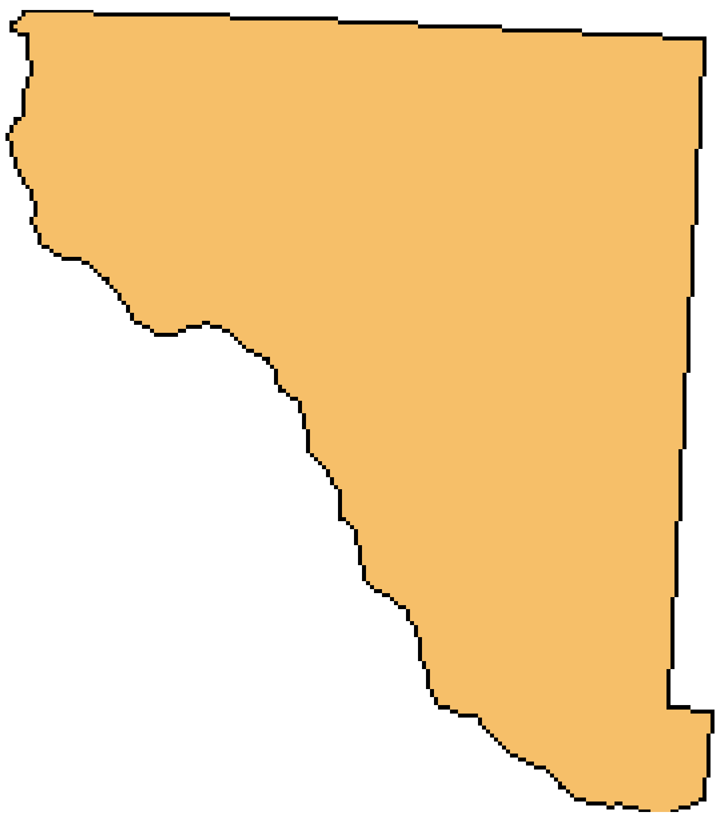
PGMA Study: EL PASO COUNTY

EVALUATION OF SELECTED NATURAL RESOURCES IN EL PASO COUNTY, TEXAS



TEXAS PARKS & WILDLIFE

RESOURCE PROTECTION DIVISION:
WATER RESOURCES TEAM

EVALUATION OF SELECTED NATURAL RESOURCES IN EL PASO COUNTY, TEXAS

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April 1998

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ACKNOWLEDGMENTS

The authors have listed in the reference section and in the “Body” of this report the people who have contributed to the report in the form of professional expertise, scientific data, or literature authorship. We appreciate the assistance of those individuals. Many other people, who have contributed to this effort, are not listed in this report. We appreciate and acknowledge the help and expertise of David Bradsby, Peggy Horner, David Hernandez, Gordon Linam, Melissa Minto, John Maresh, Andy Price, and Dorinda Scott.

EXECUTIVE SUMMARY

One of the basic challenges of living in arid to semi-arid regions is obtaining an adequate supply of fresh water for municipal, industrial, and agricultural use. The City of El Paso, located almost midway between the Pacific Ocean and the Gulf Coast, with Ciudad Juarez, Mexico, is one of the largest semi-arid international boarder communities in the world, with a combined population of 1,303,130 (International Boundary and Water Commission 1994). The El Paso - Ciudad Juarez metropolitan area has an ever-increasing demand for high quality water that meets federal and state drinking water standards.

The 1990 census estimated the population of the study area to be slightly over 591,000. Future projections predict that the population of the City of El Paso will increase from its present estimate of slightly under 600,000 to 1.12 million by the year 2040 (TWDB 1996). The total population for El Paso County is predicted to increase to slightly above 1.39 million (TWDB 1996). This increase in population is placing a higher demand on the limited freshwater supply in the area, and increasing competition with the remaining fauna and flora for that water supply.

The City of El Paso and adjacent areas of the County rely on the groundwater within the Hueco-Mesilla Bolsons and surface water supplies from the Rio Grande as common sources for their water supply (El Paso Water Utilities Public Service Board 1991). Large-scale ground-water withdrawals are depleting the aquifers of the freshest water and have caused major water-level declines and significantly changed the flow and quality of the water. The shallow groundwater is closely related to, and greatly influenced by, the Rio Grande and its associated irrigation canals and drains. Repeated agricultural and municipal reuse of these waters along the Rio Grande can lead to increased salinity and can result in negative effects on the County's natural resources. Additionally, the increased salinity can influence the quality of the deep aquifers as the Rio Grande discharges into the Hueco Bolson (Utz 1998).

In El Paso County as in other counties across the state, traditional approaches to water planning are coming under fire. Population growth, and the public's emerging understanding of environmental needs for water intensify the problems that already exist with water availability and water planning.

Developing adequate water supplies to meet growing demands should not be the primary emphasis of concerned parties. Instead, concerns should be geared towards the improvement of water management and conservation techniques to control the growing needs of the County. Alternative methods of supply, including conjunctive management of surface water and groundwater, water transfer, and changes to water allocation permits should all be used as planning and management tools.

Evaluation of Selected Natural Resources
In El Paso County, Texas

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 ground-water management areas (PGMAs) - areas in the State that are experiencing, or are expected to experience in the future, critical ground-water problems. The purpose of the PGMA program is to assist local and regional interests to address ground-water management issues; including quantity and quality of surface water and groundwater, contamination issues, and land subsidence.

Senate Bill 1 (75th legislature, 1997) placed priority on the completion of pending PGMA studies that were called for by House Bill 2 (69th Legislature) in 1985. The TNRCC and TWDB identified El Paso County in west Texas for a PGMA study in 1990. The study was initiated in 1990 with TNRCC requesting a ground-water resource and availability study from TWDB. The TWDB completed the report *Evaluation of Ground-water Resources in El Paso County, Texas* (TWDB Report No. 324, Ashworth) in March of 1990.

Location and Extent

The study area is within the Rio Grande Basin. It includes only one county: El Paso. Located in the far western tip of Texas, El Paso County is bounded by Hudspeth County on the east, the State of New Mexico on the north and west, and the State of Chihuahua, Mexico on the south (Fig. 1). The study area covers approximately 648, 384 acres, or about 1,013 square miles. The City of El Paso is the major population center in the County. The Rio Grande, originating in southern Colorado, flows southerly across New Mexico, and enters Texas just above the City of El Paso. It is the major surface water body in the County, and it forms the international boundary between the United States and Mexico.

Geography and Ecology

The El Paso County study area is located within the Trans-Pecos Natural Region (LBJ School of Public Affairs 1978; Fig. 2). The Trans-Pecos region is the northern portion of the Chihuahuan desert.

Most of the study area is in the Desert Scrub Subregion, which typifies the Trans-Pecos Region. The flora of the region is dominated by desert scrub such as creosotebush and tarbush, desert grasslands, and pinyon-oak-juniper woodland. The composition of many desert plant communities has been drastically altered in the last 75 years (Texas General Land Office undated).

Figure 1. Location Map of El Paso County, Texas.

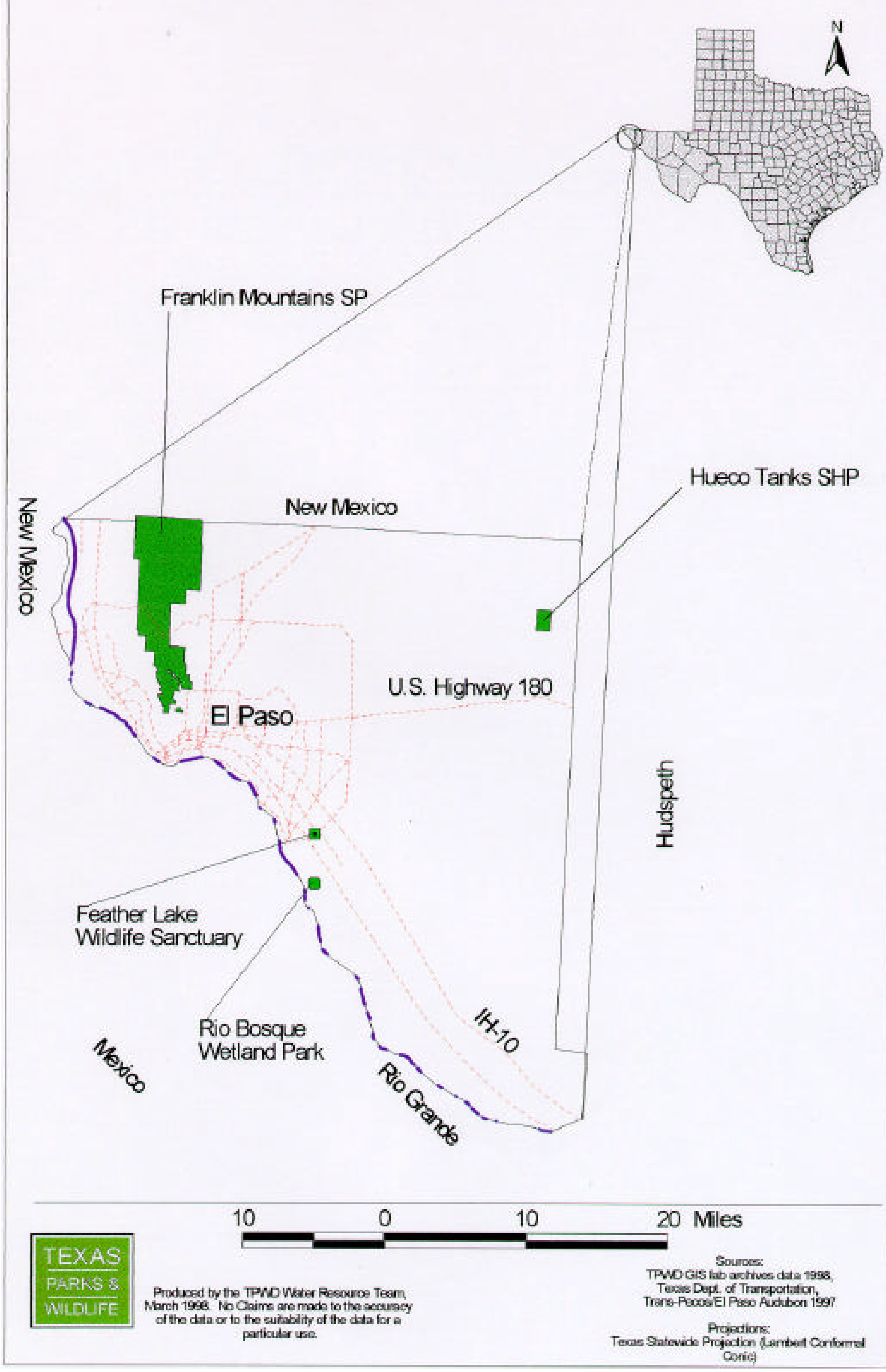
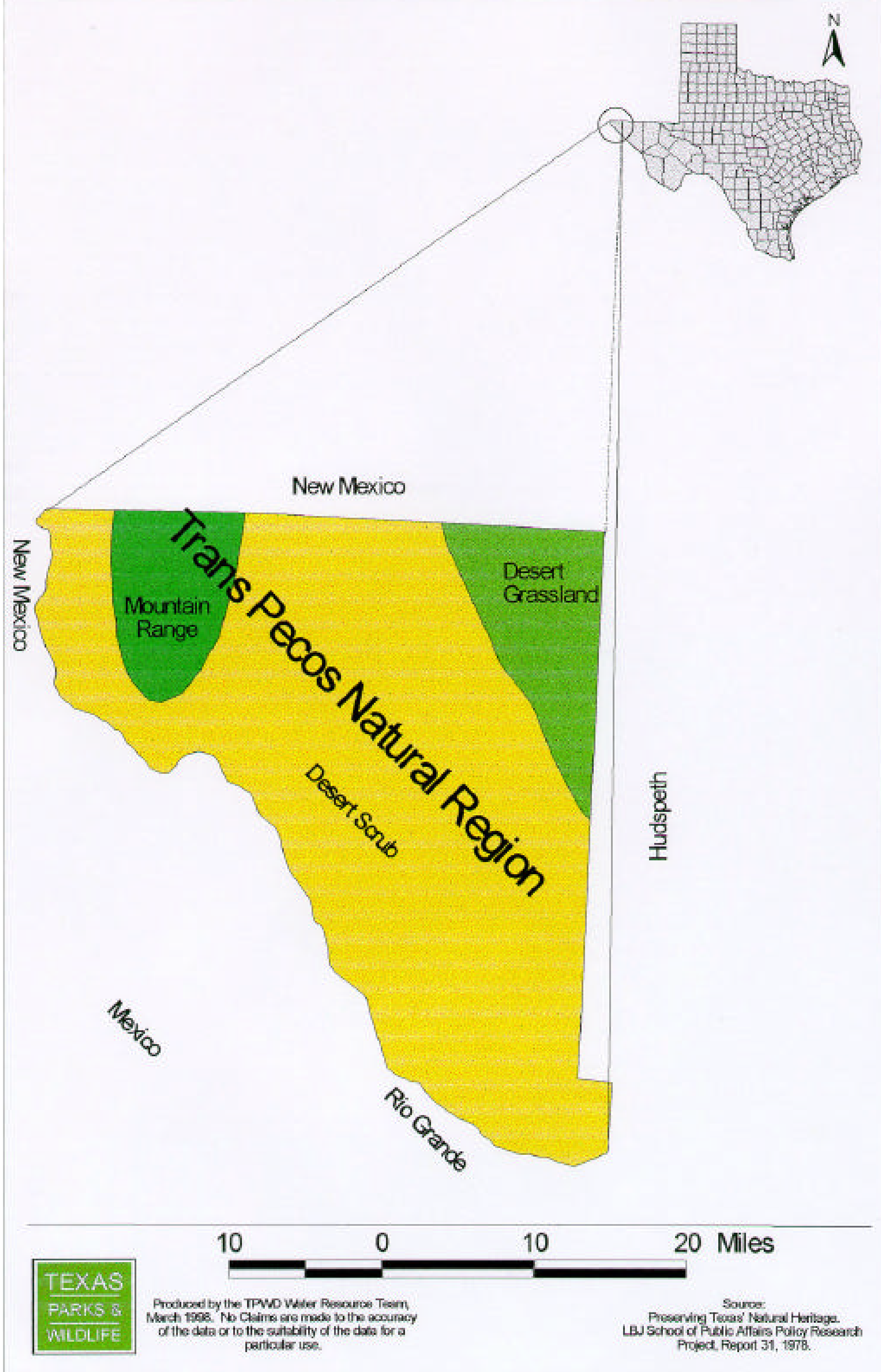


Figure 2. Natural Subregions of El Paso County, Texas.



Among the major physiographic features that make up El Paso County (Fig. 3) are (1) the flood plain of the Rio Grande; (2) the Hueco Bolson, an aquifer that slopes to the west and south; (3) the Franklin Mountains in the Western part of the County; and (4) the Hueco Mountains in the eastern part of the County.

Climate

The arid to semi-arid desert climate of El Paso County is characterized by an abundance of sunshine throughout the year, low humidity, an average annual precipitation of eight inches, and a very high evaporation rate. The annual evaporation rate is in excess of 150 inches per year. More than half of the precipitation occurs in the summer during brief, but at times heavy, thunderstorms. In the summer, the daytime temperature frequently rises above 90° F. and occasionally above 100°F, but most summer nights are comfortable because the temperature usually falls to the 60°'s.

Due to the sparse natural vegetation and the dry and loose soil in El Paso County, dust storms and sandstorms are easily formed by a moderately strong wind. These types of storms are most frequent in March and April, and rare in the fall, although they can occur at any time of the year (Soil Conservation Service 1971).

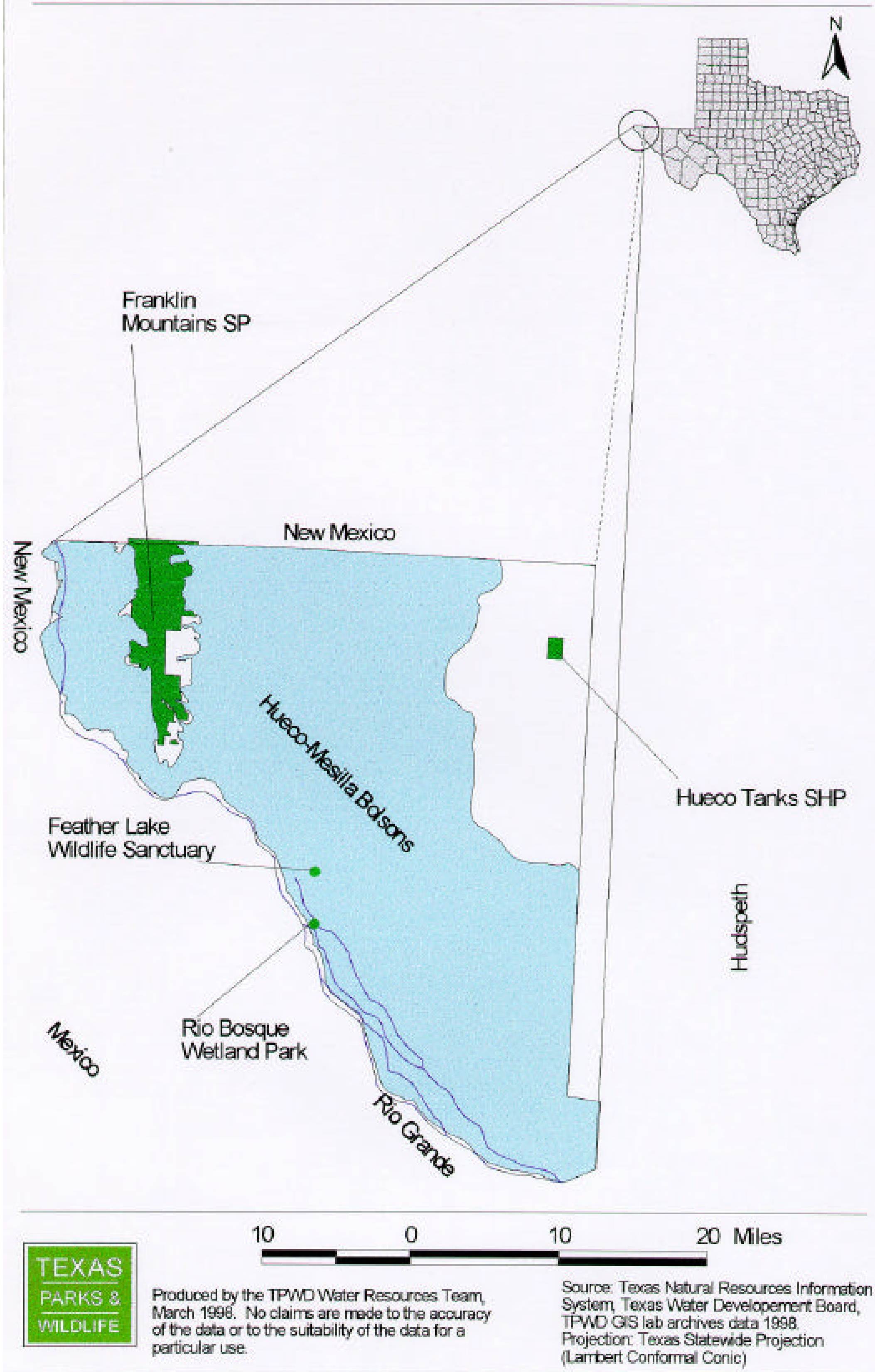
Demographics

The 1990 census estimated the population of the study area to be slightly over 591,000. Future projections predict that the population of the City of El Paso will increase from its present estimate of slightly under 600,000 to 1.12 million by the year 2040 (TWDB 1996). The total population for El Paso County is predicted to increase to slightly above 1.39 million by the year 2040 (TWDB 1996). This increase in population is placing a higher demand on the limited freshwater supply in the area. The following table shows growth predictions through year 2050.

Table 1. The Most-Likely Scenario for Population Growth in El Paso, Texas (TWDB 1996)

Year Þ Locality ß	***1990***	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***
El Paso County	591,610	770,533	921,780	1,082,445	1,254,445	1,391,586	1,536,423
City of El Paso	515,342	632,199	749,541	873,710	1,007,928	1,115,652	1,234,889

Figure 3. Water Resources in El Paso County, Texas



Economy

The City of El Paso, located almost midway between the Pacific Ocean and Gulf Coast, with Ciudad Juarez, Mexico, is the one of the largest international border communities in the world (International Boundary and Water Commission 1994). Situated in the heart of the Camino Real Economic Alliance (C.R.E.A.), which stretches from Santa Fe, New Mexico, in the North, down to Chihuahua City, Mexico, in the South, El Paso is the heart of a trade corridor linking Mexico to the U.S. and Canada, when combined with the Rocky Mountain Corridor.

El Paso has become home of computer manufacturing, telecommunications, consumer products and plastics, and is actively pursuing growth industries, such as metals, hi-tech, defense and tool & die, to relocate in the region. Industry, military installations (Fort Bliss), and tourism have the greatest influence on the local economy (El Paso Chamber of Commerce 1998).

Agriculture production, with a market value of $88 million, is still considered a driving force in the County. It includes cotton, pecans, onions, forage, peppers, as well as dairy and beef cattle. Most of the 42,000 acres under irrigation produces cotton. Total cropland is 46,923 acres with a total of 375 farms (U.S. Department of Commerce 1994)

WATER USE

One of the basic challenges of living in an arid region is obtaining an adequate supply of fresh water for municipal, industrial, and agricultural use. The El Paso - Ciudad Juarez metropolitan area, one of the largest sister - cities located along the US - Mexico border (El Paso Chamber of Commerce 1998), has an ever-increasing demand for high quality water that meets federal and state drinking water standards.

The City of El Paso and adjacent areas of the County rely on the groundwater within the Hueco-Mesilla Bolson and surface water supplies from the Rio Grande as common sources for their water supply (El Paso Water Utilities Public Service Board et al 1991). The shallow groundwater is closely related to, and greatly influenced by, the Rio Grande and its associated irrigation canals and drains. Repeated agricultural and municipal reuse of these waters along the Rio Grande can lead to increased salinity and can result in exceeding federal and state drinking water standards. Additionally, the increased salinity can influence the quality of the deep aquifers as the Rio Grande discharges into the Hueco Bolson (Utz 1998).

The City of El Paso presently supplies water to a major portion of the populated area within El Paso County. As growth within El Paso County continues, it is anticipated that water services will be extended to an even greater portion of the County (El Paso Water Utilities Public Service Board et al. 1991). The City and most of the County rely mostly on the groundwater within the Hueco-Mesilla Bolson and the surface water of the Rio Grande (Estepp 1990).

SELECTED NATURAL RESOURCES*

Natural Areas

El Paso County includes the Franklin Mountains State Park (SP) (24,049.6 acres), the largest urban park in North America, in the northwestern part of the County and the Hueco Tanks State Historic Park (SHP) (860.3 acres) in the eastern part (Fig. 1). Other natural areas include the Rio Bosque Park (350 acres) and Feather Lake Wildlife Sanctuary (43.5 acres) (Fig. 1), both of which are man made wetlands, the Wilderness Park Museum, Arroyo Park, Memorial Park, and the Sunland Park Racetrack. It is important to note that none of these areas include water-based recreation facilities, other than bird watching.

Vegetation and Soil

The Natural Regions of Texas were delineated largely on the basis of soil type and major vegetation types. Soils of El Paso County vary from fine sandy loam and clay on the Rio Grande floodplain to gravely throughout mainly on or near foot slope of the Franklin Mountains and the Hueco Mountains (Soil Conservation Service 1971).

The vegetation type map of Figure 4 shows the Mesquite-Sandsage Shrub type (14) is dominant in the study area. Associated plants include fourwing saltbush, palmella, mormon tea, sotol, sand dropseed, mesa dropseed, spike dropseed, blue grama, black grama, chino grama, broom snakeweed, and devil's claw (McMahan et al. 1984). Their distribution is in the sandy soil areas of El Paso County.

The Tobosa-Black Grama Grassland type (1) is principally found in low-lying plains. The associated plants include blue grama, sideoats grama, hairy grama, burrograss, bush muhly, Arizona cottontop, javelina bush, creosotebush, butterflybush, palmella, whitethorn acacia, cholla, broom snakeweed, and rough menodora (McMahan et al. 1984).

Cultivated crops are found mostly along the Rio Grande floodplain. As seen in Figure 4, crops cover a relatively small portion of the study area.

Riparian and aquatic vegetation of both the Franklin Mountains SP and the Hueco Tanks SHP represent the type of vegetation that would be present in El Paso County at natural creeks, rivers, and wetlands (Tables 2&3).

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*The fauna described in this report represents those species that are riparian, semi-aquatic, and aquatic. The tables provided are not considered authoritative.

Table 2. Selected Plants of Hueco Tanks State Historic Park, El Paso County (TPWD 1990)

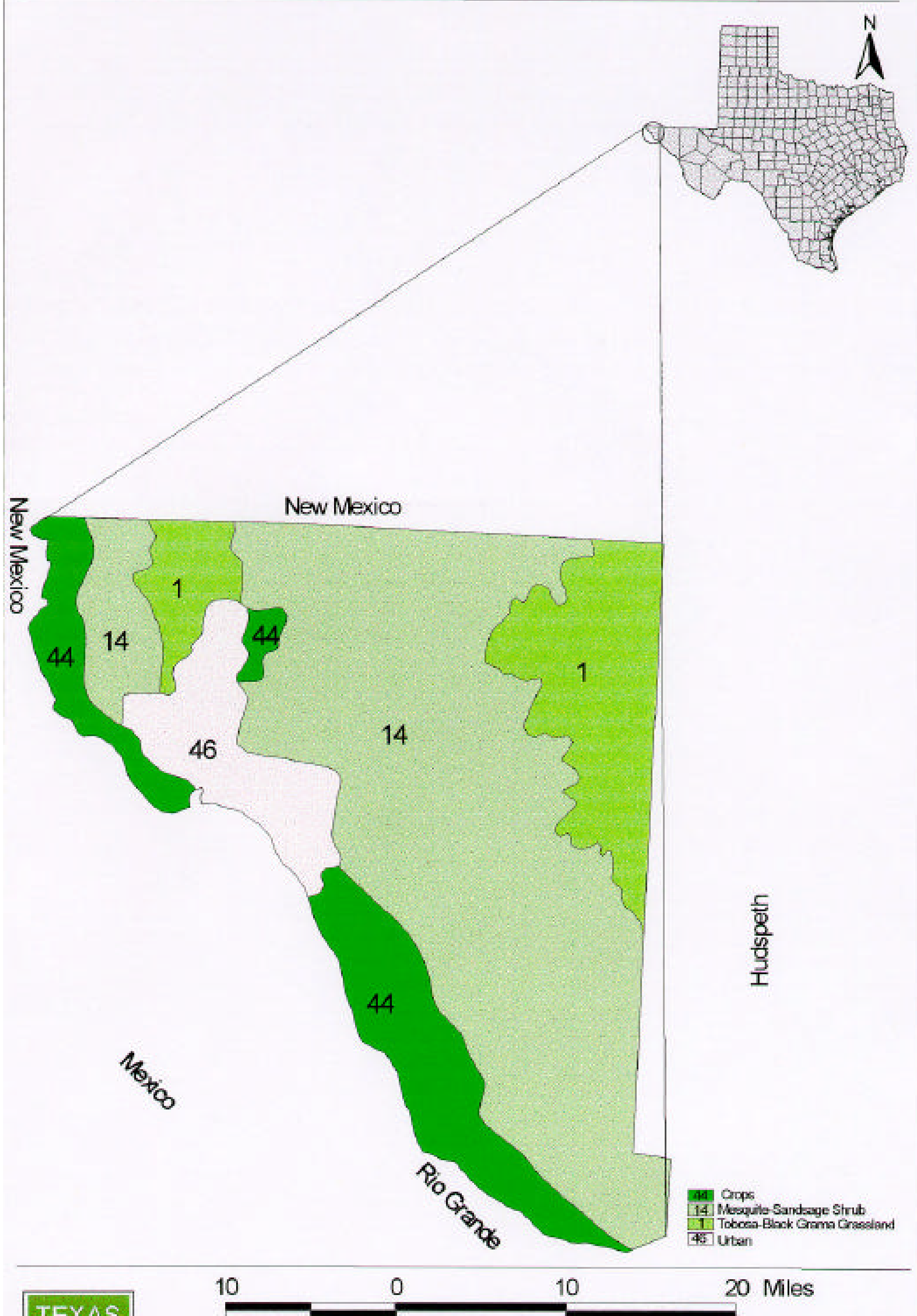
Scientific Name	**Common Name**
COMPOSITAE	**SUNFLOWER FAMILY**
Baccharis glutinosa	Sticky false-willow
Xanthium strumarium	Rough Cocklebur
CYPERACEAE	**SEDGE FAMILY**
Eleocharis macrostachya	Creeping spikerush
Scirpus californicus	California bulrush
GRAMINEAE	**GRASS FAMILY**
Agrostis semiverticillata	Water bentgrass
Echinochloa crusgalli	Barnyardgrass
JUNCACEAE	**RUSH FAMILY**
Juncus tenuis	Slender rush
Juncus interior	Inland rush
MARSILAEACEAE	**PEPPERWORT FAMILY**
Marsilea macropoda	Bigfoot waterfern
Marsilea vestita	Hairy waterfern
POLYGONACEAE	**KNOTWEED FAMILY**
Polygonum aviculare	Prostrate knotweed
POTAMOGETONACEAE	**PURSLANE FAMILY**
Potamogeton foliosus	Pondweed
SALICACEAE	**WILLOW FAMILY**
Populus fremontii	Cottonwood
Salix gooddingii	Goodding willow
SAPINDACEAE	**SOAPBERRY FAMILY**
Ungnadia speciosa	Mexican buckeye
SCROPHULARIACEAE	**FIGWORT FAMILY**
Mimulus glabratus	Round-leaf monkeyflower
Bacopa rotundifolia	Disk waterhyssop
TAMARICACEAE	**TAMARISK FAMILY**
Tamarix sp.	Salt-cedar
VERBENACEAE	**VERVAIN FAMILY**
Phyla incisa	Saw-tooth frog-fruit

Table 3. Selected Plants of Franklin Mountains State Park, El Paso County (TPWD 1990)

Scientific Name	**Common Name**
COMPOSITAE	**SUNFLOWER FAMILY**
Baccharis neglecta	Linear-leaf false-willow
Baccharis pteronoides	Yerba de pasmo baccharis
CYPERACEAE	**SEDGE FAMILY**
Carex frankii	Frank's sedge
Carex hystericina	Porcupine sedge
GRAMINEAE	**GRASS FAMILY**
Agrostis semiverticillata	Water bentgrass
Eragrostis mexicana	Mexican lovegrass
JUNCACEAE	**RUSH FAMILY**
Juncus mexicanus	Mexican rush
Juncus saximontanus	Rocky Mountain rush
Juncus torreyi	Torrey rush
OLEACEAE	**OLIVE FAMILY**
Fraxinus velutina	Velvet ash
SALICACEAE	**WILLOW FAMILY**
Populus wislizenii	Cottonwood, alamo
SCROPHULARIACEAE	**FIGWORT FAMILY**
Mimulus rubellus	Monkeyflower

Tables 1 and 2 are based on collections and observations of M. Butterwick, D. S. Correll, S. W. Oefinger, S. Osborn, J. M. Poole, D.H. Riskind, D. Siegler, T. R. and T. L. Van Devender, B. H. Warnock, and R. D. Worthington. The common names follow the National List of Plant Species that Occur in Wetlands: Texas. Fish and Wildlife Service, U.S. Department of the Interior (1988).

Figure 4. The Vegetation Types of El Paso County, Texas



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Produced by the TPWD Water Resources Team, No Claims are made to the accuracy of the data or to 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.

General Description of the Rio Grande

The Rio Grande is one of the longest rivers in the United States, beginning at an elevation of 9,842 feet (3,000 meters) in the Rocky Mountains of Colorado, flowing southward approximately 746 miles (1,200 km) to the U.S.-Mexico border at El Paso, Texas and Ciudad Juarez, Chihuahua. From there, it flows southeast forming the Texas-Mexico border for approximately 1,243 miles (2,000 km) until it reaches its mouth at the Gulf of Mexico near Brownsville, Texas. In Mexico, the Rio Grande is referred to as Rio Bravo del Norte. Major U.S. cities located along the Rio Grande include Albuquerque, New Mexico; and El Paso, Laredo, and McAllen, Texas. Major Mexican cities along the Rio Grande are Juarez, Chihuahua; and Nuevo Laredo, Reynosa, and Matamoros, Tamaulipas.

Most of the flow of the Rio Grande is diverted for irrigation and municipal uses at the American Canal in Texas and the Acequia-Madre Canal in Mexico before it reaches El Paso. Downstream of El Paso, most of the flow consists of irrigation return flow and treated municipal wastewater from the more than 1 million persons living in El Paso and neighboring Ciudad Juarez.

Springs

El Paso County Springs emanate primarily from Ordovician sandstone and weathered granite on the slopes of Franklin Mountains. Of the few springs that existed historically in El Paso County, two are dry and one has very small flow (Table 4). Mudy Springs are located 12 miles (19 km) north of the City of El Paso. Indian Springs are located 2 miles (3 km) south-east of Mudy Springs. Cottonwood Springs, the only two springs that were still flowing in 1976, are located one at 11 miles (17 km) north of El Paso and the other north of the Trans-Mountain Highway, on the east side of the Franklin Mountains. Hueco Tanks SHP has no springs, it consists of depressions (tenahas) that collect rain water (Brune 1981).

Table 4. Distribution and Estimated Size (in 1980) of Springs for El Paso County (Brune 1981).

	Mudy Springs	**Indian Springs**	**Cottonwood Springs**
Medium large			
Medium			
Small			
Very small			**X**
Seep			
Former	**X**	**X**	

Codes:

Medium large	= 28 - 280 cfs	Very small	= 0.028 - 0.28 cfs
Medium	= 2.8 - 28 cfs	Seep	= less than 0.028 cfs
Small	= 0.28 - 2.8 cfs	Former	= no flow or inundated

Most springs emanate water from the top of the ground-water reservoir, so changes in the water table elevation generally have immediate impact upon spring discharge rates. Springs support a variety of endemic plant and animal species, as well as providing valuable micro-habitats for wetland plants and animals. Typical vegetation of springs includes cottonwood, saltcedar, willows, cattails, and rushes.

Human activity in the El Paso County area, including mining, overgrazing, military target practice in the Franklin Mountains, and declining ground-water tables, caused severe damage to the soil and vegetation, and lead to the failure of most of the springs. Mining has had its effect in lowering the water tables and causing the failure of the springs. One mine pumped 14 gal/sec (52 l/sec) of water day and night (Brune 1981). Overgrazing lead to the destruction of the luxuriant natural grass and its mulch which in the past helped retain water until it could sink into the underground formations.

The potentiometric surface of water in the artesian aquifer has declined greatly due to human activities in and around the study area (Brune 1981). Proper conservation measures and management of human's activity can lead to a rise in the ground-water table, and a potential reemergence of the springs. The implementation of a PGMA in El Paso County might lead to the reappearance of some of those springs.

Groundwater

Although water conservation measures were implemented in the 1980s, El Paso County is still using more and more water each year. Additionally, pumping from the Bolsons exceeds the recharging back to them. Essentially, this results in "mining" the aquifer. It is estimated that by the year 2025, the usable portion of the Hueco Bolson will be gone (Utz 1998). El Paso Water Utilities has already begun using less groundwater to meet water-supply needs and to extend the life of the aquifer. In 1994, 41% of El Paso's water supply came from the Hueco Bolson, 16% from the Mesilla Bolson (on the west side of the Franklin Mountains of El Paso extending northward to New Mexico), while 43% came from the Rio Grande surface water. By 1996, El Paso had reduced its use of the Hueco Bolson to 35%, the Mesilla Bolson to 15%, and increased its use of the Rio Grande to 50%. However, Ciudad Juarez gets 100% of its water supply from the Hueco Bolson (Utz 1998)

The shallow aquifer is directly influenced by the surface water activities. The development of a predictive model enabling water management and decision-makers to have a fuller understanding of the impacts and consequences of their decisions is needed (Utz 1998). The end result will be better resource management of the limited freshwater supply in the desert southwest.

Wetlands

Historically, wetlands, riparian forests, and woodlands in the Rio Grande Valley were the most productive wildlife habitats in the El Paso-Ciudad Juarez area (Audubon 1997). The highly productive natural wetlands and riparian woodlands once found along the Rio Grande in the El Paso area have virtually disappeared. Restoration of what once were productive natural wetlands and riparian woodlands habitats is an effort that Audubon, the University of Texas at El Paso, and the city of El Paso are investing lots of resources in. Feather Lake Sanctuary and Rio Bosque Wetland Park are two such examples.

Feather Lake Wildlife Sanctuary is managed by the El Paso/Trans-Pecos Audubon Society. It occupies 43.5 acres, including a 40-acre wetland. The wetland is actually a City of El Paso stormwater- detention basin, built in 1969. Since 1976, Audubon has leased this land from the City and managed it for wildlife and as an environmental education area.

The wetlands, riparian woodlands and desert scrub grasslands at Feather Lake support a diverse wildlife community. "Walk the 1-mile path around the lake on a spring day, and you might see muskrats across the water surface, spiny softshell turtles and pond sliders basking on clumps of vegetation in the marsh, and little striped whiptail lizards skittering ahead of you on the trail (Audubon 1997)."

Feather Lake is best known for its birds. Over the years, 167 species have been observed at the sanctuary. "Not surprisingly, birds associated with water are especially well represented. Among the annual highlights: hordes of yellow-headed blackbirds in early fall, up to 4,000 ducks in mid-winter, squadrons of white-faced ibis in spring, and least bitterns in summer. Historically, the least bittern was a fairly common nesting species in the wetlands of the river valley; today, it is known in the El Paso area only from Feather Lake (Audubon 1997)."

The Rio Bosque Wetland project site encompasses approximately 350 acres located about 10 miles southeast of downtown El Paso. The land is owned by the City of El Paso under two quitclaim deeds from the Department of the Interior, National Park Service, under the "Lands-to Parks Program." UTEP and Ducks Unlimited are managing and developing the wetlands under a 30-year agreement with the City of El Paso (Duck Unlimited 1996).

The Rio Bosque Wetland Park is to become a unique managed wetland habitat for waterfowl and other wildlife. The park is seen as a refuge for its inhabitants and public use of the site will be consistent with maintaining this refuge setting. The quantity and quality of water available to develop, maintain, and manage the wetland is to be allocated from the tertiary treated water available from the Bustamante Wastewater Treatment Plant (Ducks Unlimited 1996).

Due to the site's proximity to the Rio Grande and the lack of natural wetland habitats in the region, heavy use of the site by waterfowl and other wetland wildlife should result.

Fishes

"Over the last 15 years development has flourished along the Mexico/U.S. border. Immigration to the area has led to a substantial growth in the cities, and given rise to many small, unincorporated communities. During this period, the population of the border region, a 124 mile (200 km) wide strip centered on the international boundary, has doubled to more than six million people (Emerson and Bourbon 1991)."
Development of agriculture and the population growth along the Rio Grande, specifically, El Paso-Ciudad Juarez, resulted in marked decrease in the Rio Grande water quality and quantity. This type of degradation, in turn, had an adverse effect on the range and distribution of many fish species. During low-flow periods, a large percentage of the river's flow consists of municipal and agricultural discharge and less water is available to dilute pollutants.

Based on the degree of toxic chemical contamination and volume of inflow, the Haskell R. Street Wastewater Treatment Plant and Ciudad Juarez sewage discharge canal appeared to have a high potential for adversely affecting the Rio Grande/Rio Bravo, where flow is dominated by municipal wastewater effluent during low-flow periods (International Boundary and Water Commission 1994).

In El Paso/Ciudad Juarez, economic growth, partially fueled by the maquiladora (product assembly) plants that now exist along the border, has been accompanied by an increased potential for water quality degradation. Sewage treatment is inadequate in many communities on both sides of the border. In addition to potential impacts from oxygen-demanding substances, pathogenic microorganisms, and toxicants associated with sewage, other water quality concerns exist. One relates to the potential for pesticide contamination in farming regions around El Paso/Ciudad Juarez. Another threat of toxic chemical contamination is posed by operation of the maquiladoras (Lewis et al. 1991) and other industries located on both sides of the border (International Boundary and Water Commission 1994).

An intensive water quality investigation of the Rio Grande/Rio Bravo from El Paso/Ciudad Juarez to Brownsville/Matamoros was conducted by TNRCC, TPWD, Texas Department of Health (TDH), U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service, U.S. National Park Service, International Boundary and Water Commission-U.S. and Mexico Sections, Comison Nacional Del Agua, and Secretaria Desarrollo Social. Fish and macrobenthic communities generally were healthy, however, 5 of 36 sampling stations exhibited aquatic-community characteristics reflecting a moderate or high probability of toxic chemical impact. One of those 5 stations, located downstream from El Paso/Ciudad Juarez, exhibited high potential for toxic chemical impacts (International Boundary and Water Commission 1994).

A total of 53 species of fish were collected from 18 sites on the mainstem Rio Grande/Rio Bravo and seven tributaries sampled during this study. Collections from upstream and downstream of El Paso/Ciudad Juarez contained similar species to those found in the Texas portion of the Rio Grande/Rio Bravo by previous researchers (Hubbs et al. 1977; Bestgen and Platania 1988). Species considered common in the upper river by Hubbs et al. (1977) were gizzard shad, red shiner, common carp, river carpsucker, channel catfish, western mosquitofish, and green sunfish. Subsequently, Bestgen and Platania (1988) indicated that those species are still common and added bullhead minnow and longear sunfish. Hubbs et al. (1977) characterized Rio Grande/Rio Bravo fauna upstream of the Rio Conchos as widely distributed and salt tolerant (International Boundary and Water Commission 1994).

The upper Rio Grande was historically a large river with a variable flow. It was characterized by the former presence of big river fishes such as the bluntnose sturgon, blue sucker, gray redhorse, long-nose gar, freshwater drum, bluntnose shiner, and phantom shiner (Sublette et al. 1990). The same goes for the Rio Grande silvery minnow, this species was historically one of the most abundant and widespread fishes in the Rio Grande basin, occurring from Espanola, New Mexico, to the Gulf of Mexico (Burton 1998). It was also found in the Pecos River, a major tributary of the Rio Grande. Collection data indicate the species presently occupies about five percent of its historic range (Burton 1998). It has been completely extirpated from the Pecos River and the Rio Grande downstream of Elephant Butte Reservoir. Throughout much of its historic range, decline of Rio Grande silvery minnow may be attributed to modification of stream discharge patterns and channel desiccation by impoudments, water diversion for agriculture, and stream channelization (Burton 1998). Other fish species, such as the yellow perch, are some of the few species that are still surviving in the study area. For a complete list of fish of El Paso County, see Table 5.

Table 5. Fishes of El Paso County (Wildlife Diversity Program 1998; International Boundary and Water Commission 1994)."

Scientific Name	Common Name	Federal Status	State Status
Carpiodes carpio	River carpsucker		
Cyprinella lutrensis	Red shiner		
Cyprinus carpio	Common carp		
Dorosoma cepedianum	Gizzard shad		
Gambusia affinis	Western mosquitofish		
Ictalurus punctatus	Channel catfish		
Lepomis cyanellus	Green sunfish		
Lepomis macrochirus	Bluegill		
Lepomis megalotis	Longear sunfish		
Micropterus salmoides	Largemouth bass		
Morone chrysops	White bass		
Notropis orca (extirpated)	Phantom shiner		
Notropis simus (extirpated)	Bluntnose shiner		T
Perca flavescens	Yellow perch		
Pimephales vigilax	Bullhead minnow		
Pylodictis olivaris	Flathead catfish		
Stizostedion vitreum	Walleye		

LE - Federally Listed Endangered E - Federally Endangered T - State Threatened

Birds and Waterfowl

Many species of migrating and wintering shorebirds, and neotropical songbirds (Table 6) stopover in the study area to feed and rest on the irrigation canals, the river, and the only two restored/created wetlands.

Feather Lake Wildlife Sanctuary provides heavily used wintering habitat for ducks, other waterbirds, and wading birds. A number of migrating birds also can be seen here in the fall and spring. Memorial Park**,** a city park in central El Paso, tends to attract a variety of birds, especially migrants. The park has been known to attract warblers, flycatchers, nuthatches and others. Sunland Park Racetrack, with its man-made lake attracts waterfowl and shorebirds. During the spring through fall months, black-necked stilts are quite common. During the fall migration Wilson's phalaropes and American avocets are commonly seen and red-necked phalaropes are occasionally seen (Audubon 1987,1997).

The irrigation canals, during the spring and fall migrations, attract warblers and other passerines. Various species of herons and waterfowl can be seen in the canals throughout the year, but there is usually not much variety; green herons, black-crowned night herons, ruddy ducks and coots are common. In the late fall and winter months, waterfowl such as ring-necked ducks, gadwall, lesser scaup, northern shoveler and American wigeon are common; a flock of white-phase snow geese can usually be found either in the canals or feeding in the fields in the surrounding areas. In the spring, the canals are also productive for snipe, black-necked stilts, spotted sandpiper, greater yellowlegs and green-winged teal. The fenceline areas can be productive (except in the summer) with phainopeplas, belted kingfishers, black phoebes, and green herons often being found. In the fall and winter months, some of the irrigation canals are good sites for finding crissal thrashers, pyrrhuloxias and scrub jays. The large dead snag trees are a favorite early morning roost for great blue herons, turkey vultures, and other birds of prey (Audubon 1987, 1997).

Hueco Tanks SHP is year-round home to such birds as scaled quail, white-throated swift, ladder-backed woodpecker, Say's phoebe, Verdin, Canyon wren, crissal thrasher, pyrrhuloxia, canyon towhee, and Cassin's and black-throated sparrows. In summer, they are joined by lesser nighthawk, common poorwill, black-chinned hummingbird, ash-throated flycatcher, cliff swallow, blue grosbeak, and scott's oriole. Winter brings green-tailed and rufous-sided towhees, Brewer's sparrow, and, in some years, scrub jay, nuthatches, bluebirds, townsend's solitaire and sage thrasher. Plus, as an island of lush habitat in the desert, Hueco Tanks is alive with migrants in spring and fall (Audubon 1987, 1997).

Birding is a profitable nature tourism industry. Texas generated $1 billion, in 1994, from bird watching, photographing, feeding, and hunting alone. The average birder takes 25 birding trips per year, and travels almost 3,000 miles to go birding (Audubon 1997). A profitable and sustainable birding industry in Texas depends on enduring natural resources. Many Texas cities use wastewater treatment facilities to enhance habitat for birds, as seen in El Paso’s Feather Lake Wildlife Sanctuary and Rio Bosque Wetland Park.

Table 6. Selected Birds and Waterfowl of El Paso County (Audubon 1987, 1997; Sproul Undated; Zimmer 1990, 1996)

Scientific Name	Common Name	Season	Fed/ State Status
Actitis macularia	Spotted sandpiper	W	
Agelaius phoeniceus	Red-winged blackbird	YR	
Aix sponsa	Wood duck	W	
Anas acuta	Northern pintail	W	
Anas americana	American wigeon	W	
Anas clypeata	Northern shoveler	W	
Anas crecca	Green-winged teal	W	
Anas cyanoptera	Cinnamon teal	YR	
Anas discors	Blue-winged teal	B	
Anas platyrhynchos	Mallard	YR	
Anas strepera	Gadwall	W	
Anser albifrons	Greater white-fronted goose	W	
Anthus rubescens	American pipit	W	
Ardea alba	Great egret	W	
Ardea herodias	Great blue heron	YR	
Aythya affinis	Lesser scaup	W	
Aythya americana	Redhead	W	
Aythya collaris	Ring-necked duck	W	
Aythya valisineria	Canvasback	W	
Botaurus lentiginosus	American bittern	W	
Branta canadensis	Canada goose	W	
Bucephala albeola	Bufflehead	W	
Bucephala clangula	Common goldeneye	W	
Buteo albonotatus	Zone-tailed hawk	B	
Butorides virescens	Green heron	B	
Calidris minutilla	Least sandpiper	W	
Ceryle alcyon	Belted kingfisher	W	
Charadrius alexandrinus	Snowy plover	B	
Charadrius semipalmatus	Semipalmated plover	M	
Charadrius vociferus	Killdeer	YR	
Chen caerulescens	Snow goose	W	
Cistothorus palustris	Marsh wren	YR	
Colaptes auratus	Northern flicker	YR	
Contopus sordidulus	Western wood-pewee	B	
Cygnus columbianus	Tundra swan	W	
Dendrocygna bicolor	Fulvous whistling-duck	B	
Egretta caerulea	Little blue heron	M	

Continue on the next page.

Egretta thula	Snowy egret	B	
Egretta tricolor	Tricolored heron	B	
Empidonax traillii	Willow flycatcher	B	
Empidonax traillii exteimus	Southwestern willow flycatcher	B	LE, E
Fullica americana	American coot	YR	
Gallinula chloropus	Common moorhen	YR	
Geothlypis trichas	Common yellowthroat	B	
Icteria virens	Yellow-breasted chat	B	
Ixobrychus exilis	Least bittern	B	
Larus pipixcan	Franklin's gull	M	
Limnodromus scolopaceus	Long-billed dowitcher	W	
Lophodytes cucullatus	Hooded merganser	W	
Melospiza georgiana	Swamp sparrow	W	
Mergus merganser	Common merganser	W	
Mycteria americana	Wood stork	M	T
Nycticorax nycticorax	Black-crowned night-heron	B	
Oxyura jamaicensis	Ruddy duck	YR	
Pandion haliaetus	Osprey	M	
Pelecanus erythrorhynchos	American white pelican	M	
Phainopepla nintens	Phainopepla	B	
Phalacrocorax auritus	Double-crested comorant	W	
Phalacrocorax brasilianus	Neotropic cormorant	W	
Plegadis chihi	White-faced ibis	B	T
Pluvialis squatarola	Black-bellied plover	M	
Podiceps auritus	Horned grebe	W	
Podiceps nigricollis	Eared grebe	W	
Podilymbus podiceps	Pied-billed grebe	YR	
Porzana carolina	Sora	W	
Rallus limicola	Virginia rail	M	
Recurvirostra americana	American avocet	B	
Riparia riparia	Bank swallow	B	
Sayornis nigricans	Black phoebe	YR	
Sayornis phoebe	Eastern phoebe	W	
Seiurus noveboracensis	Northern waterthrush	M	
Spizella passerina	Chipping sparrow	M	
Stelgidopteryx serripennis	Northern rough-winged swallow	YR	
Tachycineta bicolor	Tree swallow	M	
Tringa flavipes	Lesser yellowlegs	M	
Tringa melanoleuca	Greater yellowlegs	W	
Xanthocephalus xanthocephalus	Yellow-headed blackbird	W	

LE - Federally Listed Endangered
E - State Endangered
T - State Threatened

YR - Year Round
M - Migrant
W - Wintering
B - Breeding Season (Spring & Summer)

Mammals, Amphibians, and Reptiles

There are 1,100 vertebrate species in Texas, 60 of which are found nowhere else in the world (Audubon 1997). There are at least 28 species of amphibians, reptiles, and mammals that are either aquatic, semi-aquatic, or in some way wetland-dependent, present in the study area (Tables 7, 8 & 9).

The City of El Paso and its associated urban sprawl encompasses much of the County. This has a direct effect on the variety of wildlife species that exist in the County. All of the animal species listed in the following tables are dependent on water-related habitats in one way or another. The bats listed in Table 7 feed regularly over the river and other riparian habitats. The silver-haired, and the eastern and western red bats forage and rest in forested riparian areas. All the listed frogs, salamanders, turtles, and the beaver and muskrat are aquatic animals. All toads require aquatic habitats in order to reproduce (Stebbins 1985). The red spotted toad is found in desert streams and pools. All the snakes and lizards listed in Table 9 are restricted to riparian habitats adjacent to the Rio Grande, canals, ponds, and wetlands. The best examples are the New Mexico whiptail that lives on the flood plains of sandy river basins and around the edges of desert playas, and the New Mexico garter snake that occur mainly along creekbeds in the Franklin Mountains, Fort Bliss' Castner Range, and in the better vegetated portions of the suburban residential neighborhoods on the northwest side of El Paso (Stebbins 1985).

The following selected tables are based on the Texas Biological Conservation Database (TXBCD) inventory, Texas Parks and Wildlife staff scientist Dr. Peggy Horner, and personal communication with Dr. Carl Leib, University of Texas at El Paso, Dr. Tessa Bashour, Compa Environmental & Natural Resources Consulting, Fort Bliss. The following tables should not be considered all-inclusive.

Table 7. Selected Mammals of El Paso County (Sources: Wildlife Diversity 1998; Ederhoff 1971; Schmidly 1977, 1991)

Scientific Name	**Common Name**
Antrozous pallidus	Pallid bat
Castor canadensis kuhl	American beaver
Didelphis virginiana	Virginia opossum
Lasionycteris noctivagans	Silver-haired bat
Lasiurus blossivillii	Western red bat
Lasiurus borealis	Eastern red bat
Myotis californicus	California myotis
Myotis velifer	Cave myotis
Myotis yumanensis	Yuma myotis
Ondatra zibethicus ripensis	Pecos river muskrat
Peromyscus boylii	Brush mouse
Peromyscus leucopus	White-footed mouse
Reithrodontomys megalotis	Western harvest mouse

Table 8. Amphibians of El Paso County (Sources: Wildlife Diversity Program 1998; Lieb et al. 1996)

Scientific Name	Common Name
Ambystoma tigrinum	Tiger salamander
Bufo cognatus	Great plains toad
Bufo debilis	Green toad
Bufo punctatus	Red-spotted toad
Bufo speciosus	Texas toad
Bufo woodhousei	Woodhouse toad
Eleutherodactylus augusti	Barking frog
Gastrophryne olivacea	Great plains narrow-mouthed toad
Hyla arenicolor	Canyon tree frog
Rana berlandieri	Rio Grande leopard frog
Rana catesbeiana	Bullfrog
Rana pipiens	Northern leopard frog
Scaphiopus couchii	Couch's spadefoot
Spea bombifrons	Plains spadefoot
Speas multiplicata	New Mexico spadefoot

Table 9. Selected Reptiles of El Paso County (Sources: Wildlife Diversity Program 1998; Lieb et al. 1996)

Scientific Name	Common Name
Chrysemys picta bellii	Western painted turtle
Cnemidophorus inornatus	Little striped whiptail
Cnemidophorus neomexicanus	New mexican whiptail
Diadophis punctatus	Ringneck snake
Elaphe guttata	Corn snake
Eumeces obsoletus	Great plains skink
Kinosternon flavescens	Yellow mud turtle
Sistrurus catenatus	Massasauga
Tantilla atriceps	Plains black-headed Snake
Tantilla hobartsmithi	Southwestern black-headed Snake
Thamnophis crytopsis	Black-necked garter Snake
Thamnophis marcianus	Checkered garter snake
Thamnophis sirtalis	Common garter snake
Thamnophis sirtalis dorsalis	New mexican garter snake
Trachemys gaigeae	Big bend slider
Trachemys scripta	Red-eared slider
Trionyx spinifera	Spiny softshell

CONCLUSION

Human changes to the landscape are extensive and accelerated. The stresses on ecosystems come not just from the number of people but also from their location, and nature and scale of their activities. The current human population of El Paso County is more than 600,000, and is expected to more than double by the year 2040. The largest concentration of people in the study area is in the City of El Paso. Another population center that should be taken into consideration in the PGMA process is Ciudad Juarez, El Paso's sister city on the Mexican side of the border. Surface water and groundwater in the El Paso-Ciudad Juarez metropolitan area are directly affected by landuse activities, the best example is the maquiladora jobs on both sides of the border.

Diversion dams, flood control and irrigation structures are the most obvious signs of human intervention in the aquatic environment, but even in the absence of visible engineering works, the cumulative effects of human activities on the landscape of El Paso County are profound. Grazing, agriculture, industrialization, and urbanization all degraded, and are still degrading the river, the creeks, the groundwater, and the lands they drain- the vital watershed- in ways that make them less able to support life and to provide valuable ecosystem services.

The selected natural resources covered in this report are facing an uncertain future, a future that depend on the quality and quantity of the water resources, both surface and ground, within El Paso County and its vicinity. The study area is lacking in many habitat types-such as natural wetlands- and the resident and migratory species adapted to those habitats.

Mitigating the negative impacts of past and current practices, such as the ones mentioned above, will improve the chances of natural resources recovery, be it surface water, groundwater, or fauna and flora, but fundamental changes in land and water management and resource valuation will be needed.

References

Audubon Society. 1997. Master Plan for Feather Lake Wildlife Sanctuary. El Paso/Trans-Pecos Audubon Society, Texas, June 1997.

Audubon Society. 1987. Birds of El Paso County, Texas and Adjacent Areas. El Paso/Trans-Pecos Audubon Society, Texas, 7th Edition, October 1987.

Bashour, T. 1998. Reptiles and Amphibians of El Paso County. [Online] Available email: compa@cibola.net, February 19.

Bestgen, K.R., and S.P. Platania. 1988. The Ichthyofauna and Aquatic Habitat of the Rio Grande from New Mexico-Texas border to Big Bend National Park. Report to the U.S. Fish and Wildlife Service Office of Endangered Species, Albuquerque, NM.

Brune, G. 1981. Springs of Texas: Vol. I. Branch-Smith, Inc. Fort Worth, Texas.

Burton, G.L. 1998. Rio Grande Silvery Minnow. [Online] Available http://bluegoose.arw.r9.fws.gov /NWRSFiles/WildlifeMgmt/SpeciesAccounts/Fish /Rio_Grande_Silvery_Minnow.html., March 16, 1998.

Ducks Unlimited. 1996. Rio Bosque Wetland Park Management Plan. Unpublished.

El Paso's Chamber of Commerce. 1998. Economic Facts. [Online] Available http://www.elpaso.org/economics/index.htm

El Paso Water Utilities Public Service Board, El Paso County Water Improvement District No. 1, and Boyle Engineering Corporation. 1991. El Paso Water Resources Management Plan: *Phase I Completion Report*. July 1991.

Emerson, P.M. and E.W. Bourbon. 1991. The Border and Free Trade. Report to the North American Institute, Santa Fe, NM. Environmental Defense Fund, Austin, Texas.

Estepp, J.D. 1990. Ground Water Protection and Management Strategies for El Paso County Area: *A critical area ground water study*. Texas Water Commission, February 1990.

Harris, A. Undated. Plant List of Franklin Mountains State Park. Handwritten MS. The University of Texas at El Paso, El Paso, Texas.

Hubbs, C., R.R. Miller, R.J. Edwards, K.W. Thompson, E. Marsh, G.P. Garett, G.L. Powell, D.J. Morris, and R.W. Zerr. 1977. Fishes Inhabiting the Rio Grande, Texas and Mexico, Between El Paso and the Pecos Confluence. Pp. 91-97 in: R.R. Johnson and D.A. Jones, editors. Importance, Preservation, and Management of Riparian Habitat. U.S. Department of Agriculture, Forest Service General Technical Report RM-43.

International Boundary and Water Commission, National Water Commission of Mexico, and the U.S. Environmental Protection Agency. 1994. Binational Study Regarding the Presence of Toxic

Substances in the Rio Grande/Rio Bravo and its Tributaries Along the Boundary Portion Between the United States and Mexico. Final Report, September 1994.

Leib, C.S, R.G. Wbb, and J.D. Johnson. 1996. Checklist of Amphibians and Reptiles of the El Paso-Juarez Border Region. [Online] Available http://www.utep.edu/~leb/chklist /herps/herps.htm

Lewis, S.J., M. Kaltofen, and G. Ormsby. 1991. Border Trouble: Rivers in Peril. A report on Water Pollution Due to Industrial Development in Northern Mexico. National Toxic Campaign Fund, Boston, Massachusetts.

McMahan, C.A., R. Fry, and K.L. Brown. 1984. The Vegetation Types of Texas Including Cropland*: An Illustrated Synopsis to Accompany the Map.* Wildlife Division, Texas Parks and Wildlife Department.

Porter. R.B. 1988. National List of Plant Species That Occur in Wetlands: Texas. Fish and Wildlife Service, U.S. Department of the Interior.

Soil Conservation Service. 1971. Soil Survey of El Paso County. United States Department of Agriculture, in cooperation with Texas Agriculture Experiment Station.

Sproul, J. Unpublished. Birds Observations for Rio Bosque Park, El Paso, 1980 - 1996.

Stebbins, R.C. 1985. A Field Guide to Western Reptiles and Amphibians. 2nd ed., Houghton Mifflin Co., Boston, Massachusetts.

Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. The Fishes of New Mexico. University of New Mexico Press, Albuquerque, New Mexico.

Wildlife Diversity Program. 1998. Texas Biological and Conservation Data System (TXBCD). *Vertebrates List, El Paso County*. Endangered Resources Branch. Texas Parks and Wildlife Department, Austin, Texas.

Texas Parks and Wildlife Department. 1990. Franklin Mountains State Park, El Paso County, Texas. *Preliminary checklist of vascular plants.* Unpublished.

Texas Parks and Wildlife Department. 1990. Hueco Tanks State Historical Park, El Paso County, Texas. *Preliminary checklist of vascular plants.* Unpublished.

Texas Water Development Board. 1988. Revised Data Series.

Texas Water Development Board. 1996. Water for Texas-*Today and Tomorrow: a consensus based update to the state water plan, Vol. III,* water-use planning data appendix, Austin, Texas.

U.S. Department of Commerce. 1994. Texas: State and County Data. 1992 Census of Agriculture. Volume 1 Geographic Area Series, the Agriculture and Financial Statistics Division.

Utz, D.M. Surface Water - Shallow Groundwater Interface Study of the Hueco Bolson. [Online] Available http://rorykate.ce.utep.edu/surfgw/DennisUtz/utz.htm, March 5, 1997.

Zimmer, B.R. 1996. Birds of Franklin Mountains State Park: *a field checklist*. Natural Resource Program, Texas Parks and Wildlife Department, Austin, Texas.

Zimmer, B.R. 1990. Birds of Hueco Tanks State Historical Park: *a field checklist*. Resource Management Section, Texas Parks and Wildlife Department, Austin, Texas.

Worthington, R.D. 1989. An Annotated Checklist of the Native and Naturalized Flora of El Paso County, Texas. El Paso Southwest Botanical Miscellany No. 1. Privately Published El Paso, Texas.