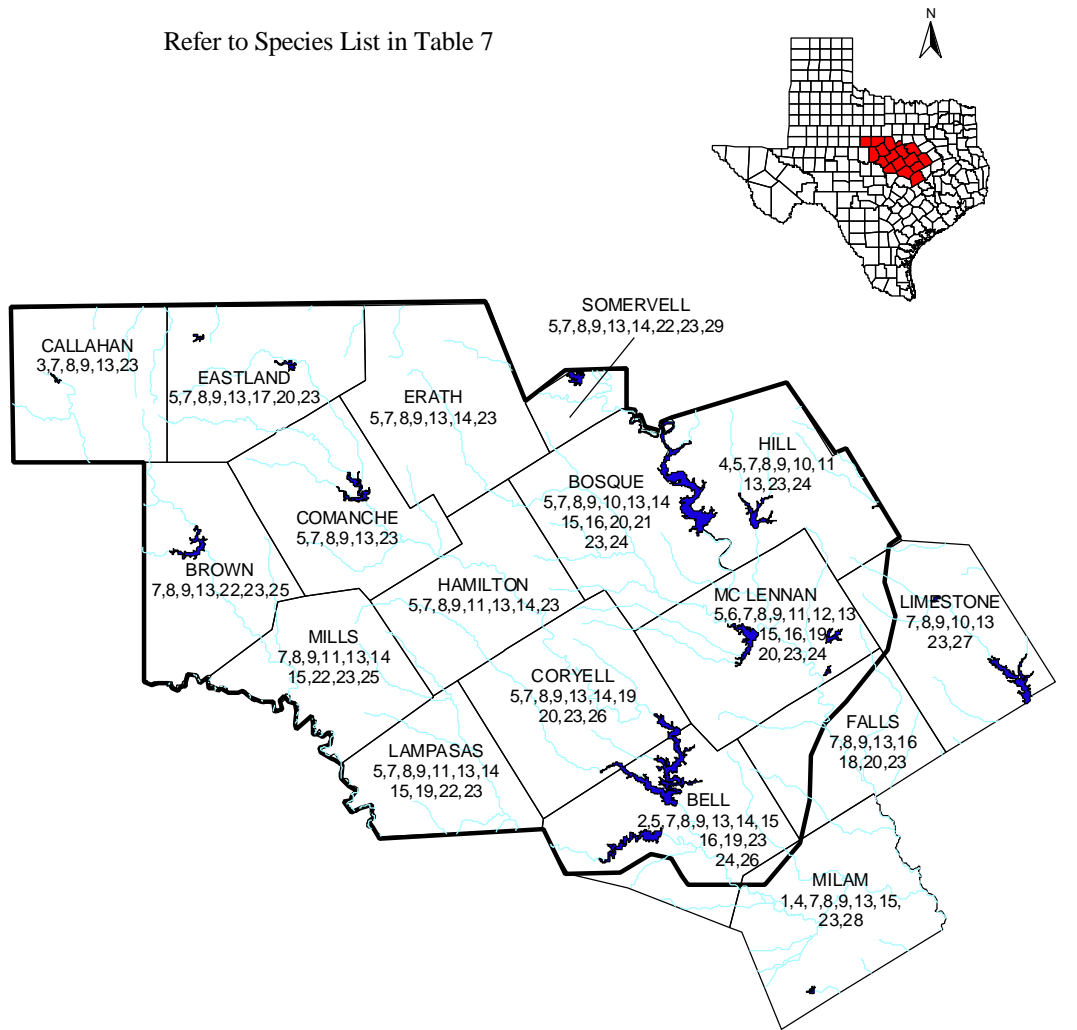
LE, LT – Federally Listed Endangered/Threatened

E/SA – Federally Endangered by Similarity of Appearance

E, T – State Endangered/Threatened

**Species on this list are not necessarily riparian or wetland dependent

Figure 5. Special Species by County in the Study Area



Produced by the TPWD Water Resources Team, July 1998. No claims are made to the accuracy of the data of the data or the suitability of the data for a particular use.

Sources:
 Texas Natural Resources Information System,
 Texas Water Development Board,
 TPWD GIS lab archives data 1998.
 Projections:
 Texas Statewide Projection

TPWD Regional Facilities

Within the study area, TPWD operates six state parks (Fig. 6): Dinosaur Valley SP, Lake Brownwood State Recreation Area (SRA), Lake Whitney SRA, Meridian SP, Mother Neff SP, and a small section of Colorado Bend SP.

The following is a general description of those facilities offering one or more of the following activities: fishing, hunting, boating, wildlife viewing, swimming, and picnicking. Water-based recreation in the following parks draws many visitors.

Colorado Bend SP (5,328.3 acres) is located at the former sites of the Gorman and Lemons Ranches upstream of Lake Buchanan. Only a small section of the park on the east side of the Colorado River is within the study area. Gorman Falls is located on the western bank of the Colorado River approximately 10 miles upstream of Lake Buchanan, and includes a portion of Gorman Creek, which feeds Gorman Falls. Around 155 species of birds can be found in the park at different times, including the golden-cheeked warbler, the black-capped vireo, and the bald eagle. White bass from Lake Buchanan use the river upstream of the lake for spawning. The spring white bass run is the busiest time of the year in the park (Texas Parks and Wildlife Department 1998).

Dinosaur Valley SP (1,524.72 acres) is located just northeast of Glen Rose in Somervell County. The park is on the Paluxy River. The river is one of the more scenic tributaries of the Brazos River. The park is well known for its dinosaur tracks, and its water-based recreation draws many visitors. The Paluxy River runs through the area, and the terrain is wooded, hilly, and semi-rocky. Plants in the Paluxy River drainage are characteristic of the Cross Timbers and Prairie vegetation areas. The area hosts many species of both resident and migrant birds including the endangered golden-cheeked warbler and the black-capped vireo. Dinosaur Valley SP serves mostly the population centers of Dallas and Fort Worth (Texas Parks and Wildlife Department 1998).

Lake Brownwood SRA (537.5 acres) is situated on Lake Brownwood, a 7,300-surface-acre reservoir created by the damming of Pecan Bayou, a tributary of the Colorado River. The park offers a variety of water sports including boating, water skiing, swimming, fishing, and goose hunting (Texas Parks and Wildlife Department 1998).

Lake Whitney SP (1,280.7 acres) is located on the east shore of Lake Whitney. The park is located in the Grand Prairie subregion of the Blackland Prairie natural region. More than 194 species of birds have been spotted in the park, including wild turkeys and bald eagles. The park offers a variety of water sports including fishing, swimming, scuba diving, and water skiing. It is also used for nature studies and birding (Texas Parks and Wildlife Department 1998).

Meridian SP (505.4 acres) is very wooded with predominantly Ashe juniper and oak. A variety of wildlife and birds includes the endangered golden-cheeked warbler in the spring. The 72-acre Lake Meridian is a very popular for bream, crappie, catfish, and bass. Park activities include camping, swimming, boating, bird watching, and fishing (Texas Parks and Wildlife

Department 1998).

Mother Neff SP (259 acres) was the first dedicated state park in Texas. The terrain in the park consists of prairie land and rugged limestone hills. The only water related activity is fishing from the riverbank of the Leon River. Wildlife observation activities are common in the park (Texas Parks and Wildlife Department 1998).

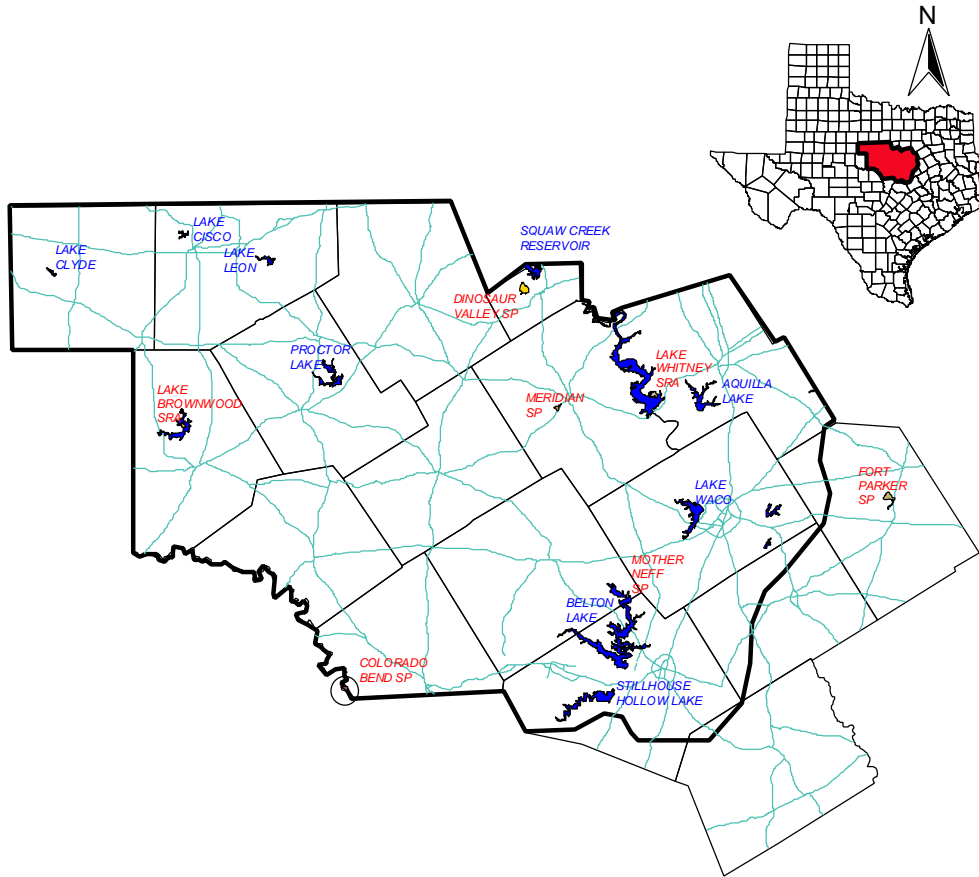
Estimates of the economic importance of some of these parks to the counties of the study area are shown in Table 8 (Crompton et al. 1998). The economic impact parameter estimates the infusion of “new money” into the local economy by out-of-county visitors to the parks. It is a more realistic indicator of economic importance than “economic surge” which also includes expenditures by local visitors. More detailed breakdowns of the data summarized in Table 8 are given in Appendix B.

Table 8. Summary of Estimated Economic Importance (Impact and Surge) of Selected TPWD Facilities in the Study Area (Crompton et al. 1998)

Facility	Total Visitors	Total Expenditures (\$)	Total Sales (\$)	Total Personal Income (\$)	Total Employment (persons)
<u>Dinosaur Valley</u>					
Impact	306,671	613,451	808,613	230,614	24.0
Surge	306,671	632,706	834,022	237,848	24.8
<u>Lake Brownwood</u>					
Impact	158,263	528,051	978,765	302,290	23.8
Surge	158,263	1,428,249	1,668,718	515,368	40.5
<u>Lake Whitney</u>					
Impact	176,708	760,035	1,537,601	414,067	38.4
Surge	176,708	1,040,985	2,103,282	566,778	52.4
<u>Mother Neff</u>					
Impact	102,246	245,425	531,844	136,064	13.4
Surge	102,246	294,616	638,426	163,326	16.0

- No data exist for Meridian SP and Colorado Bend SP.

Figure 6. Location Map of TPWD Facilities in the Study area



40 0 40 80 Miles



Produced by the TPWD Water Resources Team, July 1998. No claims are made to the accuracy of the data or the suitability of the data for a particular use.

Sources:
TPWD GIS lab archives data 1998.

Projections:
Texas Statewide Projection
(Lambert Conformal Conic)

Conclusions

While few species are directly dependent upon the groundwater resources of the study area, the springs that emanate from the groundwater reserves contribute to the surface water hydrology and have helped to shape the ecosystems that exist in the study area. Reduced springflow can result from overpumping of the aquifers of the area which can subsequently effect surface water flows. Long term decreases in flow can exacerbate water quality problems and impact the species that are directly and indirectly dependent upon freshwater resources. In addition, human uses can be affected due to diminished recreational opportunities, increased levels of required water treatment, and decreased quantities of usable water. Reduced groundwater reserves and quality also has economic consequences.

There is a trend to less dependence upon groundwater from the confined portion of the Trinity Group aquifer, and more dependence upon surface water. However, surface water projects can have significant effects upon the natural resources of an area. For example, the proposed Paluxy Reservoir would have been approximately two miles upstream from Dinosaur Valley SP, a national natural landmark. The water rights permit application for this project was recently denied by TNRCC. Operation of the reservoir could have been potentially damaging to the dinosaur tracks in the Paluxy River streambed that require certain maintenance flows. The reservoir also would have inundated up to 3848 acres including an estimated 566 acres of mixed riparian forest. In addition, the project would have reduced flows to downstream white bass spawning areas. Spotted bass and shad fisheries would have also been impacted. Also, reduced base flows will impact aquatic habitats all the way to, and including, the Gulf bays and estuaries.

Declaration of the study area as a PGMA could lead to a more efficient use of the existing water resources in the area. It could also help protect the ground and surface water quality of the region. At present, the unconfined portion of the Trinity Group aquifer is subject to contamination by oil and gas operations and confined livestock feeding operations. Surface resources are equally imperiled. For example, elevated fecal coliform levels occur in the Leon River downstream of Lake Proctor and in the North Bosque River. Elevated nutrient concentrations from several sources contribute to excessive planktonic and attached algal growth in the Bosque River.

Protecting the quality and quantity of the ground and surface water of the study area are important goals. The implementation of protection and management strategies will ultimately safeguard other natural resources in the area that are either directly or indirectly influenced by groundwater.

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APPENDIX A

Scientific Names of Plants Mentioned (from McMahan et al. 1984)

APPENDIX A

Scientific Names of Plants Mentioned

Agarito	<i>Berberis trifoliolata</i>
Baccharis	<i>Baccharis</i> spp.
Bermudagrass	<i>Cynodon dactylon</i>
Bluebonnet, Texas	<i>Lupinus texensis</i>
Bluestem, bushy	<i>Andropogon virginicus</i>
Bluestem, little	<i>Schizachyrium scoparium</i> var. <i>frequens</i>
_____, silver	<i>Bothriochloa saccharoides</i>
_____, slender	<i>Schizachyrium tenerum</i>
Buffalograss	<i>Buchloe dactyloides</i>
Dewberry, southern	<i>Rubus trivialis</i>
Dropseed, tall	<i>Sporobolus cryptandrus</i>
Elm, cedar	<i>Ulmus crassifolia</i>
Euphorbia, mat	<i>Euphorbia serpens</i>
Grama, hairy	<i>Bouteloua hirsuta</i>
_____, sideoats	<i>B. curtipendula</i>
_____, Texas	<i>B. rigidiseta</i>
Greenbriar, saw	<i>Smilax bona-nox</i>
Hackberry, netleaf	<i>Celtis reticulata</i>
Huisache	<i>Acacia farnesiana</i>
Juniper, Ashe	<i>Juniperus ashei</i>
Kidneywood	<i>Eysenhardtia texana</i>
Mesquite	<i>Prosopis glandulosa</i>
_____, curly	<i>Hilaria belangeri</i>
Oak, blackjack	<i>Quercus marilandica</i>
_____, live	<i>Q. virginiana</i>
_____, post	<i>Q. stellata</i>
_____, shin	<i>Q. sinuata</i> var. <i>breviloba</i>
_____, Texas	<i>Q. texana</i>
Panicum, Halls	<i>Panicum hallii</i>
Paspalum , brownseed	<i>Paspalum plicatulum</i>
_____, single-spike	<i>P. monostachyum</i>

Persimmon, Mexican
Pricklypear, Texas

Rabbit tobacco
Ragweed, western
Rose, Macartney

Sacahuista
Sedge, cedar
Seepwillow
Senna, two-leaved
Smutgrass
Snakeweed, broom
Soapberry
Sumac
_____, flameleaf

Three-awn
_____, purple
_____, red
Tridens, hairy
Tumblegrass

Windmillgrass
Wintergrass, Texas

Diospyros texana
Opuntia lindheimeri

Evax prolifera
Ambrosia confertiflora
Rosa bracteata

Spartina spartinae
Carex planostachys
Baccharis glutinosa
Cassia roemeriana
Sporobolus indicus
Xanthocephalum spp.
Sapindus saponaria
Rhus spp.
R. lanceolata

Aristida spp.
A. purpurea
A. longiseta
Tridens sp.
Schedonnardus paniculatus

Chloris spp.
Stipa leucotricha

APPENDIX B

Estimated Economic Importance of Selected TPWD Facilities (from Crompton et al. 1998)

DINOSAUR VALLEY STATE PARK

ECONOMIC IMPACT

AVERAGE PARTY SIZE:
 Day Visitors = 4.01
 Overnight Visitors = 3.59

AVERAGE DISTANCE TRAVELED TO SITE:
 Day Visitors = 118.9 miles
 Overnight Visitors = 86.0 miles

ACTUAL 1997 VISITATION (Fiscal Year):
 Day Visitors = 275,943
 Overnight Visitors = 30,728

PERCENT OF OUT-OF-COUNTY VISITORS:
 Day Visitors = 96.66
 Overnight Visitors = 99.00

PER PERSON PER DAY EXPENDITURES

Sector	Day Visitors			Overnight Visitors			Visitor Average
	Adjacent	Enroute	Total	Adjacent	Enroute	Total	
Transportation	\$0.30	\$3.15	\$3.45	\$0.69	\$1.87	\$2.56	\$3.00
Food	1.38	1.83	3.21	1.42	2.35	3.77	3.49
Lodging	0.12	0.09	0.22	0.07	0.01	0.08	0.15
Other	0.20	0.16	0.37	0.43	0.05	0.49	0.43
Total	2.00	5.24	7.24	2.61	4.29	6.90	7.07

ESTIMATED ANNUAL ECONOMIC IMPACT ON SALES

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$79,382	\$79,382	\$94,877	\$20,988	\$20,988	\$25,085	\$119,962
Food	368,044	368,044	494,725	43,211	43,211	58,084	552,809
Lodging	32,474	32,474	42,827	2,058	2,058	2,714	45,541
Other	54,124	54,124	72,629	13,169	13,169	17,671	90,301
Total	534,025	534,025	705,059	79,426	79,426	103,554	808,613

ESTIMATED ANNUAL ECONOMIC IMPACT ON PERSONAL INCOME

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$79,382	\$26,776	\$30,626	\$20,988	\$7,079	\$8,097	\$38,723
Food	368,044	107,174	138,237	43,211	12,583	16,230	154,467
Lodging	32,474	8,297	10,944	2,058	526	693	11,637
Other	54,124	16,226	20,740	13,169	3,948	5,046	25,787
Total	534,025	158,474	200,547	79,426	24,136	30,067	230,614

ESTIMATED ANNUAL ECONOMIC IMPACT ON EMPLOYMENT

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$79,382	1.86	2.20	\$20,988	0.49	0.58	2.78
Food	368,044	12.04	14.61	43,211	1.41	1.72	16.32
Lodging	32,474	0.80	1.02	2,058	0.05	0.06	1.08
Other	54,124	2.68	3.10	13,169	0.65	0.75	3.85
Total	534,025	17.39	20.92	79,426	2.61	3.11	24.03

DINOSAUR VALLEY STATE PARK

ECONOMIC SURGE

AVERAGE PARTY SIZE:
 Day Visitors = 4.01
 Overnight Visitors = 3.59

AVERAGE DISTANCE TRAVELED TO SITE:
 Day Visitors = 118.9 miles
 Overnight Visitors = 86.0 miles

ACTUAL 1997 VISITATION (Fiscal Year):
 Day Visitors = 275,943
 Overnight Visitors = 30,728

PERCENT OF OUT-OF-COUNTY VISITORS:
 Day Visitors = 96.66
 Overnight Visitors = 99.00

PER PERSON PER DAY EXPENDITURES

Sector	Day Visitors			Overnight Visitors			Visitor Average
	Adjacent	Enroute	Total	Adjacent	Enroute	Total	
Transportation	\$0.30	\$3.15	\$3.45	\$0.69	\$1.87	\$2.56	\$3.00
Food	1.38	1.83	3.21	1.42	2.35	3.77	3.49
Lodging	0.12	0.09	0.22	0.07	0.01	0.08	0.15
Other	0.20	0.16	0.37	0.43	0.05	0.49	0.43
Total	2.00	5.24	7.24	2.61	4.29	6.90	7.07

ESTIMATED ANNUAL ECONOMIC SURGE ON SALES (Including Local Visitors)

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$82,125	\$82,125	\$98,156	\$21,200	\$21,200	\$25,338	\$123,494
Food	380,762	380,762	511,820	43,647	43,647	58,671	570,490
Lodging	33,597	33,597	44,307	2,078	2,078	2,741	47,048
Other	55,994	55,994	75,139	13,302	13,302	17,850	92,989
Total	552,478	552,478	729,422	80,228	80,228	104,600	834,022

ESTIMATED ANNUAL ECONOMIC SURGE ON PERSONAL INCOME (Including Local Visitors)

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$82,125	\$27,701	\$31,684	\$21,200	\$7,151	\$8,179	\$39,863
Food	380,762	110,878	143,014	43,647	12,710	16,394	159,408
Lodging	33,597	8,584	11,322	2,078	531	700	12,022
Other	55,994	16,787	21,457	13,302	3,988	5,097	26,554
Total	552,478	163,950	207,477	80,228	24,380	30,371	237,848

ESTIMATED ANNUAL ECONOMIC SURGE ON EMPLOYMENT (Including Local Visitors)

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$82,125	1.93	2.27	\$21,200	0.50	0.59	2.86
Food	380,762	12.46	15.11	43,647	1.43	1.73	16.85
Lodging	33,597	0.83	1.05	2,078	0.05	0.06	1.12
Other	55,994	2.77	3.20	13,302	0.66	0.76	3.97
Total	552,478	17.99	21.64	80,228	2.64	3.15	24.79

MOTHER NEFF STATE PARK

ECONOMIC IMPACT

AVERAGE PARTY SIZE:
 Day Visitors = 3.73
 Overnight Visitors = 3.00

AVERAGE DISTANCE TRAVELED TO SITE:
 Day Visitors = 34.0 miles
 Overnight Visitors = 124.3 miles

ACTUAL 1997 VISITATION (Fiscal Year):
 Day Visitors = 98,353
 Overnight Visitors = 3,893

PERCENT OF OUT-OF-COUNTY VISITORS:
 Day Visitors = 83.00
 Overnight Visitors = 88.41

PER PERSON PER DAY EXPENDITURES

Sector	Day Visitors			Overnight Visitors			Visitor Average
	Adjacent	Enroute	Total	Adjacent	Enroute	Total	
Transportation	\$0.41	\$1.08	\$1.49	\$0.76	\$2.71	\$3.46	\$2.48
Food	2.23	0.66	2.89	2.91	2.37	5.28	4.09
Lodging	0.04	0.12	0.16	0.05	0.00	0.05	0.11
Other	0.15	0.05	0.20	0.53	0.20	0.73	0.47
Total	2.83	1.92	4.75	4.25	5.28	9.52	7.14

ESTIMATED ANNUAL ECONOMIC IMPACT ON SALES

Sector	Expenditures	Day Visitors		Expenditures	Overnight Visitors		Visitor Total
		Direct Impact	Total Impact		Direct Impact	Total Impact	
Transportation	\$33,130	\$33,130	\$58,319	\$2,607	\$2,607	\$4,590	\$62,908
Food	182,215	182,215	402,530	10,011	10,011	22,114	424,645
Lodging	3,313	3,313	7,224	186	186	406	7,630
Other	12,148	12,148	31,894	1,816	1,816	4,768	36,661
Total	230,805	230,805	499,967	14,620	14,620	31,878	531,844

ESTIMATED ANNUAL ECONOMIC IMPACT ON PERSONAL INCOME

Sector	Expenditures	Day Visitors		Expenditures	Overnight Visitors		Visitor Total
		Direct Impact	Total Impact		Direct Impact	Total Impact	
Transportation	\$33,130	\$12,503	\$17,999	\$2,607	\$984	\$1,417	\$19,416
Food	182,215	51,949	100,090	10,011	2,854	5,499	105,589
Lodging	3,313	723	1,584	186	41	89	1,673
Other	12,148	3,824	8,166	1,816	572	1,221	9,386
Total	230,805	69,000	127,839	14,620	4,450	8,225	136,064

ESTIMATED ANNUAL ECONOMIC IMPACT ON EMPLOYMENT

Sector	Expenditures	Day Visitors		Expenditures	Overnight Visitors		Visitor Total
		Direct Impact	Total Impact		Direct Impact	Total Impact	
Transportation	\$33,130	0.64	1.11	\$2,607	0.05	0.09	1.20
Food	182,215	6.06	10.31	10,011	0.33	0.57	10.88
Lodging	3,313	0.09	0.17	186	0.01	0.01	0.18
Other	12,148	0.57	0.96	1,816	0.09	0.14	1.10
Total	230,805	7.36	12.54	14,620	0.47	0.81	13.35

MOTHER NEFF STATE PARK

ECONOMIC SURGE

AVERAGE PARTY SIZE:
 Day Visitors = 3.73
 Overnight Visitors = 3.00

AVERAGE DISTANCE TRAVELED TO SITE:
 Day Visitors = 34.0 miles
 Overnight Visitors = 124.3 miles

ACTUAL 1997 VISITATION (Fiscal Year):
 Day Visitors = 98,353
 Overnight Visitors = 3,893

PERCENT OF OUT-OF-COUNTY VISITORS:
 Day Visitors = 83.00
 Overnight Visitors = 88.41

PER PERSON PER DAY EXPENDITURES

Sector	Day Visitors			Overnight Visitors			Visitor Average
	Adjacent	Enroute	Total	Adjacent	Enroute	Total	
Transportation	\$0.41	\$1.08	\$1.49	\$0.76	\$2.71	\$3.46	\$2.48
Food	2.23	0.66	2.89	2.91	2.37	5.28	4.09
Lodging	0.04	0.12	0.16	0.05	0.00	0.05	0.11
Other	0.15	0.05	0.20	0.53	0.20	0.73	0.47
Total	2.83	1.92	4.75	4.25	5.28	9.52	7.14

ESTIMATED ANNUAL ECONOMIC SURGE ON SALES (Including Local Visitors)

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$39,916	\$39,916	\$70,263	\$2,949	\$2,949	\$5,191	\$75,455
Food	219,536	219,536	484,976	11,323	11,323	25,013	509,990
Lodging	3,992	3,992	8,704	211	211	459	9,163
Other	14,636	14,636	38,426	2,054	2,054	5,393	43,819
Total	278,079	278,079	602,369	16,537	16,537	36,057	638,426

ESTIMATED ANNUAL ECONOMIC SURGE ON PERSONAL INCOME (Including Local Visitors)

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$39,916	\$15,064	\$21,686	\$2,949	\$1,113	\$1,602	\$23,288
Food	219,536	62,590	120,591	11,323	3,228	6,220	126,811
Lodging	3,992	871	1,908	211	46	101	2,009
Other	14,636	4,607	9,838	2,054	647	1,381	11,219
Total	278,079	83,132	154,023	16,537	5,034	9,303	163,326

ESTIMATED ANNUAL ECONOMIC SURGE ON EMPLOYMENT (Including Local Visitors)

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$39,916	0.77	1.34	\$2,949	0.06	0.10	1.44
Food	219,536	7.30	12.42	11,323	0.38	0.64	13.06
Lodging	3,992	0.11	0.20	211	0.01	0.01	0.21
Other	14,636	0.69	1.15	2,054	0.10	0.16	1.31
Total	278,079	8.87	15.11	16,537	0.54	0.91	16.02

LAKE BROWNWOOD STATE RECREATION AREA

ECONOMIC IMPACT

AVERAGE PARTY SIZE:
 Day Visitors = N/A
 Overnight Visitors = 2.93

AVERAGE DISTANCE TRAVELED TO SITE:
 Day Visitors = N/A miles
 Overnight Visitors = 151.9 miles

ACTUAL 1997 VISITATION (Fiscal Year):
 Day Visitors = 155,508
 Overnight Visitors = 2,755

PERCENT OF OUT-OF-COUNTY VISITORS:
 Day Visitors = 58.16
 Overnight Visitors = 89.09

PER PERSON PER DAY EXPENDITURES

Sector	Day Visitors*			Overnight Visitors			Visitor Average
	Adjacent	Enroute	Total	Adjacent	Enroute	Total	
Transportation	\$1.68	\$1.88	\$3.56	\$1.68	\$2.50	\$4.18	\$3.87
Food	2.69	1.47	4.17	2.54	1.77	4.32	4.24
Lodging	0.31	0.15	0.46	0.34	0.07	0.41	0.43
Other	1.01	0.15	1.16	0.72	0.07	0.78	0.97
Total	5.70	3.65	9.35	5.28	4.41	9.69	9.52

ESTIMATED ANNUAL ECONOMIC IMPACT ON SALES

Sector	Day Visitors*			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$151,716	\$151,716	\$233,886	\$4,117	\$4,117	\$6,347	\$240,233
Food	243,480	243,480	464,926	6,242	6,242	11,920	476,845
Lodging	28,141	28,141	53,369	830	830	1,574	54,944
Other	91,764	91,764	202,853	1,760	1,760	3,890	206,744
Total	515,102	515,102	955,034	12,949	12,949	23,731	978,765

ESTIMATED ANNUAL ECONOMIC IMPACT ON PERSONAL INCOME

Sector	Day Visitors*			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$151,716	\$61,324	\$83,641	\$4,117	\$1,664	\$2,270	\$85,911
Food	243,480	76,331	136,885	6,242	1,957	3,509	140,394
Lodging	28,141	7,001	13,859	830	207	409	14,268
Other	91,764	29,704	60,555	1,760	570	1,161	61,716
Total	515,102	174,360	294,940	12,949	4,397	7,349	302,290

ESTIMATED ANNUAL ECONOMIC IMPACT ON EMPLOYMENT

Sector	Day Visitors*			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$151,716	2.57	4.06	\$4,117	0.07	0.11	4.17
Food	243,480	7.54	11.66	6,242	0.19	0.30	11.96
Lodging	28,141	0.71	1.18	830	0.02	0.03	1.22
Other	91,764	4.19	6.29	1,760	0.08	0.12	6.41
Total	515,102	15.01	23.19	12,949	0.36	0.56	23.75

* Average PPPD expenditure data for Texas State Recreation Areas were used.

LAKE BROWNWOOD STATE RECREATION AREA

ECONOMIC SURGE

AVERAGE PARTY SIZE:
 Day Visitors = N/A
 Overnight Visitors = 2.93

AVERAGE DISTANCE TRAVELED TO SITE:
 Day Visitors = N/A miles
 Overnight Visitors = 151.9 miles

ACTUAL 1997 VISITATION (Fiscal Year):
 Day Visitors = 155,508
 Overnight Visitors = 2,755

PERCENT OF OUT-OF-COUNTY VISITORS:
 Day Visitors = 58.16
 Overnight Visitors = 89.09

PER PERSON PER DAY EXPENDITURES

Sector	Day Visitors*			Overnight Visitors			Visitor Average
	Adjacent	Enroute	Total	Adjacent	Enroute	Total	
Transportation	\$1.68	\$1.88	\$3.56	\$1.68	\$2.50	\$4.18	\$3.87
Food	2.69	1.47	4.17	2.54	1.77	4.32	4.24
Lodging	0.31	0.15	0.46	0.34	0.07	0.41	0.43
Other	1.01	0.15	1.16	0.72	0.07	0.78	0.97
Total	5.70	3.65	9.35	5.28	4.41	9.69	9.52

ESTIMATED ANNUAL ECONOMIC SURGE ON SALES (Including Local Visitors)

Sector	Day Visitors*			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$260,860	\$260,860	\$402,142	\$4,621	\$4,621	\$7,124	\$409,267
Food	418,639	418,639	799,391	7,007	7,007	13,379	812,770
Lodging	48,385	48,385	91,763	932	932	1,767	93,530
Other	157,778	157,778	348,785	1,975	1,975	4,367	353,152
Total	885,663	885,663	1,642,081	14,535	14,535	26,637	1,668,718

ESTIMATED ANNUAL ECONOMIC SURGE ON PERSONAL INCOME (Including Local Visitors)

Sector	Day Visitors*			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$260,860	\$105,440	\$143,812	\$4,621	\$1,868	\$2,548	\$146,360
Food	418,639	131,243	235,359	7,007	2,197	3,939	239,298
Lodging	48,385	12,038	23,830	932	232	459	24,289
Other	157,778	51,073	104,118	1,975	639	1,303	105,421
Total	885,663	299,794	507,119	14,535	4,936	8,249	515,368

ESTIMATED ANNUAL ECONOMIC SURGE ON EMPLOYMENT (Including Local Visitors)

Sector	Day Visitors*			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$260,860	4.41	6.99	\$4,621	0.08	0.12	7.11
Food	418,639	12.96	20.04	7,007	0.22	0.34	20.38
Lodging	48,385	1.22	2.03	932	0.02	0.04	2.07
Other	157,778	7.21	10.81	1,975	0.09	0.14	10.94
Total	885,663	25.80	39.87	14,535	0.41	0.63	40.50

* Average PPPD expenditure data for Texas State Recreation Areas were used.

LAKE WHITNEY STATE RECREATION AREA

ECONOMIC IMPACT

AVERAGE PARTY SIZE:
 Day Visitors = 3.55
 Overnight Visitors = 3.56

AVERAGE DISTANCE TRAVELED TO SITE:
 Day Visitors = 62.4 miles
 Overnight Visitors = 89.0 miles

ACTUAL 1997 VISITATION (Fiscal Year):
 Day Visitors = 136,417
 Overnight Visitors = 40,291

PERCENT OF OUT-OF-COUNTY VISITORS:
 Day Visitors = 68.34
 Overnight Visitors = 97.59

PER PERSON PER DAY EXPENDITURES

Sector	Day Visitors			Overnight Visitors			Visitor Average
	Adjacent	Enroute	Total	Adjacent	Enroute	Total	
Transportation	\$1.79	\$4.59	\$6.37	\$0.89	\$2.84	\$3.73	\$5.05
Food	3.72	3.77	7.49	2.54	4.72	7.26	7.38
Lodging	0.34	0.24	0.58	0.14	0.01	0.15	0.37
Other	0.57	1.07	1.64	0.55	0.32	0.88	1.26
Total	6.41	9.67	16.08	4.13	7.90	12.03	14.06

ESTIMATED ANNUAL ECONOMIC IMPACT ON SALES

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$166,476	\$166,476	\$281,527	\$35,107	\$35,107	\$59,369	\$340,896
Food	346,824	346,824	728,366	100,001	100,001	210,012	938,378
Lodging	31,529	31,529	60,136	5,319	5,319	10,145	70,282
Other	52,970	52,970	133,203	21,809	21,809	54,842	188,045
Total	597,799	597,799	1,203,232	162,236	162,236	334,369	1,537,601

ESTIMATED ANNUAL ECONOMIC IMPACT ON PERSONAL INCOME

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$166,476	\$62,362	\$87,883	\$35,107	\$13,151	\$18,533	\$106,415
Food	346,824	102,729	187,355	100,001	29,620	54,021	241,375
Lodging	31,529	9,213	15,664	5,319	1,554	2,643	18,306
Other	52,970	15,986	33,980	21,809	6,582	13,990	47,970
Total	597,799	190,290	324,881	162,236	50,907	89,186	414,067

ESTIMATED ANNUAL ECONOMIC IMPACT ON EMPLOYMENT

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$166,476	3.24	5.48	\$35,107	0.68	1.16	6.64
Food	346,824	11.22	18.84	100,001	3.24	5.43	24.28
Lodging	31,529	0.68	1.22	5,319	0.11	0.21	1.42
Other	52,970	2.62	4.27	21,809	1.08	1.76	6.02
Total	597,799	17.77	29.81	162,236	5.11	8.55	38.36

LAKE WHITNEY STATE RECREATION AREA

ECONOMIC SURGE

AVERAGE PARTY SIZE:
 Day Visitors = 3.55
 Overnight Visitors = 3.56

AVERAGE DISTANCE TRAVELED TO SITE:
 Day Visitors = 62.4 miles
 Overnight Visitors = 89.0 miles

ACTUAL 1997 VISITATION (Fiscal Year):
 Day Visitors = 136,417
 Overnight Visitors = 40,291

PERCENT OF OUT-OF-COUNTY VISITORS:
 Day Visitors = 68.34
 Overnight Visitors = 97.59

PER PERSON PER DAY EXPENDITURES

Sector	Day Visitors			Overnight Visitors			Visitor Average
	Adjacent	Enroute	Total	Adjacent	Enroute	Total	
Transportation	\$1.79	\$4.59	\$6.37	\$0.89	\$2.84	\$3.73	\$5.05
Food	3.72	3.77	7.49	2.54	4.72	7.26	7.38
Lodging	0.34	0.24	0.58	0.14	0.01	0.15	0.37
Other	0.57	1.07	1.64	0.55	0.32	0.88	1.26
Total	6.41	9.67	16.08	4.13	7.90	12.03	14.06

ESTIMATED ANNUAL ECONOMIC SURGE ON SALES (Including Local Visitors)

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$243,599	\$243,599	\$411,951	\$35,974	\$35,974	\$60,835	\$472,786
Food	507,499	507,499	1,065,798	102,471	102,471	215,199	1,280,996
Lodging	46,136	46,136	87,996	5,451	5,451	10,396	98,391
Other	77,509	77,509	194,912	22,347	22,347	56,197	251,108
Total	874,743	874,743	1,760,656	166,242	166,242	342,626	2,103,282

ESTIMATED ANNUAL ECONOMIC SURGE ON PERSONAL INCOME (Including Local Visitors)

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$243,599	\$91,252	\$128,596	\$35,974	\$13,476	\$18,991	\$147,587
Food	507,499	150,321	274,151	102,471	30,352	55,355	329,505
Lodging	46,136	13,481	22,920	5,451	1,593	2,708	25,628
Other	77,509	23,392	49,722	22,347	6,744	14,336	64,058
Total	874,743	278,447	475,389	166,242	52,165	91,389	566,778

ESTIMATED ANNUAL ECONOMIC SURGE ON EMPLOYMENT (Including Local Visitors)

Sector	Day Visitors			Overnight Visitors			Visitor Total
	Expenditures	Direct Impact	Total Impact	Expenditures	Direct Impact	Total Impact	
Transportation	\$243,599	4.75	8.02	\$35,974	0.70	1.18	9.20
Food	507,499	16.42	27.57	102,471	3.32	5.57	33.14
Lodging	46,136	0.99	1.78	5,451	0.12	0.21	1.99
Other	77,509	3.84	6.24	22,347	1.11	1.80	8.04
Total	874,743	26.00	43.62	166,242	5.24	8.76	52.38