A Biological Management Plan for Rio Bosque Wetlands Park




City of El Paso, Texas
University of Texas at El Paso

October 2002

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City of El Paso, Texas
Parks & Recreation Department

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Biological Sciences Department
Center for Environmental Resource Management

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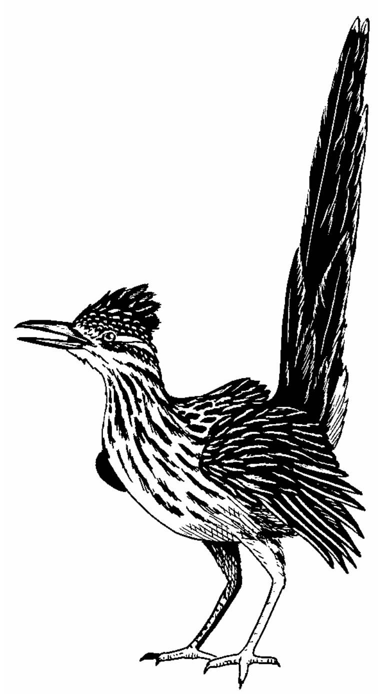

Greater Roadrunner
Geococcyx californianus

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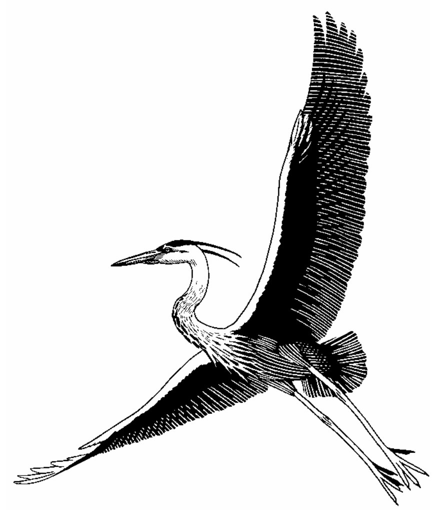
To Franklin Mountains
EXIT 34
10
80
To Van Horn
Americas Ave
LOOP 375
20
76
North Loop Road
Feather Lake
Ysleta Mission
Zaragosa Rd
Alameda Avenue
Socorro Dr
Pan American Dr.
Southside Dr
Zaragosa Bridge
canal
bridge
Socorro Mission
MEXICO
Rio Grande
Rio Bosque Park
North
0
Mile
1
Caballo
Tularosa
Alamogordo
Sunspot
San Andres N.W.R.
25
54
82
Hope
Seven Rivers
Carlsbad
Nutt
185
Las Cruces
Deming
Malaga
Sunshine
Vado
Anthony
Guadalupe Mountains Natl Park
285
Canutillo
El Paso
Cornudas
Orla
San Elizario
Socorro
Tornillo
Sierra Blanca
10
Van Horn
20
Lobo
118
Fort Davis
40mi
40km

Introduction

Rio Bosque Wetlands Park is a large park located along the Rio Grande at the southeast edge of the city of El Paso. It is the site of a long-range project to establish meaningful examples of the native wetland and riparian habitats historically found along the Rio Grande in the El Paso region.

Rio Bosque Wetlands Park provides a unique opportunity to the El Paso area. Because past alterations to the Rio Grande resulted in the loss of native vegetation, the park will become one of the few places in the region with a cottonwood-willow bosque, representative of the river's historic riparian vegetation. Other areas of the park will be vegetated with native upland plant species or will be managed as moist-soil areas to provide food for migrating waterfowl.



Great Blue Heron
Ardea herodias

In addition to providing a wildlife refuge, Rio Bosque Wetlands Park was established to provide a venue for public recreation and education. The park will have valuable wetland and riparian habitat for animals, it will provide public open space for hiking and biking, and it will offer educational opportunities for both school children and the general public. In addition, efforts to restore terrestrial and aquatic habitats provide research opportunities for students of all ages.

The following management plan begins with a description of the historic conditions of the Rio Grande floodplain so as to articulate what we are '*trying to restore to*.' Then the park's current conditions are described, which are a consequence of the management of the river for irrigation and flood control purposes. Next, a vision for the future of the park is presented, along with six specific goals for realizing that vision. The final section, which constitutes the majority of the management plan, presents detailed management recommendations for attaining the six goals.

Part One
Regional Context

Climate

(National Weather Service) El Paso County is located at high elevation in the Chihuahuan Desert of West Texas. Consequently, the climate is arid with hot summers and cool winters, but 90º+ summer days are tempered by cool summer nights in the 60's. On average, there are 12-13 days with temperatures greater than 100ºF. Average annual rainfall is 8.81 inches, which falls in a monsoonal pattern with 80% of the annual precipitation accumulating between April and October, mostly as high intensity thunderstorms. Normally, the first freeze occurs around November 13 and the last around March 21.

Geology

(Cornell 2001) About 35 million years ago, a system of extensional, or 'pull-apart' stresses began, generating one of the most important local geological features, the Rio Grande Rift. The North American Tectonic Plate is being pulled apart in this region by the rift that begins in Colorado, near Leadville, extends southerly through New Mexico to El Paso, and then dies out in Mexico. One product of the tensional forces and rifting has been the formation of numerous elongate basins, separated from one another by mountains. Local examples include the Hueco Mountains, the Hueco Bolson, the Franklin Mountains, and the Mesilla Bolson.

As the mountains uplifted, the mountain sediments began to accumulate in the basins, and this process continues to this day. Additional sediment was carried into the area by the ancestral Rio Grande which, for a few million years, emptied into Lake Cabeza de Vaca, a large, intermittent lake occupying the sites of the present-day basins. Eventually, the Rio Grande broke through the bolson wall, draining the lake and exposing the lakebed and the various accumulated sediments.

The accumulated sediments include river and lake sediments as well as aeolian deposits blown into the area from the southwest. These sediments are now known as the Fort Hancock Formation. The basins are deep structures with as much as 9,000 feet of sediment below the El Paso International Airport area of the Hueco Bolson, and as much as 12,000 feet of sediment under the Mesilla Valley. The width of the alluvial plain of the Rio Grande varies from a few hundred feet at the El Paso Narrows to broad valleys six to eight miles wide as the river courses through this region. Over time, the river has incised approximately 300 feet into the Bolson surface.

Impact of Human Settlement

Pre-settlement era: (Stotz 2000) The morphology of the river 500 years ago was very different from what we see today. Historically, the Rio Grande had a shallow, meandering, shifting channel with a sandy bottom, and the river was prone to periodic flooding. Descriptions of vegetation encountered in old documents suggest that high water tables were probably a common occurrence. In ponds, hydrophytes such as sedges and marsh grasses were common, and, depending on the length of time these ponds held water, tree species such as willow (*Salix* spp.) and cottonwood (*Populus deltoides* ssp. *wislizenii*) were present. Seepwillow (*Baccharis salicifolia*), cottonwood and willow grew along the river's edge and were occasionally washed out during spring floods. In mature plant communities, cottonwood and willow formed the overstory, with false-indigo (*Amorpha fruticosa*), yerba-mansa (*Anemopsis californica*) and saltgrass (*Distichlis spicata* var. *stricta*) scattered in the understory (Campbell and Dick-Peddie 1964). Thus, the historic river valley was characterized by a dynamic mosaic of habitat types.

Rio Grande cottonwood
Populus deltoides ssp. *Wislizenii*

Archeological evidence indicates that the Mesilla and El Paso valleys were inhabited as early as 10,000-6,000 B.C (Peterson et al. 1994), and it appears that an agricultural society existed in the area around 1000 A.D. (Kelley 1992). However, by the time when early Europeans first came to the area, as chronicled by the Rodriguez and Espejo expeditions of 1581 and 1582, no permanent farming settlements existed in these valleys, (Ackerly 1996; Everitt 1977).

A member of Ante's 1540 expedition described "the pleasant shade of the wide spreading trees which grew along the river banks…[and] grassy meadows" of the Rio Grande in the El Paso Valley, (Villagra 1933). An account of the Rodriguez expedition in 1581, described the valley below modern El Paso as "a valley of swamps, which extends over eight leagues," [about 21 miles] (Gallegos 1927).

Coming of permanent settlements & irrigation: Following the establishment of the Guadalupe Mission (in modern Ciudad Juárez) in 1659, settlements and irrigated agriculture developed quickly, altering the river morphology. After the Pueblo Revolt of 1680, refugees established settlements at Socorro and Ysleta, replicating the names of the communities they had lived in along the Middle Rio Grande of New Mexico. Such agricultural endeavors required irrigation structures such as ditches and water diversions. At that time, however, diversion structures were not permanent fixtures, because permanent fixtures could divert flood water into the fields. In 1773, an El Paso Valley resident described a diversion dam as follows:

> It is made of wattles, as the terrain of the river does not permit any other kind of fabrication, to say nothing of the trouble caused by its excessive floods and freshets, for it not seldom happened that after a dam had been built of stones, fagots, and stakes it was necessary to tear it down to prevent inundation of the town, (Hackett 1902).

Other sources described the eighteenth-century diversion structures as large baskets woven of willow wands which were filled with small rocks and placed into specific parts of the river channel during the irrigation season (Horgan 1954).

Besides the impact of irrigation by the permanent residents of the region, another major impact on the river and the adjacent areas came from the throngs of travelers making their way through the pass along the Rio Grande, from the early Spanish explorers to the Spanish missionaries and settlers traveling the Camino Real to Gold Rush 49ers traveling to California. Over the years, the diaries of the travelers document the degradation of the once lush vegetation in the Rio Grande floodplain. During the Gold Rush of 1849, two emigrant roads were established which passed through the El Paso Valley (Martin 1925). After 1849, the whole Rio Grande Valley, from Santa Fe to El Paso, was the half-way place on the overland trip where the emigrants coming via Missouri, Arkansas and Texas expected to lay in new supplies. Most parties rested for three to four weeks to build up the animals for the balance of the journey, and consequently, there was congestion at El Paso, Santa Fe, and every little village between the two places (Martin 1925). Many of these parties were quite large, such as one reported to contain 800 Americans and 300 Mexicans traveling in 300 wagons with 4,000 cattle and 300 mules. At least 4,000 emigrants (and all of their livestock) were reported camping in the vicinity of El Paso in 1849 (Martin 1925).

Historic conditions in the vicinity of Rio Bosque: In the El Paso Valley below San Elizario, Whiting noted that "This trail lies through a fine tract, heavily timbered – the trees are very large." In 1854 Bartlett (1965) wrote: "The Rio Grande Valley near El Paso, and generally in other places, is thickly timbered with cotton-wood. The trees sometimes grow to a large size. Mezquit is found on the borders between the plateau and the valley…cottonwood and the roots of the mezquit constitute the fuel of the country." He also reported that "in a small pond hard by our trail, we saw a flock of twenty-five huge white pelicans" and later that day, they "…came suddenly upon an old cut-off of the river; at the point we struck it, it was so boggy as to be impassable" (Bieber 1938).

Cottonwoods are typically described as being limited to areas along the banks of the river. For instance, in the lower El Paso Valley, Beale reported that "we came in sight of a grove of cotton-woods, which mark the line of the river" (Lesley 1949). The cottonwoods lining the river near El Paso "extend[ed] a few hundred yards on each side of the banks" in 1846 (Ruxton 1973). Where the river passes through the canyon upstream of the El Paso Valley, Magoffin (1926) observed, in 1847, that "cottonwood trees and willow bushes [are] scattered along [the river's] banks."

Goodding Willow
Salix gooddingii

An emigrant, traveling downstream of San Elizario during the month of September in 1849, reported passing a series of ponds (Eccleston 1950). When his party first entered the El Paso Valley to the south, he observed, "It was extremely boggy, and I met a man leading his horse and carrying a shovel. He had to dig his horse out." Eccleston also recorded traveling through "a handsome country. Large cottonwoods, with now and then a willow, adorned our path." Beale, near the southern end of the El Paso Valley in 1857, observed, "We found the river after groping some distance through a dense undergrowth of weeds, briars and willows..." (Lesley 1949).

Between 1892 and 1894, Mearns recorded vegetation characteristics at his mammal survey stations in the El Paso Valley. Near Ft. Hancock, he noted "Lines of cottonwood and willow mark the shifting courses of the river….The river flats are occupied by dense patches of arrowwood, flanked by the tornillo or screwbean and mesquite" (Mearns 1907).

Ground water hydrology

(U.S. IBWC and El Paso Water Utilities 2000) The ground water source for the Rio Bosque Wetlands Park is the shallow alluvium aquifer of the Rio Grande. The depth to ground water is as much as 100 feet below ground surface near downtown El Paso, but decreases to less than 10 feet below ground surface at the southeastern portion of El Paso County where irrigated agriculture continues to be practiced. The ground water flow generally follows the gradient of the river valley, which falls at a rate of about 3.5 feet per mile.

Recharge to the Rio Grande aquifer comes from irrigation water applied to fields, seepage from irrigation canals, seepage from the river, and infiltration following precipitation events. In the vicinity of Rio Bosque Wetlands Park, an important contributor to aquifer recharge is the adjacent Riverside Canal. Preliminary studies at the park indicate that depth to ground water is as little as three feet below the ground surface in the areas close to the Riverside Canal during the irrigation season, but declines dramatically during the winter when the Riverside Canal is dry. In areas remote from the canal, depth to ground water has been measured to be as great as 16 feet below the surface during the dry season.

Well-depths and ground water contour maps indicate that irrigation and ground water levels are closely linked. In the 1950s, 1960s, and 1970s, drought conditions caused water levels to drop, but they returned to normal when river flows and irrigation diversions returned to normal. Such links will be affected by the plans of El Paso County Water Improvement District No. 1 (EPCWID) to concrete line the Riverside Canal in the future to reduce seepage loss. We expect that the concrete-lining will significantly affect the ground water in the park.

The quality of the water in the shallow alluvium aquifer is relatively brackish with total dissolved solids (TDS) ranging from 1,000 to 3,000 parts per million (ppm). In most areas the TDS is lower near the Rio Grande, where fresh water seeps into the aquifer diluting the salty water.

Surface water hydrology

(Crawford et al. 1993) The headwaters of the Rio Grande are in the San Juan Mountains of southern Colorado. The river flows over 2,000 miles through New Mexico and along Texas' southern border to the Gulf of Mexico, draining an area of 247,600 square miles. Between 1889 and 1915, prior to the impoundment of water at Elephant Butte Reservoir, there were nine years during which flooding events with flows in excess of 10,000 cubic feet per second (cfs) were recorded, and the river's average peak flow was about 8,500 cfs. Since 1916, the river's average peak flow has been only 4,100 cfs, and only twice have peak flows in excess of 10,000 cfs been recorded. In the years prior to 1889 when stream gauges were installed, flooding events were reported in the El Paso/Juárez area in 1828, 1872, and 1874. Based on descriptions of the extent of flooding ("water extended all of the way across the valley"), it is estimated that the 1828 event may have had a flow in excess of 100,000 cfs.

In 1916, Elephant Butte Dam was completed and, over the last 86 years, the Rio Grande has been managed for the delivery of irrigation water. Consequently, water is released from the upstream reservoirs only in the irrigation season, which runs from mid-February to mid-October, leaving the river in southern New Mexico and west Texas with meager wintertime flows that consist primarily of agricultural return flows and sewage effluent.

Between 1934 and 1938, the International Boundary and Water Commission (IBWC) built the Rio Grande Rectification Project between El Paso and Ft. Quitman, Texas. Its purposes were to stabilize the international boundary in the El Paso-Juárez Valley and to provide flood protection. The project involved channelizing that reach of the river, thereby reducing its length from 155 miles to 86 miles. One of the river meanders that the project eliminated passed through what is today Rio Bosque Wetlands Park.

Today, the channel of the Rio Grande is immediately southwest of the park. The river has little direct impact on the park, because diversion dams near downtown El Paso divert the bulk of its flow into irrigation canals, leaving only a small amount in the river channel. However, a large irrigation canal (Riverside Canal) runs adjacent to the park, and seepage from that canal positively affects the ground water of the park.

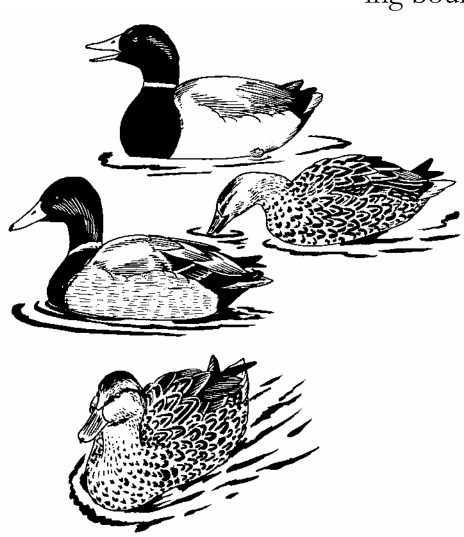
Part Two

Rio Bosque Wetlands Park

Park History

Rio Bosque Wetlands Park is 372 acres in size located in southeast El Paso County. It lies within the corporate limits of the city of El Paso; northeast and southeast of the park is the city of Socorro, Texas; immediately southwest of the park is the Rio Grande, which forms the international border between the U.S. and Mexico. The majority of the site carries the legal designation of U.S. Parcel No. 18, as it was created in 1936 by a formal transfer of land from Mexico to the U.S. as part of the Rio Grande Rectification Project.

For 37 years, U.S. Parcel No.18 was controlled by the IBWC; during a brief period from 1969 to 1973, the parcel was leased to adjoining property owners for agricultural purposes. In 1973, the IBWC declared U.S. Parcel No. 18 as excess and transferred control to the General Services Administration, which in turn transferred it to the Bureau of Outdoor Recreation. In December 1973, ownership of the parcel was transferred to the city of El Paso with the stipulation that the property be used for the development of a park. The city subsequently acquired the surrounding parcels. Today, the area designated as Rio Bosque Wetlands Park is enclosed by irrigation canals and drains on three sides and by the Rio Grande levee on its remaining boundary. The city has had the long-standing goal of developing the park site; over the years the concept of the park's development has changed from one of an active recreation site to a natural area and wildlife refuge. Unfortunately, at no time has the city been able to commit sufficient financial resources to undertake the park's development.



Mallard
Anas platyrhynchos

In 1995, an opportunity to develop Rio Bosque Wetlands Park emerged out of the coalescing interests of a number of entities. Upstream of the park, the U.S. Section of the International Boundary and Water Commission (IBWC) was undertaking the construction of the American Canal Extension, a facility that serves as the principal conduit of irrigation waters through the city of El Paso to serve the downstream agricultural interests. Studies indicated that the construction of the canal would disrupt wetland areas and therefore mitigation measures were required. As a means of fulfilling this requirement, the IBWC approached the city of El Paso and offered to assist the city in developing

Rio Bosque as a wetlands park. Ducks Unlimited, a private, non-profit organization, underwrote the cost of the project design and also provided water control structures. The design called for rebuilding the historic river meander through the park to serve as a water-delivery channel and excavating three wetland cells, totaling 183 acres, capable of being flooded by diverting water from the channel.

El Paso Water Utilities, which operates the Roberto Bustamante Wastewater Treatment Plant (WWTP) immediately northwest of the park, and EPCWID agreed to make treated effluent available to the park during the non-irrigation season. The University of Texas at El Paso (UTEP) volunteered to assume management responsibility for the park and was granted a license agreement for that purpose by the city in November 1996. The IBWC completed construction of the initial site improvements in 1997.

The goal of park management is the restoration and enhancement of valuable wetland and riparian habitat along the Rio Grande while providing public open space and educational opportunities.

Water Resources

The amount, timing and quality of water available will constrain the extent of wetland habitat practically achievable within Rio Bosque Wetlands Park. If wetland species are to be sustained, relatively constant environmental conditions must be created. Water flows may vary, and probably should be varied to mimic the natural ebb and flow of the river. Care must be exercised in the application of water with high levels of dissolved minerals, as soil conditions must not be allowed to become increasingly saline over time or this could impede the establishment of desired riparian species. Consequently, sufficient water must be applied to carry soluble minerals away and thereby maintain a 'salt balance.'

Treated Wastewater: The primary water supply to the park is treated wastewater from the adjoining Bustamante WWTP. This plant has a design capacity of 39 million gallons per day (gpd). Inflow exhibits a slight seasonal variation. During 2001, inflow was approximately 30 mgd in the summer months and 27 million gpd in the winter. In the future, as the volume of influent approaches the plant's capacity, the facility will be expanded. Although the volume of wastewater generated would seem to provide ample water for the park, other entities compete for the same water.

The plant has two permitted discharges: Riverside Canal and Riverside Drain. Treated wastewater discharged into Riverside Canal supplements diverted river water and is used by agricultural irrigators downstream. Only when treated wastewater is discharged into the Riverside Drain can it be diverted into Rio Bosque Wetlands Park. Because both the canal and drain are controlled by EPCWID, it is the irrigation district, rather than the utility, that determines the availability of treated wastewater to the park. Consequently, water is reliably available only after the irrigation season is complete. Despite this limitation, water in the fall and winter allows the park's wetland ponds to be filled, which support a variety of migrating waterfowl.

Through the cooperation of EPCWID, the park received an average of seven million gpd to Rio Bosque Wetlands Park during the spring and summer months of 2001. The availability of water during the growing season dramatically accelerated the growth and spread of native riparian species. In 2002, EPCWID is again making water available to the park. Unfortunately, the park is less likely to receive water during the 2003 irrigation season, as the broader region is experiencing drought and surface water allocations in the El Paso region are expected to be dramatically reduced.

In addition to agricultural interests, other entities will compete for the Bustamante WWTP's effluent in the future. Currently, the utility has a reclaimed water system in place that is capable of supplying two million gpd of treated wastewater to a nearby industrial park for non-potable uses; as of 2001, the actual usage of this reclaimed water was only 700,000 gpd, but it is expected to increase over time. El Paso Water Utilities is also planning a major investment for a reclaimed water system (the so-called "purple pipe" system) to provide treated wastewater to area parks and school playgrounds. When fully implemented, as much as 7 million gpd will be needed for this purpose.

Staff from UTEP/CERM are actively discussing options with El Paso Water Utilities and EPCWID for providing sufficient treated wastewater during the spring and summer to keep the park's main channel wet year-round, thereby expanding the riparian habitat and, possibly, enabling a small perennial deepwater pond to be established.

Table One
Bustamante WWTP Effluent Quality

	2000	2001
CBOD5 *	4 mg/L	3 mg/L
TSS	5	2
TDS	1,048	1,051
NH_4-N (Apr-Oct)	1.97	2.34
NH_4-N (Nov-Mar)	4.33	3.32
Cl (residual)	1.99	1.95
Dissolved O_2	6.53	6.25
pH	7.1	7.2
Flow (mgd)	27.11	27.35

* CBOD5 refers to Carbonaceous Biological Oxygen Demand, based on a 5-day test.

Source: El Paso Water Utilities

Surface Water Quality: Treated wastewater from the Bustamante WWTP is mildly brackish and has a higher nutrient level than river water. Table 1 provides data on the water chemistry of the plant's effluent. Water chemistry tests have also been performed for samples collected from one of the ponds within the park and from four locations along the channel within the park. Results of this testing for alkalinity, chloride, dissolved oxygen, pH, nitrates, silica, phosphates, carbon dioxide, sulfide, and conductivity can be found in Appendix D.

Ground Water: As discussed in a preceding section, the alluvium aquifer of the Rio Grande underlies Rio Bosque Wetlands Park. Under Texas law, property owners have the 'right of capture' for ground water. UTEP/CERM, working with the city of El Paso, could drill one or more wells to tap into the Rio Grande aquifer as a supplemental source of water for the park. So doing would entail capital costs to drill and equip the wells, and operational costs for pumping and equipment maintenance.

Unfortunately, the Rio Grande alluvium aquifer is of poor quality. In July 2000, 13 shallow wells were installed at the park to permit monitoring of ground water depth and quality. The wells were logged under the direction of Dr. Richard Langford of UTEP's Geological Sciences Department. A map of monitoring well locations and well logs appear in Appendix A; water quality data obtained thus far are found in Appendix C. The data show considerable variation in this shallow ground water with total dissolved solids (TDS) ranging from 660 to nearly 3,800 ppm. Deeper strata should contain better quality ground water, but it is still expected to be mildly brackish. Irrigating with brackish water will require careful management so as not to cause the salination of soils.

Auger boring for a Monitoring Well

In the spring of 2001, a team of UTEP civil engineering students, working under the direction of Dr. Charles Turner, prepared a feasibility study for constructing a one-half acre pond at the park. The students took a novel approach that involved a chemical seal to impede seepage loss, a well served by a pump sized to provide sufficient flow to offset evaporation loss and thereby maintain a constant water level, and the use of a photovoltaic system to provide power to the pump.

A test well, drilled to a depth of 140 feet, is planned for the fall of 2002. This will be the first effort at accessing the park's ground water as a supplemental water source. Provided the water is not overly brackish, one or more permanent wells may be developed to ensure a water supply for the park during the summer growing season.

Alternative Source of Water: Few other sources of water are available to the park. Direct precipitation is meager, and stormwater runoff from outside the park boundaries is not an option, as the park is isolated from all adjoining parcels by the Riverside Canal (on the northeast and southeast), the Riverside Drain (on the southwest), and the remnant of the Rio Intercepting Drain (on the northwest).

Soil Characteristics

Because the park lies within the floodplain of the river, there are many different types of depositional soils in the park ranging from sandy loams to silty clays (see Appendix B2). Salt cedar appears to be closely associated with the "Mg – man-made Gila material" soil type. This soil type is especially prominent in the area where the former river channel was filled during the 1930s era Rio Grande Rectification Project.

The different soil types within the park have varying permeability. Unfortunately, the initial pond design did not well-account for the varying soil types, and ponds are positioned over soils of varying permeability. If the ponding areas are modified in the future, soil type must be taken into consideration. Generally, ponds should be positioned in areas with low permeability soil, as soils higher in clay content will better hold water. Clay content should not be too high, however, as a through-flow of water will be required to maintain equilibrium conditions regarding soil salt content.

In February 1997, Dr. Jan Hendrickx from New Mexico Tech conducted a soil salinity study at the park at the request of the Bureau of Reclamation (Hendrickx et al. 1998). This study found large areas with soil salinity less than 40 milliSiemens per meter (mS/m) and salinities greater than 100mS/m are rare (Appendix B1). This is important because many native riparian species like cottonwood require salinity of less than 50 mS/m for survival. Salinity appears to increase with depth, with a mean salinity of 24 mS/m at 0.75 meters (2.5 feet) and 49 mS/m at 6 meters (20 feet). There is a strong correlation between soil salinity and the interaction of soil type and ground water depth. Some 30 to 39% of the variability in salinity measurements appears to be attributable to the soil type and ground water interactions.

Ecosystems

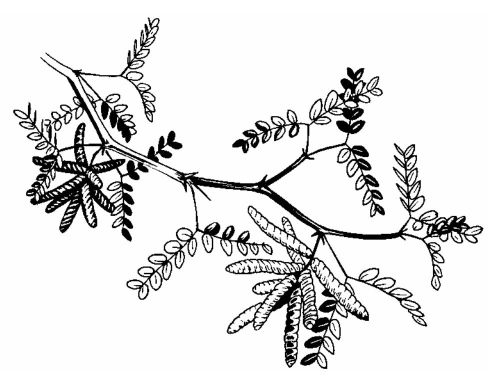
Aquatic ecology: In summer 2001, a baseline aquatic survey was conducted by UTEP students under the direction of Dr. Elizabeth Walsh. Samples were collected at five sites within the park on seven different occasions between May 15th and August 23rd, (approximately 14-day intervals). Sampling sites included the channel inlet and outlet and two mid-channel sites, on opposite sides of Gate 4 (see the map in Appendix A1). The fifth site was Wetland Cell 2. Among the organisms identified were various protists including ciliates (*Vorticella, Paramecium* and other slipper-shaped organisms*, Didnium nasutum,* Lacrymaridae, Ophryoglena, Strobidiidae, Philasteridae), flagellates (*Sphaeroeca volvox , Histomonas),* and amoeba (Thecamoebidae). Two algal species were identified: *Hydrodictyon reticulatum* and *moegeotia scalaris.* A number of invertebrates were identified including coelenterates, rotifers, bdelloids, cladocerans, gastrotrichs, flatworms, nematodes, oligochaetes, gastropods, ostracods, copepods, collembola, and insects (adults and larvae). Fish and toads (adults and larvae) were the only vertebrates identified and duckweed (*Lemna*) and cattails (*Typha* sp.) were the only plants identified.

Terrestrial Vegetation: Appendix E1 provides a partial list of plant species currently found in the park. Nomenclature follows Worthington (1989, 1997). Current vegetation patterns in the park have been greatly influenced by past disturbance, including the channelization of the Rio Grande in the 1930s, past farming of park lands, vehicular traffic over much of the park, and, most recently, the construction of the wetland cells and water-delivery system. Currently, the vegetation in over approximately 65% of the park is in early successional stages.

The construction work in 1997 significantly altered the park landscape. While care was exercised to avoid disturbing desired native vegetation, much existing vegetation, including several extensive saltcedar (*Tamarix ramosissima*) stands, was cleared during the course of creating the wetland cells and water-delivery system. The areas now in early successional stages are dominated by species such as Russian thistle (*Salsola australis*), seepweed (*Suaeda* sp.), alkali heliotrope (*Heliotropium curassavicum),* jackass clover (*Wislizenia refracta*), bitterweed (*Hymenoxys odorata*), tansy mustard (*Descurainia pinnata*), mountain pepperweed (*Lepidium montanum*) and Indian rushpea (*Hoffmanseggia glauca).* Some areas remain largely barren, with a hardpan soil surface.

Approximately 15% of the park supports shrublands dominated by fourwing saltbush (*Atriplex canescens*), honey mesquite (*Prosopis glandulosa* var. *torreyana*) and jimmyweed (*Isocoma pluriflora*). These areas were left largely undisturbed during the 1997 construction work.

Another 15% of the park supports woodlands, with tornillo (*Prosopis pubescens*) and saltcedar the dominant species. Prior to construction of the wetland cells, dense monotypic stands of saltcedar covered approximately 25% of the park. Much saltcedar was removed in the course of construction. Although several dense stands remain, much of what is now present is interspersed with tornillo. The clearing done in 1997 was not complete, however, and in many of the cleared areas, saltcedar has resprouted from incompletely removed root systems. Preventing the reestablishment of saltcedar requires manual removal or treatment with herbicide.



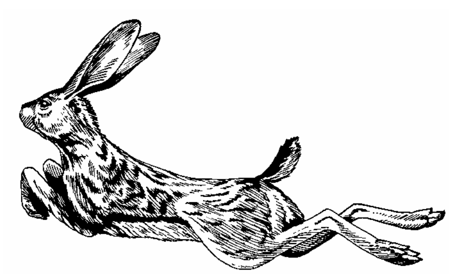
Tornillo
Prosopis pubescens)

Approximately 5% of the park supports riparian scrub associations dominated by wolfberry (*Lycium berlandieri*), arrowweed (*Pluchea sericea*), spiny aster (*Chloracantha spinosa* var. *spinosus*) and coyote willow (*Salix exigua*). These associations are best represented near the park perimeter, in areas influenced by the Riverside Canal and the irrigation drains bordering the park.

The best-developed sand dunes in the park are in a small area along the historic river channel. This site, in the southeast part of the park, is the only area where broom psorothamnus (*Psorothamnus scoparius*), a shrub that favors deep, well-drained sands, grows in the park.

At one time, the city of El Paso maintained a small area in the interior of the park as a tree farm where it grew trees and shrubs for landscaping city parks and other properties. The remnant rows of trees and shrubs still present in this area are an eclectic mix of native and exotic species very different from the rest of the park.

Grasslands are essentially nonexistent in the park. A few scattered individuals of species such as plains bristlegrass (*Setaria leucopila*) and alkali sacaton (*Sporobolus airoides*) are present in upland areas, and species such as barnyardgrass (*Echinochloa crusgallii*), hare barley (*Hordeum murinum* ssp. *glaucum*) and rabbitfoot grass (*Polypogon monospeliensis*) are beginning to invade along the re-built river channel. The park's large population of black-tailed jackrabbits (*Lepus californicus*) appears to play an important role in the current scarcity of grasses.



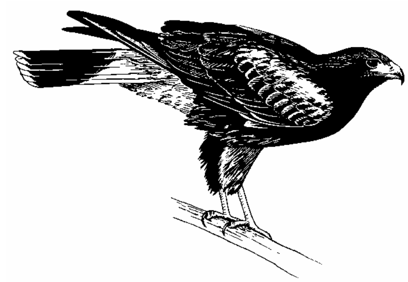
Black-tailed Jackrabbit
Lepus californicus

Prior to 2001, the park received water only in fall and winter. There was no opportunity for native wetland or riparian-forest habitat to become established beyond the plantings described in the following "Restoration Projects to Date" section. Through the cooperation of EPCWID and El Paso Water Utilities, the park received water during the spring and summer of both 2001 and 2002. As a result, wetland and riparian plant communities are now beginning to develop along the water-delivery channels and in the wetland cells.

Birds: Rio Bosque has long provided important habitat for birds, 191 species of which have been recorded to date (Appendix E2). Common nesting species include Harris's Hawk (*Parabuteo unicinctus*), Swainson's Hawk (*Buteo swansoni*), Gambel's Quail (*Callipepla gambelii*), Mourning Dove (*Zenaida macroura*), Greater Roadrunner (*Geococcyx californianus*), Burrowing Owl (*Speotyto cunicularia*), Black-chinned Hummingbird (*Archilochus alexandri*), Western Kingbird (*Tyrannus verticalis*), Verdin (*Auriparus flaviceps*), Northern Mockingbird (*Mimus *polyglottos*), Crissal Thrasher (*Toxostoma crissale*), Yellow-breasted Chat (*Icteria virens*), Cassin's Sparrow (*Aimophila cassinii*), Blue Grosbeak (*Guiraca caerulea*), Painted Bunting (*Passerina ciris*) and House Finch (*Carpodacus mexicanus*).

During the 1990s, a large colony of Snowy Egrets (*Egretta thula*), Cattle Egrets (*Bubulcus ibis*) and Black-crowned Night-Herons (*Nycticorax nycticorax*) nested in a saltcedar stand at the park, though they have not nested there since 1999. Over 100 nests were present in 1999, including the first documented Great Egret (*Ardea alba*) nest in El Paso County.

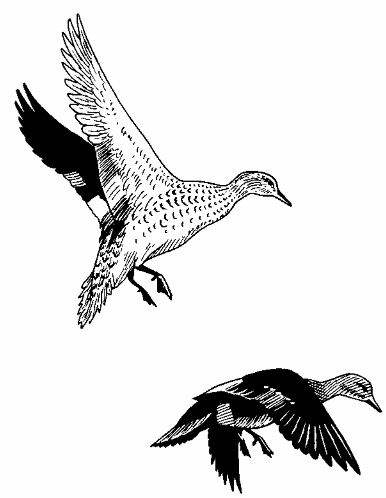
A wide variety of raptors use the park. The peak season is winter, when, in addition to the resident Harris's Hawks, wintering Northern Harriers (*Circus cyaneus*), Sharp-shinned Hawks (*Accipiter striatus*), Cooper's Hawks (*Accipiter cooperii*), Red-tailed Hawks (*Buteo jamaicensis*), Ferruginous Hawks (*Buteo regalis*) and Peregrine Falcons (*Falco peregrinus*) all may be present. In both 2000-2001 and 2001-2002, a Bald Eagle (*Haliaeetus lecucocephalus*) over-wintered at the park. Also of note in winter are large numbers of American Crows *(Corvus brachyrhynchos*) and Chihuahuan Ravens (*Corvus cryptoleucus*) that roost in the park's woodlands.



Harris's Hawk
Parabuteo unicinctus

Summer-resident birds include a number of nearctic-neotropical migrants, such as Yellow-breasted Chat, Blue Grosbeak and Painted Bunting, that are restricted in the El Paso region to riparian habitats. The Yellow-billed Cuckoo (*Coccyzus americanus*), a rare and declining species throughout the western United States, formerly nested in saltcedar woodlands at the park, but cuckoos have not been observed since much of the saltcedar was removed in the course of constructing the wetland cells.

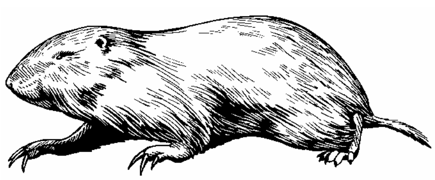
The new element brought by the wetland project that has greatly increased the park's avian diversity is water. Thousands of ducks and other water-associated birds now use Rio Bosque when the wetlands are flooded. The ducks attracted to these shallow-water areas are mainly dabbling ducks, including Gadwall (*Anas strepera*), American Wigeon (*Anas americana*), Mallard (*Anas platyrhynchos*), Cinnamon Teal (*Anas cyanoptera*), Northern Shoveler (*Anas clypeata*), Northern Pintail (*Anas acuta*) and Green-winged Teal (*Anas crecca*). Great Blue Heron (*Ardea herodias*), Great Egret, Snowy Egret and Greater Yellowlegs (*Tringa melanoleuca*) are other regular users of the wetlands in winter. In 2001, with water present all spring and summer, both Mallard and Cinnamon Teal nested at the park.



Gadwall
Anas strepera

Some 20 shorebird species have been recorded at the park, most using the area as migratory stopover habitat. During each of the past 3 years, 20-30 pairs each of Black-necked Stilts (*Himantopus mexicanus*) and American Avocets (*Recurvirostra americana*) have nested in the park's wetland cells.

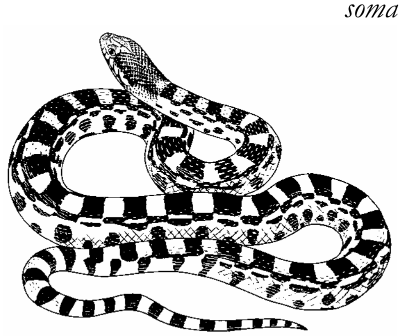
Mammals: Current knowledge of the mammalian fauna of the park (Appendix E3) is limited and comes mainly from incidental observations of the more conspicuous species. To date, researchers have conducted some live-trapping, but no nocturnal road cruising, infrared-triggered photography or other systematic survey work has been undertaken.



Pocket Gopher
Geomys sp.

The park's most conspicuous mammal is the black-tailed jackrabbit. Desert cottontail (*Sylvilagus audubonii*) is also seen regularly; spotted ground squirrel (*Spermophilus spilosoma*), desert pocket gopher (*Geomys arenarius*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), raccoon (*Procyon lotor*) and striped skunk (*Mephitis mephitis*) less so. When water is present, muskrat (*Ondatra zibethicus*) and beaver (*Castor canadensis*) use the water-delivery channels in the park.

Amphibians & reptiles: Present knowledge of the park's herpetofauna (Appendix E3) is incomplete. The commonly observed lizards are the little striped whiptail (*Cnemidophorus inornatus*), prairie lizard (*Sceloporus undulatus*) and side-blotched lizard (*Uta stansburiana*). Also present but seen less often is the Texas horned lizard (*Phrynosoma cornutum*), a state-listed threatened species.



Gopher Snake
Pituophis catenifer

Snakes observed include Great Plains rat snake (*Elaphe emoryi*), night snake (*Hypsiglena torquata*), common kingsnake (*Lampropeltis getula*), coachwhip (*Masticophis flagellum*), gopher snake (*Pituophis catenifer*) and checkered garter snake (*Thamnophis marcianus*). The common turtle seen in the park's vicinity is the spiny softshell (*Trionyx spiniferus*), observed regularly in the Riverside Canal but only sporadically seen in the park.

Red-spotted toad (*Bufo punctatus*), Woodhouse's toad (*Bufo woodhousii*) and Couch's spadefoot (*Scaphiopus couchii*) have all have been observed at the park. In years when no spring-summer water is available, these species take advantage of ephemeral rain-fed pools and moist areas maintained by seepage from the Riverside Canal. Bullfrogs (*Rana catesbeiana*) first appeared in 2000, when water persisted all summer at several of the park's water-control gates. During 2001 and 2002, with water present throughout spring and summer, this species became fairly common.

Restoration Projects Undertaken to Date

Following construction of the wetland cells and water-delivery system, in 1998 UTEP began restoration efforts, including both establishing native species and controlling exotic species. Much of the work has concentrated along the historic river channel that is now the main water channel through the park. Each winter since 1999, clusters of Rio Grande cottonwood, coyote willow and Goodding willow (*Salix gooddingii*) poles have been planted along the channel. Other plantings include rooted seepwillow cuttings and plugs of inland saltgrass at a variety of sites along the main channel and overflow channel. During the summer of 2002, ten Western Honey Mesquite trees (*Prosopis glandulosa*) were planted in the eastern end of the park along trails nearby the park's proposed visitor center. To document progress in site restoration, 28 permanent photographic stations were established within the park.

Western Honey Mesquite
Prosopis glandulosa

With the exception of the honey mesquite trees that were acquired from a local nursery, and the cottonwood and willow poles that were obtained from Bosque del Apache National Wildlife Refuge in 2001, all plant materials have been obtained locally. In 1999 and 2000, water was trucked to the park regularly in spring and summer to ensure estab lishment of the plantings. These plantings are intended to provide source populations from which the species can spread through natural regeneration if and when year-round water is obtained for the park. The reestablishment of native species will be further enhanced if water flows can be managed to mimic springtime overbank flooding events characteristic of the natural hydrograph of the Rio Grande. In 2001, when water flowed through the channel in spring and summer, cottonwoods, willows, seepwillow and other native riparian species began to spread to new areas along the channel.

In 2000, scouringrush (*Equisetum hyemale*) was collected from a nearby irrigation lateral and transplanted along the main water channel in the park. These plants did well as long as water flowed through the channel but died after the flows ended despite weekly watering. Future efforts to establish scouringrush will likely await the presence of year-round water in the park.

In 2001, four plots, ranging in size from 0.25 to 0.75 acres, were seeded with a mix of eight native grass species and irrigated intermittently during the summer with water pumped from the park's main water channel. Only one plot was irrigated often enough to permit extensive seed germination, and the plants that did appear on this plot were quickly lost to jackrabbits. Future grass seeding efforts may employ smaller areas with jackrabbit-proof exclosures and more frequent irrigation.

Even though the IBWC removed a large amount of saltcedar during the initial project construction in 1997, this species remains common in the park. Saltcedar-removal efforts undertaken thus far have concentrated along the main channel and in previously cleared areas where trees have re-grown from incompletely removed root systems or where new seedlings are appearing. Removal methods depend on the size of the tree and include mechanical removal using hand tools, application of Garlon 4™ (triclopyr) to cut stumps, and foliar application of 1% Arsenal® (imazapyr), or a 0.5% Arsenal® and 0.5% Rodeo® (glyphosate) formulation. Limbs from the removed saltcedar have been used to build barriers to exclude vehicle traffic from areas targeted for future restoration.

Other control efforts have been directed at two other exotic species: Russian thistle and perennial pepperweed (*Lepidium latifolium*). Russian thistle is widespread in the park. It has been removed from selected areas mechanically and by burning. Perennial pepperweed is currently present only in isolated pockets. In 2002, areas containing pepperweed were treated using a 1% Oasis® (imazapic/2,4-D) formulation.

Community outreach

UTEP began offering public tours at the park in October 1999. Currently, one introductory tour and one birding tour are offered each month. Staff members from UTEP's Center for Environmental Resource Management (CERM) also give group tours for school classes, community organizations and others on request. In 2000, approximately 160 people took part in the monthly public tours, 52 in 2001, and 37 during the first 6 months of 2002. Special group tours were provided to 425 people in 2000, 145 in 2001, and 138 through the first six months of 2002.

In March 2000, CERM staff began holding monthly community workdays to give citizens a chance to get directly involved in habitat management at the park. Some 70 individuals took part in these workdays in 2000, 76 in 2001, and 50 during the first 6 months of 2002. CERM staff also have given formal presentations about Rio Bosque Wetlands Park to a wide range of groups, from school classes to civic organizations to professional associations. Approximately 750 attended these presentations in 2000, 100 in 2001, and 130 during the first six months of 2002.

Two community meetings have been held to solicit public input regarding the plans for the park's development. The first meeting was held at Socorro High School on January 20, 2001, and included tours of the park. Over 130 people participated in this event. On Saturday, January 26, 2002, a second community meeting was held in a shelter that was erected in Rio Bosque Wetlands Park. Between 120 and 150 people attended this second event. Comments from both meetings were used to refine the master development plan for the park.

Break-out session discussion during a 2001 community meeting

In May of 2002, CERM staff, with the assistance of the National Park Service's Rivers and Trails Program, helped form an organization called "Friends of the Rio Bosque" to assist in a variety of capacities including trail construction, clean-up activities, saltcedar eradication, revegetation efforts, and providing guided tours to park visitors.

School children at Rio Bosque Wetlands Park

Volunteer tour guides

Part Three

Park Management Concerns

Water Delivery Considerations

The goal of the restoration effort is to re-create native wetland and riparian habitats that are, to the maximum extent practicable, self-sustaining. The depth to the water table, however, requires that water continue to be applied to the park to maintain the moist soil conditions necessary for the desired plant communities. Currently, the timing of water deliveries limits restoration efforts. Following are descriptions of the likely future conditions if water deliveries are limited to the fall and winter months.

Aquatic Ecosystems: Riverine areas of this region were historically characterized by a mosaic of aquatic and wetland habitats. If water is available only in the fall and winter, the park's aquatic ecosystems will continue to be dominated by invertebrates because fish and amphibian populations in the park cannot survive due to drying of the ponds in spring/summer. Aquatic vegetation in the form of algae or wetland plants, like southern cattail (*Typha domingensis*), could be present in the wet season, but the cool temperatures of fall/winter may preclude heavy growth. If some wetland/aquatic plants do become established, they would probably return year after year as the seed bank becomes established.

Upland/Riparian Ecosystems: Without water during the spring and summer, little additional riparian vegetation can be established. Current conditions favor deep-rooted trees and shrubs that can get their roots to the water table. Revegetation efforts will have to be limited largely to upland species that depend on summer rain only. The amount of organic material in the soil of the wetland ponds will increase as plants grow and die in response to the filling and drying of the ponds. Currently, the dominant plant species in the pond areas are early successional species. This will change as the plant community matures, but changing soil conditions, particularly associated with accumulation of salts, may influence the rate of maturation and types of plant communities that develop.

Water Table Changes: The proposed lining of the Riverside Canal is likely to affect the vegetation closest to the canal that is dependent on the relatively shallow water table made possible by seepage from the canal. Because lining the canal will reduce recharge to the shallow alluvial aquifer, the salinity of the ground water may increase. The lowering of the water table and potential diminution in ground water quality will affect the viability of all of the shrubs and trees in the park that have deep root systems.

Desired Future Condition

As stipulated in the agreement between CERM/UTEP and the city of El Paso, management of the park is to focus on restoring and enhancing valuable wetland and riparian habitat along the Rio Grande while providing public recreation and educational opportunities. The latter concern, that of developing the park to facilitate public access for appropriate recreation and educational purposes, was addressed through the development of a master plan for the park's development, as shown in Figure Two. Portions of this plan are currently being implemented.

Park development plans are contingent on the establishment of a viable and robust riverine environment. Thus, restoration work is of paramount importance. The overarching goal for the biological management of Rio Bosque Wetlands Park is to re-create the mosaic of habitats characteristic of the Rio Grande and its floodplain in pre-settlement days. A variety of habitat types is achievable within a 372-acre park, because within arid ecosystems, the transition from obligate wetland species through riparian floodplain species to upland species can occur within a distance of only a few hundred feet. By restoring native plant communities, habitat will be provided for native animal communities like birds, fish, small mammals, amphibians, and reptiles.

American Crow
Corvus brachyrhynchos

Based on variations in soil type, water flow patterns, pond configurations, and the patterns of existing or emerging stands of late seral vegetation, a map was created of the distribution of aquatic and terrestrial habitats practically achievable in Rio Bosque Wetlands Park. This map, shown in Figure One, displays the distribution of habitats that this management plan seeks to promote. Specific goals and recommendations that follow provide guidance for achieving this desired future condition. The map of potential habitat distribution is conceptual and is not intended to be an exact blueprint to which the park's vegetation communities must conform. Ultimately, site-specific environmental conditions will dictate which communities develop where within the park.

General Restoration Considerations

Water availability and water quality are ecosystem factors that will have profound effects on the various habitats within the park. Water quantity issues include draw-down rates and whether water will be available during the summer months. When a year-round body of water is present, then total dissolved solids (TDS) and levels of dissolved oxygen become important factors that should be monitored and controlled to ensure the survivability of aquatic animals and plants.

An ecosystem factor that should be analyzed is 'patch' size. Salinity and water availability may dictate the size and composition of vegetated areas, but plans must also consider the needs of the animals that would utilize such habitat. The size and distribution of habitat patches within the park will influence the animal community the park supports. Wet conditions and improved habitat have already attracted large numbers of migrating waterfowl. Over time, it may be possible to establish sufficient habitat to support populations of fish, amphibians, reptiles, and birds within the park year-round. Questions that must be answered include: What animals are expected to be associated with a particular plant community? How many animals could a 'patch' of given size support? Are the animals migratory or year-round residents?

The impact of the park's animal populations on its plant communities also needs to be considered. Currently, the park has a well-established population of black-tailed jackrabbits, desert cottontails, spotted ground squirrels and gophers, and attracts muskrat and beaver when the channels and wetland cells are flooded. Many of these species will have a significant influence on the composition and structure of the plant communities that are present.

Yellow-billed Cuckoo
Coccyzus americanus

Particular attention should be given to ecosystem factors that affect habitat for species of special concern. For example, restored habitat within Rio Bosque Wetlands Park has the potential to attract and support such riparian-obligate birds as Yellow-billed Cuckoo and Southwestern Willow Flycatcher (*Empidonax traillii* ssp. *extimus*). Critical to achieving this goal is adequate water. Not only is water necessary to establish and maintain the desired riparian plant communities, but the aquatic ecosystem must be healthy enough to support the lifecycles of the insects that are food for these birds.

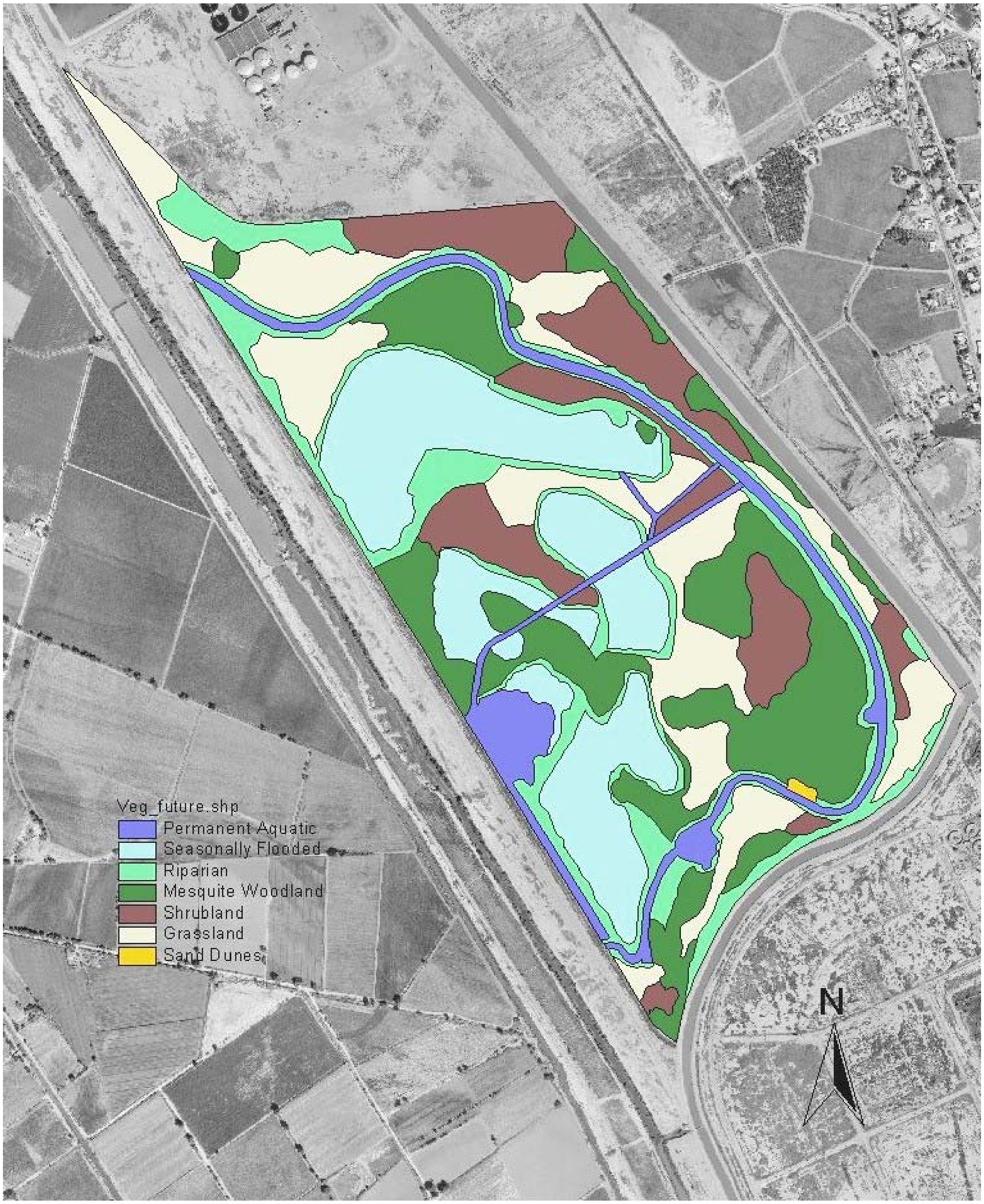


Figure 1: Future Vegetation of Rio Bosque Wetlands Park

Figure 2: Rio Bosque Wetlands Park Development Plan

Design prepared by Michael Williams, R.L.A.; approved by the City of El Paso Parks Advisory Board May 6, 2002

Part Four

Park Management Goals

This biological management plan establishes six goals, each of which has associated recommendations. The goals and recommendations are listed below. Following this initial listing, the next section discusses the recommendations in greater detail and proposes specific actions to implement the plan.

Goal 1: Identify Data Gaps.

1. Compile past and present data for the park and, as data are collected, create a geographic information system (GIS) overlay map with all relevant biotic and abiotic information.
2. Develop a prioritized list of data needs and obtain data needed to fill important data gaps.

Goal 2: Develop a Terrestrial Habitat Restoration and Management Plan.

Recommendations for terrestrial habitat focus on the reestablishment of a variety of self-sustaining native plant communities appropriate for the soil type and water availability of different areas of the park. At the same time, exotic vegetation will be removed and controlled. To prevent accidental damage to native species, proper removal of downed wood and fire control are necessary.

3. Protect, extend, and enhance all native plant communities in the park, especially riparian communities because this habitat type is in serious decline regionally.
4. For un-vegetated areas, select appropriate plant communities for each site based on soil characteristics and water availability.
5. Control or eliminate, where possible, non-native vegetation. Where stands of mature non-native vegetation persist, study the ecology of these stands and develop creative ways of maximizing their biological values.
6. Manage activities that remove dead wood in a manner compatible with biological quality and ecosystem integrity.
7. Prevent unmanaged fires in the park. Use fire only under controlled conditions when needed to achieve specific management objectives.

Goal 3: Develop an Aquatic Habitat Restoration and Management Plan.

Recommendations for aquatic habitat focus on expanding the types of aquatic habitats available in the park. Also important is enhanced water management to mimic the historic hydrograph to aid in the maintenance of channel and floodplain vegetation.

8. Coordinate water management activities to support and improve the park's aquatic and terrestrial habitats, with special emphasis on mimicking the historic hydrograph to provide periodic overbank flooding and fluvial processes that modify the streambed.
9. Protect, extend, and enhance the diversity of the aquatic habitats to benefit native plant and animal communities.
10. Develop a channel-management plan and implement non-structural methods for channel maintenance such as 'flushing flows' to remove accumulating sediment and allow the channel to 'meander' around sandbars.
11. Evaluate the feasibility of constructing a treatment wetland at the water inlet site to remove excess nitrogen and phosphorus from the treated effluent.

Goal 4: Monitor Ecological Factors that Affect Biotic Communities.

Factors such as changing soil and water salinity affect the diversity of species that can survive in the park. Awareness of changing conditions will facilitate appropriate management adaptations.

12. Monitor water table fluctuations and assess the causes of such fluctuations, including factors external to the park.
13. Develop a coordinated program to monitor the interrelationship of environmental factors and biological quality (with emphasis on diversity and abundance of native species) and ecosystem integrity (with emphasis on restoring and maintaining ecological processes).

Goal 5: Integrate Biological Management with Educational and Public Access Goals.

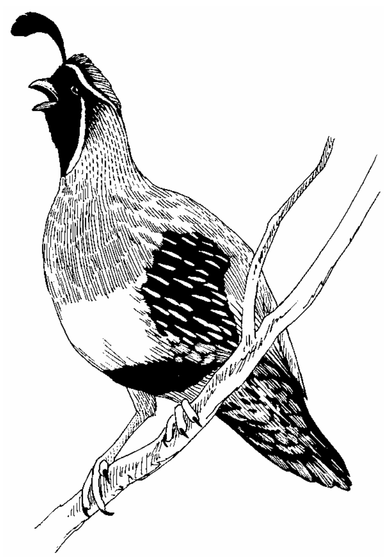
The biological management plan must be closely integrated with the educational and recreational functions of the park through placement of trails, research areas, bird-watching areas, visitor education center, and necessary facilities such as public restrooms.

14. Manage recreational activities in the park in a manner compatible with the park's biological quality and ecosystem integrity.
15. Develop an educational program that accommodates K-12 curricula, as well as casual visitors.

Goal 6: Develop an adaptive management plan.

Because biologic systems are not static, so also the park's management plan must be adaptable. As on-going monitoring identifies changes in such things as vegetation and water quality, management strategies may need to be adapted. Successful restoration requires an ongoing process of experimentation, evaluation of results, and refinement of techniques.

16. Regularly review and update this Biological Management Plan.
17. Integrate resource management activities in the park with those in surrounding areas to protect and enhance biological quality and ecosystem integrity.



Gambel's Quail
Callipepla gambelii

Part Five
Recommended Actions

Recommendation 1:

Compile past and present data for the park and, as data are collected, create a geographic information system (GIS) overlay map with all relevant biotic and abiotic information.

Need

Data for the park have been collected over a period of several years. This information needs to be compiled and mapped to facilitate an on-going evaluation of relationships among the existing data, such as the relationship of soil salinity to vegetation type.

Actions

Consolidate known data, and generate and maintain a geographic information system (GIS) file with data layers for soil type, vegetation, soil salinity, topography, depth to ground water, etc.

- Plant lists from recent studies have been compiled and consolidated in Appendix E1.
- Extensive bird data from the park for the period 1980-1996 have been collected. These data need to be summarized to provide a record of avian use of the park prior to the construction of the wetland cells.
- Mammal, reptile, amphibian, and fish lists are found in Appendix E3.
- The Natural Resource Conservation Service (NRCS) soil survey for the park is shown in Appendix B2. Dr. Jan Hendrickx's soil salinity and depth-to-ground water data from Feb 1997 are shown in Appendix B1.
- New data to be incorporated include: data from ground water monitoring wells (depth, salinity), and soil salinity along the gradient of drying ponds.

Recommendation 2:

Develop a prioritized list of data needs and obtain data needed to fill important data gaps.

Need

Although some data on park resources are already available, much information still needs to be collected to support sound management of the park's biological resources. The actions listed below are all needed to fill important data gaps. They will be carried out as funding permits.

Actions

- Perform a complete floral survey of the park.
- Perform a complete survey of vertebrates and invertebrates currently in the park.
- Establish permanent vegetation plots, including exclosures free of jack-rabbit herbivory and other disturbances, to monitor successional changes in vegetation.
- Develop annual narratives of restoration efforts and wildlife responses.
- Acquire a detailed topographic survey of the entire park, and use the same to assess localized drainage patterns.

Recommendation 3:

Protect, extend, and enhance all native plant communities in the park, especially riparian communities because this habitat type is in serious decline regionally.

Need

The park contains remnants of several vegetation communities that can be expanded into areas as salt cedar is removed. Upland communities can be expanded even if water is only available in fall and winter. With additional water in spring and summer, riparian communities can be reestablished. Such riparian communities are in serious decline regionally but are required by endangered species like the Southwestern Willow Flycatcher and the Yellow-billed Cuckoo.

Introduction of non-native plant species such as *Salsola* and *Tamarix* has challenged the survivability of native species. As exotic species have expanded their ranges, native species have been displaced from their usual habitats. This is due to both competitive advantages inherent in weedy, exotic species and to changes in the physical characteristics of the environment.

General Recommendations

- As much as possible, allow areas to revegetate naturally. Within each community, seek to establish appropriate ecological conditions and processes that will allow the native vegetation to develop and persist on its own. Use selective, targeted interventions (e.g. removal of exotics, plantings, seeding, periodic disturbance, fertilization) to help steer development of the vegetation in the desired direction.

- Use native plant species appropriate to the river valley and local genetic stock for revegetation efforts throughout the park. Appendix F1 presents a list of plant species to consider for revegetation efforts in the park.

Community-specific Recommendations:

Aquatic:

- Recommended plant species for ponds and channel areas with permanent water:

    Duckweed (*Lemna minuta*)
    Pondweed (*Potamogeton* sp.)

Emergent wetland:

- Recommended plant species for areas that have saturated soils and shallow standing water:

    Cattail (*Typha* sp.)
    Bulrush, rush (*Scirpus* sp., *Juncus* sp.)
    Sedges (*Carex emoryi, Cyperus* sp.)
    Scouring rush (*Equisetum hyemale*)

Wet Meadow:

- Recommended plant species for moist soil areas that are periodically inundated, (too moist for upland grasses, but not moist enough for wetland plants):

    Inland salt grass (*Distichlis spicata* var. *stricta)*

Seasonal Moist-soil Managed Wetlands:

- Recommended plant species for pond areas that are to be managed for food for migrating waterfowl:

    Barnyardgrass (*Echinochloa crusgallii*)
    Western wheatgrass (*Elytrigia smithii*)
    Plains lovegrass (*Eragrostis intermedia*)
    Green sprangletop (*Leptochloa dubia*)
    Littleseed ricegrass (*Oryzopsis hymenoides*)
    Plains bristlegrass (*Setaria leucopila, S. macrostachya)*
    Curltop smartweed (*Polygonum lapathifolium* var. *lapathifolium*)

Riparian Forest/Woodland (bosque):

- Establish riparian forest/woodland communities along the rebuilt river channel and on portions of the wetland cells not part of moist soil area. Seek to have a range of successional stages.
- When willow and cottonwood seeds are flying, manage water flows through the park to mimic natural flooding.
- Establish clusters of cottonwoods and willows along the main channel through pole plantings, then allow them to spread on their own through natural regeneration.
- Clear all saltcedar from main channel, and aggressively remove any new saltcedar seedlings.
- Recommended plant species:

  Rio Grande cottonwood (*Populus deltoides* ssp. *wislizenii*)
  Goodding willow (*Salix gooddingii)*
  Coyote willow (*Salix exigua)*
  Tornillo (*Prosopis pubescens)*
  Seepwillow (*Baccharis salicifolia)*
  Willow baccharis (*Baccharis salicina)*

Riparian Scrub (transition zone between riparian and upland):

- Monitor and control, as needed, the spread of arrowweed. This species tends to grow in large uniform stands. Having some such stands at the park is desirable, but, in general, a more diverse plant community should be encouraged in the riparian-scrub zone.
- Recommended plant species:

  Wolfberry (*Lycium berlandieri, L. torreyi)*
  Willow baccharis (*Baccharis salicina)*
  Spiny aster (*Chloracantha spinosa* var. *spinosus)*
  Bitterweed (*Hymenoxys odorata)*
  Seepweed (*Suaeda depressa)*
  Arrowweed (*Pluchea sericea)*
  Jimmyweed (*Isocoma pluriflora)*

Mesquite Woodland:

- In mesquite-dominated areas with scattered saltcedar, remove all saltcedar with hand tools followed by treatment of the cut stumps with Garlon™ 4.
- In saltcedar-dominated areas, remove the saltcedar gradually and, over time, convert these areas from a saltcedar-mesquite association to a tornillo-honey mesquite association. Currently, the remaining saltcedar-dominated woodlands are the most extensive woodlands in the park, and they provide an important element of habitat diversity. Therefore, selective stands of mature saltcedar should remain until such time as desired native trees and shrubs are established.
- Recommended plant species:

  Tornillo (*Prosopis pubescens*)
  Western honey mesquite (*Prosopis glandulosa)*
  Wolfberry (*Lycium berlandieri, L. torreyi)*

Mesquite/Saltbush Shrubland:

- In areas to be restored to this habitat type, plant desired species in selected areas to initiate the restoration process, and then allow them to spread on their own. Encourage school groups and other volunteers do this planting as a service-based learning opportunity.
- Recommended plant species:

  Western honey mesquite (*Prosopis glandulosa)*
  Fourwing saltbush (*Atriplex canescens)*
  Wolfberry (*Lycium berlandieri, L. torreyi)*
  Jimmyweed (*Isocoma pluriflora)*

Upland Grassland:

- Seek to establish in plots one to five acres in size at disturbed upland sites in the park.
- Provide water either by pumping water from the channel, or via a rain harvest method whereby rainfall is funneled to seedlings positioned in the bottom of a shallow trench lined with plastic mulch. The rain harvesting approach will only prove beneficial during years with normal rainfall.
- Recommended plant species:

  Sixweeks needle grama (*Bouteloua aristidoides*)
  Sixweeks grama (*Bouteloua barbata)*
  Blue grama (*Bouteloua gracilis)*
  Prairie wild rye (*Elymus canadensis)*
  Western wheat grass (*Elytrigia smithii)*
  Plains lovegrass (*Eragrostis intermedia)*
  Little bluestem (*Schizachyrium scoparium)*
  Alkali sacaton (*Sporobolus airoides)*
  Sand dropseed (*Sporobolus cryptandra)*
  Giant dropseed (*Sporobolus giganteus)*
  Six-weeks fescue (*Vulpia octoflora*)

Sand Dune:

- Recommended plant species:

  Broom psorothamnus (*Psorothamnus scoparius*)
  Sand sagebrush (*Artemisia filifolia)*
  Sand pricklypear (*Opuntia arenaria)*
  Giant dropseed (*Sporobolus giganteus)*
  Sand dropseed (*Sporobolus cryptandra)*
  Plains penstemon (*Penstemon ambiguus*)

Hard Pan:

- Leave at least one open hard-pan site for reptiles that favor such habitat.
- Recommended plant species:

  Spurge (*Chamaesyce* spp.)
  Indian rushpea (*Hoffmanseggia glauca*)

Recommendation 4:

For un-vegetated disturbed areas, select appropriate plant communities for each site based on soil characteristics and water availability.

Need

The goal of vegetation management is to allow areas to revegetate naturally to the extent possible. In some areas of the park, vegetation is sparse and limited to early successional stages, usually because the land was disturbed by the wetland-cell construction, salt cedar removal, or unrestricted vehicle traffic. In such cases, vegetation communities should be expanded from adjacent areas into these disturbed areas. In addition, desired native plants can be seeded or planted as appropriate based on soil characteristics and water availability.

Actions

Develop recommended native vegetation communities for known soil types and water availability:

- Upland (distance to ground water greater than three feet)

  Sand

  Sandy loam

  Clay/hardpan

  Silt/loam

- Riparian/Wetland (distance to ground water less than three feet and/or degree of soil saturation)

  Sand

  Clay/hardpan

  Silt/loam

Recommendation 5:

Control or eliminate, where possible, non-native vegetation. Where stands of mature non-native vegetation persist, study the ecology of these stands and develop creative ways of maximizing their biological values.

Need

The exotic plant *Tamarix* sp., or saltcedar, has displaced many native floodplain species because it grows quickly and produces dense shade. This prevents the establishment of other species beneath the canopy, resulting in a saltcedar monoculture. This has decreased the diversity of species in the area and the diversity of habitats available. In spite of this, saltcedar does provide habitat, especially for some bird species, in the absence of preferred vegetation. In addition, once saltcedar is removed, many areas are slow to revegetate, creating extensive hardpan areas. This may be due to the excessive soil disturbance required for saltcedar removal or changes in soil salinity that may prevent germination of some species.

Russian thistle is another exotic species that is common in some parts of the park, especially areas disturbed in 1997 during construction of the wetland cells and water-delivery system. As native plant communities get established over time, Russian thistle is expected to become less common, but sustained effort will still be needed to remove it from the park.

A third exotic plant that has gained a toehold in the park and has created ecological problems elsewhere in the western U.S. is perennial pepperweed. Although the existing pockets of this species in the park are still small, they expanded noticeably between 2001 and 2002. Without active control, perennial pepperweed could potentially take over large areas in the park.

Actions

Continue the systematic removal of saltcedar through foliar application of Arsenal® and cut-stump application of Garlon® 4, but work should be performed on small areas and coupled with revegetation efforts. Over time, hopefully, this will eliminate expansive hard pan areas.

Determine which characteristics of saltcedar are most attractive to wildlife species, such as use for denning (e.g., gray fox), roosting (e.g., Barn Owl (*Tyto alba*), American Crow, Chihuahaun Raven) or nesting (e.g., egrets, night-herons, Harris's Hawk, Yellow-breasted Chat, Painted Bunting). Questions that must be answered are: Would native species of different size/age class be a suitable replacement for saltcedar? Should we leave some saltcedar stands intact?

Russian thistle stands should decrease in size and number over time, but some systematic removal of Russian thistle will continue throughout the park by burning wind-blown accumulations of dead plants, by appropriately-timed disking and flooding in moist-soil-management areas, and by hand removal in areas where it is invading native plant communities or interfering with efforts to establish such communities.

Control of perennial pepperweed through spot treatment with Oasis® or another suitable herbicide should continue. This species will be much easier to control now, while not yet widespread, than if allowed to become well established in the park.

Several Siberian elm (*Ulmus pumila*) and other exotic trees and shrubs are scattered throughout the park. The most conspicuous concentration is in the area that the City of El Paso formerly used as a tree farm to supply trees for city parks. The tree farm can play an educational role by demonstrating the issues of native species vs. adapted species and might be retained for that purpose.

Recommendation 6:

Manage activities that remove dead wood in a manner compatible with biological quality and ecosystem integrity.

Need

Tree cavities provide forage, shelter, and nesting sites for many bird species, and downed wood provides shelter and/or food for insects and reptiles. In the park, the old cottonwood snags are especially important as roosting and nesting sites for raptors. Efforts must be made to preserve as many of these sites as possible.

Actions

Minimum density of cavity trees should be six per acre. Optimal density would be 15 per acre with trees at least 12 inch diameter. Dead limbs greater than six inches in diameter should be retained. Snags could be created by girdling trees or nest boxes could be provided for some species to create a greater density of roosting/nesting sites.

Downed wood on the channel bank and in the water should be left in place if possible to provide shelter for aquatic and amphibian species. Some downed wood in upland areas should be left in place to provide forage and shelter for insects and reptiles. Decomposing wood provides nutrients to the underlying soil.

Recommendation 7:

Prevent unmanaged fires in the park. Use fire only under controlled conditions to achieve specific management objectives.

Need

An unmanaged fire could destroy the native vegetation in the park. The likelihood of fire is low, but fire has been used as an effective means of eradicating uprooted saltcedar and *Salsola*. To date, this has been done only on a small scale in order to be in compliance with City-County burning regulations. In the future controlled burns may prove to be an effective way to alter vegetation composition.

Actions

Develop a fire management plan that includes policies and restrictions for controlled burns – weather, personnel, permits, etc. In developing this plan, evaluate both the positive and negative impacts of fire on desired native plant species and communities.

Recommendation 8:

Coordinate water management activities to support and improve the park's aquatic and terrestrial habitats, with special emphasis on mimicking the historic hydrograph to provide periodic overbank flooding and fluvial processes that modify the streambed.

Need

Currently, water is available to the park only in fall and winter, and management is focused on filling and maintaining the wetland cells which attract and support migrating waterfowl. The park normally receives no water and is dry in spring and summer. The lack of water throughout this period prevents establishment of native wetland and riparian communities within the park and limits the use of moist-soil management in the wetland cells to promote growth of native grasses and forbs with high seed production.

Especially important for the establishment of native riparian communities is the ability to provide periodic overbank flooding followed by gradual water-level declines. Because many of the native riparian species (both animal and plant) require properly timed springtime overbank flooding for reproduction, it would be desirable to be able to produce such conditions periodically.

Action

Working with El Paso Water Utilities, EPCWID, and other partners, secure a flow of water through the park in the spring and summer. A minimum flow is needed through the main channel, supplemented by occasional pulses of higher flow for overbank flooding and flood-irrigation of the wetland cells. This will maintain the saturated soil conditions required by wetland vegetation and will help to maintain ground water levels required by the riparian trees.

To the extent that water is available for flood-irrigation, follow the management guidance Ducks Unlimited developed for moist-soil management of the wetland cells (Appendix G). If water availability is limited, reduce the acreage irrigated or reduce the frequency of irrigation.

Recommendation 9:

Protect, extend, and enhance the diversity of the aquatic habitats to benefit native plant and animal communities.

Need

Because the river meander within the park has been cut off from the mainstem of the river for many years, aquatic habitats no longer exist and must be reinitiated. The first phase of the development of the wetland park has been to secure water to establish fall/winter wetland habitat for migrating waterfowl. In the future, provided some water can be made available in spring and summer, a variety of aquatic habitats that have different soil-moisture requirements can be re-created.

General Recommendations

- Methods for establishing and maintaining different community types will be based on:
    - water availability (both quantity and timing)
    - landscape contouring (water depth, sloping of banks, dredging and/or widening of channel)
    - flooding depths and rates; draw down rates
- Develop a mosquito-control policy in conjunction with the City-County Health & Environmental District.
- Develop a plan for the detection and control of bacterial and viral avian diseases. The plan should include recommendations for proper collection and disposal of carcasses.
- Excavate one or more small ponds and develop supplemental water sources to provide water to these ponds thereby ensuring that the park provides some aquatic habitat year-round.

Community-specific Recommendations

Aquatic:

- Secure water to ensure a flow through the main channel in spring and summer.
- Excavate a one- or two-acre site along the main channel to create a permanent pond. Contour the bottom to promote maintenance of both an open-water area and shallower areas where emergent-wetland habitat can develop.
- The water depth and bed conditions must be optimized for vegetation and animals present/desired. Potential fish species for the park are found in Appendix F2.

Emergent wetland:

- Do targeted plantings and seeding of desired native species to get them started in the emergent-wetland areas along the main channel and at the permanent pond, then let them spread naturally. Cattail and bulrush will invade readily and will not require assistance.
- Control cattails, as needed, along the main channel and in the permanent pond. In the permanent pond, seek to maintain an approximately even mix of open water and emergent vegetation. If cattail control is needed, possible approaches include mechanical removal, burning, water-level manipulation, and, as a last resort, chemical control.

Moist-soil Managed Wetland:

- Modify the wetland cells to permit the flooding of additional acreage within the cells. The water-delivery system for the park was intended to provide the capability to flood approximately 180 acres, but currently only 80-100 acres receive water. Leveling, construction of additional dikes and installation of additional water-control structures can permit more effective and complete distribution of water within the wetland cells.

Recommendation 10:

Develop a channel management plan and implement non-structural methods for channel maintenance such as 'flushing flows' to remove accumulating sediment and allow the channel to 'meander' around sandbars.

Need

Currently, flows and channel morphology are relatively uniform. There is some variation in height and slope of banks, but bottoms are uniformly sandy. Sediments appear to be moving somewhat with pools and riffles forming. Dredging may be required in the near future. Stormflows have done some headcutting in the banks.

Actions

- No alteration of the channel bottom should be undertaken at this time. Instead, a wait-and-see approach should be adopted, but the changing channel morphology should be monitored. If water begins pooling upstream, channel alteration will be needed to reinstitute a through flow.
- The channel should not remain as a uniform ditch. Banks should be sloped and embayments formed. Sandbars can be left in place if the flow is not completely obstructed. Boulders or large tree limbs could be embedded in canal or banks to alter/slow the flow.
- Dredge only at specific sites to maintain deep areas.
- Consider and evaluate the feasibility of creating areas with gravelly or rocky bottoms to increase habitat diversity.
- Develop a water-management plan that better defines the water-control structures or channel modifications required to attain the desired overbanking effects in specific areas.

Recommendation 11:

Evaluate the feasibility of constructing a treatment wetland at the water inlet site to remove excess nitrogen and phosphorous from the treated effluent.

Need

The wetland ponds are able to provide more than habitat for waterfowl and other animals. They might also be used to improve the quality of water discharged from the Bustamante WWTP. Wetlands are used in many communities to 'polish' treatment plant effluent. In many cases, water meeting advanced secondary standards can be released into wetlands and the water leaving the wetland can be brought to tertiary standards.

Action

Initiate a pilot study to determine the trade offs between nutrient removal and TDS increases due to evaporation.

Recommendation 12:

Monitor water table fluctuations and assess the causes of such fluctuations, including factors external to the park.

Need

Because the Rio Bosque Wetlands Park is part of the Rio Grande floodplain, the shallow alluvial aquifer lies just a few feet below the soil surface, rising and falling in response to water availability in the river and irrigation canals. Competition for water is increasing in this arid region, and water managers are under increasing pressure to reduce seepage loss of water from irrigation canals into the shallow alluvial aquifer. The proposed concrete-lining of the adjoining Riverside Canal has direct implications on the park's water table. Also, as expanding urban development displaces the remaining agriculture in the surrounding area, surface water is being converted from agriculture to urban and industrial use. The resulting reductions in recharge may increase the depth to ground water and possibly increase the salinity of the ground water.

The trees of the park depend on a supply of quality ground water to survive. Seepage from the canals and drains bordering the park sustains a relatively high water table which maintains nearby stands of riparian-scrub vegetation in the park. Changes in the area surrounding Rio Bosque Wetlands Park that lower the water table and diminish ground water quality will have a deleterious effect on the park vegetation.

Action

- Monitor seasonal changes in depth to ground water and water quality and the effects that such changes have on the vegetation in the park.
- Be proactive in regional water management issues that will impact the park.

Recommendation 13:

Develop a coordinated program to monitor the interrelationship of environmental factors and biological quality (with emphasis on diversity and abundance of native species) and ecosystem integrity (with emphasis on restoring and maintaining ecological processes).

Need

Park managers do not yet have enough long-term data to create a comprehensive management plan. Studies will be required that evaluate the success or failure of restoration efforts, along with the systematic monitoring of environmental factors that have the greatest impact on biodiversity and ecosystem integrity.

Action

Monitoring should include the following:

- changes in soil moisture and soil salinity;
- water-quality parameters that affect aquatic communities, like nutrient levels, salinity, turbidity, temperature, and dissolved oxygen;
- changes in the composition of plant and animal communities in different habitat areas including incidental sightings and regular surveys of mammals, herpetofauna and birds;
- recruitment and spread of native vegetation;
- control of exotic species; and
- the extent and impact of recreational use.

Other factors to be addressed are the effects of 'patch' size, predation, and competition on various communities.

It is especially important to monitor surface water quality. As stated above, if water quality deteriorates, it will certainly have a profound effect on the aquatic communities, but it will also affect many of the vegetation communities. When soil salinity is elevated, the ability of plants to uptake water is impaired. Water from soil often moves into plant roots by osmosis, whereby water molecules go from an area of high water concentration to lower concentration across a membrane.

As the amount of salt in soil increases, the amount of available soil water decreases, thereby reducing the water available for plant uptake. When salinity is very high, the soil water is completely unavailable to plants. Properly treated sewage effluent may meet regulatory guidelines, but may be unhealthy for plants or some aquatic organisms. In the future, it may be necessary to develop a system to pre-treat the effluent before it enters the park.

Students and volunteers can conduct much of the long-term ecological monitoring. The monitoring program needs to be designed in a way that allows participants with different levels of familiarity with the taxa under study to contribute effectively. Where the monitoring work requires particular skills or levels of taxonomic familiarity, those skills and levels of familiarity must be clearly identified.

Recommendation 14:

Manage recreational activities in the park in a manner compatible with the park's biological quality and ecosystem integrity.

Need

Rio Bosque Wetlands Park is and will remain a City of El Paso park, and when the vegetation is mature and the various habitats are established, the park will be a very attractive area. As a city park, it must be open to the public, and decisions must be made about which recreational activities are appropriate in the park. Once those decisions have been made, then the areas of the park dedicated to those activities should be identified and incorporated into the revegetation plan.

Actions

- Wherever possible, place developed facilities such as a visitor center in areas that are currently devoid of vegetation rather than clearing vegetated areas to accommodate such facilities.
- Select an alignment for the main public-use trail such that it passes through or near all of the major habitat types in the park but, at the same time, avoids sensitive areas. Use particular care in selecting the alignment with respect to riparian and wetland areas.
- Design park facilities such as restrooms, ramadas, benches and interpretive displays to be relatively unobtrusive but adequate to enhance the park visitation experience.
- Evaluate public activities to determine whether restrictions on public access to the ponds and channel are needed to prevent fishing and swimming.
- Seek sites for wildlife viewing areas that provide opportunities for observing the park's wildlife with minimal disturbance to the wildlife. Elevated wildlife viewing areas, for example, might be located at sites remote from, but overlooking the ponds.
- Provide an area for picnicking near the park entrance. Plant trees and locate benches and picnic tables at this site rather than dispersing such facilities throughout the park.

- Fence the park to control vehicular access and after-hours access. Currently, unrestricted off-road driving damages native vegetation in the park and prevents recovery of vegetation in disturbed areas. Vehicular traffic should be minimized within the park and confined to designated roads. The existing chain-link fence along the south boundary should be repaired and a 3-strand barbed-wire fence (with the bottom strand smooth) or other suitable barrier to vehicle access, but not wildlife movement, should be built where needed around the rest of the park perimeter.

- Control access to sensitive vegetation areas, such as recently seeded/planted areas and areas supporting species with few representatives.

- Time construction work to avoid periods when any wintering Bald Eagles are present to avoid potential impacts to this federally-listed threatened species.

- Establish an animal-control policy that addresses such issues as:
    - Should pets be allowed in the park?
    - If so, should they be allowed on leashes only?
    - How should stray or feral animals in the park be controlled?

- Do not permit release of domesticated ducks or geese or any other non-native wildlife at the park.

Recommendation 15:

Develop an educational program that accommodates K-12 curricula, as well as casual visitors.

Need

An important goal of the Rio Bosque Wetlands Park is to educate the public about the river and the plants and animals associated with it. To this end, a nature trail is under construction in the park to guide visitors to representative habitat types. Nearby schools can become valuable allies in the effort to educate the public about wetlands environments. This can be facilitated by developing K-12 curricula and by involving the students in restoration activities.

Actions

- Develop facilities to accommodate school classes and other groups.
- Locate educational features and activity centers close to the visitor center so as to accommodate mobility-impaired visitors, better manage large school groups, and minimize disturbance to the wildlife.
- Align the main public-use trail to pass through or near the major habitat types in the park.
- Provide school classes and other groups opportunities to participate in plant and animal studies, monitoring programs and restoration work at the park.
- Adapt the *Florida Plant-a-Seed* program to fit the needs of the park.
- As the plant communities mature, expand the public-tour program and begin providing other public educational opportunities such as workshops, field classes and day camps.
- In conjunction with the Ysleta del Sur Pueblo and other Native American groups, develop cultural demonstrations of Native American utilization of native vegetation and animals.
- Foster a relationship between the park and the Mission Trail Heritage project and the City Socorro.

Recommendation 16:

Regularly review and update this Biological Management Plan.

Need

This Biological Management Plan requires regular review and updating. Many recommendations involve data gathering and further policy development. Even when such additional information and policies are developed, the planning process will not be complete. Plans, themselves, reflect present understandings and priorities. As the various ecological communities pass through successional changes, as more management experience is gained, as patterns of the public's use of the park evolve, and as factors outside the boundaries of the park impact the park, priorities will change. Thus, this plan is not an end, but a point in time of an on-going adaptive planning process.

Based on the current park conditions, the availability of water is the critical factor that will dictate whether the desired outcomes, as identified in this plan, are realized. Regular review is needed to ensure that this plan, and the management activities it recommends, correspond to actual water availability.

Actions

There will be data to collect and analyze, reports to be written, and recommendations to be made. Utilize the existing advisory committees for the park as review committees. Keep all partners, supporters of the park, and other interested parties informed about progress implementing this management plan, and seek and consider their input in future revisions to the plan.

Develop appropriate contingency plans in the event water becomes less available.

- Investigate alternative water sources and water management strategies.
- Prioritize habitat areas based on sustainable water sources, wildlife value, and minimum 'patch' size.
- If the park becomes primarily or exclusively dependent on rainfall, determine the kinds of plant communities that can be supported and the types of modifications to the park necessary to maintain a range of habitat types.

Recommendation 17:

Integrate resource management activities in the park with those of surrounding areas to protect and enhance biological quality and ecosystem integrity.

Need

Adjacent to or near the park, there are other sizeable parcels of open space, including the Rio Grande. Depending on how these areas are used and managed in the future, they can either complement and enhance or diminish the park's ecological value.

The viability of the Rio Bosque Wetlands Park is intimately tied to the water management policies of the region. As the urban populations increase on both sides of the border, more demands will be made on the limited amount of surface water available, so the quantity and quality of water for the park will constantly be at risk. One means of overcoming this risk is to link the park to regional water management actions that are subject to the National Environmental Policy Act (NEPA) review. The park is well-suited as a site for mitigation and environmental enhancement activities, and thus investment in the park can enable, rather than impede, other water management projects.

Action

Be active and involved in environmental issues in the region. Continue to work closely and coordinate with the diverse political subdivisions and resource-management agencies whose activities potentially influence the park. These include, but are not limited to, the cities of El Paso and Socorro, El Paso Water Utilities, EPCWID, Hudspeth County Irrigation District, Ysleta del Sur Pueblo, IBWC, U.S. Bureau of Reclamation, El Paso County, the Texas Department of Transportation, and the U.S. Army Corps of Engineers.

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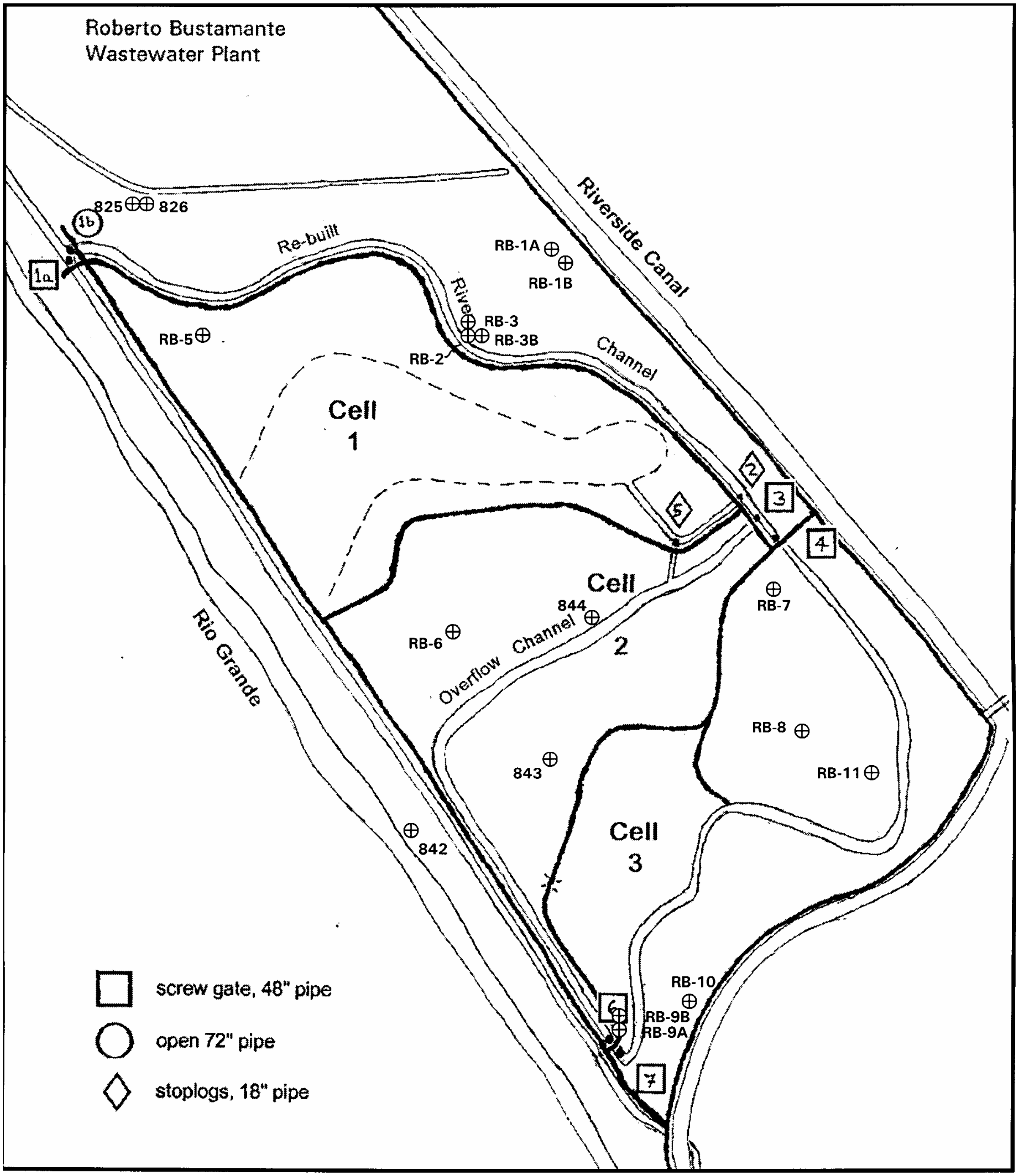
Appendices

Appendix A1

Monitoring Well Sites within Rio Bosque Wetlands Park



Appendix A2

Monitoring Well Geologic & Construction Logs

The City of El Paso contracted with Raba-Kistner Consultants, Inc. to drill thirteen monitoring wells in Rio Bosque Wetlands Park. Drilling commenced on July 15, 2000 and was completed on July 19, 2000. UTEP students, contracted through the EPA Wetlands Grant, constructed the well caps and Raba-Kistner Consultants, Inc. subsequently filed reports on the wells with the Texas Department of License and Regulation's Water Well Driller/Pump Installer Program. During the course of the drilling operations, UTEP students, working under the supervision of Dr. Richard P. Langford, an Assistant Professor of Geology, logged the wells. Core samples from the well drilling have been retained by UTEP's Geological Sciences Department to permit further analysis. The following pages provide the well logs for a selected group of the monitoring wells.

Opening the boring cylinder ("split spoon" sampling)

Well logging by UTEP students

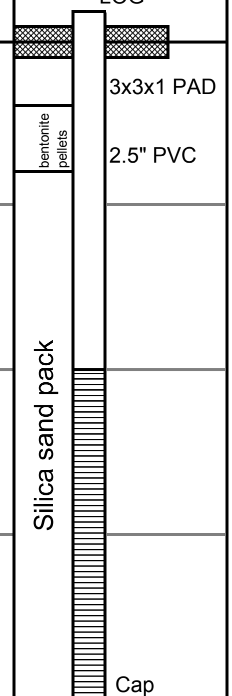
Appendix A2: Monitoring Well Geologic & Construction Log

PROJECT NUMBER	WELL NUMBER
RB-2000	RB-1A

PROJECT: Rio Bosque Park 2000
LOCATION: UTM 375796 Easting, 3502040 N.
ELEVATION, NGVD (Top of Well Casing):
SURFACE ELEVATION, NGVD:
WATER LEVEL ELEVATION, NGVD:
START DATE: July 15, 2000
DRILLING CONTRACTOR: Raba Kistner
FINISH DATE: July 15, 2000
DRILLING METHOD: Continuous core
COMMENTS: S. canal, mean park entrance

DEPTH FT	SAMPLE ID	GEOLOGIC LOG Soil name, Color, Grain size, Moisture Density or Consistency, Structure
	RB01-040-050	Light gray, rooted, loamy sand organic rich. Medium to fine grain size
	RB01-050-070	Light gray sand. Loamy fine grain
	RB01-070-150	Firm coarsely laminated silt / very fine grain sand brownish. 1-2 mm calcitic nodules. Some small shells
5		
	RB01-208-225	Brown clay/silt. Laminated 1 mm calcitic carbonate nodules
	RB01-225-265	Brown clay, plastic, moist and organic
	RB01-265-300	Brown, well sorted, wet medium grain sand
10		
	RB01-387-450	Well sorted, medium grain, brown sand. Wet, magnetite rich. Placer laminated magnetite. Thin sand/clay beds ~1 cm
15		
		Water level at 17'
	RB01-550-600	Brown medium grain quartz rich sand. Few structures than above Red/brown clay balls from 560/580 cm
20		
	RB01-600-750	Medium grain size sand (drilled without core)
25		
27	RB01-750-810	Coarse grain sand, moderate magnetite, dark gray clay balls 1 cm diameter Abundant organic 1 mm. Preserved for C_{14} analysis

WELL CONSTRUCTION LOG



Appendix A2: Monitoring Well Geologic & Construction Log

PROJECT NUMBER	WELL NUMBER
RB-2000	RB-1B

PROJECT: Rio Bosque Park 2000
LOCATION:
ELEVATION, NGVD (Top of Well Casing):
SURFACE ELEVATION, NGVD:
WATER LEVEL ELEVATION, NGVD:
START DATE:
DRILLING CONTRACTOR: Raba Kistner
FINISH DATE:
DRILLING METHOD: Wooden plug in the auger, No core
COMMENTS: Samples taken from auger after 25 ft

DEPTH FT	SAMPLE ID	GEOLOGIC LOG Soil name, Color, Grain size, Moisture Density or Consistency, Structure	WELL CONSTRUCTION LOG
	RB01-040-050	Light gray, rooted, loamy sand organic rich. Medium to fine grain size	3x3x1 PAD
	RB01-050-070	Light gray sand. Loamy fine grain	
5	RB01-070-150	Firm coarsely laminated silt / very fine grain sand brownish. 1-2 mm calcitic nodules. Some small shells	2.5" PVC
	RB01-208-225	Brown clay/silt. Laminated 1 mm calcitic carbonate nodules	
	RB01-225-265	Brown clay, plastic, moist and organic	
10	RB01-265-300	Brown, well sorted, wet medium grain sand	
15	RB01-387-450	Well-sorted, medium grain, brown sand. Wet, magnetite rich. Placer laminated magnetite. Thin sand/clay beds ~1 cm	
		Water level at 17'	
20	RB01-550-600	Brown medium grain quartz rich sand. Fewer structures than above Red/brown clay balls from 560/580 cm	Cap
25	RB01-600-750	Medium grain size sand (drilled without core)	
27	RB01-750-810	Coarse grain sand, moderate magnetite, dark gray clay balls 1 cm diameter Abundant organic 1 mm. Preserved for C^{14} analysis	bentonite pellets
25			bentonite pellets
30	RB01-25-30'	Dark gray, medium grained sand moderately sorted with lithified sand chunks	Silica sand pack
35	RB01-30-35'	Medium fine grained sand slightly silty, same as above	Silica sand pack

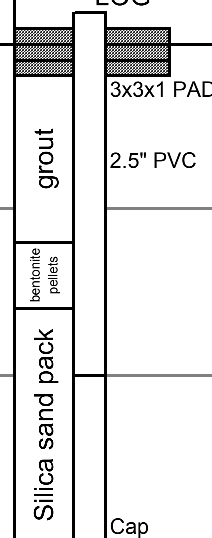
Appendix A2: Monitoring Well Geologic & Construction Log

PROJECT NUMBER	WELL NUMBER
RB-2000	RB-3

PROJECT: Rio Bosque Park 2000
LOCATION: UTM 375620 Easting, 3501879 N.
ELEVATION, NGVD (Top of Well Casing):
SURFACE ELEVATION, NGVD:
WATER LEVEL ELEVATION, NGVD:
START DATE: July 15, 2000
DRILLING CONTRACTOR: Raba Kistner
FINISH DATE: July 15, 2000
DRILLING METHOD: Continuous core
COMMENTS:

DEPTH FT	SAMPLE ID	GEOLOGIC LOG Soil name, Color, Grain size, Moisture Density or Consistency, Structure
	RB03-072-120	Laminated, light brown slightly silty fine sand; many clay balls between 1-1.5 m. depth
	RB03-120-150	Firmer, slightly browner and cleaner sand, fewer clay balls
5		
	RB03-228-270	Cross-stratified, light brown beds of coarser and medium to fine sand; quartz rich; moist, rich with organics; muscovite, little heavy minerals.
	RB03-270-300	Darker medium grained sand; coarser and finely laminated with depth
10		
	RB03-400-450	Brownish fine saturated sand; quartz rich and iron stained
15		Water table not reached

WELL CONSTRUCTION LOG



Appendix A2: Monitoring Well Geologic & Construction Log

PROJECT NUMBER	WELL NUMBER
RB-2000	RB-5

PROJECT Rio Bosque Park 2000
LOCATION UTM 375130 Easting, 3501865 N.
ELEVATION, NGVD (Top of Well Casing)
SURFACE ELEVATION, NGVD
WATER LEVEL ELEVATION, NGVD
START DATE July 15, 2000
DRILLING CONTRACTOR Raba Kistner
FINISH DATE July 15, 2000
DRILLING METHOD Continuous core
COMMENTS

DEPTH FT	SAMPLE ID	GEOLOGIC LOG Soil name, Color, Grain size, Moisture Density or Consistency, Structure	WELL CONSTRUCTION LOG
	RB05-000-030	Sandy loam, firm light brown	3x3x1 PAD
	RB05-105-135	Brown loamy sand	grout; 2.5" PVC
5	RB05-135-150	Structureless, light gray fine grained sand; moderately sorted	grout
	RB05-225-300	Fine grain, slightly pebbly sand closer to centimeter 225 Firmer and moist, well sorted, homogeneous medium sand	grout
10			bentonite pellets
	RB05-375-445	At 375 dirty fine sand with few mud balls ~ 0.5 cm Clean coarse sand; small amounts of heavy minerals; drainage at 4.35 m	silica sand pack
15	RB05-450-650	Saturated brown to gray, moderately sorted medium grained sand with some organics.	silica sand pack
20		Water table encountered at 21'	silica sand pack
		No soil sample recovered from 650 to 750 cm. Same as above	silica sand pack
25			Cap

Appendix A2: Monitoring Well Geologic & Construction Log

PROJECT NUMBER	WELL NUMBER
RB-2000	RB-6

PROJECT: Rio Bosque Park 2000

LOCATION: UTM 375560 Easting, 3501374 N.

ELEVATION, NGVD (Top of Well Casing):

SURFACE ELEVATION, NGVD:

WATER LEVEL ELEVATION, NGVD:

START DATE: July 17, 2000

DRILLING CONTRACTOR: Raba Kistner

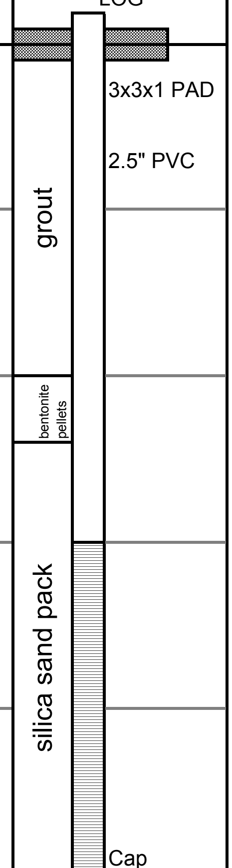
FINISH DATE: July 17, 2000

DRILLING METHOD: Continuous core

COMMENTS: Middle of Rio Bosque

DEPTH FT	SAMPLE ID	GEOLOGIC LOG Soil name, Color, Grain size, Moisture Density or Consistency, Structure
	RB06-065-125	Brownish, loamy clay with no evidence of structure
5	RB06-125-150	Mottled, brownish fine grained sand. Moderately sorted.
	RB06-225-300	Fine grain moist sand; light brown heavy minerals greenish at 225 cm. Slightly pebbly clay At >280 cm., cleaner and more moist and saturated
10		
	RB05-375-445	At 375 cm. dirty fine sand with a few mud balls ~ 0.5 cm Clean coarse sand; Small amounts of heavy minerals; drainage at 4.35 m
15		
	RB06-525-600	Liquefied fine grained sand with very coarse grained darker color, rich with organics Water table at 19'
20		
		No soil sample recovered from 650 to 750 cm. Same as above
25		

WELL CONSTRUCTION LOG



Appendix A2: Monitoring Well Geologic & Construction Log

PROJECT NUMBER	WELL NUMBER
RB-2000	RB-7

PROJECT: Rio Bosque Park 2000

LOCATION: UTM 376103 Easting, 3501491 N.

ELEVATION, NGVD (Top of Well Casing):

SURFACE ELEVATION, NGVD:

WATER LEVEL ELEVATION, NGVD:

START DATE: July 17, 2000

DRILLING CONTRACTOR: Raba Kistner

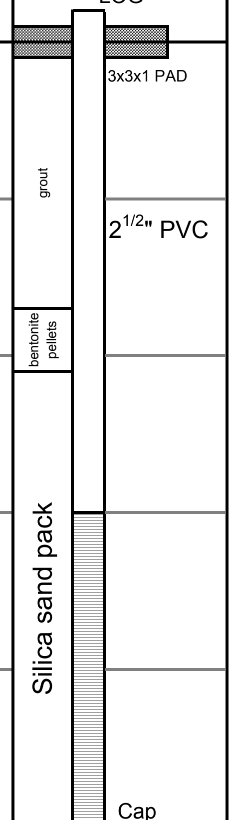
FINISH DATE: July 17, 2000

DRILLING METHOD: Continuous core

COMMENTS:

DEPTH FT	SAMPLE ID	GEOLOGIC LOG Soil name, Color, Grain size, Moisture Density or Consistency, Structure
	RB07-070-080	Dark brown, crumbly clay; some white spots slightly sand/silt sharp contact
	RB07-080-105	Crudely laminated, ripple cross-strata fine to very fine brown sand
	RB07-105-125	Grades into dark brown silt; laminated, grades to good clay to 125cm
	RB07-125-135	Upward coursing interval
5	RB07-135-150	
	RB07-213-300	Upward coursing intervals up to 273cm (as above) 220-240, 240-258, 258-280
10		
		Water table between 12 and 13ft
	RB07-406-450	Liquefied sand with muddy fine/very fine at top, mud clean sand at bottom
15		
	RB07-600-620	At 600cm dark gray organic rich coarse sand Med/coarse sand at 615cm, volcanic rich particles & 2cm barite/gypsum
20		
25		
30		
35		

WELL CONSTRUCTION LOG



Appendix A2: Monitoring Well Geologic & Construction Log

PROJECT NUMBER	WELL NUMBER
RB-2000	RB-8

PROJECT Rio Bosque Park 2000

LOCATION UTM 376122 Easting, 3501114 N.

ELEVATION, NGVD (Top of Well Casing)

SURFACE ELEVATION, NGVD

WATER LEVEL ELEVATION, NGVD

START DATE July 17, 2000

DRILLING CONTRACTOR Raba Kistner

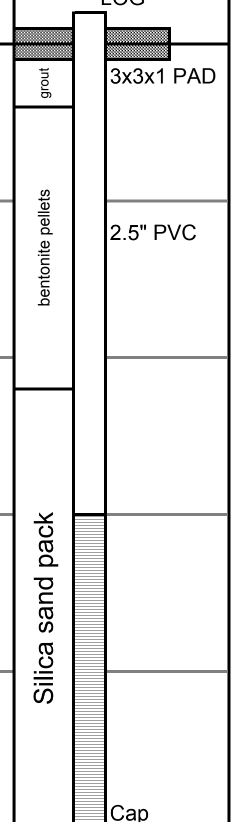
FINISH DATE July 17, 2000

DRILLING METHOD Continuous core

COMMENTS

DEPTH FT	SAMPLE ID	GEOLOGIC LOG Soil name, Color, Grain size, Moisture Density or Consistency, Structure
5		
	RB08-150-300	177-260 cm brown fine sand well sorted; fine laminations 260-300 cm upward medium graded, well sorted clean sand
10	RB08-300-450	Moderately sorted, medium graded sand; many rock fragments, slightly dirty, liquefied organic. Water table at 13ft
15	RB08-450-600	Liquefied sand, gray brown, organic rich well sorted, fine graded, slightly silt, sand
20		
25		
30		
35		

WELL CONSTRUCTION LOG



Appendix A2: Monitoring Well Geologic & Construction Log

PROJECT NUMBER	WELL NUMBER
RB-2000	RB-9B

PROJECT: Rio Bosque Park 2000

LOCATION:

ELEVATION, NGVD (Top of Well Casing):

SURFACE ELEVATION, NGVD:

WATER LEVEL ELEVATION, NGVD:

START DATE: July 18, 2000

DRILLING CONTRACTOR: Raba Kistner

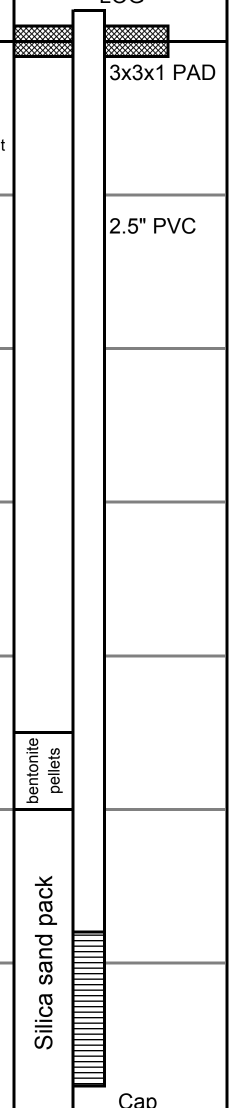
FINISH DATE: July 18, 2000

DRILLING METHOD: Wooden plug in the auger, No core

COMMENTS: Samples taken from auger after 20 ft

DEPTH FT	SAMPLE ID	GEOLOGIC LOG Soil name, Color, Grain size, Moisture Density or Consistency, Structure
	RB09-090-140	light brown fine/very fine sand w/black speckles of magnetite; black layer of about 1 cm thick of charcoal; compacted silty sand with clay at 150 cm
	RB09-140-150	Fine grained sand with a very light brown color
5	RB09-220-231	Dry light grained sand fine grained, subangular, subrounded; quartz-rich
	RB09-231-300	Slightly damp fine-grained sand, angular - subangular, quartz and feldspars; small plant fibers throughout this section
10	RB09-308-450	Light brown sand, black laminations consistent throughout section of 1.5 - 2.0 mm thickness; medium upper lower size sand, angular and subrounded; damp to wet at 450 cm but not completely liquefied
15		Water table at 15ft
	RB09-550-600	Saturated dark brown sand, medium grain angular, subrounded green and black grains are in large quantities, leading to the sands darker shade.
20	RB-09-20-25'	Fine to medium grained sand. Brown to gray, well sorted, micaceous organic rich
25	RB-09-25-30'	Medium to coarse sand, medium well sorted rounded. Same as above
30	RB-09-30-35'	Coarse sand, same as above but with 1cm thick brown silt/clay layers. Plastic Moderately brown
35		

WELL CONSTRUCTION LOG



Appendix A2: Monitoring Well Geologic & Construction Log

PROJECT NUMBER	WELL NUMBER
RB-2000	RB-10

PROJECT Rio Bosque Park 2000

LOCATION UTM 376097 Easting, 3506668 N.

ELEVATION, NGVD (Top of Well Casing)

SURFACE ELEVATION, NGVD

WATER LEVEL ELEVATION, NGVD

START DATE July 17, 2000

DRILLING CONTRACTOR Raba Kistner

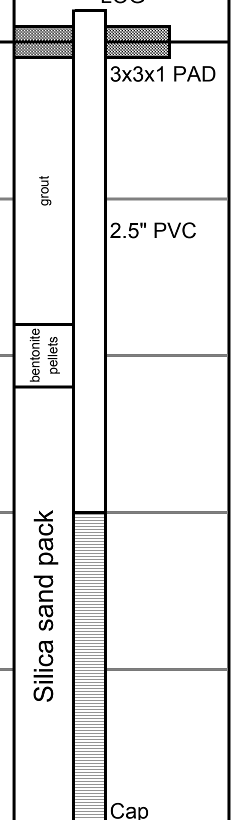
FINISH DATE July 17, 2000

DRILLING METHOD Continuous core

COMMENTS In trees southeast corner

DEPTH FT	SAMPLE ID	GEOLOGIC LOG Soil name, Color, Grain size, Moisture Density or Consistency, Structure
5	RB10-075-150	70 - 120 cm sandy loam, light gray dry pebble 2-3 cm, blocky, no strata 120 - 150 cm sand graded into loam; dry light gray brownish fine grained sand
10	RB10-225-300	Fine grained sand with cross bedding of light brown, moderately sorted fine-grained with some volcanics; moist at 270cm
15	RB10-375-450	375 cm same as above. 450 cm same but wet and better sorted; wet at 430 cm
20	RB08-450-600	Water table at 16ft Liquefied sand, fine well sorted, dark gray brown, organics
25		
30		
35		

WELL CONSTRUCTION LOG



Appendix A2: Monitoring Well Geologic & Construction Log

PROJECT NUMBER	WELL NUMBER
RB-2000	RB-11

PROJECT: Rio Bosque Park 2000

LOCATION: UTM 376419 Easting, 3501019 N.

ELEVATION, NGVD (Top of Well Casing):

SURFACE ELEVATION, NGVD:

WATER LEVEL ELEVATION, NGVD:

START DATE: July 17, 2000

DRILLING CONTRACTOR: Raba Kistner

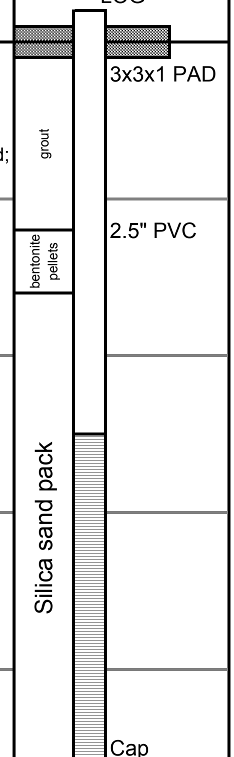
FINISH DATE: July 17, 2000

DRILLING METHOD: Continuous core

COMMENTS: North southwest corner of site in trees

DEPTH FT	SAMPLE ID	GEOLOGIC LOG Soil name, Color, Grain size, Moisture Density or Consistency, Structure
5	RB11-075-150	75 - 102 cm gray sandy loam 102 - 150 cm very fine grained slightly silty, ripple cross-stratified sand; thin brown silt at 115cm; moist
10	RB11-200-300	Very fine grained sand coarsening down to medium grained;cross-stratified at bottom; 2 cm clay bed at 140 cm.
15	RB11-400-450	Liquid medium grained sand, moderately sorted slightly silt; at 410 cm, 2 cm thick clay bed red/brown, clastic Water table at 14 ft
20	RB11-550-600	Liquefied slightly silty, medium grained sand rounded well sorted
25		
30		
35		

WELL CONSTRUCTION LOG



Appendix B1

Soil Salinity & Depth to Ground Water at Rio Bosque Wetlands Park

(Source: Hendrickx et al. 1998)

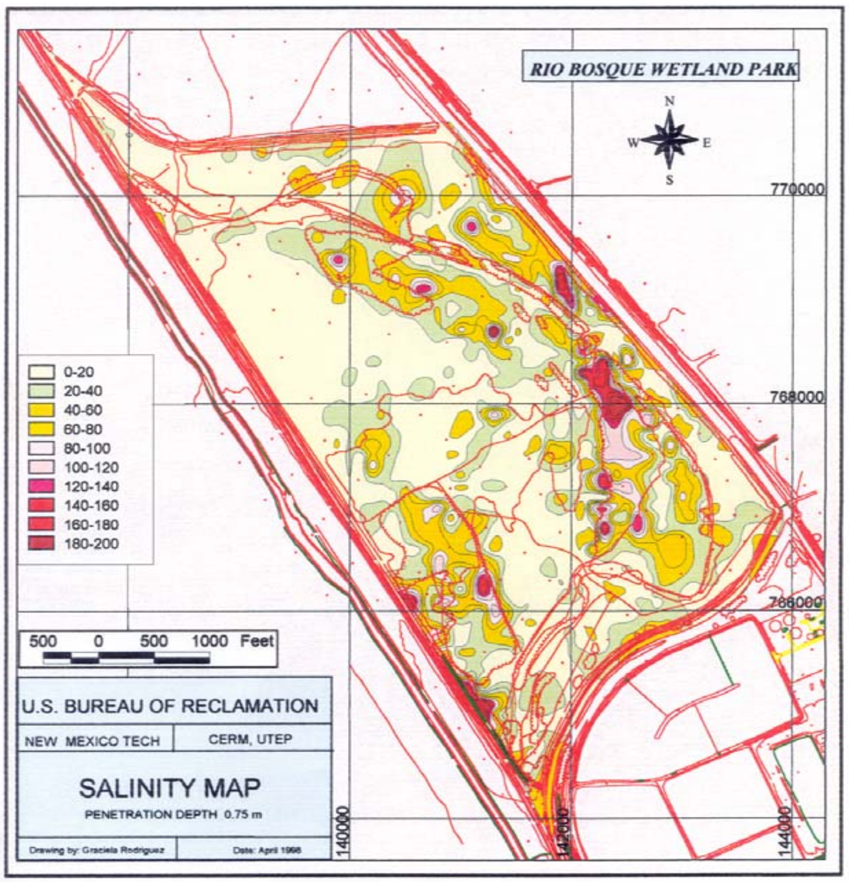


Figure B1-1: Salinity map of the top 0.75 m taken with EM38 in horizontal mode.

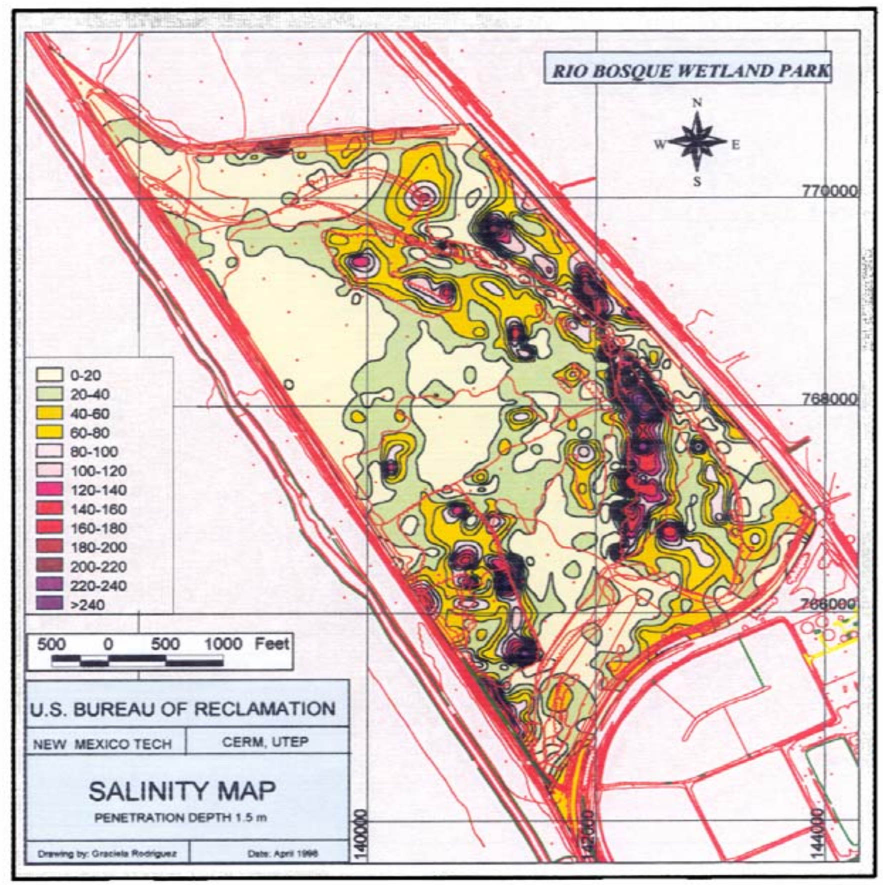


Figure B1-2: Salinity map of the top 1.5 m taken with EM 38 in vertical mode.

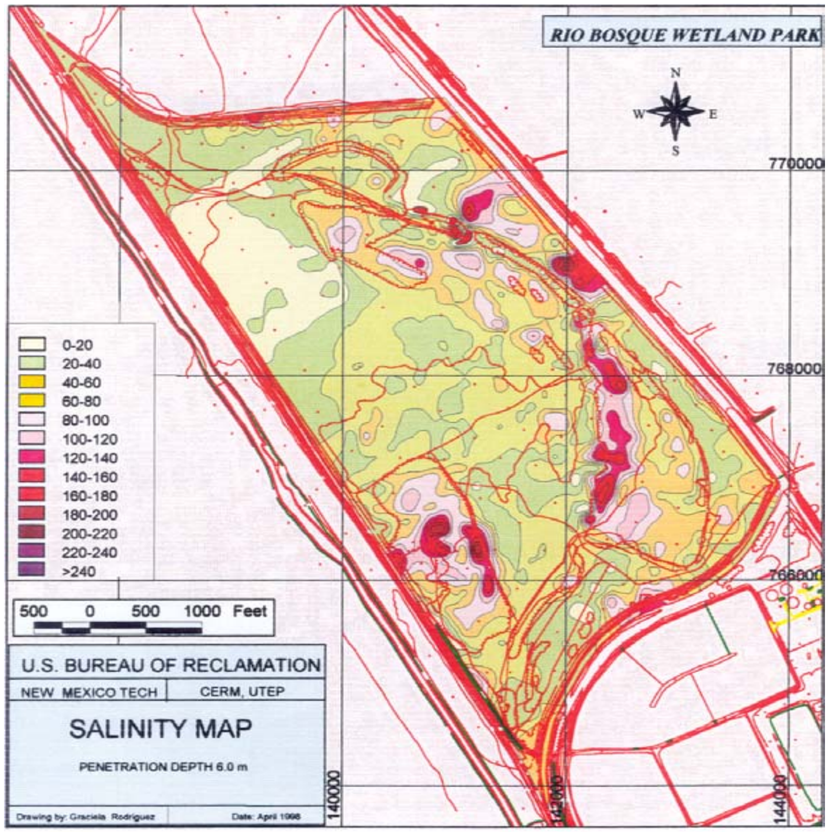


Figure B1-3: Salinity map of the top 6.0 m taken with EM 31.

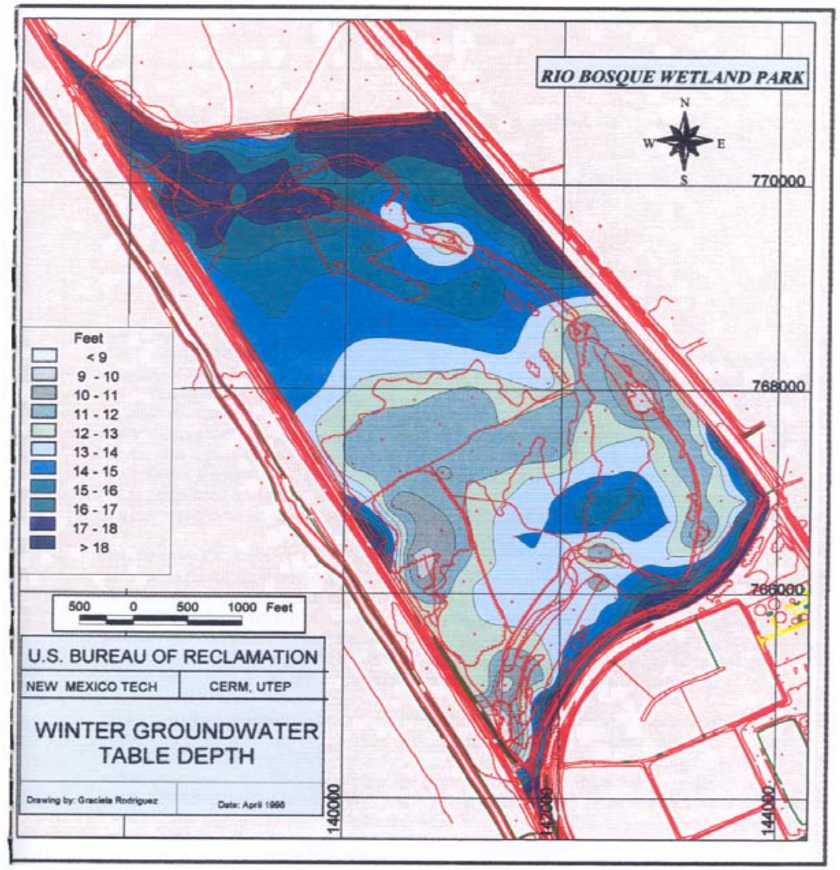
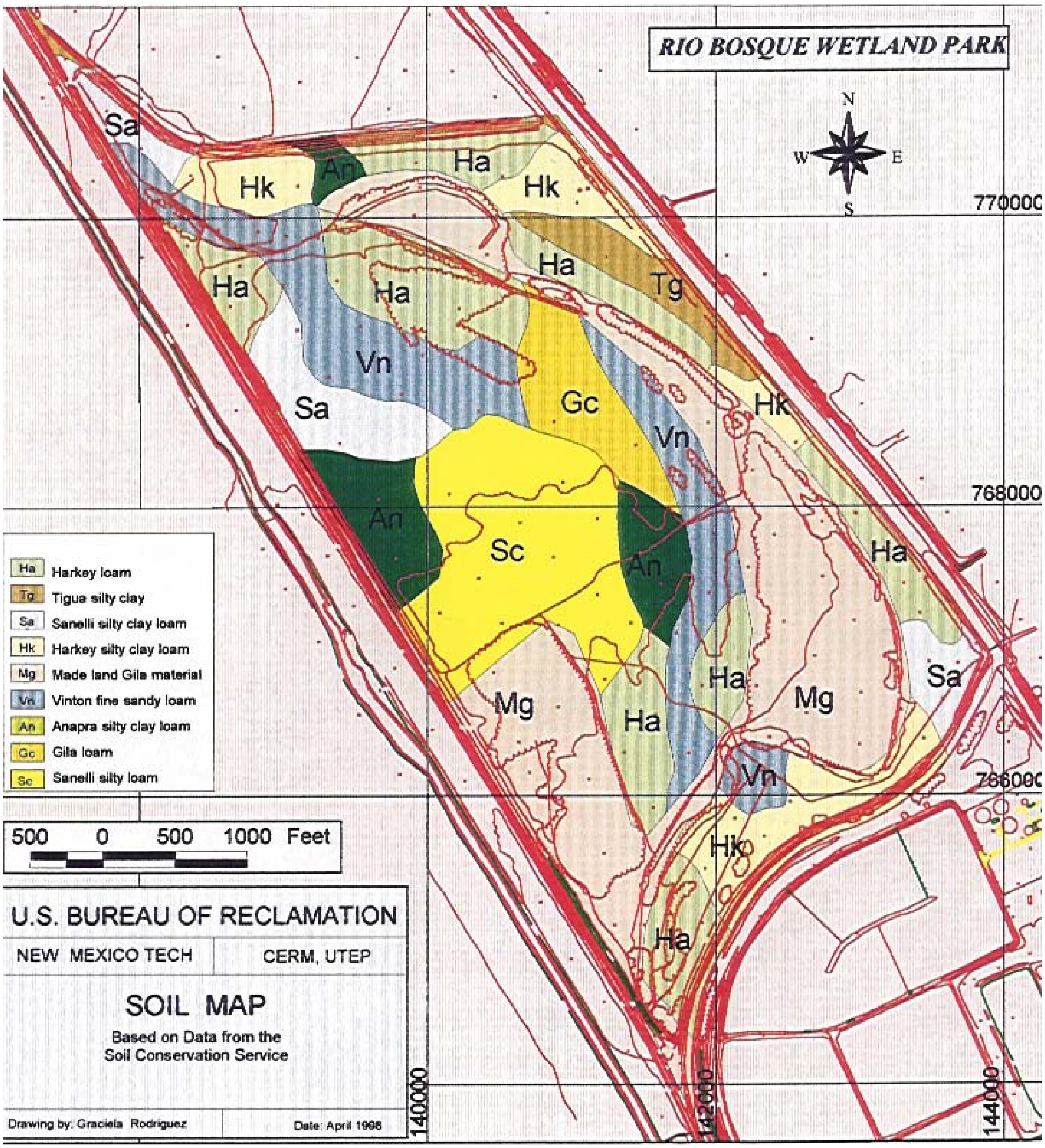


Figure B1-4: Ground water table depths in February 1997. Map based on 11 observations.

Appendix B2

Soils of Rio Bosque Wetlands Park

(Source: U.S.D.A. Natural Resources Conservation Service with shading added by Hendrickx et al. 1998)



Appendix C1

Ground Water Data from the Rio Bosque Wetlands Park Vicinity

(Source: Las Cruces USGS office (505-646-1335). Ed Nickerson or John Haines)

Well number/Station name Latitude – Longitude	Well depth (Ft.)	Date collected	Water level (Ft.)	Comments
JL-49-22-805 USBR 17 lat 313843 long 1061757	25.5	8/14/51	7.8	Well plugged as of 1-1991 C774, C235, C237 monthly from 8-14-51 to 12-1990 from USBR
JL-49-22-825 lat 313850 long 1061907	74	11/19/56	13.8	One well was plugged and cemented in 1973 Uncertainty exists regarding which well (825 or 826) still remains and which was destroyed. The most recent information from the Texas Water Development Board assumes that well no. 826 is the remaining well. (4-15-99)
JL-49-22-826 lat 313849 long 1061908	83	11/19/56	13.1	Contradictory data between well nos. 825 and 826 have created some confusion. One of the two wells was destroyed, and the other is still being measured. Well no. 826 is most likely the remaining well.
		4/12/94	12.45	
		2/3/95	12.98	
		1/16/96	13.78	
		1/12/98	14.16	
		12/8/98	13.27	
		12/2/99	9.47	
JL-49-22-842 lat 313817 long 1061847	25	6/7/84	6.93	USBR observation well no. 6R located inside RG levee 1.7 mi downstream of Riverside Dam. Slotted interval 20-25 ft in the Rio Grande alluvium.
		2/3/95	14.59	
		1/16/96	14.56	
JL-49-22-843 lat 313817 long 1061834	28	6/7/84	6.1	USBR observation well no. 18 is located at Bosque Wildlife Refuge. Slotted from 23-28 ft in the Rio Grande alluvium. Well could not be found for 1998 and 1999 measurements, and may have been destroyed. (12-07-98)
		4/12/94	10.32	
		2/3/95	10.5	
		1/7/96	11.11	
		1/13/97	10.5	
JL-49-22-844 USBR lat 313829 long 1061835	27	6/1/84	5.54	USBR observation well no. 2B located at Bosque Wildlife Refuge. Slotted interval 22-27 ft in the Rio Grande alluvium
		4/12/94	9.17	
		2/3/95	9.72	
		1/16/96	9.15	
		1/13/97	9.19	
		1/12/98	10.19	
		12/7/98	9.25	
		12/2/99	3.68	
	27	6/1/84	5.54	

Appendix C2

Ground Water Quality from Field Tests of Rio Bosque Wetlands Park Monitoring Wells

(Source: Studies by UTEP/CERM using an Oakton hand-held conductivity/TDS meter.)

Total Dissolved Solids (ppm)

Date	RB1	RB1B	RB2	RB3	RB3B	RB5	RB6	RB7	RB8	RB9A	RB9B	RB10	RB11
1/10/01	982	896	875	925	880	995	2,470	1,320	3,300	1,230	865	853	1,450
1/10/01	986											970	
2/23/01							3,490			2,170	1,070	1,100	2,190
2/27/01	853	794	1,180	1,170	1,120	1,010		2,260	3,770				
4/4/01	838	731	988	950	974	1,090	2,740	1,320	3,290	1,100	972	1,100	1,750
5/16/01	845	755	1,070	972	979	1,070	2,630	1,220	3,160	973	959	974	1,360
7/18/01	756	649	982	827	876	864	2,630	1,390	2,960	861	853	788	1,220
8/21/01	757	656	966	877	891	869	2,770	1,210	3,060	824	845	840	948
1/9/02	731	664	1,080	1,090	1,190	1,220	2,630	1,097	2,910	1,046	825	838	1,955
3/12/02	701	694	X	908	993	974	3,170	1,340	2,780	953	826	861	2,540
5/30/02	695	662	942	947	942	1,090	2,580	1,130	2,550	894	831	813	921
avg	814	722	1,010	963	983	1,020	2,790	1,365	3,087	1,117	894	914	1,593
stdev	106	82	95	106	108	113	328	350	352	415	86	115	558

Conductivity (μS)

Date	RB1	RB1B	RB2	RB3	RB3B	RB5	RB6	RB7	RB8	RB9A	RB9B	RB10	RB11
1/10/01	1,960	1,816	1,750	1,850	1,750	1,981	4,890	2,670	6,490	2,410	1,750	1,690	2,930
1/10/01	1,973	1,817										1,970	
2/23/01							7,150			4,370	1,958	2,170	4,480
2/27/01	1,709	1,579	2,320	2,350	2,220	2,030		4,470	7,610				
4/4/01	1,668	1,482	1,950	1,881	1,889	2,230	5,460	2,520	6,690	2,240	1,918	2,220	3,450
5/16/01	1,708	1,505	2,140	1,944	1,954	2,140	5,300	2,530	6,320	1,925	1,917	1,924	2,760
7/18/01	1,488	1,314	1,957	1,662	1,743	1,731	5,370	2,810	6,010	1,735	1,702	1,569	2,460
8/21/01	1,499	1,336	1,919	1,738	1,782	1,756	5,460	2,440	6,020	1,664	1,688	1,695	1,884
1/9/02	1,454	1,300	2,100	2,210	2,128	2,450	5,240	2,180	5,800	2,071	1,657	1,664	3,860
3/12/02	1,402	1,390	X	1,815	1,981	1,938	6,370	2,650	5,590	1,902	1,653	1,722	5,110
5/30/02	1,391	1,331	1,868	1,887	1,906	2,190	5,110	2,300	5,070	1,804	1,643	1,632	1,832
avg	1,625	1,487	2,001	1,926	1,928	2,050	5,594	2,730	6,178	2,236	1,765	1,826	3,196
stdev	215	196	178	220	165	231	712	680	725	836	129	231	1,129

Depth (cm)

Date	RB1	RB1B	RB2	RB3	RB3B	RB5	RB6	RB7	RB8	RB9A	RB9B	RB10	RB11
1/10/01	-165	-165	-56	-80	-106	-252	-199	-165	-167	-357	-357	-205	-173
1/10/01		-158											
2/23/01							-257			-430	-430	-260	-217
2/27/01	-187	-181	-93	-118	-143	-318		-198	-212				
4/4/01	-179	-173	-82	-106	-131	-294	-258	-171	-195	-386	-386	-235	-175
5/16/01	-193	-186	-98	-124	-149	-317	-285	-193	-207	-405	-406	-251	-187
7/18/01	-196	-190	-110	-137	-161	-314	-303	-197	-220	-412	-411	-251	-195
8/21/01	-212	-207	-148	-168	-194	-334	-304	-206	-213	-364	-366	-234	-167
1/9/02	-264	-258	-171	-192	-218	-393	-250	-217	-212	-423	-423	-269	-226
3/12/02	-329	-324	-281	-303	-331	-510	-344	-274	-257	-475	-475	-307	-259
5/30/02	-240	-235	-147	-172	-197	-367	-261	-186	-186	-252	-351	-216	-174
avg	-218	-208	-132	-155	-181	-344	-273	-201	-208	-389	-400	-247	-197
stdev	52	51	67	66	67	74	41	32	25	63	40	30	31

Appendix C3: Ground Water Quality from Laboratory Analysis of Rio Bosque Wetlands Park Monitoring Wells

Water samples, collected in Nalgene containers from monitoring wells within Rio Bosque Wetlands Park, were analyzed using either IC or ICP instrumentation at the Texas A&M Environmental Analytical Research Laboratory.

Samples Collected March 12, 2002

Well	Ca	K	Mg	Na	F	Cl	NO_2	Br	NO_3	PO_4	SO_4	As	Cd	Cr	Cu	Pb	Se	Zn
1	89	14.9	20.3	196	0.74	172	<MDL	1.47	8.3	7.9	260	21.6	<MDL	2.77	<MDL	22.0	<MDL	<MDL
1B	73	11.3	17.1	209	0.95	157	<MDL	1.32	7.7	7.5	266	12.3	<MDL	1.90	<MDL	17.0	<MDL	<MDL
3	90	27.2	19.8	279	0.61	336	<MDL	2.97	42.7	13.3	223	18.2	<MDL	3.47	4.31	20.0	<MDL	3.2
3B	106	24.7	23.8	305	0.85	356	7.29	2.90	88.7	13.2	238	<MDL	<MDL	3.53	2.19	22.1	<MDL	2.5
5	103	20.1	22.8	306	1.03	352	<MDL	3.07	8.0	<MDL	333	<MDL	<MDL	2.89	<MDL	16.3	<MDL	<MDL
6	251	25.0	59.1	865	3.50	1,138	<MDL	1.61	29.8	<MDL	1,106	12.2	<MDL	3.04	<MDL	26.7	<MDL	<MDL
7	89	11.8	26.1	367	1.20	394	<MDL	3.18	8.5	<MDL	474	<MDL	<MDL	2.25	<MDL	15.6	<MDL	<MDL
8	183	29.8	38.8	825	3.37	762	<MDL	<MDL	29.9	<MDL	1,074	0.6	<MDL	2.34	<MDL	28.4	<MDL	5.8
9A	79	11.1	16.8	327	1.08	308	<MDL	2.97	9.4	<MDL	349	<MDL	<MDL	2.84	<MDL	14.3	<MDL	<MDL
9B	51	16.3	10.0	278	1.02	332	<MDL	2.74	8.9	<MDL	207	<MDL	<MDL	1.67	<MDL	11.4	<MDL	<MDL
10	93	11.6	19.2	250	1.06	336	<MDL	2.54	7.7	<MDL	278	<MDL	<MDL	2.81	<MDL	16.8	<MDL	5.1
11	314	22.2	75.7	603	3.41	494	<MDL	<MDL	28.4	<MDL	1,463	17.1	<MDL	2.56	<MDL	26.0	<MDL	10.2

Samples Collected May 30, 2002

Well	Ca	K	Mg	Na	F	Cl	NO_2	Br	NO_3	PO_4	SO_4	As	Cd	Cr	Cu	Pb	Se	Zn
1	74	14.3	16.5	150		177			3.7	7.7	251							
1B	77	9.3	18.1	133		156			3.5	7.5	273							
2	84	31.8	18.0	217		316			49.9	13.8	340							
3	87	32.2	18.2	222		342			59.2	12.7	338							
3B	89	32.8	16.3	217		332			44.0	12.6	367							
5	107	20.9	23.8	227		352			4.1	8.6	423							
6	234	23.2	50.8	623		1,060			9.6	<MDL	1,098							
7	83	14.9	24.4	280		387			3.4	<MDL	413							
8	197	32.6	39.8	748		844			7.9	<MDL	1,205							
9A	59	12.9	13.3	231		352			4.6	<MDL	330							
9B	52	17.8	10.4	212		345			5.4	7.2	232							
10	77	14.0	15.8	187		347			3.8	<MDL	249							
11	90	12.6	23.0	217		376			12.4	<MDL	301							

Notes: All units reported in mg/L
MDL = minimum detection limit

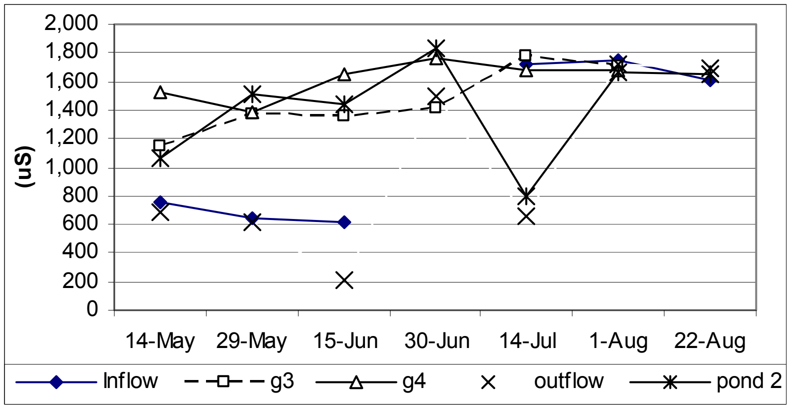
Appendix D

Surface Water Chemistry Data from Rio Bosque Wetlands Park

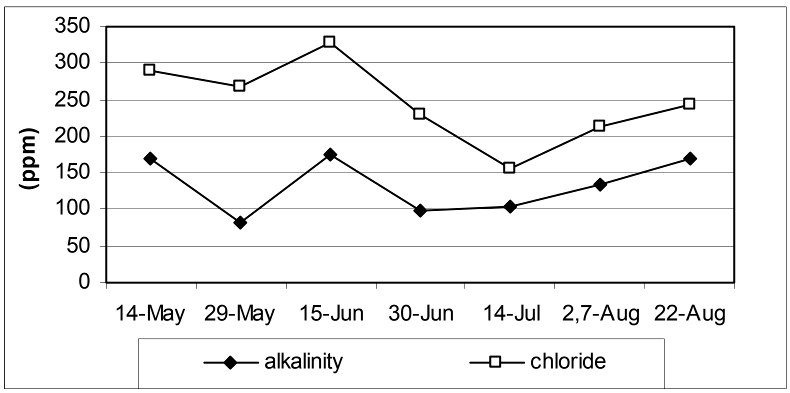
Between May and August 23, 2001, UTEP students, working under the direction of Dr. Elizabeth Walsh, measured plankton levels along and collected other aquatic organisms at five locations in Rio Bosque Wetlands Park. As part of this study, surface water chemistry measurements were made. The instrumentation that was used consisted of a LaMotte water chemistry test kit used to test the nitrate, phosphate, silica, water hardness, sulfide, dissolved carbon dioxide, ammonia nitrogen, alkalinity, and chloride levels; Oakton conductivity and Oakton temperature/pH meters used to measure those variables; a Sper Scientific meter used to measure dissolved oxygen; and a secchi disc used to determine transparency. The table below contains the some of the water chemistry data that were acquired. The graphs on the following two pages portray the same information.

sampling date	sampling site	water temp. °C	pH	dO	conductivity	nitrates (ppm)	silica (ppm)	phosphates (ppm)	CO_2 (ppm)	sulfide (ppm)	alkalinity (ppm)	chloride (ppm)	water depth (cm)
15-May	inflow	29.8	7.0	9.3	756	16.0	16	0.2	10	0.2	155	328	42
15-May	gate 3	29.5	7.6	14.4	1,144	2.4	16	0.2	17	0.2	170	288	>58
15-May	gate 4	29.2	7.4		1,528	2.4	16	0.2	17	0.2	170	288	60
15-May	outflow	32.0	8.3	13	692	4.0	16	0.3	0	0.2	155	256	9
15-May	pond 2	29.9	8.4	30.3	1,066	4.0	12	0.5	10	0.2	200	296	
30-May	inflow	27.4	7.1	9.1	638	0.4	30	0.6	14	0.2	83	264	60
30-May	gate 3	26.2	7.1	3.7	1,373	0.6	30	0.6	11	0.2	90	256	89
30-May	gate 4	28.5	7.1	4	1,382	0.6	30	0.6	13	0.2	90	272	39
30-May	outflow	28.2	7.6	9.4	621	0.6	30	0.4	14	0.5	75	272	
30-May	pond 2	30.7	8.9	9.7	1,513	1.0	30	0.6	0	0.2	75	280	
16-Jun	inflow	26.5	7.1	5.3	614	2.6	30	0.4	9	0.5	135	300	47
	gate 3	29.3	7.4	7.2	1,385	4.4	40	0.4	7	0.2	175	290	75
	gate 4	28.4	7.5	8.3	1,656	4.4	30	0.4	8	0.2	160	340	59
	outflow	25.2	8.1	10.6	211	0.9	30	0.6	3	0.2	225	400	13
	pond 2	30.0	7.9	6.9	1,435	4.4	30	0.6	0	0.2	175	310	30
1-Jul	Inflow					0.4		0.4	6	clear	85	85	
	gate 3	29.2	6.9	2.3	1,407	1.0		0.6	5	clear	85	296	73
	gate 4	30.0	6.9	10.1	1,756	1.0		0.4	16	clear	100	288	60
	outflow	30.6	6.9	77.3	1,498	0.4		0.6	12	clear	125	296	88
	pond 2	29.9	7.8	9.7	1,839	1.0	0.6	0.6	7	clear	100	180	
15-Jul	inflow		6.5		1,723	0.6		0.4	4	0.2	95	158	49
15-Jul	gate 3		6.6		1,770	1.0		0.6	2	0.2	90	152	86
15-Jul	gate 3		6.1		1,685	0.6		0.6	6	0.2	92	148	70
15-Jul	outflow		6.8		658	1.0		0.4	0	0.2	115	160	86
15-Jul	pond 2		7.2		801	1.0		0.6	5	0.2	125	160	40
7-Aug	inflow	29.1	6.8		1,754	0.6		1.0	9	0.2	130	268	58
2-Aug	gate 3	29.2	7.3	8.8	1,768	0.6	0	0.4	9	clear	120	136	82
2-Aug	gate 4	29.0	6.5	8.8	1,682	1.0		0.6	10	clear	120	152	65
7-Aug	outflow	27.2	6.9		1,719	0.6		0.6	10	0.2	150	264	96
7-Aug	pond 2	26.4	7.7		1,669	1.0		0.6	7	0.2	150	250	70
23-Aug	inflow	32.3	7.1		1,615	0.2		1.0	15	0.2	175	240	42
23-Aug	gate 3					1.0		0.6	10	0.2	145	264	
23-Aug	gate 4	19.1	6.7			1.0		0.6	15	0.2	175	248	64
23-Aug	outflow	29.4	7.7		1,693	0.6		0.6	7	0.2	200	282	75
23-Aug	pond 2	31.0	8.0		1,651	0.6		0.6	12	0.2	155	232	56

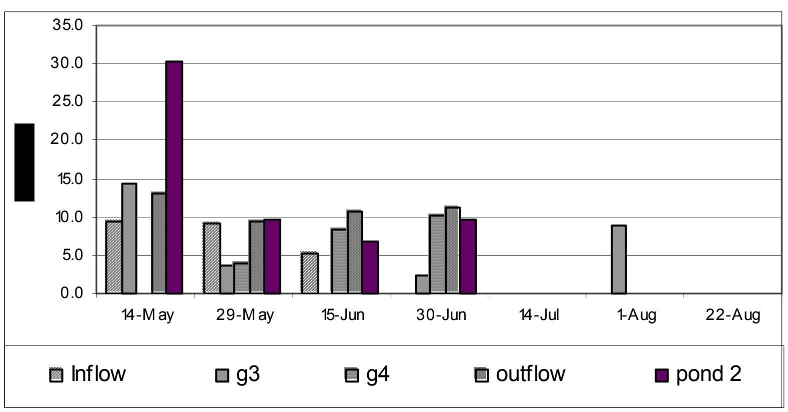
Conductivity



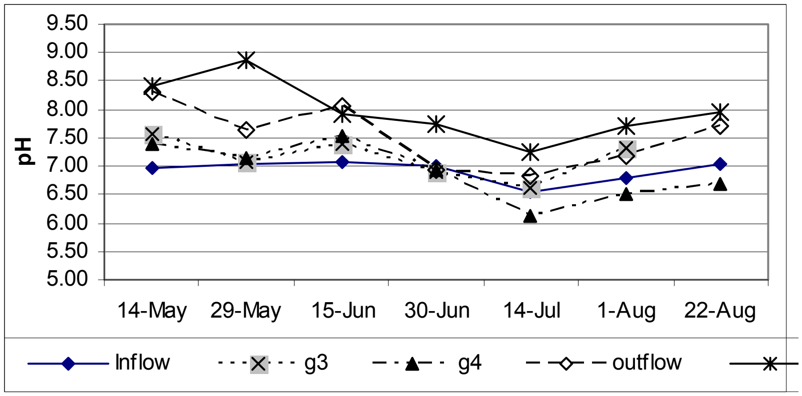
Alkalinity and Chloride



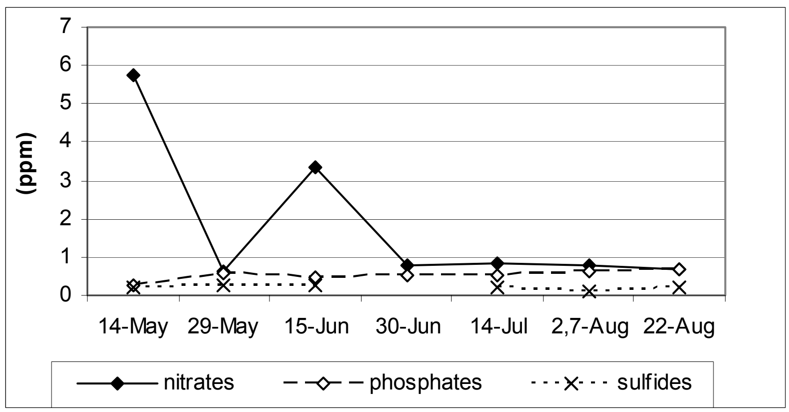
Dissolved Oxygen



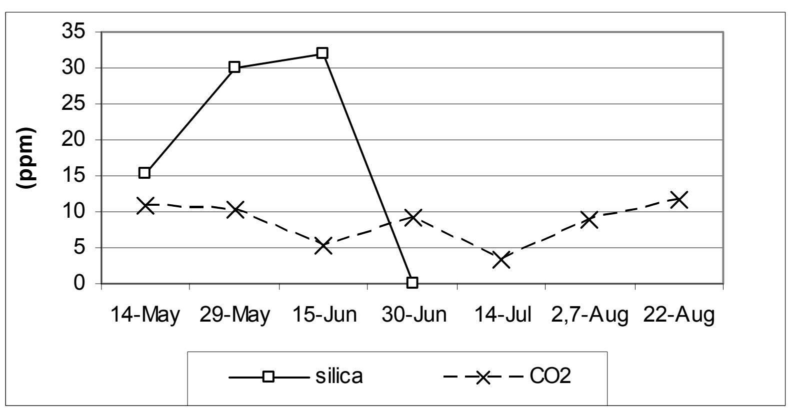
pH



Nitrates, Phosphates and Sulfides



Silica and CO_2



Appendix E1

Vegetation of Rio Bosque Wetlands Park

(Revised September 5, 2002; * = introduced)

EQUISETACEAE	
scouringrush	*Equisetum hyemale* var. *affine*
AIZOACEAE	
sea-purslane	*Sesuvium verrucosum*
AMARANTHACEAE	
Palmer amaranth	*Amaranthus palmeri*
BIGNONIACEAE	
desert willow	*Chilopsis linearis*
BORAGINACEAE	
alkali heliotrope	*Heliotropium curassavicum*
CACTACEAE	
sand pricklypear	*Opuntia arenaria*
tree cholla	*Opuntia imbricata*
purple pricklypear	*Opuntia macrocentra*
CAPPARIDACEAE	
jackass clover	*Wislizenia refracta*
CHENOPODIACEAE	
fourwing saltbush	*Atriplex canescens*
silver saltbush	*Atriplex obovata*
*summer cypress	*Kochia scoparia*
*Russianthistle	*Salsola australis*
seepweed	*Suaeda* sp.
COMPOSITAE	
ragweed	*Ambrosia acanthicarpa*
sand sagebrush	*Artemisia filifolia*
seepwillow	*Baccharis salicifolia*
willow baccharis	*Baccharis salicina*
spiny aster	*Chloracantha spinosa* var. *spinosus*
horseweed	*Conyza canadensis*
broom snakeweed	*Gutierrezia sarothrae*
sunflower	*Helianthus annuus*
Plains sunflower	*Helianthus ciliaris*
bitterweed	*Hymenoxys odorata*
jimmyweed	*Isocoma pluriflora*
sand aster	*Machaeranthera canescens*
tansyleaf	*Machaeranthera tanacetifolia*
purple pluchea	*Pluchea odorata*
arrowweed	*Pluchea sericea*
Riddell groundsel	*Senecio riddellii*
*annual sow thistle	*Sonchus oleraceus*
cowpen daisy	*Verbesina encelioides*
cocklebur	*Xanthium strumarium*
CONVOLVULACEAE	
*white-edge morning glory	*Ipomoea nil*
CRUCIFERAE	
tansy mustard	*Descurainia pinnata*
desert spectacle pod	*Dimorphocarpa wislizenii*
*garden rocket	*Eruca vesicaria* ssp. *sativa*
mountain pepperweed	*Lepidium montanum*
*perennial pepperweed	*Lepidium latifolium*
*London rocket	*Sisymbrium irio*
CUCURBITACEAE	
buffalo gourd	*Cucurbita foetidissima*
EUPHORBIACEAE	
spurge	*Chamaesyce* spp.

LEGUMINOSAE

Indian rushpea	*Hoffmanseggia glauca*
*honey mesquite	*Prosopis glandulosa* var. *glandulosa*
western honey mesquite	*Prosopis glandulosa* var. *torreyana*
tornillo	*Prosopis pubescens*
broom psorothamnus	*Psorothamnus scoparius*

LOASACEAE

stickleaf, blazing star	*Mentzelia* sp.

MALVACEAE

scruffy sida	*Malvella leprosa*
narrowleaf globemallow	*Sphaeralcea angustifolia*

NYCTAGINACEAE

winged sand verbena	*Tripterocalyx carnea*

POLYGONACEAE

curltop smartweed	*Polygonum lapathifolium* var. *lapathifolium*
dock	*Rumex* sp.

SALICACEAE

Rio Grande cottonwood	*Populus deltoides* ssp. *wislizenii*
coyote willow	*Salix exigua*
Goodding willow	*Salix gooddingii*

SOLANACEAE

oakleaf datura	*Datura quercifolia*
sacred datura	*Datura wrightii*
wolfberry	*Lycium sp.*
*tree tobacco	*Nicotiana glauca*
Wright's groundcherry	*Physalis acutifolia*
purple nightshade	*Solanum elaeagnifolium*
buffalo-bur	*Solanum rostratum*

TAMARICACEAE

*saltcedar	*Tamarix ramosissima*

ULMACEAE

*Siberian elm	*Ulmus pumila*

VERBENACEAE

sawtooth frogfruit	*Phyla nodiflora* var. *incisa*

VISCACEAE

mistletoe	*Phoradendron tomentosum*

AGAVACEAE

soaptree yucca	*Yucca elata* var. *elata*

COMMELINACEAE

birdbill dayflower	*Commelina dianthifolia*

CYPERACEAE

Emory sedge	*Carex emoryi*
chufa	*Cyperus esculentus*
largespike spikesedge	*Eleocharis macrostachya*

GRAMINEAE

six-weeks needle grama	*Bouteloua aristidoides*
six-weeks grama	*Bouteloua barbata*
*showy chloris	*Chloris virgata*
*Bermudagrass	*Cynodon dactylon*
inland saltgrass	*Distichlis spicata* var. *stricta*
*barnyardgrass	*Echinochloa crusgallii*
*hare barley	*Hordeum murinum* ssp. *glaucum*
bearded sprangletop	*Leptochloa fascicularis*
Mexican sprangletop	*Leptochloa uninervia*
*rabbitfoot grass	*Polypogon monospeliensis*
plains bristlegrass	*Setaria leucopila*
*Johnsongrass	*Sorghum halepense*
alkali sacaton	*Sporobolus airoides*
six-weeks fescue	*Vulpia octoflora*

LEMNACEAE

least duckweed	*Lemna minuta*

TYPHACEAE

southern cattail	*Typha domingensis*

Appendix E2

Birds of Rio Bosque Wetlands Park

(Revised September 15, 2002)

Legend

Sp -- Spring (March-May)
Su -- Summer (June-August)
F -- Fall (September-November)
W -- Winter (December-February)

A --	Abundant	should see 90%-100% of time in proper habitat and season
C --	Common	should see 50%-90% of time in proper habitat and season
U --	Uncommon	should see 20%-50% of time in proper habitat and season
R --	Rare	should see <20% of time in proper habitat and season
X --	Accidental	only 1 or 2 records

* -- breeding confirmed
† -- breeding suspected
‡ -- formerly nested

Total Species: 191

	Sp	Su	F	W
Pied-billed Grebe (*Podilymbus podiceps*)	R	R	R	U
Eared Grebe (*Podiceps nigricollis*)			R	R
American White Pelican (*Pelecanus erythrorhynchos*)	X		X	
Double-crested Cormorant (*Phalacrocorax auritus*)	X	R	X	
Neotropic Cormorant (*Phalacrocorax brasilianus*)		X	X	
Great Blue Heron (*Ardea herodias*)	C	R	C	C
Great Egret (*Ardea alba*)	U	U*	U	U
Snowy Egret (*Egretta thula*)	C	C*	U	R
Little Blue Heron (*Egretta caerulea*)		X		
Tricolored Heron (*Egretta tricolor*)	X	X		
Reddish Egret (*Egretta rufescens*)		X		
Cattle Egret (*Bubulcus ibis*)	C	C*	U	
Green Heron (*Butorides virescens*)	U	U‡	U	X
Black-crowned Night-Heron (*Nycticorax nycticorax*)	U	C*	R	
Yellow-crowned Night-Heron (*Nyctanassa violacea*)		X		
White-faced Ibis (*Plegadis chihi*)	U	R	U	R
Turkey Vulture (*Cathartes aura*)	R	U	R	
Fulvous Whistling-Duck (*Dendrocygna bicolor*)	X	X		
Snow Goose (*Chen caerulescens*)	X		R	X
Canada Goose (*Branta canadensis*)	X			X
Wood Duck (*Aix sponsa*)	X		R	X
Gadwall (*Anas strepera*)	U	X	C	C
American Wigeon (*Anas americana*)	R		U	C

	Sp	Su	F	W
Mallard (*Anas platyrhynchos*)	C	U*	C	A
Blue-winged Teal (*Anas discors*)	R	R†	R	X
Cinnamon Teal (*Anas* cyanoptera)	U	R*	R	C
Northern Shoveler (*Anas clypeata*)	C	R	C	A
Northern Pintail (*Anas acuta*)	U	R	C	C
Green-winged Teal (*Anas crecca*)	C	X	C	C
Canvasback (*Aythya valisineria*)			R	R
Redhead (*Aythya americana*)	R	R	R	U
Ring-necked Duck (*Aythya collaris*)	R		R	U
Greater Scaup (*Aythya marila*)	X			
Lesser Scaup (*Aythya affinis*)	R		R	R
Bufflehead (*Bucephala albeola*)	R		R	R
Common Goldeneye (*Bucephala clangula*)			X	X
Hooded Merganser (*Lophodytes cucullatus*)			X	
Ruddy Duck (*Oxyura jamaicensis*)	R	R	R	R
Osprey (*Pandion haliaetus*)	R		R	
Mississippi Kite (*Ictinia mississippiensis*)	X	R		
Bald Eagle (*Haliaeetus leucocephalus*)	X			X
Northern Harrier (*Circus cyaneus*)	C	X	C	C
Sharp-shinned Hawk (*Accipiter striatus*)	U		R	U
Cooper's Hawk (*Accipiter cooperii*)	R	X	R	U
Harris's Hawk (*Parabuteo unicinctus*)	C	C*	C	C
Swainson's Hawk (*Buteo swainsoni*)	U	U*	U	
Zone-tailed Hawk (*Buteo albonotatus*)			X	
Red-tailed Hawk (*Buteo jamaicensis*)	C		C	C
Ferruginous Hawk (*Buteo regalis*)				X
American Kestrel (*Falco sparverius*)	U	U†	U	R
Merlin (*Falco columbarius*)				X
Prairie Falcon (*Falco mexicanus*)			R	R
Peregrine Falcon (*Falco peregrinus*)	R		R	R

	Sp	Su	F	W
Scaled Quail (*Callipepla squamata*)	X	X	R	X
Gambel's Quail (*Callipepla gambelii*)	C	C*	C	C
Sora (*Porzana carolina*)		X		X
Common Moorhen (*Gallinula chloropus*)	R	R*	R	U
American Coot (*Fulica americana*)	U	U*	C	C
Sandhill Crane (*Grus canadensis*)	X		U	R
American Golden-Plover (*Pluvialis dominica*)	X			
Snowy Plover (*Charadrius alexandrinus*)	X			
Semipalmated Plover (*Charadrius semipalmatus*)	X			
Killdeer (*Charadrius vociferus*)	C	C*	C	C
Black-necked Stilt (*Himantopus mexicanus*)	U	U*	R	X
American Avocet (*Recurvirostra americana*)	U	U*	X	X
Greater Yellowlegs (*Tringa melanoleuca*)	R	X	U	U
Lesser Yellowlegs (*Tringa flavipes*)	R	R	R	
Solitary Sandpiper (*Tringa solitaria*)	R	R	R	
Willet (*Catoptrophorus semipalmatus*)	R			
Spotted Sandpiper (*Actitis macularia*)	R	R	R	R
Long-billed Curlew (*Numenius americanus*)	R	R	R	
Marbled Godwit (*Limosa fedoa*)			X	
Western Sandpiper (*Calidris mauri*)	X	X		
Least Sandpiper (*Calidris minutilla*)	R	R	U	U
Baird's Sandpiper (*Calidris bairdii*)	X		R	
Stilt Sandpiper (*Calidris himantopus*)	X	X	X	
Long-billed Dowitcher (*Limnodromus scolopaceus*)	U	R	U	U
Common Snipe (*Gallinago gallinago*)	X		X	X
Wilson's Phalarope (*Phalaropus tricolor*)	R	R	R	

	Sp	Su	F	W
Franklin's Gull (*Larus pipixcan*)	X			
Bonaparte's Gull (*Larus philadelphia*)	X			
Ring-billed Gull (*Larus delawarensis*)	R		X	R
Forster's Tern (*Sterna forsteri*)		X	X	
Least Tern (*Sterna antillarum*)	X	X		
Black Tern (*Chlidonias niger*)		R	R	
Rock Dove (*Columba livia*)	X	X	R	
White-winged Dove (*Zenaida asiatica*)	U	U	R	X
Mourning Dove (*Zenaida macroura*)	C	A*	C	C
Yellow-billed Cuckoo (*Coccyzus americanus*)		R‡		
Greater Roadrunner (*Geococcyx californianus*)	C	C*	C	C
Barn Owl (*Tyto alba*)	X	R	X	
Burrowing Owl (*Athene cunicularia*)	U	C*	U	R
Lesser Nighthawk (*Chordeiles acutipennis*)	R	R	R	
Common Nighthawk (*Chordeiles minor*)		X	X	
White-throated Swift (*Aeronautes saxatalis*)				R
Black-chinned Hummingbird (*Archilochus alexandri*)	C	C*	U	
Broad-tailed Hummingbird (*Selasphorus platycercus*)	X	R	X	
Belted Kingfisher (*Ceryle alcyon*)	R		U	U
Ladder-backed Woodpecker (*Picoides scalaris*)	R	R†	R	R
Northern Flicker (*Colaptes auratus*)	U		U	C
Olive-sided Flycatcher (*Contopus cooperi*)	X			
Western Wood-Pewee (*Contopus sordidulus*)	R	X	X	
Willow Flycatcher (*Empidonax traillii*)	X	X		
Dusky Flycatcher (*Empidonax oberholseri*)	X			
Cordilleran Flycatcher (*Empidonax occidentalis*)	X			
Black Phoebe (*Sayornis nigricans*)	R	R	U	U
Eastern Phoebe (*Sayornis phoebe*)				X

	Sp	Su	F	W
Say's Phoebe (*Sayornis saya*)	U		U	C
Vermilion Flycatcher (*Pyrocephalus rubinus*)	X			
Ash-throated Flycatcher (*Myiarchus cinerascens*)	R	R		
Cassin's Kingbird (*Tyrannus vociferans*)	X		X	
Western Kingbird (*Tyrannus verticalis*)	A	A*	U	
Loggerhead Shrike (*Lanius ludovicianus*)	U	U	U	U
Bell's Vireo (*Vireo bellii*)	X	X		
Western Scrub-Jay (*Aphelocoma californica*)	R	X	X	R
American Crow (*Corvus brachyrhynchos*)	U		A	A
Chihuahuan Raven (*Corvus cryptoleucus*)	C	R	A	A
Horned Lark (*Eremophila alpestris*)	X			
Tree Swallow (*Tachycineta bicolor*)	R		X	X
Violet-green Swallow (*Tachycineta thalassina*)			R	
N. Rough-winged Swallow (*Stelgidopteryx serripennis*)	R	R	R	X
Bank Swallow (*Riparia riparia*)	R	R	R	
Barn Swallow (*Hirundo rustica*)	C	C	C	
Cliff Swallow (*Petrochelidon pyrrhonota*)	U	U	U	
Cave Swallow (*Petrochelidon fulva*)	U	R	U	X
Verdin (*Auriparus flaviceps*)	C	C*	C	U
Cactus Wren (*Campylorhynchus brunneicapillus*)	R	R	R	R
Rock Wren (*Salpinctes obsoletus*)	X			
Bewick's Wren (*Thryomanes bewickii*)	U		U	U
House Wren (*Troglodytes aedon*)	R			R
Marsh Wren (*Cistothorus palustris*)	R		U	U
Ruby-crowned Kinglet (*Regulus calendula*)	U		U	C

Species	Sp	Su	F	W
Blue-gray Gnatcatcher (*Polioptila caerulea*)	X			
Black-tailed Gnatcatcher (*Polioptila melanura*)			X	
Western Bluebird (*Sialia mexicana*)	X			
Mountain Bluebird (*Sialia currucoides*)				X
Hermit Thrush (*Catharus guttatus*)	X			
American Robin (*Turdus migratorius*)	R			
Northern Mockingbird (*Mimus polyglottos*)	A	A*	R	R
Sage Thrasher (*Oreoscoptes montanus*)		X		
Curve-billed Thrasher (*Toxostoma curvirostre*)	X			
Crissal Thrasher (*Toxostoma crissale*)	U	U*	U	U
European Starling (*Sturnus vulgaris*)		R		
American Pipit (*Anthus rubescens*)	R		U	U
Phainopepla (*Phainopepla nitens*)	R	X		
Orange-crowned Warbler (*Vermivora celata*)		X	R	
Nashville Warbler (*Vermivora ruficapilla*)	X			
Virginia's Warbler (*Vermivora virginiae*)	X	X	R	
Yellow Warbler (*Dendroica petechia*)	X	X		
Yellow-rumped Warbler (*Dendroica coronata*)	U		C	C
Palm Warbler (*Dendroica palmarum*)			X	
American Redstart (*Setophaga ruticilla*)	X	X		
Common Yellowthroat (*Geothlypis trichas*)	R	R	X	
Wilson's Warbler (*Wilsonia pusilla*)	U	X	C	
Yellow-breasted Chat (*Icteria virens*)	C	C*		
Summer Tanager (*Piranga rubra*)	R	R		
Western Tanager (*Piranga ludoviciana*)	R	R		
Green-tailed Towhee (*Pipilo chlorurus*)	R		U	
Spotted Towhee (*Pipilo maculatus*)	U		U	R
Cassin's Sparrow (*Aimophila cassinii*)	R	U†		
Chipping Sparrow (*Spizella passerina*)	X	X	R	R
Clay-colored Sparrow (*Spizella pallida*)		X	X	
Brewer's Sparrow (*Spizella breweri*)	C	X	U	R
Vesper Sparrow (*Pooecetes gramineus*)	U		U	R
Lark Sparrow (*Chondestes grammacus*)	R	X		
Black-throated Sparrow (*Amphispiza bilineata*)	X			
Lark Bunting (*Calamospiza melanocorys*)	R	R	R	X
Savannah Sparrow (*Passerculus sandwichensis*)	U		R	C
Song Sparrow (*Melospiza melodia*)	R		U	C
Lincoln's Sparrow (*Melospiza lincolnii*)	R		X	R
Swamp Sparrow (*Melospiza georgiana*)	X			X
White-throated Sparrow (*Zonotrichia albicollis*)				X
White-crowned Sparrow (*Zonotrichia leucophrys*)	C		C	A
Dark-eyed Junco (*Junco hyemalis*)	C		U	C
Northern Cardinal (*Cardinalis cardinalis*)	X			
Pyrrhuloxia (*Cardinalis sinuatus*)	R	X	R	R
Black-headed Grosbeak (*Pheucticus melanocephalus*)		X		
Blue Grosbeak (*Guiraca caerulea*)	U	U*	U	
Painted Bunting (*Passerina ciris*)	U	C*		
Red-winged Blackbird (*Agelaius phoeniceus*)	U	U‡	U	U
Western Meadowlark (*Sturnella neglecta*)	R		R	R
Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*)	R	U	U	
Brewer's Blackbird (*Euphagus cyanocephalus*)	R		R	R
Common Grackle (*Quiscalus quiscula*)				X
Great-tailed Grackle (*Quiscalus mexicanus*)	U	U	R	R
Brown-headed Cowbird (*Molothrus ater*)	U	U†		
Bullock's Oriole (*Icterus bullockii*)	U	U		
House Finch (*Carpodacus mexicanus*)	A	A*	A	A
Pine Siskin (*Carduelis pinus*)				X
Lesser Goldfinch (*Carduelis psaltria*)	R	R	R	
House Sparrow (*Passer domesticus*)	R	R		

Appendix E3

Mammals, Reptiles, Amphibians and Fish of Rio Bosque Wetlands Park

(Revised August 22, 2002)

MAMMALS

Brazilian Free-tailed Bat
Tadarida brasiliensis

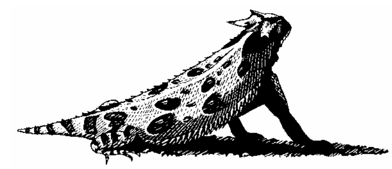
Molossidae	
Brazilian free-tailed bat	*Tadarida brasiliensis*
Leporidae	
desert cottontail	*Sylvilagus audubonii*
black-tailed jackrabbit	*Lepus californicus*
Sciuridae	
spotted ground squirrel	*Spermophilus spilosoma*
Geomyidae	
desert pocket gopher	*Geomys arenarius*
Heteromyidae	
Sonoran pocket mouse	*Chaetodipus,* sp.
Castoridae	
beaver	*Castor canadensis*
Cricetidae	
Western harvest mouse	*Reithrodontomys megalotis*
white-footed mouse	*Peromyscus leucopus*
deer mouse	*Peromyscus maniculatus*
hispid cotton rat	*Sigmodon hispidus*
muskrat	*Ondatra zibethicus*
Muridae	
house mouse	*Mus musculus*
Canidae	
coyote	*Canis latrans*
gray fox	*Urocyon cinereoargenteus*
Procyonidae	
raccoon	*Procyon lotor*
Mephitidae	
striped skunk	*Mephitis mephitis*

Striped Skunk
Mephitis mephitis

REPTILES

Trionychidae
spiny softshell — *Trionyx spinifera*

Iguanidae
Texas horned lizard — *Phrynosoma cornutum*
prairie lizard — *Sceloporus undulatus*
side-blotched lizard — *Uta stansburiana*



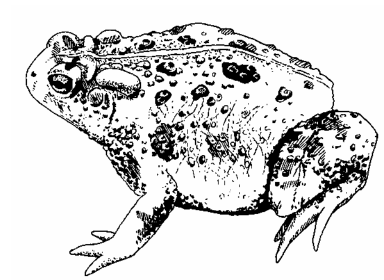
Texas Horned Lizard
Phrynosoma cornutum

Teiidae
little striped whiptail — *Cnemidophorus inornatus*

Colubridae
Great Plains rat snake — *Elaphe emoryi*
night snake — *Hypsiglena torquata*
common kingsnake — *Lampropeltis getula*
coachwhip — *Masticophis flagellum*
gopher snake — *Pituophis catenifer*
checkered garter snake — *Thamnophis marcianus*

AMPHIBIANS

Bufonidae
red-spotted toad — *Bufo punctatus*
Woodhouse's toad — *Bufo woodhousii*



Woodhouse's Toad
Bufo woodhousii

Pelobatidae
Couch's spadefoot — *Scaphiopus couchii*

Ranidae
bullfrog — *Rana catesbeiana*

FISH

Cyprinidae
common carp — *Cyprinus carpio*

Poeciliidae
mosquitofish — *Gambusia affinis*

Appendix F1

Recommended Plant Species for Revegetation at Rio Bosque Wetlands Park

(Developed by Wynn Anderson, University of Texas at El Paso Centennial Museum)

B= banks F=flats U=uplands U/A= arroyo U/S= sandhills

PRINCIPAL TREES

Populus deltoides ssp. *wislizenii*	B,F	Rio Grande Cottonwood
Prosopsis pubescens	F	Screwbean mesquite
Salix gooddingii var. *variabilis*	B,F	Goodding/black willow

Note: The presence of similar *S. amygdaloides* (Black willow) has not been confirmed in El Paso County.

SECONDARY TREES

Prosopsis glandulosa var. *torreyana*	F,U	Honey mesquite
Chilopsis linearis	U/A	Desert willow

PRINCIPAL SHRUBS and woody perennials

Lycium torreyi	B,F	Wolfberry
Atriplex canescens	F	Four wing Saltbush
Salix exigua	B	Coyote willow

Note: The presence of similar *S. interior* (Sandbar willow) has not been confirmed in El Paso County.

Tessaria sericea	B	Arrowweed
Baccharis salicifolia (*B. glutinosa*)	B,F	Seepwillow
Isocoma wrightii	F,U	Jimmyweed

SECONDARY SHRUBS and woody perennials

Glycyrrhiza lepidota	B	Wild licorice
Allenrolfea occidentalis	F	Pickelweed
Baccharis salicina	F	Willow baccharis
Apocynum sibiricum (*A.cannabinum*)	B	Dogbane
Rhus trilobata	U	Threeleaf sumac
Amorpha fruiticosa	B	False Indigo
Opuntia engelmannii	U	Prickly Pear
Artemesia filifolia	U/S	Sand sage

PRINCIPAL GRASSES

Distichlis stricta	F	Saltgrass
Phragmites australis (*P. communis*)	B	Common reed
Sporobolus airoides	F,U	Alkali sacaton

FORBS

Cressa depressa – Alkali weed (Found in heavy valley soils)
Sesuvium verrucosum – Salt purslane (Common on flats near river banks)
Suaeda suffrutescens –Seepweed
Suaeda depressa –Seepweed
Phyla nodiflora var. *incisa* – Frogfruit
Sphaeralcea angustifolia – Globemallow
Malvella leprosa (*Sida hederacea*) – Alkali mallow
Rumex hymenosepalus – Dock

Note: *R. mexicana* is found along the Rio Grande in New Mexico and in the Big Bend, but it has not been confirmed in El Paso County.

Polygonum aviculare – Smartweed
Polygonum amphibium – Smartweed (An aquatic plant)
Polygonum lapathifolium – Willowweed (Probably introduced but well-established)
Polygonum bicorne – Knotweed
Anemopsis californica – Yerba mansa
Kallstroemia parviflora – Caltrop
Helianthus annuus – Sunflower
Helianthus ciliaris – Blueweed
Verbesina encelioides – Cowpen daisy
Heliotropium curassavicum – Salt heliotrope (Found on alkaline flats)
Lepidium montanum – Peppergrass
Oenothera speciosa var. *mexicana* – Mexican evening primrose
(Occasional resident of river banks)

Atriplex acanthocarpa – saltbush (Alkaline soils)
Atriplex saccaria -- annual saltbush (Open flats near river)
Sphaerophysa salsola – Red bladderpod (Introduced but well-established)
Cucurbita foetidissima – Buffalo gourd
Centaurium calycosum – Centaury
Eustoma russellianum (or *E. exaltatum*) – Gentian, Alkali chalice
Wislizenia refracta – Jackass clover (Common in dry fields, flats of the river valley)
Senecio douglasii var. *longilobus* – Threadleaf groundsel
Portulaca oleracea – Purslane
Solanum elaeagnifolium – Nightshade
Machaeranthera canescens – Sand aster
Hoffmanseggia glauca – Rush pea
Conyza canadensis – Horseweed

SEDGES/RUSHES and CATTAILS

Typha domingensis – Cattail
Carex emoryi –Sedge
Eleocharis macrostachya –Spikerush
Cyperus esculentus – Nutgrass
Cyperus odoratus "
Scirpus acutus – Bulrush
Scirpus americanus "
Scirpus maritimus "
Scirpus californicus "
Juncus balticus – Rush
Juncus torreyi "

OTHER AQUATICS

Lemna minima – Duckweed
Samolus ebracteatus – Brookweed (Found at Sunland Park drain)
Myosurus minimus – Mousetail
(Reported at Hueco Tanks, but not a Rio Grande River plant)

Bacopa rotundifolia – Water hyssop (Reported at Hueco Tanks)
Ludwegia peploides – Waterweed
Myriophyllum aquaticum – Water feather
Rorippa palustris – Marsh cress
Potamogeton pectinatus – Pondweed (Found in irrigation canals in El Paso County)
Azolla caroliniana – Mosquito fern (Common in irrigation ditches in El Paso County)
Note: May be *A. filiculoidus* per Dr. Richard D. Worthington.

Equisetum hyemale – Scouring rush
Ranunculus cymbalaria – Crowfoot
(Saline marshes, common in New Mexico including the Mesilla Valley)

Sagittaria longilobus – Arrowhead

Appendix F2

Rio Grande Fish Species Found in the Paso del Norte Region

(Adapted from Stotz, 2000)

List of fish species that have been found in the Rio Grande between Caballo Dam in Sierra County, New Mexico, and Ft. Quitman in Hudspeth County, Texas, and which could potentially live within Rio Bosque Wetlands Park if their required habitat were available

E=*Endemic,* ***N=****Native,* ***I=****Introduced,* ***x=****extirpated from that stretch*
Shading indicates species caught during USFWS survey 1999 (DEIS).

Family	Species	Common Name	Caballo – El Paso	El Paso – Ft. Quitman
Acipenseridae	*Scaphirhynchus platorhynchus*	shovelnose sturgeon	N-x	N-x
Anguillidae	*Anguilla rostrata*	American eel	N-x	N-x
Clupeidae	*Dorosoma cepedianum*	gizzard shad	N	N
	D. petenense	threadfin shad	I	
Cyprinidae	*Ctenopharyngodon idella*	grass carp	I	
	Cyprinella lutrensis	red shiner	N	
	Cyprinus carpio	common carp	I	
	Gila pandora	Rio Grande chub	N-x	
	Hybognathus amarus	Rio Grande silvery minnow	N-x	N-x
	Macrhybopsis aestivalis	speckled chub	N-x	N-x
	Notemigonus crysoleucas	Golden shiner		
	Notropis jemezanus	Rio Grande shiner	N-x	
	N. orca	phantom shiner	E-x	E-x
	N. simus simus	Rio Grande bluntnose shiner	E-x	E-x
	Pimephales promelas	Fathead minnow		
	P. vigilax	bullhead minnow	I	I

Family	Species	Common Name	Caballo – El Paso	El Paso – Ft. Quitman
Cyprinidae (contd.)	*Platygobio gracilis*	flathead chub	N-x	
	Rhinichthys cataractae	longnose dace	I	
Catostomidae	*Carpiodes carpio*	river carpsucker	N	N
	Ictiobus bubalus	smallmouth buffalo	N	N
	Scartomyzon congestum	gray redhorse	N-x	N-x
Characidae	*Astyanax mexicanus*	Mexican tetra	N-x	
Ictaluridae	*Ameiurus melas*	black bullhead		
	A. natalis	yellow bullhead	I	
	Ictalurus sp.	Chihuahua catfish	N-x	N-x
	I. punctatus	channel catfish	I	I
	Pylodictis olivaris	flathead catfish	N-x	
Fundulidae	*Lucania parva*	rainwater killifish	I	
Poeciliidae	*Gambusia affinis*	mosquitofish	N	
Moronidae	*Morone chrysops*	white bass	I	
Centrarchidae	*Lepomis cyanellus*	green sunfish	I	
	L. macrochirus	bluegill	N	
	L. megalotis	longear sunfish	I	
	Micropterus punctulatus	Spotted bass		
	M. salmoides	largemouth bass	I	
	Pomoxis annularis	white crappie	I	

Appendix G

Moist Soil Management Guidelines for Rio Bosque Wetlands Park

(Developed by Ducks Unlimited, Inc. and made an attachment to the License Agreement between the City of El Paso and UTEP)

Habitat Management

Depth: Water depth of individual cells should be maintained at 6-12 inches, and maximum depth within the cells should not exceed 18 inches. Ideally, topography within the impoundments should be varied to create diversity in water depth, a feature that typically attracts a greater variety of waterfowl and wetland wildlife.

Vegetation: The three units created as a result of this project lend themselves very well to the practice of moist soil management. As the phrase implies, moist soil management involves drying and periodic saturation of soils to stimulate growth of desirable species of vegetation, i.e., those that provide sources of food for migrating and wintering waterfowl.

The goal of moist soil management is to create and maintain soil moisture conditions that allow germination and growth of early successional species of vegetation that produce copious amounts of seeds. Species of wild millet (*Echinochloa* spp.), panic grasses (*Panicum* spp.), and certain species of smartweed (*Polygonum* spp.) are examples of plants of value to waterfowl. Generally, in former floodplain areas such as this, seeds of these species occur in the soil seed bank, thus no seeding is required. However, millets in particular may be encouraged by seeding to expedite development of dense stands.

Undesirable species of vegetation may invade the area. Generally, invasions either occur rapidly after draw down by pioneering species such as cockleburr, or slowly as a result of plant succession. Such invasions can be controlled by several means. Identified early (before individual plants attain a height of 3-4 inches), cockleburr and other noxious species including salt cedar may be killed by inundation for a period of about 2 weeks. Taller plants, including salt cedar, may be mowed. This is especially effective when done prior to development of seed heads. Spraying with broad leaf herbicides approved for use in wetlands (e.g., Rodeo) also promotes control of problem species including salt cedar.

Over time, wetland plant species changes may occur due to the process of succession. This natural process may result in development of undesirable plant species composition within the wetland cells. Late successional species typically are perennial plants (as opposed to annual grasses). They often have woody stems they grow back each year from the root base or from aerial woody stems, and the stems persist through winter and often into spring. Perennials may also prevent germination and growth of more desirable vegetation by shading newly germinated plants.

Wetland succession matures usually in seven years. Succession may be set back to the early, more productive stage by several means, including mowing, disking, fire, and via herbicides approved for use in wetlands. Of these, fire is typically the most cost-effective, followed by mowing, disking, and spraying. Mowing and disking probably are most commonly used to disturb the soil and create early successional conditions.

Regardless of management techniques applied, some undesirable species will almost always be present. The objective of management is not necessarily eradication, rather it is control to prevent dense stands of undesirable vegetation from developing. In addition, control of succession assures to a certain extent that the wetland will remain a productive source of food for wintering and migrating ducks.

Ducks Unlimited can provide limited technical assistance pertaining to control of undesirable vegetation. The most knowledgeable and available support will be available from the manager of Bosque del Apache, New Mexico, U.S. Fish and Wildlife Service. Texas Parks and Wildlife personnel may also be available. A site inspection by DU or other wildlife professionals trained in wetland management should be done annually to identify potential management problems.

Flooding and Drawdown Regimes: The primary management objective for this project is to provide habitat for migrating and wintering waterfowl, and to a lesser extent, migrating shorebirds. A secondary objective is to provide potential nesting and brood–rearing habitat for Mexican Ducks.

Flooding and draw down should be done gradually. This allows ducks and shorebirds to consume foods as water moves into new areas within each cell. Gradual draw down is very important, even more so than gradual flooding. Slow draw downs in spring concentrate invertebrates that serve as a primary food source for spring migrant waterfowl and shorebirds.

Management of the wetland cells should vary in a particular cell from year to year avoiding a repetition of the previous year's regime in a particular cell.

Availability of Water: The availability of water in a given year will be verified by contacting the El Paso County Water Improvement District No.1 General Manager and determining the outlook for the year. The availability of water for the year can be verified with the U.S. Bureau of Reclamation, Project Superintendent. Early planning will be necessary to determine what type of flow regime will be permitted.

Drawdown and Flooding

Bosque del Apache Experience: The best experience that Bosque del Apache has had with fall flooding in terms of the maximum extended use of produced wetland foods has been through a progressive flooding schedule of several units at the same time. Flooding for shore birds (7/29-10/12) is planned after units are rehabilitated to reinitiate the succession cycle. Invertebrate production should be high on decaying vegetation matter resulting from mowing, discing and plowing done to reestablish the beginning of a new succession cycle. A continuous flood up through the winter will provide continued emergent vegetation control.

The schedule of each cell should vary from year to year rather than remaining the same perpetually. Assuming that there will be three management units to manipulate, and assuming water is available to flood individual units at will, the following example of flooding and draw down may be appropriate.

Flooding:

Early fall flooding (8/22-10/4) supports early teal during this period.

Mid-fall flooding (10/5-10/31) supports teal, mallards and northern pintail.

Late fall flooding (11/1-12/11) support peak sustained use on moist soil impoundments through November and early December and mainly supports northern pintails and mallards.

One unit should be flooded early in the fall migration period to provide habitat to blue-winged teal, cinnamon teal, northern pintails, and fall migrant shorebirds. The earliest migrant waterfowl to arrive on site in large numbers likely will be blue-winged teal. Blue-winged teal may appear as early as mid-August. Hence, one unit should be flooded in mid to late August, but no later than mid-September, to attract and hold these early migrants. Numbers of early migrants may increase dramatically in September.

Most species of waterfowl begin arriving in this area in October. It would be best to flood two units beginning with one of the two units in mid-October (early October if large numbers of early migrants are present), and the other unit in mid to late November. In so doing, an increasing base of habitat will be provided to increasing numbers of ducks as they move south for the winter. Flooding should be gradual so as to expose new food sources as water levels rise within the units. Flooding up to 1 foot in depth should be accomplished in 2 to 4 weeks.

Flooding in mid to late fall generally attracts green-winged teal, American widgeon, gadwall, northern shovelers, northern pintails, mallards, snow geese, Ross' geese, Canada geese, sandhill cranes, snipe, and a variety of wading birds.

Drawdown: Early spring drawdown (4/12-5/28) leads to germination of smartweed, millet, sprangletop and chufa. Staggered drawdowns during this period will also favor shorebirds with good waterfowl use of concentrated invertebrates expected. Any irrigations will occur if needed in May or June. Spot mowing will occur in late June to control cocklebur and other undesirable vegetation. An additional irrigation will occur in late June or early July following mowing. A final irrigation will occur in early August due to exceptional seed yields when following this irrigation regime.

Late spring drawdowns (5/29-7/13) benefit waterbirds including herons, egrets, bitterns and rails. Millet, sprangletop and Bidens will be the important plants germinating during this period. Spot mowing will be needed in mid-July to control undesirable vegetation followed by a late July or early August irrigation.

Summer drawdowns (7/14-8/20) provide good shorebird habitat.

A key point about draw down, as previously discussed, is that it must be done gradually, i.e., about 1-2 inches per day. Hence, if the maximum depth within a unit is about 18 inches, draw downs should require 3-6 weeks to accomplish. Considering migration chronology of species of waterfowl most likely to occur on the project, draw down should occur as follows:

Begin drawdown on a unit in late February to mid April, complete by the end of April. This will concentrate invertebrates and expose remaining seeds, thereby providing excellent habitat for early and mid season migrant waterfowl and shorebirds. Most waterfowl will be gone from the project by the end of April, with peak numbers of blue-wings departing in late April. Some blue-wings will remain into May, and some may remain to nest. These sites also will provide a concentrated source of invertebrates for nesting female Mexican Ducks, and it will offer brood-rearing habitat for Mexican Duck broods.

Begin drawdown on one unit in early to late March, complete by mid April to early May. This will provide good habitat for migrant shorebirds, late migrant blue-wing teal, and brood-rearing habitat for Mexican Ducks.

Begin drawdown on another unit in mid to late April, complete by the end of May. This will provide habitat for migrant shorebirds, late migrant blue-winged teal, and brood-rearing Mexican Ducks.

There is no substitute for experience when managing any particular site. What works on one site may not work on another. Waterfowl use should increase over the first few years of the project as birds locate the site and "home in" in following years. The above water regime may be altered to better suit the requirements of the birds, and to accommodate migration events that may vary in any given year. Hence, the site should be inspected weekly and waterfowl and other water bird use noted, estimated, and if possible recorded. In doing so, after a few years, patterns of migration and use may become apparent and the site may be managed to accommodate those needs.

Irrigation of Germinated Plants: The group of plants collectively known as moist soil plants requires exposure of wetland soil for germination. After germination, when seedlings are 1-4 inches in height, the cells should be briefly flash flooded to saturate the soils and keep them moist. This will result in optimal growth of the desirable vegetation.

Given the arid nature of this region with associated high evaporative losses of water from the soil, it will be necessary to flash irrigate the soils monthly, or possibly as much as every two weeks at times. The site manager simply needs to check soil moisture. If it is wet to the touch, or damp just below the soil surface, it is sufficiently moist. If it appears hard, dry, or cracked, it should be flash irrigated as soon as possible.

Periodic irrigation of soils should continue until the area is flooded for waterfowl, or until a killing frost occurs in winter.

Burrow Owl
Athene cunicularia

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