GENERAL REEVALUATION REPORT AND

SUPPLEMENTAL ENVIRONMENTAL

IMPACT STATEMENT II:

RIO GRANDE FLOODWAY,

SAN ACACIA TO BOSQUE DEL APACHE UNIT,

SOCORRO COUNTY, NEW MEXICO

APPENDIX E

Supplemental Fish and Wildlife Coordination Act Report

Rio Grande and Tributaries

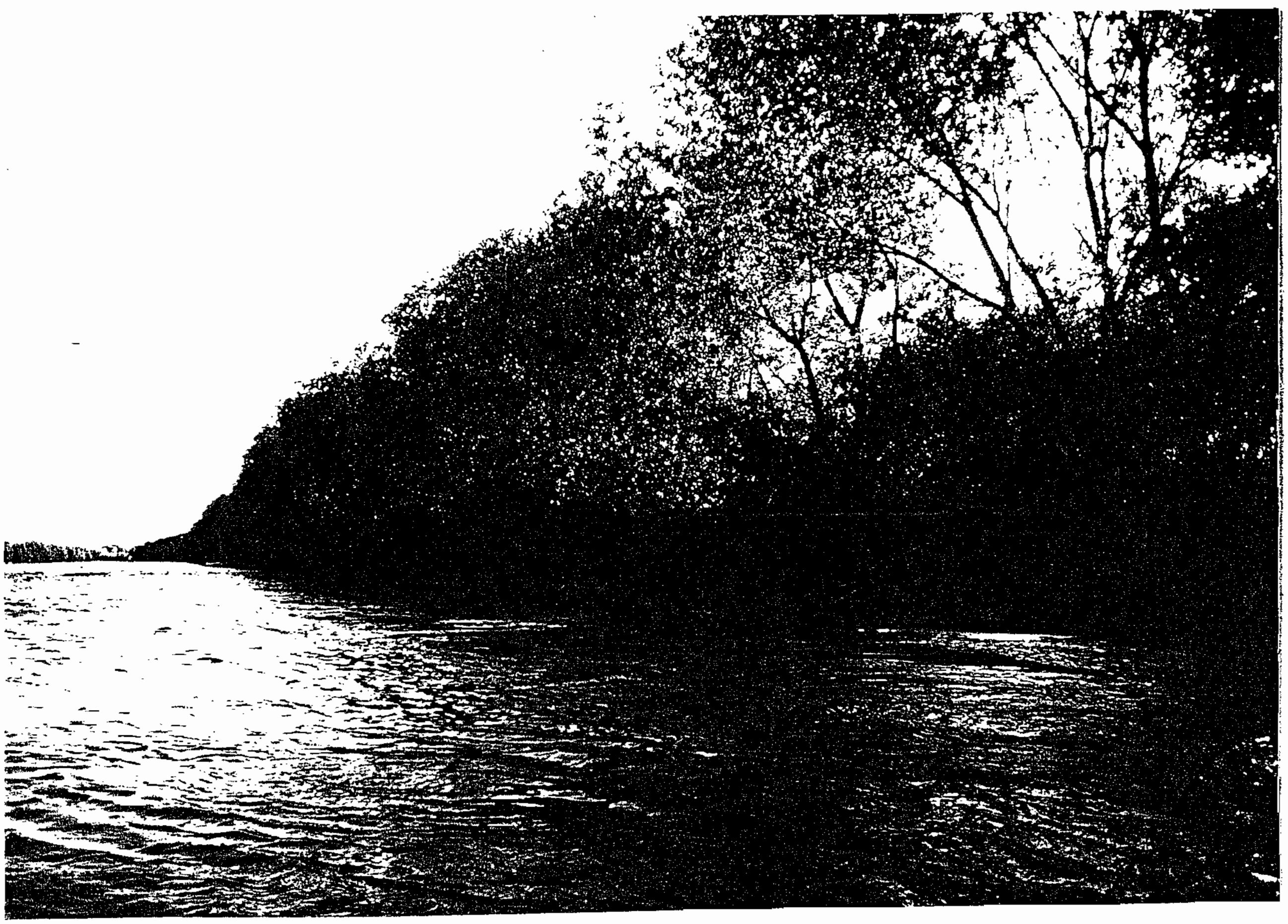
San Acacia to Bosque del Apache Unit, 1997

SUPPLEMENTAL FISH AND WILDLIFE COORDINATION ACT REPORT

RIO GRANDE AND TRIBUTARIES FLOOD CONTROL

SAN ACACIA TO BOSQUE DEL APACHE UNIT

SOCORRO COUNTY, NEW MEXICO



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Supplemental Fish and Wildlife Coordination Act Report

Rio Grande and Tributaries Flood Control

San Acacia to Bosque del Apache Unit

Socorro County, New Mexico

March 1997

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INTRODUCTION

This report supplements and replaces the Final Fish and Wildlife Coordination Act Report for the San Acacia to Bosque del Apache Unit, Rio Grande and Tributaries Flood Control Project, dated November 7, 1989, prepared by the U.S. Fish and Wildlife Service (USFWS 1989a). A supplement is necessary because the proposed project has been modified; two species, the Rio Grande silvery minnow and the southwestern willow flycatcher, have been added to the Federal endangered species list and are present in the project area; and additional biological information for the project area is available. Project modifications include a change in levee design, elimination of about 13 miles (mi) (21 kilometers, km) of proposed levee (downstream of San Marcial, and 3 mi (4.8 km) immediately upstream of the railroad bridge), and a change in levee alignment immediately upstream of the railroad bridge crossing the Rio Grande at San Marcial.

The proposed levee project from San Acacia Diversion Dam to San Marcial is part of the Rio Grande and Tributaries Flood Control Project, a flood control plan for the Rio Grande. The purpose of the project is to provide increased flood protection to floodplain improvements, human welfare and security, water conveyance facilities, and the Bosque del Apache National Wildlife Refuge. The Corps has separated the integral whole of the entire flood control project into three units and is currently constructing the Corrales Unit and planning the Belen Unit of the Rio Grande and Tributaries Flood Control study. A Reevaluation Report (October 1989) and a Supplemental Environmental Impact Statement (July 1992) have been prepared for the San Acacia fraction of the levee system. The Corps will prepare a Limited Reevaluation Report and another Supplemental Environmental Impact Statement.

The U.S. Fish and Wildlife Service (Service) has coordinated with the Corps and provided written comments concerning this project since 1990. The Office of the Secretary, Department of the Interior, provided review comments in a letter dated November 19, 1990. The review of the Draft Supplemental Environmental Impact Statement concluded:

> "... we do not believe the statement, as written, adequately reflects impacts which can be anticipated under the proposed alternative. ... The comments and suggestions we have listed below reflect our findings that the document is inadequate with respect to specific discussions of primary and secondary impacts of construction and operation of the proposed levee."

In summary, the Department of the Interior recommended that the Draft Supplemental Environmental Impact Statement be revised to:

a specify impact areas and quantify all analyses of impacts and effects.
b. correct identified discrepancies of acreage figures for all impacts.
c. commit mitigation efforts to all areas throughout the proposed project area, not just the Bosque del Apache National Wildlife Refuge.
d. discuss the relationship and possible conflicts of the proposed action with increased commitment of resource agencies to conserve and enhance the resources of the Middle Rio Grande corridor.

e. provide adequate information of sufficient detail to the Fish and Wildlife Service for use in determining the compatibility of the proposed project with the purposes for which the Bosque del Apache National Wildlife Refuge was established.

The Service provided comments to the Corps responding to a request for concerns to be addressed in the future Supplemental Environmental Impact Statement. The following statement was included in a Service letter dated June 30, 1995, to the Corps.

> "Numerous meetings occurred prior to the Corps' issuance of the final document; January 5 and September 23, 1991, and January 28, March 20 and July 1, 1992. More recently, field trips with your staff occurred at least four times during 1994; February 29, November 2, November 14 and 28 followed by contacts in 1995; two field trips, January 19 and May 15 and meetings on February 15, May 6, May 15 and June 20. During meetings, field trips and within correspondence, the need for adequate analysis of impacts and the need for further exploration of alternatives was continually stressed. In addition, the severity of the impacts upon the Rio Grande Ecosystem, especially upon aquatic and terrestrial organisms, two of which have been recently listed under the Endangered Species Act, was emphasized. To date, we do not believe that the majority of these comments have been incorporated into the project planning documents with respect to the National Environmental Policy Act, Council on Environmental Quality regulations on cumulative effects, inclusion of cooperating agencies, adequacy of alternative arrays for analysis, and the consideration of the environmental impacts of the proposed action."

In this report, the Service is reviewing the project data again to assess project impacts upon fish and wildlife. Scientific names for plants and animals discussed in this report are found in Appendices A-E.

RIO GRANDE BASIN DESCRIPTION

The Rio Grande is one of the longest rivers in North America. It originates in the southern Rocky Mountains of Colorado, flows the whole length of New Mexico, and forms the entire border between the state of Texas and the Republic of Mexico. This river is the greatest source of permanent water in the desert southwest other than the Colorado River. It is home to the largest cottonwood forest in North America, locally referred to as "bosque." The Rio Grande flows through New Mexico from north to south in the central portion of the State (Figure 1).

Headwaters of the Rio Grande are located along the Continental Divide at elevations ranging from 8,000 to 12,000 feet (ft) (2,440-3,660 meters, m) in the San Juan Mountains of southern Colorado. The entire area of the Rio Grande drainage basin is 181,468 square miles (sq mi) (470,000 sq km), of which about 88,800 sq mi (230,000 sq km) are in the United States and the remainder in Mexico (Hunt 1974). The drainage basin area above Elephant Butte Reservoir is about 29,450 sq mi (76,275 sq km) including 2,940 sq mi (7,615 sq km) in the closed basin of the San Luis Valley in Colorado. The closed basin is now physically connected to the Rio Grande via man made canals. Above Velarde, New Mexico, the drainage basin area is about 10,550 sq mi (27,325 sq km) including the closed basin. The Rio Chama, one of the most important tributaries to the Rio Grande in New Mexico, has its headwaters in the Jemez, Conejos, and San Juan mountains of New Mexico and Colorado. The Middle Rio Grande extends from Cochiti Dam downstream 160 mi (260 km) to San Marcial; this stretch constitutes 8% of the River's total length and 34% of its length in New Mexico. The middle valley's direct drainage accounts for 7% of the total Rio Grande drainage and about half of New Mexico's direct tributary drainage (Bullard and Wells 1992).

Relief is high in headwater regions, and tributary streams characteristically flow through steep canyons. The river has a gradient of about 3 feet per mile (ft/mi) (0.56 m per km, m/km) through the San Luis Valley. Through the Rio Grande Gorge in northern Mexico, river slope ranges from 12 to 138 ft/mi (2.25-28.4 m/km). From Velarde to Cochiti Lake (the downstream end of White Rock Canyon) river gradient is about 10 ft/mi (1.9 m/km). From below Cochiti Dam to Elephant Butte Reservoir, the gradient is about 4 ft/mi (1.2 m/km) (Bullard and Wells 1992).

Geomorphology and Hydrology

Hydrologic characteristics of the Rio Grande Basin, such as infiltration, runoff, and sediment discharge, are dependent on the geology, geomorphic evolution of tributary basins, and late Tertiary and Quaternary geologic and climatic history. Structural geology (such as faults and folds) of a region governs spatial and geometric relations of rock units in that region. Geologic structures and lithology influence the development of topographic features, river and tributary position, and landscape evolution. Tectonic activity can produce measurable effects on channel and sediment transport characteristics (Ouchi 1983, 1985; Schumm 1986).

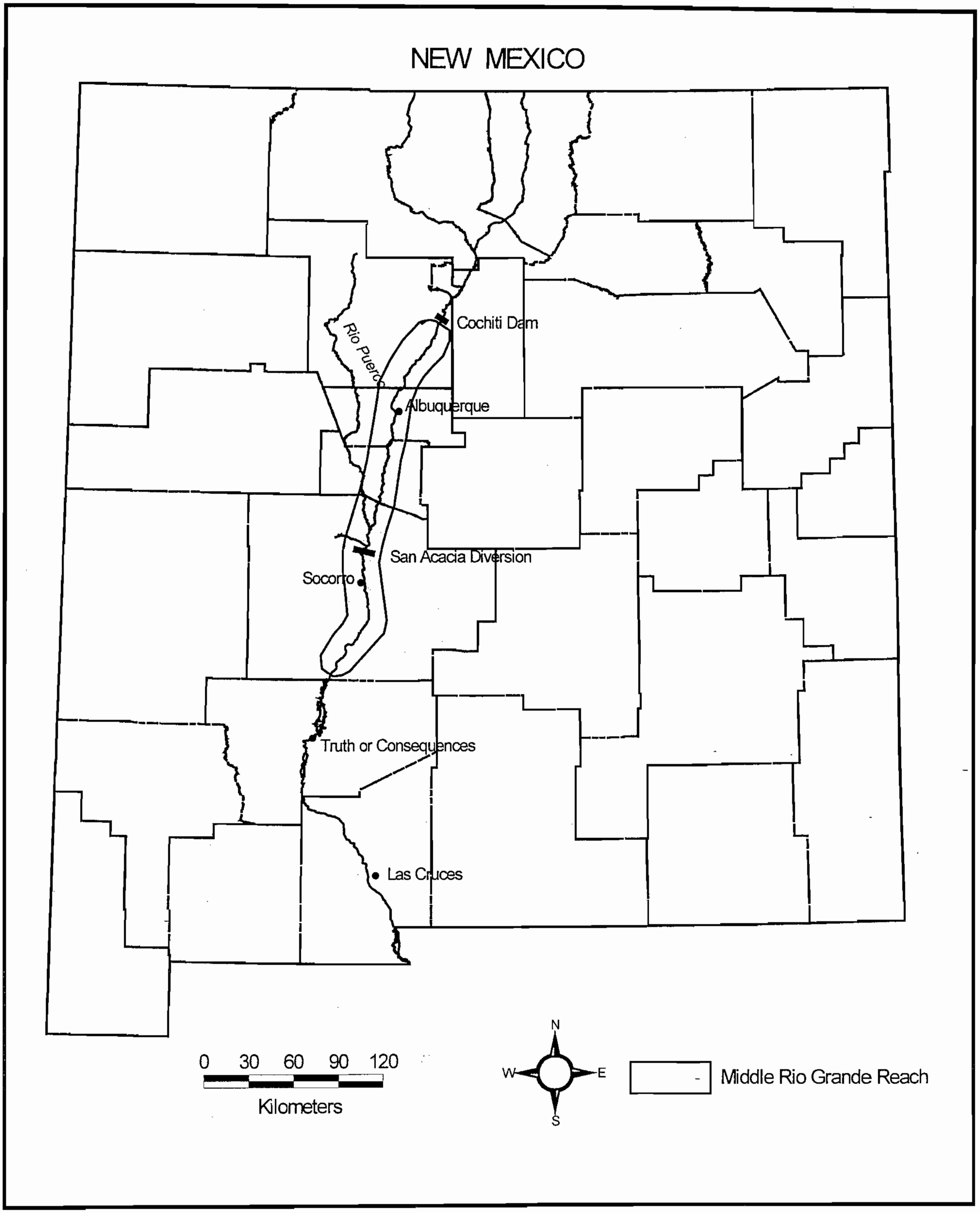


Figure 1. Rio Grande in New Mexico.

The location of the Rio Grande is controlled by the dominant geologic structure of the region, the Rio Grande Rift. The Rio Grande Rift is a linear topographic feature that separates the Great Plains from the Colorado Plateau mountain ranges (Hawley 1978), which can influence weather patterns, and are a direct result of geologic processes. The rift, active for at least 18 million years (Wilkins 1986), is characterized by extension, seismicity, local tectonic uplift, and volcanism (Lozinski et al. 1991).

The Middle Rio Grande valley is actually a series of graben basins. These grabens (depressions) formed a series of linked, but slightly offset, depositional basins, each of which once contained its own ephemeral lake. Over time, the surface water eroded canyons between the intervening bedrock sills that defined the basins, integrating the area into the Rio Grande system (Bullard and Wells 1992). The ancestral Rio Grande developed into a single river about five million years ago (Lozinski et al. 1991). The basins, and their geographic locations in the Middle Rio Grande are:

Santo Domingo Basin	White Rock Canyon to San Felipe
Albuquerque Basin	San Felipe to Isleta
Belen Basin	Isleta to San Acacia
Socorro Basin	San Acacia to San Marcial

The channel of the Rio Grande varies dramatically with geographic location within the river basin. Channel characteristics such as width and sinuosity are strongly influenced by position within the drainage basin and proximity to tributaries that discharge large volumes of sediment into the mainstem.

In all discussions regarding river morphology, it is important to recognize the differences within spatial and temporal scales. To describe a river system in a state of dynamic equilibrium (or energy balance) does not mean that it is static. To the contrary, this equilibrium results from a collection of processes that is by definition predicated on change. For example, even during periods when the entire river system is considered to be in a state of dynamic equilibrium, changes constantly occur in areas as small as the outside bend of a meander, or as large as many river miles (kilometers) upstream and downstream from a tributary inflow. The geomorphic processes triggered in response to a change in magnitude or duration of a variable, will be the same, regardless of the cause (Leopold et al. 1964). The river constantly adjusts to establish a new equilibrium between its discharge and sediment load (Bullard and Wells 1992).

The width of the Rio Grande Valley ranges from less than 656 ft (200 m) in the Rio Grande Gorge to 1 - 6 mi (1.5-10.0 m) from Velarde to Elephant Butte Reservoir, with the exceptions of White Rock Canyon and the San Marcial constriction. Short canyons or narrows also exist at San Felipe, Isleta, and San Acacia at the boundaries of the sub-basins within the Rio Grande Rift. The floodplain of the Rio Grande ranges from 500 ft (150 m) or less in the Rio Grande Gorge to greater than .62 mi (1 km) in the reaches from Velarde to White Rock Canyon and from Cochiti Dam to San Acacia.

The channel is narrowest in the bedrock canyons and widest in the broad alluvial valleys downstream from Bernalillo, New Mexico. Generally, the channel is 195-295 ft (60-90 m) wide, flows on shifting sand and gravel substratum, and has low, poorly defined banks (Lagasse 1980).

Much of the following information is based on the discussion provided by Whitney (1996).

The following channel widths occur within four distinct reaches of the Middle Rio Grande (Crawford et al. 1993):

Cochiti to Angostura		
Floodway width -	230 - 4,720 ft	(70-1,400 m)
Channel width, average -	300 ft	(91 m)
Angostura to Isleta		
Floodway width -	250 - 3,020 ft	(75-920 m)
Channel width, average -	600 ft	(183 m)
Isleta to San Acacia		
Floodway width -	500 - 3,060 ft	(150-930 m)
Channel width -	200 - 1,000 ft	(60-30 m)
San Acacia to San Marcial		
Floodway width -	800-4,900 ft	(245-1,495 m)
Channel width -	100 - 1,000 ft	(30-305 m)

Within the Middle Rio Grande, the active floodplain is largely confined between earthen levees and is cleared for much of its length, especially in urban areas and areas prone to highest aggradation. The floodplain, now defined by levees, contains a mixture of cottonwood, willow, Russian-olive, and salt cedar, which together form a dense growth of riparian woodland (known as bosque) (Lagasse 1981). The remainder of the floodplain defined by the river, but lying exterior to the levees, supports remnants of the bosque, interspersed with pasture, cultivated land, residential and industrial lands. The existing contiguous bosque that abuts the Rio Grande is generally limited by the system of levees or natural bluffs where such features are present. In the southern half of the valley where the bosque is widest, the bosque is 2.5 to 3 mi (4-5 km) wide (Crawford et al. 1993). Comparison of active floodplain areas before mans' influence, to the current active floodplain, shows a reduction of 85 percent (216,021 to 34,361 ac [87,424 to 13,906 ha]) in the Middle Rio Grande.

The Middle Rio Grande is slightly sinuous with straight, meandering, and braided reaches. The river is generally characterized by a shifting sand substrate in the lower reaches and by a gravel riverbed in the river downstream of Cochiti Dam. The slope of the river bed decreases from north to south, and tributary contributions of water and sediment are important in defining the river's local and overall morphology. Although considered a perennial river, there are reaches of the Rio Grande that experience no surface flow during some summer months in dry climatic periods (Crawford et al. 1993). The formation of sediment bars in the channel during low-flow periods and, in particular, during the recession of flood flows, together with rapid growth of vegetation, generally determine the channel configuration within the levees. In some places the active floodway is undefined. In these areas, the channel has virtually no banks, and the bed of the river is at or above the surface of lands outside the levees due to sediment deposition between the levees. Braided, meandering patterns are especially common downstream from major sediment-supplying tributaries such as the Rio Puerco and the Rio Salado and other small, unregulated, high-sediment-discharge tributaries in the reach below Cochiti Dam (Bullard and Wells 1992).

Suspended sediment loads for the Rio Grande and tributaries are variable. These are regulated to a certain degree by flood and sediment control structures, particularly in the regions above Albuquerque. Tributaries, however, can be major contributors of sediment to the Rio Grande. An increase in sediment supplied to the Rio Grande can have dramatic effects on river behavior and geomorphology both upstream and downstream of the site of input (Schumm 1977, Lagasse 1980 and 1981).

Based upon data reviewed by Bullard and Wells (1992), the Rio Puerco, which has half the drainage area of the Rio Chama and the Jemez River, contributes far more sediment. This is attributed to the dams on the Rio Chama and Jemez River. However, this conclusion may be faulty since the characters, including soils, elevation, and vegetative ground cover of the respective watersheds are not similar. Flow regimes are also very dissimilar; the Rio Chama is perennial, while the Jemez River ceases to flow for short periods and the Rio Puerco lacks discharge of water or sediment for most days of the year (Heath 1983). Approximately 82 percent of the sediment transported by the Rio Puerco occurs during events that recur about once per year (Leopold et al. 1964).

<u>Rio Grande Discharges</u>

Peak discharges occur from late spring snow melt and rainstorms. Summer convective storms produce runoff in isolated parts of the basin, which may increase the discharge for brief periods. The majority of the discharge in the Rio Grande comes from the headwaters of the Rio Grande in Colorado and from the Rio Chama, which joins the Rio Grande 35 mi (56 km) north of Cochiti Lake. The Rio Chama usually maintains a perennial discharge because of the San Juan-Chama transmountain diversion, a large watershed, and dams along the Rio Chama and its tributaries (U.S. Bureau of Reclamation 1981). Average annual discharge for the Rio Grande into the Gulf of Mexico is about 9,000,000 acre-feet (af) (1,107,000 hectare meters, ha-m) (Hunt 1974). The annual runoff in headwater regions ranges from 215,000 to 1,100,000 af (26,445 to 135,300 ha-m) with an average of 660,000 af (81,180 ha-m) (U.S. Army Corps of Engineers 1989).

Water flow amounts in the river vary seasonally, with spring snow melt runoff and summer/fall precipitation. Flows are generally low during the fall and winter, with the mean (1895-1991) flow of 900 cubic feet per second (cfs) (25.475 cubic meters per second, cms) from August through February (Otowi gauge above Cochiti Lake). Mean monthly flows (1895-1991) for the remainder of the year (Crawford et al. 1993) were:

March -	1,200 cfs (33.97 cms)
April -	2,300 cfs (65.10 cms)
May -	4,200 cfs (118.88 cms)
June -	3,300 cfs (93.41 cms)
July -	1,300 cfs (36.78 cms)

Water flows also fluctuate between years. Total annual flow at the Otowi gauge from 1895 to 1989 ranged from 400,000 af (49,200 ha-m) to above 2,600,000 af (319,800 ha-m). Generally, low runoff years are about 400,000 af (49,200 ha-m) with high runoff years averaging 1,500,000 af (184,500 ha-m). Most runoff years appear to be around 800,000 af (98,400 ha-m) (Allen et al. 1993). The Otowi gauge on the Rio Grande measures natural runoff from the Rio Grande drainage plus flows from the Rio Chama. Flows in the Rio Chama are regulated by Heron, El Vado, and Abiquiu dams.

All water in the Rio Grande water is appropriated. Releases from upstream reservoirs, under non-flood conditions, are regulated to make reservoir outflows equal to inflows in order to meet water demands. Irrigation accounts for about 90% of demands, however, water diverted for agricultural purposes is not fully utilized. About 67% of all diverted water does not reach farmlands. This water consists of transportation losses (spills, seepage losses to unlined canals), evapotranspiration, and groundwater recharge. About 45% of all water diverted eventually returns to the river. About 33% of water diverted reaches the farms; crops use about 55% of this amount (or about 20% of the total diverted from the river). About 35% of the total diverted water is lost to evapotranspiration or groundwater recharge (U.S. Army Corps of Engineers 1979).

Historic Water Management and Flood Control

Prior to measurable human influence on the system, up to the 14th century (Biella and Chapman 1977), the river was a perennially flowing, aggrading river with a shifting sand substrate. Its pattern was, as a rule, braided and slightly sinuous. The river would freely migrate across the floodplain, the extent being limited only by the valley terraces and bedrock outcroppings. The Rio Grande's bed would aggrade over time; then, in response to a hydrologic event or series of events, it would leave its elevated channel and establish a new course at a lower elevation in the valley. This process is called river avulsion (Leopold et al. 1964). Although an aggrading system, the Rio Grande was in a state of dynamic equilibrium, providing periods of stability that allowed riparian vegetation to become established on river bends and islands alternating with periods of instability (e.g., extreme flooding) that provided, by erosion and deposition, new locations for riparian vegetation.

The earliest phase of significant water development activities (from about A.D. 1400 through the early part of this century) progressively decreased river flows as irrigated agriculture increased. More influential on the morphology of the river, however, was the increased sediment deposition into the ecosystem resulting from land-use activities in the watershed. When coupled with natural climatic variability, the net effect was to accelerate the aggradation of the river bed and, accordingly, the frequency of overbank flooding and points of river avulsion. The channel configuration, while still braided and sinuous, began to broaden and became shallower. The increasing rapidity of channel movement caused riverbanks and islands to become unstable. This may have, together with decreasing water holding capabilities of the uplands, contributed to an increased frequency of floods. Between 1822 and 1941, a total of 46 moderate floods was recorded along the reach (Crawford et al. 1993). During nonflood periods, diminished river flows caused the active channel to retreat to fewer, narrower channels within the wide and shallow sandy river bed.

As human settlement and irrigated agriculture expanded in the middle valley and in the upper Rio Grande Basin, more irrigation water was diverted from the river reducing total river discharges and altering the periodicity of yearly flows. The further downstream one proceeded in the system, the less water there was. Prior to the construction of storage and flood control facilities, diversions from the Rio Grande and some of its tributaries were limited to the growing season. Other seasonal flows, peak runoff, and precipitation flows were not affected. By 1913, storage reservoirs in the headwaters of the Rio Grande had been built, and in 1935 the Middle Rio Grande Conservancy District completed El Vado Reservoir on the Rio Chama (Shupe and Folk-Williams 1988). These facilities began to reduce peak discharges during high river discharges and increased the duration of lower flows. The expansion of these reservoirs and the addition of the flood and sediment control dams and reservoirs further accentuated this trend.

Other water management facilities have influenced the hydrology of the Middle Rio Grande. The 75 mi (121 km) long Low Flow Conveyance Channel (LFC Channel), its downstream half operational in 1954 and its full length completed in 1959, had the capability of reducing flows in the Rio Grande downstream from its diversion at San Acacia Diversion Dam. The San Juan-Chama Project, completed in 1971, imports up to 110,000 af (13,530 ha-m) of San Juan River water from the Colorado River Basin to the Rio Chama/Rio Grande basins, 69,100 af (8,499 ha-m) of which is delivered to or through the middle valley. One of the effects of this importation has been to slightly increase mean daily flows. In addition, the City of Albuquerque's annual treated wastewater discharge into the Rio Grande is currently about 60,000 af (7,380 ha-m) (R.Hogrefe, pers. comm. in Crawford et al. 1993).

During the next phase of human interaction with the river, from the mid-1920's through 1950, a system of levees was constructed to constrain the river to a single floodway through portions of the middle valley. Concurrently, water diversions in the middle valley and upstream in the Rio Grande Basin increased. This had the net effect of further accelerating channel aggradation, especially in those areas where levees concentrated the deposition of sediment in the floodway (Crawford et al. 1993).

Beginning in the early 1950s, sediment and flood control structures constructed in the upper portion of the Middle Rio Grande valley reversed channel aggradation in the Cochiti and Albuquerque reaches. The lowering river bed is resulting in a more incised and sinuous single-channel river. This process becomes less pronounced with downstream distance from Cochiti and Jemez Dams. Adequate flows are not available to transport the sediment. Sediment deltas are more persistent, reducing river gradient upstream (tending to increase aggradation) and increase the gradient downstream (tending to reduce aggradation) (Crawford et al. 1993). This process is especially evident in the Rio Grande downstream of the Rio Puerco and Rio Salado watersheds.

Beginning in 1953, the U.S. Bureau of Reclamation (Bureau) and the Corps initiated projects to control sediment, drainage, flooding and provide a more secure and stable water supply. To safely pass high flows and move sediments, the Bureau employs bank stabilization, river training (pilot channels and dikes), sediment removal, and vegetation clearing. Within the stabilized floodway, reaches of the Middle Rio Grande have been straightened, the irregularity of the channel width has been reduced, and the riverbanks have been stabilized (Whitney 1996). To provide flood protection, water supply (agriculture and municipal), and recreation, the Corps and Bureau built and operate several dams on the Rio Grande (Cochiti and Elephant Butte) and Rio Chama (El Vado and Abiquiu). The Corps constructed Jemez Dam on the Jemez River, and Galisteo Dam on Galisteo Creek, both tributaries to the Rio Grande upstream of Albuquerque, to control sediment input to the Rio Grande and provide flood control. Heron Reservoir, constructed and operated by the Bureau, provides water to the Rio Chama through a trans-basin diversion project, the San Juan-Chama Project (Bullard and Wells 1992).

Current Water Management and Flood Control

Water management in the Rio Grande is governed by the Rio Grande Compact, treaty obligations with Mexico, reservoir legislation, and flood protection legislation and various other Federal and State laws. The present operating plan for water management in the Rio Grande in New Mexico is presented in a July 1989 document entitled "Reevaluation of the Rio Grande Operating Plan" (U.S. Army Corps of Engineers 1989).

Water management within the Middle Rio Grande Valley is affected by numerous developments and activities within the valley itself, by the interconnected operation of facilities in the tributaries to the Rio Grande, and by the importation of water from other basins. Because of this interconnectedness, a brief discussion of the facilities and operations that interact with the extensive levee system, of which the San Acacia to Bosque del Apache Unit is only a portion, is presented below.

In 1962, Congress authorized the transbasin diversion of San Juan basin water in an amount that would provide a firm yield of 94,000 af (11,562 ha-m) to Rio Grande users for irrigation, domestic, industrial, recreational, fish, and wildlife purposes. The San Juan-Chama Project began diversion of flow from three streams in the San Juan River headwaters in 1970. The water is carried in tunnels through the Continental Divide, and is discharged into Willow Creek, a tributary of the Rio Chama. Willow Creek flows into Heron Reservoir, a 400,000 af (49,200 ha-m) facility constructed and operated by the Bureau to store project waters only. Within existing legal constraints, no water natural to the Rio Chama can be stored at Heron. The Bureau then releases transbasin diversion water in response to demands of users who have contracts for project deliveries.

Jemez Canyon Dam was the first flood control dam built as part of the Middle Rio Grande Project authorized by the Flood Control Act of 1948. Completed by the Corps in 1953, the dam is used to regulate summer floods and also traps sediment that would otherwise be transported downstream. Jemez Reservoir has a storage capacity of 113,100 af (13,911 ha-m). The reservoir is evacuated as quickly as possible since the entire flood storage capacity of this small facility is potentially needed to control subsequent thunderstorm events. In 1979 the Interstate Stream Commission provided water to establish a 2,000 af (246 ha-m) permanent pool at Jemez in order to facilitate sediment capture. In recent years, the Interstate Stream Commission maintained a pool of 24,000 af (2952 ha-m), using flood water and San Juan-Chama water from the City of Albuquerque, primarily for sediment trapping.

The construction of Abiquiu Dam was completed by the Corps in 1963. The reservoir has a potential storage capacity of more than 1.2 million af (147,600 ha-m). This dam is the primary flood control structure on the Rio Chama. In 1981, Congress authorized the use of Abiquiu Reservoir for storage of San Juan-Chama Project water. The City of Albuquerque uses most of the 200,000 af (24,600 ha-m) of authorized storage capacity. The cities of Santa Fe and Taos, the Department of Energy, and other San Juan-Chama contractors utilize the remainder. Approximately half of the remaining one million af of remaining storage capacity is used to store and control flood waters. The unoccupied 500,000 af (61,500 ha-m) of capacity is designated for structure protection.

Cochiti Dam and Lake, and the much smaller Galisteo Dam on a tributary to the Rio Grande, were authorized by the Flood Control Act of 1960 (P.L. 86-645), 12 years following the first legislation of 1948. Galisteo Dam was completed by the Corps in 1970 to control summer flooding and sediment transport from Galisteo Creek to the Rio Grande. Galisteo Dam is located approximately 12 mi (20.3 km) upstream from the confluence with the Rio Grande. The reservoir holds water only during flood flows, and empties as soon as the water can flow through the dam's uncontrolled outlet. About 79,600 af (97,908 ha-m) of storage capacity is dedicated to flood control, 9,400 af (1156 ha-m) is used for sediment storage.

Cochiti Dam was completed in 1975 as a mainstem flood control structure. Operated by the Corps, Cochiti is the primary flood control structure on the mainstem of the Middle Rio Grande. Although the primary purpose, under the 1960 authorizing legislation, is flood control, in 1964, Congress also authorized the storage of San Juan-Chama water in Cochiti to establish and maintain a 1,200 surface acre (ac) (486 hectares [ha]) recreational pool. By P.L. 88-293, Congress authorized the Secretary of the Interior to make water available for a permanent pool for fish and wildlife and recreation purposes at the reservoir. The Act authorized approximately 50,000 af (6,150 ha-m) for the initial filling of the permanent pool and sufficient water annually to offset evaporation losses. This pool takes up about 47,000 af (5,781 ha-m) of storage, with the remaining 539,000 af (66,297 ha-m) of capacity dedicated to flood control.

The Corps operates Cochiti Dam and Lake, in accordance with procedures in P.L. 86-645, as follows:

- The outflow from Cochiti Lake during each spring flood and thereafter will be at the maximum nondamaging rate of flow that can be carried at the time in the channel of the Rio Grande through the middle valley: provided, that whenever during the months of July, August, September, and October, there is more than 212,000 af (26,076 ha-m) available within the reservoir for flood regulation and the inflow to the reservoir (exclusive of releases from upstream flood control storage) is less than 1,500 cfs (42.46 cms), no water will be withdrawn from storage within the reservoir and the releases from upstream flood control storage will be retained in the reservoir.

- Storage of water in and the release of water from the reservoir will be accomplished for flood and sediment control: provided, that the Corps of Engineers will endeavor to avoid encroachment on the upper 212,000 af (26,076 ha-m) of capacity in Cochiti Lake, and that all reservoirs in the Middle Rio Grande project will be evacuated on or before March 31 of each year.

- All reservoirs of the Middle Rio Grande project (including Cochiti) will be operated at all times in the manner described in conformity with the Rio Grande Compact Commission, and no departure from the operation schedule set forth in the Act will be made except with the advice and consent of the Rio Grande Compact Commission, provided, that whenever the Corps of Engineers determines that an emergency exists affecting the safety of major structures or endangering life and shall advise the Rio Grande Compact Commission in writing these rules of operation may be suspended during the period of and to the extent required by the emergency.

In accordance with the above criteria, flood waters are stored and regulated releases are made from the reservoir during the period April 1 through June 30. If, after this period, there is at least 212,000 af (26,076 ha-m) of storage available within the reservoir and river flows are less than 1,500 cfs (42.46 cms) at the Otowi gauge, flood water will be carried over until November 1 when these waters will be evacuated such that on March 31, all flood control storage (442,000 af, 54,366 ha-m) is available within the reservoir of the following year. Any departure from the criteria set forth in P.L. 86-645 is prohibited. Modification to the operation schedules can be made with the advice and consent of the Rio Grande Compact Commission.

Completed by the Bureau in 1971, Heron Reservoir stores only imported San Juan-Chama Project water and releases it in accordance with requests from entities who have contracted with the Bureau for its delivery. Water levels in the reservoir have generally been maintained at or near the 400,000 af (49,200 ha-m) capacity. The Bureau is authorized to divert an average of 110,000 af (13,530 ha-m) per year in order to replenish reservoir storage and to meet project requirements. The Bureau requires that contractors for project water must accept delivery of their water by December 31 of each year. Users are not entitled to carryover storage in Heron Reservoir. This constraint led to the release of large flows down the Rio Chama at the close of each year as users took delivery of their contracted water. Such releases and their subsequent effects on the fishery resources of the Rio Chama led to negotiations between the Bureau and the Service. With the concurrence of project water use contractors, the Bureau has, on a year-to-year basis, extended the December delivery deadline to March and April to permit Heron Reservoir releases for fish enhancement during the winter months.

El Vado Dam was constructed in 1935 by the Middle Rio Grande Conservancy District. Its storage capacity of 186,000 af (22,878 ha-m) has been used primarily to store Rio Chama spring flows for summer release to irrigators in the Middle Rio Grande Valley. The reservoir also provides storage for San Juan-Chama water contractors. Storage and delivery of water for six Pueblos in the middle valley is also provided at El Vado. The Bureau assumed responsibility for operations of El Vado Dam in 1956.

In addition to large dams, other structures affect water flow in the Rio Grande. Three diversion dams used for irrigation, are located downstream of Cochiti Dam: Angostura, Isleta, and San Acacia (Figure 2). The Middle Rio Grande Conservancy District constructed riverside drains along the Rio Grande to intercept shallow groundwater to convey to the river for water conservation and to dry adjacent wet areas for agricultural or residential use. The Soil Conservation Service (now the Natural Resources Conservation Service) and the Albuquerque Metropolitan Flood Control Authority have constructed detention dams on intermittent tributaries of the Rio Grande and constructed channels to convey water to the river to regulate sediment and high flow event inputs into the Rio Grande.

Figure 2. San Acacia Dam Looking Downstream, 1995.

The Bureau has the responsibility to develop and implement a plan for flood control and water conservation in the Rio Grande basin for 286 mi (460 km) from Velarde downstream to Caballo Dam. In addition to operation of Elephant Butte and Caballo dams, the Bureau develops and maintains a river maintenance program (U.S. Bureau of Reclamation 1993). The program goals are to efficiently deliver water to Texas and Mexico by transporting water to Elephant Butte Reservoir, conserve surface and groundwater, reduce aggradation in the Rio Grande, and effect floodway maintenance. River maintenance includes:

- Bank stabilization (riprap, gabions, windrows, stabilized soil, revetment units, confinement systems, jetty jacks)
- River training works (groins, dikes, pilot channels, vanes)
- Sediment removal (arroyo plugs, island and bar removal)
- Vegetation control to maintain flow capacity (mowing, rootplowing, spraying)
- Snag removal
- Levee maintenance

The LFC Channel (75 mi, 121 km) was built between 1951 and 1959 to reduce water losses through infiltration, evaporation and plant transpiration. For the past 10 years, water has not been diverted into the LFC Channel at the San Acacia Diversion Dam because of channel sedimentation at Elephant Butte Reservoir. In this river reach, from San Acacia Diversion Dam downstream to Elephant Butte Reservoir, the Bureau maintains the levee to protect the LFC Channel from higher river flows. This is the levee under consideration by the Corps for rehabilitation. The Bureau maintains protection up to 8,500 cfs (240.60 cms). The 75 mi (121 km) channel has been reduced to 54 mi (89 km) because of reservoir inundation in the lower 11 mi (18 km) of channel. In 1993 the Bureau estimated 2,000,000 cubic yards (1,680,000 cubic meters) of sand would have to be removed from the LFC Channel to restore the lower 10 mi (16 km) of the facility (U.S. Bureau of Reclamation 1993).

In response to the maintenance needs of the channel, the Bureau, with the cooperation of the New Mexico Interstate Stream Commission, has initiated a comprehensive study to evaluate its management of the Rio Grande Floodway and LFC Channel system between San Acacia and Elephant Butte Reservoir (U.S. Bureau of Reclamation 1995). The goals of the study (draft document) are:

- Conserve water by reducing conveyance losses
- Maintain system elements for effective valley drainage
- Protect endangered species
- Minimize environmental impacts and maximize benefits
- Minimize operation and maintenance

Basic evaluation criteria for alternative formulation include:

- Water conveyance efficiency
- Water salvage benefits
- Effect on sediment transport and deposition
- Environmental costs and benefits

- Effect on endangered species
- Effect on storage capacity at Elephant Butte Reservoir
- Cost for construction, operation, and maintenance
- Consistency with existing law and policy
- Effects on water quality

Vegetation Changes

The removal and change in the native riparian forest, river manipulation, hunting, trapping, livestock grazing, and introduction of exotic species (plants and animals) have impacted the vegetation and historic abundance and diversity of fish and wildlife (Crawford et al. 1993). Human development and use of the floodplain have greatly restricted the active floodplain width. Within the Middle Rio Grande reach, 234.6 mi (378 km) of levees (includes distances on both sides of the river) occur. Analysis of aerial photography taken by the Bureau February 1992 shows that of the 180 mi (290 km) of river, only 1 mile (1.6 km), or 0.6 percent of the floodplain has remained undeveloped. Woody vegetation, especially trees, was important as fuel for heating homes in the 1800s, resulting in little vegetation remaining near settlements (Abert 1962). Since then, vegetation species composition and abundance have changed in response to both natural and anthropogenic factors.

Vegetation surveys in 1981 and 1982 from Velarde to San Acacia Diversion Dam (Hink and Ohmart 1984) found an abundance of cottonwood/juniper vegetation at the northern end and an abundance of salt cedar vegetation at the southern end of the reach. Comparison of vegetation along the Rio Grande, from Velarde to San Acacia Diversion Dam, between 1918 and 1982 showed little difference in riparian forest acreage (Hink and Ohmart 1984). However, the forest in 1918 occurred in broad patches and was less continuous than the 1982 vegetation distribution. The riparian forest species composition did change with the replacement of cottonwood and willow by salt cedar in the lowest-most areas. Areas classified as "marsh" have shown a dramatic change during the 64-year period; 87% of the marsh disappeared. In addition, wet meadow habitat, which was the dominant vegetation mapped in 1918, has been converted to cropland, with only 232 ac (94 ha) mapped in 1982.

The most dramatic changes in vegetation composition along the Rio Grande have been the reduction of wet areas, and the increase in exotic vegetation, primarily salt cedar and Russian olive. Both plants were introduced into New Mexico in the early 1900s. By 1935, both plants were common in the Rio Grande Valley.

The changes in land use in the Middle Rio Grande (Cochiti Dam to Elephant Butte Reservoir) from 1935 to 1989 are addressed in Crawford et al. 1993. Land use and vegetation were compared using the following cover types:

River or man-made channel (we will use river to describe this type)
Forest
Scrub-shrub
Lake, wet meadow, marsh or pond (we will use wetland to describe this type)
Urban
Range
Agriculture

Significant reductions occurred in the cover types of river, scrub-shrub, wetland, and range. The urban, agriculture, and forest cover types increased. The Middle Rio Grande can be divided in four parts, from north to south.

Cochiti Reach
The cover types of river, scrub-shrub, wetland experienced significant reductions. Forest, and urban cover types increased.

Albuquerque Reach
The cover types of river, scrub-shrub, wetland, range, and agriculture experienced significant reductions. The urban cover type showed a huge increase in size, from 5,278 to 21,752 ac (2,136 to 8,803 ha).

Belen Reach
The cover types of river, scrub-shrub, wetland, and range experienced significant reductions. The agriculture type increased in size by 21 percent.

Socorro Reach
The cover types of river, forest, and wetland experienced significant reductions. Only the cover type urban experienced a large increase.

Fish and Wildlife Changes
Historically, 27 fish species occupied the Rio Grande (Sublette et al. 1990). Many fish species have disappeared completely from the drainage, including the American eel, longnose gar, shovelnose sturgeon, gray redhorse, blue sucker, freshwater drum, speckled chub, Rio Grande shiner, phantom shiner, and Rio Grande bluntnose shiner (Sublette et al. 1990). The Rio Grande silvery minnow, now federally listed as endangered, is rare and now only occupies 5% of it's former range (USFWS 1994).

Terrestrial species that have been extirpated from the Rio Grande include the gray wolf, jaguar, grizzly bear, river otter, and mink (Hink and Ohmart 1984). Other species that may have been plentiful, but are now absent or rare are swans, and loons (Abert 1962).

Surveys in 1981 and 1982, documented 277 bird species (Hink and Ohmart 1984) and 259 species were documented in 1992 and 1993 (Thompson et al. 1994). Bird species occurrence and abundance have changed with habitat changes. The southwestern willow flycatcher occupies the bosque on the Rio Grande in reduced numbers and is federally listed as endangered. Twelve bird species are declining with 14 species increasing. The declining species are associated with riparian areas and the increasing species are associated with agriculture areas (Thompson et al. 1994).

PROJECT DESCRIPTION

The need for water resource and related land use development in New Mexico was identified by Congress beginning with Public Law No. 228, 77th Congress, dated August 18, 1941.

> "The Secretary of War is hereby authorized and directed to cause preliminary examinations and surveys for flood control... Rio Grande and tributaries, New Mexico."

The Flood Control Act of 1948, (Public Law 80-858, Section 203) approved the San Acacia to Bosque del Apache Unit, by "approving" a plan submitted by the Chief of Engineers (House document no. 243, 81st Congress, 1st session, dated April 5, 1948).

Additional legislation concerning the Rio Grande basin, with increased emphasis near Albuquerque, and the Rio Grande between Los Lunas and Belen occurred August 2, 1950; June 11, 1952; and June 28, 1956. A House of Representatives Resolution, dated April 11, 1974, directed a review of the Rio Grande and tributaries as follows:

> "...with a particular reference to providing a plan for development, utilization and conservation of water and related land resources of "the metropolitan planning activities in the six county area, consisting Santa Fe, Sandoval, Bernalillo, Valencia, Socorro, and Sierra Counties." Such studies to include appropriate consideration of the needs for protection against floods with particular emphasis on the levee system of the Middle Rio Grande Conservancy District, wise use of the Middle Rio Grande Conservancy District, wise use of flood-plain lands, regional water supply and waste management facilities system, general recreation facilities, enhancement and control of water quality, enhancement and conservation of fish and wildlife and other measures for environmental enhancement, economics and human resources development..."

Investigations by the Corps after the 1974 authorization narrowed the potential project area for levee work to the Rio Grande from Bernalillo to Belen and the San Acacia Diversion Dam to Elephant Butte Reservoir reach. The Corps produced an April 1986 document entitled "Middle Rio Grande Flood Protection, Bernalillo to Belen, NM." Since the 1986 document, the Corps has divided the project into two units; Corrales Unit and the Belen East and West Unit. The Corps completed a Limited Reevaluation Report for the Corrales Unit, August 1994, followed by a final environmental impact statement April 1995. Plans for the Belen East and West Unit have not been updated since 1986 but studies are in progress for its rehabilitation.

The Corps continued studies of the San Acacia Unit, producing many reports since the original report of April 5, 1948, including:

- Decision Document, San Acacia to Bosque del Apache, NM (March 1988)
- Reevaluation Report, San Acacia to Bosque del Apache, NM (October 1989)
- Final Supplemental Environmental Impact Statement, Rio Grande Floodway, San Acacia to Bosque del Apache Unit, Socorro County, NM (July 1992)

The following description of the San Acacia to Bosque del Apache Unit Levee proposal is based on information provided by the Corps in the above listed documents with limited updated information provided in an October 19, 1995, biological assessment and an amended biological assessment dated March 26, 1996. The Corps preferred alternative is to reconstruct 42 mi (68 km) of earthen levees on the west bank of the Rio Grande from San Acacia Diversion Dam downstream to a point 13,000 ft (3,962 m) north of the railroad bridge at San Marcial. The constructed levees would replace the current levees now maintained by the Bureau and would provide flood protection for the 1% chance flood (100 year flood) for high magnitude/short duration and low magnitude/long duration flows in the Rio Grande (Figure 3). The proposed levees would contain a 51,000 cfs (1,443.58 cms) flow at the San Acacia Diversion Dam decreasing to 39,000 cfs (1,103.91 cms) at the San Marcial railroad bridge. The LFC Channel would be protected except for the lowermost 14 mi (22.5 km). Agricultural land and some residences would also be protected.

Figure 3. The Current Levee Protects the LFC Channel (right side of photo).

Material for the levees would originate from the existing levee and supplemental borrow areas. The majority of the fill requirements, 1,886,400 cubic feet (53,385 cubic meters), can be obtained from the existing levee. Extensive borrow areas will be required. The levee alignment would be to the west of the railroad tracks for the first 4,500 ft (1,368 m) of levee below the San Acacia Diversion Dam, and then to the east of the tracks downstream to Tiffany. Downstream of Tiffany, the railroad tracks would not be protected from flood. The levee alignment would follow the existing levee from 4,500 ft (1,368 m) below San Acacia Diversion Dam down to Tiffany. The lowest-most levee improvement would tie into the existing western escarpment of the floodplain at Tiffany.

For the first 4,500 ft (1,368 m) of levee, the levee would consist of a concrete wall and protective soil cement. The remainder of the levee would be designed with a 15 foot (4.6 m) wide gravel road on the crest, a height of 15 ft (4.6 m) and a base width of 90 to 105 ft (27-32 m). An additional 15 ft (4.6 m) at the toe of the levee would also be cleared. The landward toe of the proposed levee would be at least 42 ft (12.8 m) from the eastern edge of the low flow channel. Within the levee, a bentonite slurry core would protect the levee during long duration flows. In addition, an internal drainage blanket would direct seepage to the LFC Channel through 8-inch (203 millimeters) perforated PVC pipes.

EVALUATION METHODOLOGY

Field reconnaissance of the project area was conducted on numerous occasions by personnel from the New Mexico Ecological Services Field Office. Site visits occurred on February 29, 1994; November 2, 14, 28, 1994; January 19 and October 25, 1995, and over a dozen trips in 1996 and 1997. Biological data and background information were also derived from a review of relevant literature. The Corps provided information on project features, and construction methods.

VEGETATION, TERRESTRIAL RESOURCES, AQUATIC RESOURCES IN THE RIO GRANDE BASIN

Vegetation

The Rio Grande basin lies in five physiographic provinces: Coastal Plain, Great Plains, Basin and Range, Colorado Plateau, and the Southern Rocky Mountains (Hunt 1974). The Middle Rio Grande and its tributaries that form the project area for this analysis are located within the latter three provinces (Crawford et al. 1993).

Human populations have increased dramatically along the Rio Grande since European settlement. Irrigation, domestic water consumption, agriculture, development of urban centers, livestock grazing, and recreation have changed the Rio Grande ecosystem by altering flood cycles, channel geomorphology, watershed processes, and water quality and quantity. These alterations of abiotic factors have influenced the biological diversity and ecological functions of the Middle Rio Grande, changing the distribution, structure, and composition of riparian plant and animal communities.

The Middle Rio Grande riparian forest, represents the largest cottonwood gallery riparian forest in the southwestern United States. The valley traverses three major biotic communities: 1) Plains and Great Basin Grassland, 2) Semidesert Grassland and 3) Chihuahuan Desertscrub (Brown and Lowe 1980). The Rio Grande is regulated for water supply (primarily irrigation) and flood control, and that regulation has contributed to the character of the riparian ecosystem in its current expression.

This discussion will summarize the dominant cover types as identified in 1989 within each of the four reaches from Cochiti Dam downstream to Elephant Butte Reservoir (Crawford et al. 1993).

Cochiti Reach

The dominant cover types in order of decreasing size were range, agriculture, and forest, comprising 78 percent of the total area mapped. The smallest areas, from smallest to largest, was wetland, scrub-shrub and urban.

Albuquerque Reach

The urban cover type dominated this reach, with 45 percent of the total floodplain area identified. Agriculture represented 24 percent, with forest and range closely following. Scrub-shrub was the smallest identified area, 3 percent.

Belen Reach

The cover type of agriculture dominates this reach, 46 percent. The cover types of urban, range, forest, and scrub-shrub were common. Wetland was the smallest land area identified, one percent.

Socorro Reach
This reach essentially maps the proposed project area for the San Acacia to Bosque del Apache Unit levee construction. The dominant cover types in the floodplain were scrub-shrub, agriculture, and range. The urban cover type represents the smallest cover type.

The majority of the riparian zone along the Middle Rio Grande is dominated by cottonwood trees, which form a sparse to dense canopy cover along the river. In the understory, native species include coyote willow, seepwillow, false indigo bush, New Mexico olive, and others. Introduced species have become increasingly abundant, frequently dominating the understory and occasionally the canopy. In the northern reach, the major introduced species is Russian olive. In the south (downstream from Bernardo), salt cedar is prevalent in the understory, and it also forms large monotypic stands along the river and adjacent floodplain. Other introduced species (e.g., Siberian elm, tree-of-heaven, china-berry tree, mulberry, and black locust) are found in the bosque, mostly along levee roads and other disturbed communities. These exotics have the potential for becoming the dominant species.

Six structural types of plant communities were recognized by Hink and Ohmart (1984), based on the overall height of the vegetation and the amount of vegetation in the understory or lower layers. Type I had vegetation in all layers, with trees 50-60 ft (15-18 m) high. Type I areas were mostly mixed to mature age class stands dominated by cottonwood/coyote willow, cottonwood/Russian olive, and cottonwood/juniper. Type II areas consisted of mature trees from 50 to 60 ft (15-18 m) with a sparse understory. Intermediate age stands of cottonwood trees with a dense understory were classified as Type III, while similarly aged trees with open understory were called Type IV. Type V was characterized by dense vegetation up to about 15 ft (4.6 m) often with dense grasses and annuals. Type VI had low, often sparse vegetation, typical of sandbars with cottonwood, willow, and other seedlings. This type also included sparsely vegetated drains. Hink and Ohmart (1984), described three cottonwood dominated community types based on the overstory species and on the type and abundance of the understory species; the cottonwood/coyote willow community, cottonwood/Russian olive, and cottonwood/juniper.

Other plant communities also occurred in the study area (Hink and Ohmart 1984). Russian olive occurred along the river channel in narrow, 50-200 ft (15-61 m) wide bands. Cattail marshes, dominated by cattails with some bulrush and sedge, were found in areas that were inundated or had a high water table. Wet meadows with saltgrass and sedges were also designated as marsh communities. In the southern reach, salt cedar was the primary component of the plant community almost to the complete exclusion of other species.

Hink and Ohmart (1984) also delineated sandbars in and adjacent to the river, and the river channel. Most of the sandbars were bare, but some had developed vegetation consisting of grasses, forbs, cottonwood and willow seedlings, and other species. Many of these bars were scoured during annual peak flows. If not removed by scouring, vegetation in these locations was periodically mowed by the Bureau to keep the floodway clear.

While structure and diversity of native plant communities appear to be significant factors in determining the diversity of species in animal communities, introduced plants that have become naturalized in the region also provide shelter and sometimes food. Fruits of Russian olive, a species that is prominent in the community types in the northern reach of the Middle Rio Grande, appear to be a significant part of the diet for some resident, migrant, and breeding bird species. Salt cedar, found throughout the study area, but particularly abundant in the southern portion, provides cover for birds and mammals and habitat for many insect species (Hink and Ohmart 1984).

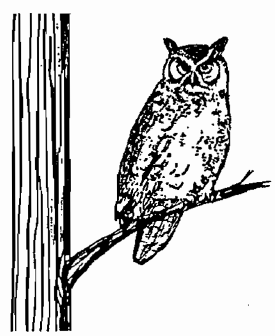
Currently the U.S. Forest Service is updating the riparian vegetation in the Middle Rio Grande using the same criteria as the Hink Ohmart classification with funding provided by the Service, Corps, and Bureau. The San Acacia Levee Project reach was recently classified in 1997, and was based upon 1996 photography and ground truthing.

Landscapes that compose the majority of the active floodplain in the project area include the 1996 burn area (3,350 ac, 1,356 ha), river (2,294 ac, 928 ha) and vegetated areas (7,682 ac, 3,109 ha). Within the 42 mi (67.58 km) stretch of this project, the active floodplain (area to the east of the levee) is dominated by salt cedar, 28 percent. If the river and burned area are excluded, the percentage is 49 percent. Much of the remaining vegetation has salt cedar as a component. Of the total area that is vegetated (excludes river and burned area), salt cedar is present as a component (at 25% species composition or higher) in 7,370 ac of 7,682 ac (2,983 ha of 3,109 ha) or 96% of the area (Figure 4). Other major vegetation species mapped included Fremont cottonwood, Russian olive, and willow. Native vegetation, Fremont cottonwood and willow, that were identified as dominant, discrete areas, comprised only 8 ac (3 ha), or 0.1% of the vegetated active floodplain.

<u>Terrestrial Resources</u>

Avian species

Avian studies in the Rio Grande corridor have documented an abundance of species. Hink and Ohmart (1984) documented 277 bird species along the Rio Grande from Velarde, New Mexico downstream to San Acacia Diversion Dam. A recent study by Thompson et al. (1994) in 1992 and 1993 along the Rio Grande from Velarde to Mesquite, New Mexico documented 259 species.



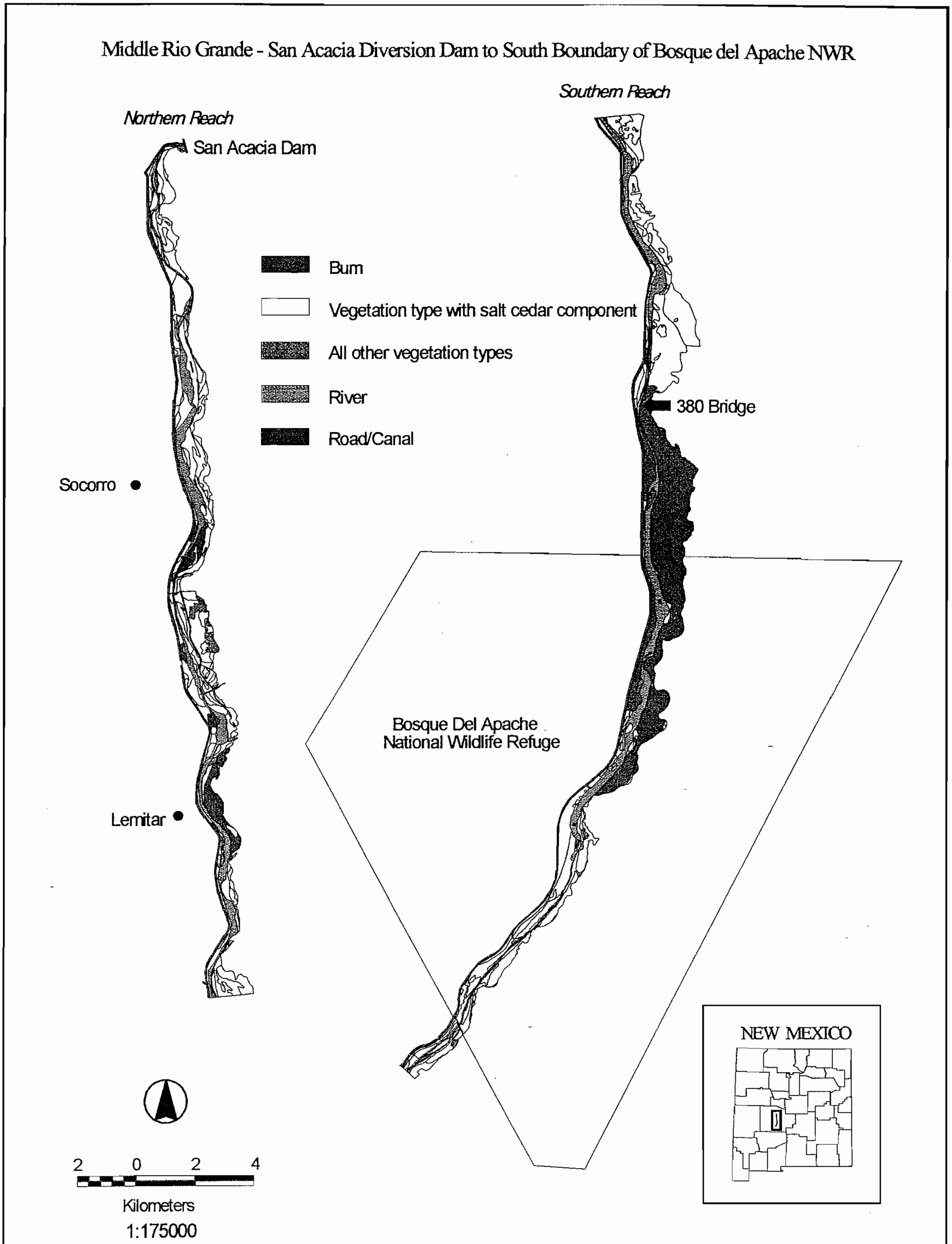


Figure 4. Salt Cedar Dominates the Rio Grande in the Project Area, 1996.

Hink and Ohmart (1984) found bird densities as high as 2,159 birds per 100 ac (40 ha) with as many as 55 species in one community structure type. The most common species were the mourning dove and black-chinned hummingbird. Other common species include gambel's quail, northern flicker, ash-throated flycatcher, European starling, American robin, black-headed grosbeak, dark-eyed junco, white-crowned sparrow, Coopers hawk, and American kestrel.

The three most common bird species identified during a 1992 and 1993 survey along the Rio Grande (Thompson et al. 1994) were the black-chinned hummingbird, blue grosbeak, and mourning dove. Other common species were the western kingbird, Bullock's oriole (then called northern oriole), red-winged blackbird, house finch, barn swallow, American robin, cliff swallow, northern mockingbird, great-tailed grackle, and western meadowlark. Bird species common and unique to riparian areas were the great blue heron, curve-billed thrasher, Bewick's wren, cactus wren, Lucy's warbler, pyrrhuloxia, and spotted towhee (then called rufous-sided towhee). Fourteen species are thought to be increasing in numbers with 12 species declining. Four of the increasing species are introduced and the remaining eight native species are most often associated with agriculture areas. The declining species are associated with riparian areas and water bodies (Thompson et al. 1994). These data indicate that habitat for riparian associated bird species is declining along the Rio Grande.

North and south travel along major waterways is characteristic of migratory birds that nest in North America. River corridors may be more important to migrating birds in deserts than in other regions of North America. During spring and fall migration, riparian habitats can attract more than 10 times the number of migratory birds compared to surrounding upland sites (Stevens et al. 1977, Hehnke and Stone 1979, Hink and Ohmart 1984). The riparian habitats along the Rio Grande are potential stopover sites for migratory land birds that use the great Plains-Rocky Mountain "flight route" (Finch et al. 1995). Riparian corridors may provide suitable habitat at an especially critical time for migrating birds. The availability of food, water, cover, and the north-south orientation of this river contributes to survival and guide migration of landbirds (Ligon 1961, Stevens et al. 1977, Wauer 1977, Finch 1991).

Of the 325 avian species known to occur in New Mexico, a total of 241 (74%) have been detected within the riparian habitat and adjacent agricultural areas of the Middle Rio Grande (Hubbard 1987). About one-third of these species occupy the Middle Rio Grande only during annual migrations between their breeding and wintering grounds (Finch et al. 1995). Studies from other areas suggest riparian systems may attract more than 10 times the number of migratory birds as surrounding upland sites during spring and fall migration (Stevens et al. 1977, Hehnke and Stone 1979). Yong and Finch (Yong 1996) captured 157 species at Bosque del Apache National Wildlife Refuge and the Rio Grande Nature Center during spring and fall migration in 1994. and a total of 6,509 birds were captured during the study. Of the total, 74 species (47%) were neotropical long-distance migrants, 78 species (50%) were short-distance migrants, and 5 species (3%) were resident or border migrants (Yong 1996, Shaw and Finch 1996).

W. Yong and D. Finch studied migrating birds on the Bosque del Apache National Wildlife Refuge (Refuge) and elsewhere in the Middle Rio Grande. The Refuge has compiled a list of 320 bird species that have been documented within the Refuge since 1940 (the Refuge includes the Rio Grande floodplain). This 57,191 ac (23,144 ha) Refuge was established to provide breeding grounds and winter habitat for migratory birds and other wildlife. Specific goals for the Refuge as stated in the 1982 Master Plan are:

- To provide habitat and protection for endangered species with emphasis on the whooping crane,
- To provide habitat and protection for migratory birds during the winter with special special emphasis on sandhill cranes, snow geese, dabbler ducks and Canada geese,
- To provide habitat and protection for resident animals,
- To provide the general public with an opportunity to see and understand wildlife and provide visitors with a high quality wildlife and educational oriented experience.

Habitat on the Refuge has been classified as:

Desert	24,900 ac	10,077 ha
Grassland	24,800 ac	10,037 ha
Brush	3,000 ac	1,214 ha
Marsh	1,600 ac	648 ha
Forestland	1,300 ac	526 ha
Cropland	1,300 ac	526 ha
River	66 ac	27 ha

Food for wintering birds is grown by the Refuge and local farmers. Moist soil management on the Refuge produces aquatic plants and invertebrates that are utilized by migratory waterfowl and other migratory birds. The Refuge is also active in reestablishing native vegetation, such as cottonwood and black willow, by clearing salt cedar followed by planting. The native vegetation is much more valuable to wildlife than the exotic plants such as salt cedar. Mallard ducks and sandhill cranes are especially dependent on the sand bars in the river on the Refuge for night roosting habitat during winter months (M. Oldham, pers. comm., USFWS, Bosque del Apache National Wildlife Refuge, 1996).

In addition to being species rich, the Middle Rio Grande riparian habitat supports high densities of birds. The average density is 300-600 birds/100 ac (40 ha) and densities of over 1,000 birds/100 ac (40 ha) are recorded for some native riparian habitats such as cottonwood-willow in certain seasons (Finch et al. 1995). High species richness and density in the Middle Rio Grande are consistent with patterns observed in other southwestern riparian ecosystems, and confirm the value of this limited riparian habitat to bird populations (Finch et al. 1995).

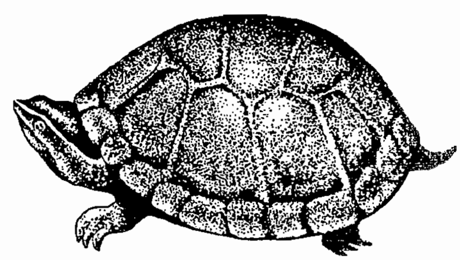
Banding data suggest that more forest-breeding migrants and long distance migrants have negative population trends than birds using other breeding habitats or those having short migration distances. Finch et al. (1995) speculate that a variety of changes along the river, mostly related to increases in human population probably have contributed significantly to bird population change. Habitat succession and disturbance are additional factors that may explain bird population changes detected on the breeding grounds (Finch 1991).

During fall migration, a large portion of Rio Grande migrants are hatching-year birds thought to be particularly vulnerable to navigational mistakes, starvation, and predation on their first journey south to the wintering grounds. Disturbance and changes in riparian habitat structure and plant species composition in the Rio Grande bosque will increase the probability that migration of some species will be altered or disrupted, and that such changes will affect not only local New Mexico birds, but also populations from a much wider geographic region (Shaw and Finch 1996).

Problems of survival are exacerbated when migrants with depleted energy stores arrive at stopover sites that have been disturbed, degraded, or destroyed. In addition to dealing with predator avoidance, food acquisition, inclement weather, and migration errors, changes in habitat suitability may increase the cost of migration and jeopardize successful completion of migration. How well migrants "offset" costs of migration, (i.e., satisfy their energy demands and meet contingencies that arise en route), determines the success of an individual's migration as well as the future status of the population itself.

Many species of migratory birds exhibit strong site fidelity and have specific habitat needs or constraints. As riparian habitats decrease or are altered in area and suitability, so may diversity and abundance of these species. Loss of riparian habitats in the Southwest could potentially affect 78 (47%) of 166 avian species that breed in riparian habitats of the region (Johnson et al. 1987).

Reptiles and Amphibians



Fifty-seven species of reptiles may occur in the Middle Rio Grande Valley (Degenhardt et al. 1996). Hink and Ohmart (1984) documented 23 species in the area. The most common reptiles observed during 1982 and 1983 studies were the plateau lizard and New Mexico whiptail. Other species that were documented included: painted turtle, ornate box turtle, spiny softshell turtle, lesser earless lizard, collared lizard, leopard lizard, eastern fence lizard, side-blotched lizard, short-horned lizard, round-tailed lizard, Great Plains skink, little striped lizard, Chihuahuan whiptail, western hognose snake, coachwhip, gopher snake, mountain pathnose snake, glossy snake, common king snake, common gartersnake, and prairie rattlesnake (Hink and Ohmart 1984).

Thirteen amphibian species may be found in the Middle Rio Grande Valley (Degendardt et al. 1996). Hink and Ohmart (1984) found seven amphibian species in the Rio Grande. Amphibians captured in association with temporary or permanent water during the study included the tiger salamander, bullfrog, western chorus frog, painted turtle, and the spiny softshell turtle. The plains spadefoot toad, Woodhouse toad, ornate box turtle, and Great Plains toad were found in open, drier habitats. The Great Plains skink was associated with herbaceous, shrubby vegetation. The most often captured, and perhaps the most abundant amphibians along the Rio Grande were the bullfrog and Woodhouse toad (Hink and Ohmart 1984). Other species documented along the Rio Grande include: Couch spadefoot toad, New Mexico spadefoot, red-spotted toad, and northern leopard frog (Hink and Ohmart 1984 and Applegarth 1981). Applegarth (1983), suggests the northern leopard frog and painted turtle were more abundant when wetlands were more numerous.

Small mammals

Hink and Ohmart (1984) captured 16 small mammal species in the Rio Grande Valley from Velarde downstream to San Acacia Diversion Dam. The white-footed mouse, western harvest mouse, and house mouse were most numerous. Other species captured were desert shrew, rock squirrel, Ord kangaroo rat, Merriam kangaroo rat, western harvest mouse, deer mouse, pinon mouse, hispid cotton rat, Norway rat, plains pocket mouse, silky pocket mouse, northern grasshopper mouse, and the New Mexican jumping mouse. Highest capture rates were in community structure type III and IV and areas associated with water. Type III is composed of stands of intermediate-age cottonwood trees with a thick understory of willow or Russian olive. Type IV areas are relatively open stands of intermediate-age cottonwoods with most foliage between 20 and 40 ft (6-12 m).

Seven small mammal species were captured in the Rio Grande in a recent 1995 study (Stuart and Bogan 1996). Surveyed areas included fragmented patches of Rio Grande bosque at six locations from as far north as Bernalillo to as far south as Caballo Reservoir. Captured species were the white-footed mouse, house mouse, Tawny-bellied cotton rat, white-throated woodrat, and rock squirrel. The most common species were the white-footed mouse and house mouse.

Large mammals

Eighteen large mammal species were documented in the Rio Grande by Hink and Ohmart (1984). Species especially dependent upon riparian areas were the beaver, muskrat, and raccoon. Other species identified were American porcupine, long-tailed weasel, striped skunk, Botta pocket gopher, yellow-faced pocket gopher, desert cottontail, black-tailed jackrabbit, spotted ground squirrel, Gunnison's prairie dog, badger, mule deer, coyote, gray fox, bobcat. Two species documented by Hink and Ohmart that are rare in riparian areas included the red squirrel and Colorado chipmunk.

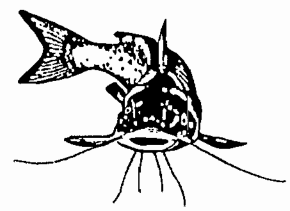
Eleven species of bats are found along the Rio Grande (Findley et al. 1975). Two bat species are restricted to riparian areas, the Yuma myotis and little brown bat. Other species that may occur in the valley are: pallid bat, Brazilian free-tailed bat, big free-tailed bat, Townsend's big-eared bat, long-legged myotis, silver-haired bat, big brown bat, hoary bat, and spotted bat.

Summary

No comprehensive study of terrestrial wildlife in the San Acacia reach of the Middle Rio Grande (San Acacia Diversion Dam downstream to Elephant Butte Reservoir) has been conducted. The only existing information on terrestrial wildlife has been gathered at the Bosque del Apache National Wildlife Refuge (Refuge). Since the Hink Ohmart (1984) biological study addressed only certain portions of the Rio Grande, and it occurred in the early 1980's, an additional Basin-wide biological inventory should be conducted. The updated information would provide crucial data to make correct decisions concerning wildlife impact assessment and restoration and creation of wildlife habitat.

Aquatic Resources

In New Mexico, 27 native fish species occur in the Rio Grande drainage, with 33 nonnative species (Sublette et al. 1990). Coldwater species are prevalent in the upper drainages (upstream of Cochiti Lake), with warmwater species dominating the fauna near Elephant Butte Reservoir. The fishery in the Middle Rio Grande contains both coldwater and warmwater species.



A fish survey of the Upper Rio Grande near the Colorado State line in 1987, confirmed 11 fish species: brown trout, rainbow trout, northern pike, red shiner, common carp, Rio Grande chub, fathead minnow, flathead chub, longnose dace, white sucker, and black bullhead. Based on the total number of fish captured, common carp, white sucker and longnose dace were dominant. Brown trout, northern pike, longnose dace and white sucker were common (Hanson and Bristol 1994).

The Rio Chama is the largest tributary of the Rio Grande in New Mexico and originates in south central Colorado. In this drainage, Heron, El Vado and Abiquiu dams and a major transbasin diversion have influenced flows to the Rio Grande. Coldwater species dominate the fishery. Fourteen fish species were captured in the Rio Chama during surveys by the Service downstream of El Vado and Abiquiu dams: Kokanee salmon, brown trout, rainbow trout, Rio Grande chub, flathead chub, white sucker, Rio Grande sucker, river carpsucker, common carp, longnose dace, fathead minnow, channel catfish, black crappie and green sunfish (Hanson 1992 a and b).

Fish sampling by Platania (1993 and 1988) from 1987 to 1991 in the Rio Grande from Velarde to Elephant Butte Reservoir confirmed 24 species: rainbow trout, brown trout, gizzard shad, common carp, red shiner, Rio Grande chub, Rio Grande silvery minnow, fathead minnow, flathead chub, longnose dace, river carpsucker, white sucker, smallmouth buffalo, Rio Grande sucker, black bullhead, yellow bullhead, channel catfish, western mosquitofish, green sunfish, bluegill, largemouth bass, white bass, white crappie and black crappie. Resulting from releases from Cochiti Dam, the Rio Grande from the dam to Albuquerque is usually cold, clear, and fast moving. The red shiner, white sucker, flathead chub and western mosquitofish were the most numerous fish captured in this stretch. In the Rio Grande from Albuquerque to Elephant Butte Reservoir, the water is warmer, and more turbid. The most numerous fish captured in this stretch were red shiner, Rio Grande silvery minnow, western mosquitofish, and flathead chub.

Because of the nature of water releases from Cochiti Dam, the Rio Grande supports cold and cool water fish species near the dam. The Rio Grande becomes a warmwater fishery downstream of Albuquerque. The fish species found in the river is also influenced by species occupying Elephant Butte Reservoir downstream of the project area.

Fish sampling by Platania (1993) from 1987 to 1988 in the Rio Grande from San Acacia Diversion Dam downstream to Elephant Butte Reservoir, confirmed 14 species: gizzard shad, common carp, red shiner, Rio Grande silvery minnow, fathead minnow, flathead chub, longnose dace, river carpsucker, white sucker, smallmouth buffalo, black bullhead, channel catfish, western mosquitofish, and white crappie. Red shiners and Rio Grande silvery minnows were the most abundant fish captured. Other fish that were common include flathead chub, river carpsucker, channel catfish, and western mosquitofish.

An inventory of fish species in the LFC Channel in October 1992 (Lang and Platania 1993) found 18 species: gizzard shad, red shiner, common carp, Rio Grande chub, fathead minnow, flathead chub, longnose dace, river carpsucker, white sucker, black bullhead, yellow bullhead, channel catfish, rainbow trout, western mosquitofish, green sunfish, bluegill, largemouth bass, and yellow perch. In addition, two additional surveys identified two additional species: the longeared sunfish (Bestgen and Platania 1989) and the white bass (USFWS 1989a).

Endangered Species

Southwestern Willow Flycatcher (Empidonax traillii extimus)

The Service included the southwestern willow flycatcher (flycatcher) on its Animal Notice of Review as a category 2 candidate species on January 6, 1989 (USFWS 1989b). The flycatcher was proposed for listing as endangered, with critical habitat, on July 23, 1993 (USFWS 1993a). A final rule listing it as endangered was published on February 27, 1995 (USFWS 1995a); the listing became effective on March 29, 1995. The State of New Mexico lists the flycatcher as endangered, group 2 (New Mexico Department of Game and Fish 1987 and 1988). Following the review of comments received during the public comment period, the Service deferred the designation of critical habitat, invoking an extension on this decision until July 23, 1995. A moratorium on listing actions under Public Law 104-6 passed by Congress in April 1995, required the Service to cease work on the final determinations of critical habitat and all final listings of species until the moratorium is lifted. Until the moratorium is lifted, and action taken on any final determination, we are still considering critical habitat as proposed.

The following New Mexico locations have been proposed as critical habitat for flycatcher:

- The Rio Grande, Bernalillo County, from Alameda Boulevard Bridge in northern Albuquerque downstream to southbound Interstate 25 Bridge

- The Gila River and the East and West Forks of the Gila River, Catron and Grant counties, from El Rincon Creek on the Gila River upstream to Hell's Hole Canyon on the west Fork of the Gila River and upstream to the confluence of Taylor Creek and Beaver Creek on the East Fork of the Gila River

- The Gila River, Grant and Hidalgo counties, from the confluence of Hidden Pasture Canyon downstream to the confluence of Steeple Rock Canyon

- The San Francisco River, Catron County, from the confluence of Trail Canyon downstream to San Francisco Hot Springs, near the confluence with Box Canyon (USFWS 1993a)

Proposed critical habitat includes the main river channel and all associated side channels, backwaters, pools, and marshes, and areas where such surface water may no longer exist owing to habitat degradation but may be recovered with habitat rehabilitation. The boundaries include the areas within 328 ft (100 m) of the edge of surface waters. This includes areas with thickets of riparian shrubs and trees, and areas where such riparian vegetation does not currently exist but may become established with natural regeneration or habitat rehabilitation (USFWS 1993a).

The range of the flycatcher in the United States includes southern California, extreme southern portions of Nevada and Utah, all of Arizona and New Mexico, west Texas, and extreme southwestern Colorado (Unitt 1987, Browning 1993). Although this range encompasses a large geographic area, the flycatcher's riparian nesting habitat has always been relatively rare in this predominantly arid region. The flycatcher can be a locally abundant, almost colonial species where extensive riparian habitat exists (Egbert 1981, Whitfield 1990). However, loss and modification of nesting habitat is a primary threat to this species (Phillips et al. 1964, Unitt 1987, USFWS 1993a). Loss of habitat used during migration may also impact the flycatcher's survival.

Large scale losses of southwestern wetlands have occurred, particularly the cottonwood-willow riparian habitats of the flycatcher (Phillips et al. 1964, Carothers 1977, Rea 1983, Johnson and Haight 1984, Katibah 1984, Hubbard 1987, Johnson and Jones 1977, Johnson et al. 1987, Unitt 1987, General Accounting Office 1988, Bowler 1989, Szaro 1989, Dahl 1990, State of Arizona 1990, Howe and Knopf 1991). Loss and modification of southwestern riparian habitats have resulted from urban and agricultural development, water diversion, impoundment and levees, channelization, livestock overgrazing, off-road vehicle and other recreational uses, and hydrological changes resulting from these and other land uses. Changes in riparian plant communities have resulted in reduction, degradation and elimination of nesting habitat for the willow flycatcher, curtailing the ranges, distributions, and numbers of all three willow flycatcher subspecies in western North America, including the southwestern willow flycatcher (Gaines 1974, Serena 1982, Cannon and Knopf 1984, Klebenow and Oakleaf 1984, Taylor 1986, Hunter et al. 1987, Unitt 1987, Schlorff 1990, Ehrlich et al. 1992).

The flycatcher is a small neotropical passerine approximately 5.75 inches (146 millimeters) in length. The back and wings are brownish-olive, the throat is whitish, the breast is olive-grey, and the belly is pale yellow. The wings have two whitish or buff wingbars. The eye ring is faint or absent. The upper mandible is dark, and the lower mandible is light. The flycatcher is an insectivorous bird, foraging within and above dense riparian vegetation, capturing its prey while in flight or from foliage (Wheelock 1912, Bent 1963). No information is available on specific prey species. Male flycatchers sing during spring migration and early in the breeding season, but tend to sing less often later in the season, and rarely sing during fall migration (Blake 1953, Peterson and Chalif 1973).

The flycatcher is a riparian obligate, nesting in riparian thickets associated with rivers, streams, and other wetlands where dense growth of willow, Baccharis, buttonbush, boxelder, Russian olive, salt cedar, or other plants are present, often with a scattered overstory of cottonwood. Throughout the flycatcher's range, these riparian habitats tend to be rare, widely separated, small and/or linear locales, separated by vast expanses of arid lands. Flycatchers nest in thickets of trees and shrubs approximately, 6 to 23 ft (1.8-7 m) in height or taller, with a densely vegetated understory from ground or water surface level to 13 ft (4 m) or more in height. Surface water or saturated soil is usually present beneath or adjacent to occupied thickets (Phillips et al. 1964, Muiznieks et al. 1994). At some nest sites, surface water may be present early in the breeding season with only damp soil present by late June or early July (Muiznieks et al. 1994, Sferra et al. 1995). Habitats not selected for either nesting or singing, are narrower riparian zones, with greater distances between willow patches and individual willow plants. Suitable habitat adjacent to high gradient streams does not appear to be used for nesting. Areas not selected for nesting or singing may still be used during migration.

Flycatchers begin arriving on the breeding grounds in late April and May (Sogge and Tibbitts 1992, Sogge et al. 1993, Maynard 1995, Sferra et al. 1995). Breeding begins in late spring, and young begin to fledge in early summer. Late nests and renests may not fledge young until late summer (Whitfield 1990, Sogge and Tibbitts 1992, Sogge et al. 1993, Maynard 1995). The breeding cycle, from laying of the first egg to fledging, is approximately 28 days. Flycatchers typically raise one brood per year. They have been documented renesting after nest failure (Whitfield 1990, Sogge and Tibbitts 1992, Sogge et al. 1993).

The flycatcher has declined in both extent of range occupied and population size, as a result of habitat loss, modification, fragmentation, and cowbird parasitism. Currently, flycatcher breeding populations are small, and most nesting groups have five or fewer pairs. At current population levels, and with continuing threats, extinction of this species is foreseeable. Flycatchers are absent from many previously occupied areas, or are present in reduced numbers (Hubbard 1987, Unitt 1987, Sogge et al. 1993, Muiznieks et al. 1994, Sferra et al. 1995). The current range wide estimate of total numbers of flycatchers is 500 or fewer nesting pairs (Unitt 1987, USFWS 1993a). Surveys conducted throughout the species' range in 1994 verified approximately 50-100 territories in California, 60 territories in Arizona, and 25-31 territories in New Mexico (R. Marshall, pers. comm., USFWS, 1995; Maynard 1995). Additional pairs may have been observed in New Mexico, but no field data forms from these areas were submitted to the New Mexico Department of Game and Fish or the Service in 1994, and therefore these sightings are not considered verified. Preliminary range-wide survey results for 1995 confirmed approximately 110-143 territories in California (Loren Hays pers. comm. 1995), 83-87 territories in Arizona, and 170-173 territories in New Mexico. The 1995 survey coverage in New Mexico was not as extensive as 1994 coverage. State surveys were focused on the Cliff/Gila area along the Gila River in southwestern New Mexico.

Occupied and unoccupied suitable and potential flycatcher nesting habitat exists within the proposed project area. This habitat is primarily composed of riparian shrubs and trees, chiefly Goodding's willow and peachleaf willow, Rio Grande cottonwood (P. fremontii var. wislizenii), coyote willow, and salt cedar. Suitable and potential sites are scattered along the Rio Grande from San Acacia to the headwaters of Elephant Butte Reservoir. The project area provides nesting and foraging sites for flycatchers, and is important habitat for migrating flycatchers.

In 1994 and 1995, the Corps contracted New Mexico Natural Heritage Program (Heritage) to conduct flycatcher surveys in the project area. In 1994, Heritage surveyed the west side of the Rio Grande, from San Acacia Diversion Dam to 8.8 mi (14.2 km) south of the Burlington Northern and Santa Fe railroad bridge at San Marcial, a total of 54.3 mi (87.4 km). The Heritage surveyed a much smaller area of the project in 1995. Surveys began at the southern boundary of Bosque del Apache

National Wildlife Refuge and ended 0.5 mi (0.8 km) downstream of the railroad bridge. The Heritage did not survey the area north of the Refuge's south boundary in 1995, because they determined during their 1994 surveys that there was no suitable flycatcher habitat on the west side of the river in that reach. Because the Corps decided to eliminate Phase 4 from the project, the 1995 survey ended 0.5 mi (0.8 km) downstream of the railroad bridge, 8.3 mi (13.4 km) shorter than the 1994 survey.

Heritage conducted two surveys during the 1994 breeding season. Seven flycatcher pairs and three territorial males were observed on the west side of the river, in an area between the river and the Bureau's levee, immediately upstream of the U.S. Geological Service's San Marcial gauging station, north and west of the railroad bridge (Mehlhop and Tonne 1994). One probable sighting occurred approximately 2.5 mi (4 km) upstream of the other sightings. Nests were confirmed for five of the seven pairs. Nest success appeared to be low. Brown-headed cowbird (cowbird) brood parasitism affected at least one nest (Mehlhop and Tonne 1994). The number of nestlings that fledged was undetermined.

Surveys conducted in 1995 did not begin until July 12, late in the breeding season. Five pairs, and one possible pair were found. Six nests, one of which was a renest, were confirmed. A total of 13 flycatcher eggs were observed, and 6 flycatcher nestlings were recorded. No fledglings were verified, but three were suspected (A. Henry, pers. comm., New Mexico Natural Heritage Program, 1995).

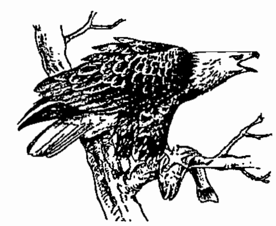
Cowbird brood parasitism is a factor implicated in the decline of the species (Harris et al. 1986, Brown 1991, Whitfield 1990, Sogge et al. 1993). Although native to North America, the cowbird has greatly expanded its range as a result of livestock grazing, the expansion of agriculture and other human activities, and fragmentation of host species' habitats. Brown-headed cowbirds have been observed in the project area, and flycatcher nest parasitism was observed during the 1994 and 1995 surveys (Mehlhop and Tonne 1994, Maynard 1995). Four cowbird eggs and one cowbird nestling were present in four of the six flycatcher nests located by Heritage.

Ahlers and White (1995) conducted additional surveys downstream of the project area in 1995. During their survey, they observed a single male near the San Marcial/Fort Craig berm (berm station 212+00), and two males in the area of the 1830 berm. Cowbirds were observed by the investigators throughout the area they surveyed.

Surveys conducted in the project area and further downstream to the reservoir in 1996 yielded only nine birds observed and one unsuccessful nest. The Heritage conducted surveys in 13.7 mi (22 km) on the west side of the Rio Grande beginning at the 1830 berm (8 mi, [13 km] downstream of the railroad bridge) and proceeding upstream. The Technical Service Center with the Bureau surveyed the LFC Channel and the area on the west side of the river.

Flycatcher surveys have not been conducted on the east side of the Rio Grande downstream of the Refuge. There are several areas on the east side of the river that appear to have suitable and potential flycatcher habitat, especially from the southern boundary of the Refuge to the headwaters of Elephant Butte Reservoir, a distance of 16 mi (26 km).

Bald Eagle (Haliaeetus leucocephalus)



The bald eagle was listed as endangered throughout the conterminous 48 States under the Endangered Species Act (Act) in 1967. The state of New Mexico lists this species as threatened. Since its initial listing, the bald eagle population has clearly increased in numbers and expanded in range as a direct result of banning DDT and other organochlorines, habitat protection and other recovery efforts. The breeding population has doubled every 6-7 years since the late 1970s. At present and in the foreseeable future, the major threats are destruction and degradation of its habitat and environmental contamination. This occurs through removal of trees for development, human disturbance, and contamination of waterways from point and non-point sources of pollution. Other threats include poisoning and illegal shooting, lead poisoning by lead ingestion, and electrocution. Despite these various threats, none are of sufficient magnitude, individually or collectively, to place the species at risk of extinction. For these reasons, the population has been reclassified to threatened (USFWS 1995c).

The bald eagle is associated with aquatic ecosystems throughout most of its range. This species's typical diet consists primarily of fish; however, many other types of prey are also taken, including waterfowl, small mammals, and carrion, depending on location, time of year, and availability. Several hundred migratory bald eagles winter in New Mexico along major river systems, reservoirs and lakes, but there are only two known nest sites in the State. The main threats to New Mexico's wintering population are habitat loss and degradation, including declines in prey and availability of roost-sites. Human disturbance near foraging areas probably poses the greatest threat to wintering eagles since birds will choose to move to more secluded areas, possibly with less prey.

No bald eagles are known to nest in or around the project area; however, migrant eagles occur regularly on the Bosque del Apache National Wildlife Refuge each winter (November to March). They are attracted to this area to feed on the abundance of waterfowl overwintering at the Refuge. Eagle use of the Refuge primarily occurs around the ponds outside the riparian zone, although some cottonwood trees in the riparian zone are used for perches and night roosts. Weekly surveys for eagles are done by Refuge personnel during the winter months each year.

American Peregrine Falcon (Falco peregrinus anatum)

The American peregrine falcon occurs throughout much of North America, from the subarctic boreal forests of Canada and Alaska, south to Mexico. In 1973 this subspecies was federally listed as endangered because of a precipitous decline in the population. Currently, the Service is considering removing the peregrine falcon from the endangered species list, because some data suggest that it has recovered following restrictions on the use of organochlorine pesticides in the United States and Canada, and due to management activities including the reintroduction of captive-bred peregrine falcons (USFWS 1995d). In New Mexico the Service and the New Mexico Department of Game and Fish are concerned that the population is not sufficiently stable to delist. While habitat occupancy by adult pairs has increased dramatically (2.8 times) since 1985, productivity of adult pairs has declined 34 percent since 1988 (Johnson 1995). Continued protection and enhancement of habitat remains important to promote continued recovery of the peregrine falcon in New Mexico. In New Mexico, this species is State listed as endangered.

Peregrine falcons occur and forage throughout New Mexico. Breeding territories are on cliffs in wooded/forested habitats, with large "gulfs" of air nearby in which they can forage. Prey consists almost entirely of birds ranging in size from swallows to ducks and larger shore birds. There is no potential breeding habitat in or around the project area, however, peregrine falcons are a rare (but common) visitor to the Middle Rio Grande Valley. According to Bosque del Apache Refuge personnel, 1 to 2 peregrine falcons are commonly seen on the Refuge throughout the year (M. Oldham, pers. comm., Bosque del Apache Refuge, 1995).

Rio Grande Silvery Minnow (Hybognathus amarus)

The Rio Grande silvery minnow (silvery minnow) was listed as endangered under the Endangered Species Act in July 1994 (USFWS 1994). This species is listed by the State of New Mexico as endangered. Primary reasons for listing involve a number of factors contributing to a massive collapse of the species throughout its historic range due to:

- Regulation of stream waters, which has led to severe flow reductions, often to the point of dewatering extended lengths of stream channel;

- Alteration of the natural hydrograph, which impacts the species by disrupting the environmental cues for a variety of life functions, including spawning;

- Both the stream flow reductions and other alterations of the natural hydrograph throughout the year can severely impact habitat availability and quality, including the temporal availability of habitats;

- Actions such as channelization, bank stabilization, levee construction, and dredging result in both direct and indirect impacts to the silvery minnow and its habitat by severely disrupting natural fluvial processes throughout the floodplain;

- Introduction of nonnative fishes that directly compete with, and can totally replace the silvery minnow, as was the case in the Pecos River, where the species was totally replaced in a time frame of 10 years by its congener the plains minnow (Hybognathus placitus); and,

- Introduction of contaminants into the stream system from industrial, municipal, and agricultural sources (USFWS 1993b, USFWS 1994).

Proposed critical habitat for the species includes the Rio Grande from the New Mexico Highway 22 Bridge, immediately downstream of Cochiti Dam, to the Burlington Northern and Santa Fe Railroad Bridge near San Marcial, New Mexico, representing 170 mi (273.5 km) of stream channel. Constituent elements of critical habitat required to sustain the silvery minnow include:

- Suitable stream morphology that supplies sufficient flowing water to provide food and cover needs for all life stages of the species,

- Eliminate water stagnation to prevent detrimental water quality conditions (elevated temperatures, decreased oxygen, presence of toxicants etc.), and,

- Sufficient water quantity to prevent formation of isolated pools that restrict fish movement, foster increased predation by birds and aquatic predators, and congregate disease-causing pathogens (USFWS 1993b, USFWS 1994).

A moratorium on listing actions under Public Law 104-6 passed by Congress in April 1995, required the Service to cease work on the final determinations of critical habitat and all final listings of species until the moratorium is terminated. Thus, critical habitat for the silvery minnow has not been finalized and remains proposed.

Habitat for the silvery minnow includes stream margins, side channels, and off-channel pools where water velocities are low or reduced from main-channel velocities. Areas with detritus and algal covered substrates are preferred. The lee sides of islands and debris piles often serve as good habitat. Stream reaches dominated by straight, narrow, incised channels with rapid flows are not typically occupied by the species.

The historic range of the species included the Rio Grande from near Española, New Mexico, to the Gulf of Mexico, and the Pecos River from near Santa Rosa, New Mexico, to the confluence with the Rio Grande. Extreme downstream portions of several tributaries to these streams, including the Rio Chama on the Rio Grande and the Rio Felix on the Pecos River were also known habitat (Bestgen and Platania 1991, USFWS 1993b).

The species is now restricted to the Middle Rio Grande in New Mexico, occurring in only five percent of its historic range from Cochiti Dam downstream to the headwaters of Elephant Butte Reservoir. Comparison of fish surveys between 1988 and 1992 in the Rio Grande basin indicated a decline in the abundance of silvery minnows (Platania 1993).

Human development and use of the floodplain have greatly restricted the width that is available to the active river channel where the silvery minnow survives. A comparison of "river" area between 1935 and 1989 shows a 52 percent reduction, from 26,598 ac (10, 764 ha) to 13,901 ac (5,626 ha) (Crawford et al. 1993). These data refer to the Rio Grande from Cochiti Dam downstream to the "Narrows" in Elephant Butte Reservoir. Within the same stretch, 234.6 mi (378 km) of levees (includes distances on both sides of the river) occur and only 1 mi (1.6 km), or 0.6 percent of the floodplain has remained undeveloped.

This remaining occupied habitat can be subdivided into four reaches:

1. Cochiti to the Angostura Diversion
2. Angostura Diversion to the Isleta Diversion
3. Isleta Diversion to the San Acacia Diversion, and
4. San Acacia Diversion Dam to the headwaters of Elephant Butte Reservoir

Fish collections from 1986 to 1989 (Bestgen and Platania 1991) resulted in very few silvery minnows collected in the Cochiti Dam to Angostura reach. Surveys in 1990 (Platania 1993) at five sites yielded no silvery minnows. This stretch is poor habitat for the silvery minnow, because it is dominated by large size substrates with very little sand. The trapping of sediment in Cochiti Reservoir prevents formation of preferred silvery minnow habitat in this downstream reach.

In the Angostura Diversion to the Isleta Diversion reach, fish were regularly collected, but were still very scarce. The fish fauna was depauperate in the Rio Grande immediately downstream of Albuquerque (Bestgen and Platania 1991). During surveys from 1987 to 1990 at 7 sites, 45 silvery minnows were collected at 3 sites (Platania 1993).

In the Isleta Diversion to San Acacia Diversion reach, silvery minnows were more abundant than the upstream reaches. The number of silvery minnows captured per 1.196 square yards (1 square meter) of habitat seined was 0.08 as compared to 0.01 in the reach upstream (Bestgen and Platania 1991). During 1987, 1,441 silvery minnows were captured at 11 sites of 12 sites sampled. In 1988, 876 silvery minnows were captured at all 8 sites sampled (Platania 1993).

The reach between San Acacia Diversion and the headwaters of Elephant Butte Reservoir had the greatest number of silvery minnows captured. This reach yielded 0.17 silvery minnows captured per 1.196 square yards (1 square meter), which was twice the catch rate of the reach upstream (Bestgen and Platania 1991). During 1987, 581 silvery minnows were captured at 6 sites of 7 sites sampled. In 1988, 427 silvery minnows were captured at all 10 sites sampled (Platania 1993).

Probable reasons for the high abundance downstream of San Acacia Dam include:

- Downstream dispersal of buoyant eggs and developing larvae during the spring and early summer high flows;

- Diversion dams restricting the redispersal of mature fish into upstream reaches; and

- Reduction in available habitat in upstream reaches by stream bed degradation, reduction in off-channel habitat, and the general narrowing and incising of the stream channel caused by releases from Cochiti Dam.

This species is a moderately sized, stout minnow, reaching lengths of 3.5 inches (90 millimeters) total length. The silvery minnow spawns in the late spring and early summer, coinciding with high spring flows. The species is a pelagic spawner, producing neutrally buoyant eggs that drift downstream with the current. As development occurs during the drift, which may last as long as a week depending on temperature and flow conditions, the larvae seek quiet waters off-channel to continue their development. Considerable stream lengths can be traversed by the drifting, developing eggs depending upon stream discharge. Maturity is reached toward the end of the first year. Most individuals of this species live 1 year, with only a very small percentage reaching age 2. It appears that the adults die following the spawn. It is theorized that fish reaching their second year probably did not reproduce the prior year (Sublette et al. 1990, Bestgen and Platania 1991, USFWS 1993b, S. Platania, pers. comm., Univ. of N.M., 1996).

This reproductive strategy, where the progeny disperse downstream, is likely a partial reason for the greater abundance of the species in the San Acacia Diversion Dam to Elephant Butte Reservoir reach. The young drift downstream, develop to maturity, and then proceed back upstream to occupy available habitat. However, upstream migration is blocked by the diversion dam at San Acacia, thus restricting the species' redistribution. Concurrently, a portion of the reproduction of the populations above San Acacia Diversion Dam is being distributed downstream by the drift, and recruited into the reach between San Acacia Diversion Dam and Elephant Butte Reservoir. It is not believed that any survival of these fish occurs within Elephant Butte Reservoir.

The river reach downstream of San Acacia Dam to the Railroad Bridge at San Marcial, where the silvery minnow is found in the greatest abundance, is 28 percent of the total length of proposed critical habitat (47.6 mi [76.6 km]). During 1996, 53 percent of this reach was dewatered, even with flow augmentation. This results in only 22.2 mi (35.7 km) of habitat that has recently supported the majority of the silvery minnow population. Poor habitat conditions in this best reach increases the chances that the range of this species will be further reduced or altogether eliminated.

The primary food item for this species is algae. However, detritus filtered from bottom ooze is also ingested along with some bottom materials, including sand and silt (Sublette et al. 1990, Bestgen and Platania 1991).

A recovery team of species experts and stakeholders potentially impacted by recovery efforts has formed and is charged with the task of developing and implementing a formal recovery plan. Most likely, stabilization of the species in its present range, removal or reduction of threats, and the establishment of additional populations will be required for recovery.

Whooping Crane (Grus americana)

The whooping crane was originally listed as a threatened species in 1967 (USFWS 1967) and upgraded to endangered status in 1970 (USFWS 1970) due to hunting, specimen collecting, human disturbance, and conversion of its primary nesting habitat to hay, pasture land, and grain production (Allen 1952). This species is listed by the State of New Mexico as endangered. In 1975, the Service began reintroducing whooping cranes. A technique called "cross fostering" was employed, where whooping crane eggs are placed into greater sandhill crane nests and the chicks are subsequently hatched and reared by the adult sandhill cranes into a migratory population of sandhill cranes breeding in or near Grays Lake National Wildlife Refuge, Idaho, and wintering on or near the Bosque del Apache National Wildlife Refuge. This was an effort to establish a second wild population (termed the Rocky Mountain Population) to safeguard the population breeding in Canada and wintering on the Texas Gulf Coast (termed the Aransas/Wood Buffalo population). Critical habitat was designated for the whooping crane May 15, 1978 in Idaho, Colorado, New Mexico, Kansas, Nebraska, Oklahoma, and Texas (USFWS 1978). The Aransas/Wood Buffalo population has grown to 131 individuals with 45 breeding pairs. Currently there are 5 captive populations composing a total of 96 individuals, including 14 breeding pairs.

Numbers of whooping cranes in the reintroduced Rocky Mountain flock were as high as 33 individuals at one time but there are currently believed to be only 3 remaining adult cranes and 1 hybrid whooping X sandhill crane. The cross fostering program was discontinued due to the lack of successful pairing and the mortality rate being too high to establish a self-sustaining population.

Whooping cranes wintering in the Middle Rio Grande Valley of New Mexico are usually found in association with sandhill cranes feeding in moist soil or agricultural fields during the day. The cranes generally feed on a mixture of native wetland plant seeds, agricultural crops and aquatic invertebrates. Both crane species roost either in wetland impoundments on state and Federal areas or on sand bars within the river channel. The Bosque del Apache Refuge is designated as critical habitat for this species. Three whooping cranes wintered in New Mexico during the winter of 1996, 1997. Six to eight captive-raised whooping cranes will be escorted by a ultra-light aircraft to New Mexico in the fall of 1997. These birds will begin their journey at Grace, Idaho.

Currently, the Service is proposing to designate the remainder of the Rocky Mountain Population an experimental, nonessential population and to remove the critical habitat designation from four national wildlife refuges (Bosque del Apache, Monte Vista, Alamosa, and Grays Lake) associated with the Rocky Mountain Population (USFWS 1996).

Interior Least Tern (Sterna antillarum)

The interior least tern was federally listed as endangered in 1985 (USFWS 1985) and is also listed by the New Mexico Department of Game and Fish (NMDGF) as State endangered. Severe declines of interior least tern populations were due to habitat loss from river channelization, dam construction, and regulated flows. The interior least tern is found primarily in the Mississippi basin and was first recorded breeding in New Mexico at Bitter Lake National Wildlife Refuge, Chaves County, in 1949. Least terns breed on sand bars in rivers and lake or pond edges free of vegetation. They have bred annually at or in the vicinity of Bitter Lake Refuge since 1949 and are not known to breed elsewhere in New Mexico. The NMDGF considers the least tern to be a migrant along the Pecos River in Eddy County and it has occurred as a vagrant in Catron, Rio Arriba, Doña Ana, Socorro (Bosque del Apache Refuge), and Otero counties. Least terns are piscivorous and are associated with shallow water areas.

Within the Rio Grande Valley, interior least terns have occurred as vagrants usually at Bosque del Apache National Wildlife Refuge (Refuge). They are often in association with migrating Forster's terns and/or black terns and are usually found feeding and roosting in manmade ponds on the Refuge. They may use the river if the water levels are low and prey are abundant. It is unlikely that least terns will use the Rio Grande channel during higher flows due to poor foraging conditions and lack of exposed sand bars for roosting and nesting habitat. Vagrant least terns remain in the area for varying lengths of time. An individual least tern was observed at Bosque del Apache Refuge for a short time during spring 1995 (M. Oldham, pers. comm., Bosque del Apache Refuge, 1996).

It is unlikely that the Rio Grande within the project area provides suitable habitat for least terns. The restricted channel and relatively high spring flows within the channel act to eliminate potential roost/nest sites and calm pools for feeding during May when least terns are initiating nesting.

Mountain Plover (Charadrius montanus)

The mountain plover was designated a category 2 candidate species on December 30, 1982 (USFWS 1982) and elevated to category 1 on May 3, 1993. The species was retained as a candidate species in the February 1996 Notice of Review of Plant and Animal Taxa. Candidate species are those for which the Service has substantial information to support their listing as endangered or threatened. The development and publication of proposed rules for these species are anticipated. The Service is currently evaluating whether to propose listing the mountain plover as a threatened species. Mountain plover populations have declined steadily due to conversion of native shortgrass prairie to agricultural and urban land uses and possibly the decline in prairie dog numbers (Leachman and Osmundson 1990). Mountain plovers historically bred in Colorado, Wyoming, Montana, western Nebraska, west Texas, and New Mexico in short grass prairie and may also be associated with heavily grazed areas or near prairie dog colonies which simulate shortgrass habitat conditions. Mountain plovers appear to use similar habitat in migration and are not known to regularly occur in riparian or wetland habitats. Mountain plovers primarily winter in the San Joaquin and Imperial valleys of California and are often associated with fallow agricultural fields and grazed pasture lands.

In the Middle Rio Grande Valley, mountain plovers can be observed regularly in migration (sometimes in large numbers) at the Grasslands Turf Farm in Los Lunas, Valencia County, just outside the flood plain. While they are regularly seen at the nearby turf farm, mountain plovers are only occasionally observed near the river (D. Leal, pers. observation, USFWS, 1996). Observations of mountain plovers in the floodplain are generally of single birds using open bare ground areas or short grass and meadow habitats.

FUTURE CONDITIONS WITHOUT THE PROJECT

The Rio Grande and its watershed have undergone extreme modification over the past centuries, especially during the last 100 years. The river and adjacent wetland and riparian areas have been highly controlled and physically altered by the construction of dams, flood control structures, drainage ditches, bank stabilization projects, river channelization, and agriculture water diversion. Urban development, bridges, roads, and power and gas lines have fragmented the remaining habitat. In addition, lack of overbank flooding which is necessary for regeneration, and introduction of exotic species are contributing to the decline and sustainability of the bosque.

The river, floodplain and the associated fish and wildlife continue to experience adverse effects from Federal, State, and private actions, including new and long-term ongoing activities. Examples of activity upstream, downstream and within the proposed project area are numerous: operation and maintenance of the LFC Channel, use of jetty jacks, San Acacia Diversion Dam, interior drain rehabilitation projects, work on San Marcial Levee, construction of San Marcial/Fort Craig berm, removal of sediment plugs from the river, operation and maintenance of Elephant Butte Reservoir, and operation and maintenance of the existing levee from San Acacia Diversion Dam to Elephant Butte Reservoir. In addition, increasing urbanization and development within the historic floodplain eliminates remnant riparian areas located outside the levees, while putting increasing pressure on the habitat and wildlife in the bosque. Changes to the river channel and the floodplain that affect how base flow and flood currents move downstream and across the floodplain have effects on patterns of erosion, aggradation, and maintenance or regeneration of riparian vegetation.

All of the actions listed above have affected the riparian ecosystem and associated wildlife. River dynamics on which the native communities depend have been so modified that these native communities are no longer able to sustain themselves, and clearly the ecosystem is highly stressed (Crawford et al. 1993). Wetland and riparian areas have been greatly reduced and fragmented, reducing the quality and quantity of suitable habitat available to wildlife.

Endangered species

Without identification and effective implementation of recovery measures for the endangered flycatcher and silvery minnow, the Service expects these species to become extinct in the foreseeable future. Given current management practices, flycatcher habitat will continue to decline and be unsuitable in the future, replaced by salt cedar, Russian olive, and Siberian elm. The wetted channel will continue to decrease in width and increase in depth, a situation that is detrimental to the silvery minnow. Mature cottonwood trees will die naturally of senescence, and stochastic events such as drought and fire, will continue to negatively affect native bosque habitat. Without adequate cottonwood regeneration, bald eagle perch and roost habitat will continue to decline, thus impacting the bald eagle. The status of the peregrine falcon, whooping crane, interior least tern, and mountain plover is unlikely to change or be affected as a result of no action.

IMPACTS TO FISH AND WILDLIFE WITH THE PROJECT

The Corps provided the Service with information for its preferred alternative, levee rehabilitation. Therefore, this section analyzes potential effects of levee reconstruction only.

The proposed levee would perpetuate the continued decline of the Middle Rio Grande ecosystem. The active, healthy floodplain has been significantly reduced in the Middle Rio Grande and especially in the floodplain downstream of San Acacia Dam, a reduction of 78 percent (56,656 to 12,621 ac [22,929 to 5,108 ha]). The effects that have occurred and will continue are described below.

The three segments of the Corps levee rehabilitation projects on the Rio Grande - Corrales (10.6 mi, 17 km), Belen (22.1 mi, 35.6 km) and San Acacia (42 mi, 67 km), will limit the already reduced floodplain. Cumulatively, 74 mi (119 km) of the 161 mi (260 km) of the Middle Rio Grande, or 46% will be permanently limited to a narrower floodplain. In addition, existing levees also occur in other portions of the Rio Grande. A narrower floodplain may be acceptable for a short stretch of the river but the proposed total project distances, and even the San Acacia Levee Project length of 42 mi (67 km), will have major limitations for ecosystem preservation and restoration. None of the levees are operated in isolation from its counterpart within the overall Rio Grande Project. Hence, the modification of one discrete stretch of river by one of the three interconnected parts of the whole is felt in the river, both above and downstream. As the river is manipulated in an upstream reach, its flow dynamics alter its downstream course and its ability to sustain plant, wildlife, and fish communities throughout its length.

Narrowing of the active floodplain, changing vegetation and altering water flow characteristics caused by levee construction results in fragmentation of habitat. The adverse effects of fragmentation are well documented (Harris 1984, Meffe and Carroll 1994, Noss 1987, Crawford et al. 1993, Saunders et al. 1991). Species that are highly migratory, such as neotropical songbirds, are especially vulnerable to fragmentation (Lynch and Whigham 1984). Large carnivores are negatively impacted by fragmentation because small areas may not provide sufficient prey (Harris and Gallagher 1989). Hoffman (1990), during bird surveys in the Rio Grande, found riparian vegetation exceeding 400 ft (122 m) in width was more valuable to birds than narrower areas. Species that are especially vulnerable are rare species, those with large home ranges, species that have difficulty with dispersing, species with low reproductive potential, species dependent upon unpredictable resources, ground nesting species, species normally occupying interiors of habitats, and those that are exploited by man (Meffe and Carrol 1994).

The proposed project would guarantee that the floodplain for 42 mi (72.4 km) would remain in a relatively narrow active channel (Figure 5). The historic floodplain outside the levees would not support biologically diverse fauna normally inhabiting such lands. Areas exterior to the levees along the Rio Grande are often dominated by agriculture, urban developments, or salt cedar in wetter areas. Species that depend upon river dynamics for their habitat creation and maintenance could not maintain viable populations indefinitely along the Rio Grande.

The proposed levee would protect the operation of the LFC Channel, which could dewater the Rio Grande and its floodplain. The LFC Channel can divert as much as 2,000 cfs (203,800 cm-h) from the Rio Grande. Further degradation of fish and wildlife habitat would occur because of adverse hydrologic impacts. Floodplain vegetation and aquatic habitat would be impacted due to a reduced water supply. Habitat that is created and maintained by river flows would continue to be adversely modified. Fish and wildlife in the active floodplain would also be negatively impacted because of reduced water levels caused by seepage to the LFC Channel.

The proposed levee rehabilitation would maintain the current lack of small tributary inflows to the Rio Grande that are beneficial to ecosystem functions. Historic flow events that carried soil and water to the river have, and will continue to be prevented or severely restricted. In the proposed levee reach of 42 mi (72.4 km), all the west side tributary flows have been blocked except for two: the Socorro North Diversion Channel and Brown Arroyo. These periodic flow events created physical habitat diversity in the aquatic and terrestrial components of the Rio Grande. Large flows from tributaries rearranged the stream bed and bank material, creating suitable sites for vegetation colonization. Aquatic species also benefited because material pushed into the river channel created back water areas and areas that resulted in swifter river velocities. In addition, corridors for movement of wildlife from upland areas to riparian areas on the Rio Grande were created with arroyo flows.

Environmental conditions in the Middle Rio Grande have been deteriorating, especially since the turn of the century, and most recently since the 1950s (Crawford et al. 1993, Finch and Tainter 1995). The completion of the proposed levee rehabilitation project will prevent consideration of floodplain management options, especially active floodplain expansion. For example, it is unlikely that the proposed new levees will be removed to create a larger floodplain in the future because of the investment in the levee and the cost of removal.

Endangered species

The effect of the proposed levee upon listed endangered species is being evaluated during the formal Section 7 consultation process. The Service provided the Corps a Draft Biological Opinion on September 1996.

The primary reason for the recent listings of both the southwestern willow flycatcher and Rio Grande silvery minnow has been the degradation and loss of habitat resulting

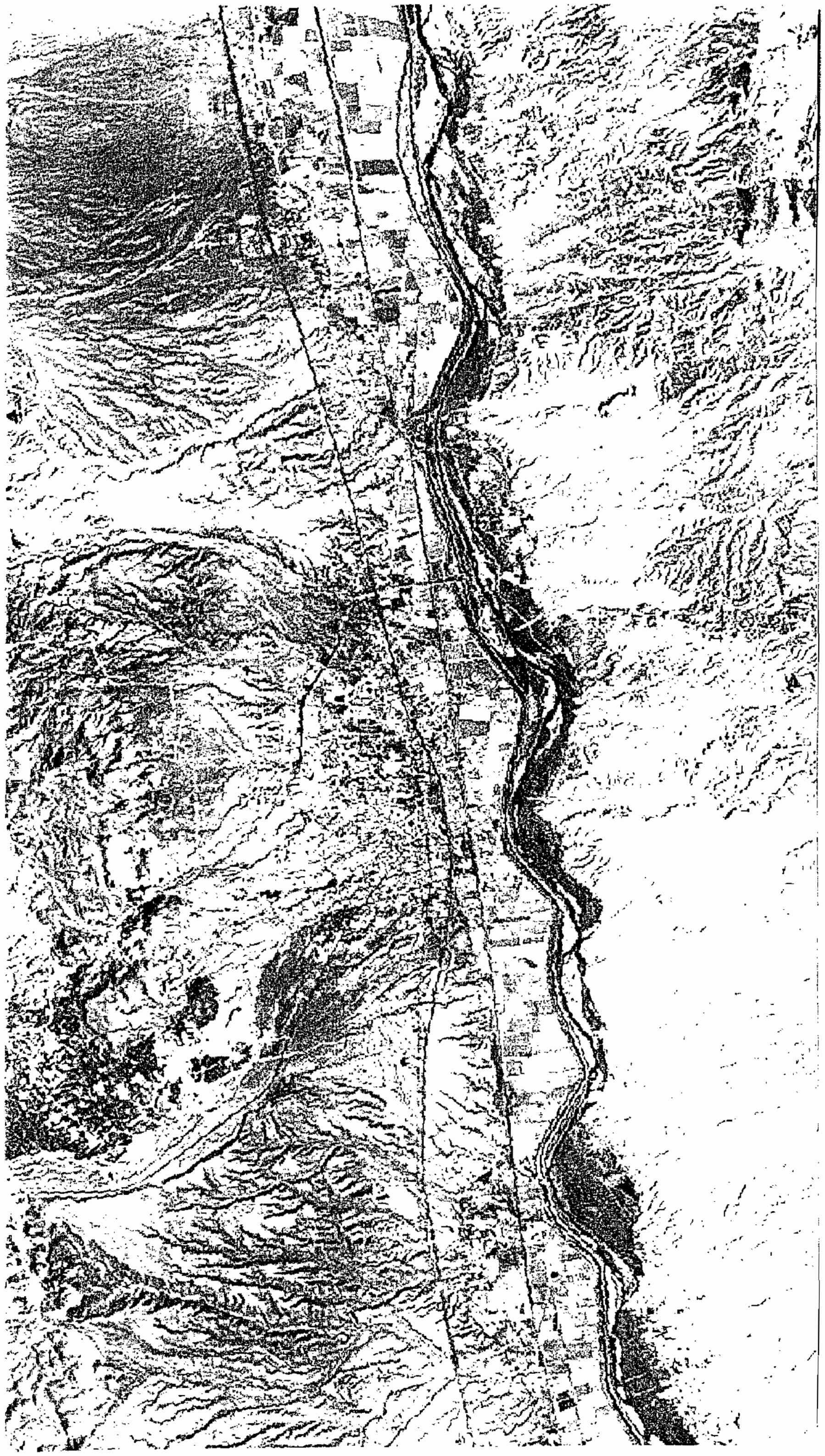


Figure 5. Existing Active Floodplain of the Rio Grande at Socorro.

from flow manipulations and destruction of natural floodplain and riverine communities. This result is attributed to continued manipulation of the Middle Rio Grande Valley facilitated by levee construction specifically and detrimental flow management practices. Flow management, addressing fish and wildlife needs, has improved, but present river flows continue to contribute to adverse impacts to species dependent upon the floodplain.

The proposed action will continue to limit the river's ability to meander or flood outside of the artificial floodplain created by levees, thus preventing expansion of the natural floodplain and affecting native riparian regeneration along the river, perpetuating the declining trend of the bosque. Loss of habitat and cowbird parasitism are the two major causes of flycatcher decline. Based on the information provided by the Corps, the proposed project does not allow for recovery of a more natural riparian ecosystem or for the recovery of the flycatcher. Also, the project would continue to maintain vegetation conditions that facilitate cowbird access to host nests. If project construction is scheduled in areas of suitable flycatcher habitat between mid April and mid September, construction activity may disturb nesting flycatchers, possibly causing nest abandonment or increased incidence of cowbird parasitism.

A substantial number of projects are proposed in the general area of known flycatcher sites in the project area (See "Future Conditions without the Project" section). If implemented, the cumulative effects of these projects on the flycatchers that occupy this area could be significant. All past, present and future activities should be evaluated for cumulative effects.

The Corps has stated that the rehabilitated levee would be able to withstand much greater levels of flows and there may be indirect beneficial effects through increased flexibility in water management. The Service interprets this to mean that the Corps predicts overbank flooding could be accommodated with the proposed project to improve and regenerate bosque habitat, thus improving habitat for the flycatcher. However, major obstacles upstream (residential development in the floodplain) and downstream (the safety of the railroad bridge) severely limit the capacity of the river channel for higher flows. In addition, levees severely limit establishment of flycatcher habitat outside of these structures.

The proposed project could affect the bald eagle by reducing the overall habitat in the Rio Grande floodplain through disturbance and reduced availability of roost sites. Removal of large trees would constitute a loss of potential roost habitat that is used for resting and hunting. In addition, foraging and roosting behavior could be affected by project generated noise and activity. Disturbance from construction activities during the winter months could cause bald eagles and their prey to temporarily refrain from using the project area, forcing them to hunt in less productive or contaminated areas.

Even though the peregrine falcon may occur in the project area, it is unlikely that disturbance and habitat alterations resulting from the proposed levee rehabilitation project will have any effects on this species' ability to forage in the area.

Impacts to the silvery minnow and its habitat resulting from completion of the San Acacia levee rehabilitation include:

- Continued reduction of quantity and quality of off-channel and side-channel habitat due to the levee restricting channel migration and formation to only a portion of the floodplain

- Continued limitation of overbank flood flows to areas only within the levee, resulting in a more narrow and incised channel, thus increasing habitat degradation

- Continued restriction of the active channel and floodplain by the levee in areas where channel aggradation is ongoing, encouraging maintenance activities such as dredging and further levee construction, that negatively impact the species and its habitat

- Continued operation of the LFC Channel that can divert water out of the river and results in main river channel losses to the Low Flow via seepage

- Continued limitation of the hydrologic functions will encourage exotic plant invasion that will result in elimination of habitat and a decrease in habitat quality.

These combined impacts affect every biological and physical function of the species, including spawning, recruitment, feeding, growth, habitat selection, and overwintering.

Since whooping cranes primarily use wetland impoundments and agricultural fields, impacts from construction of the San Acacia Levee Project will be minimal to cranes wintering in the Middle Rio Grande Valley. However, potential exists for disturbance from construction noise to feeding and roosting cranes. Construction particularly within Bosque del Apache Refuge during the period from November to March may disturb feeding and roosting cranes depending on the level of noise from construction equipment. Operation of the LFC Channel and the potential dewatering of the river channel may limit safe roost sites during low water years.

Project impacts to the interior least terns are unlikely to be significant.

Due to the mountain plover's preference for upland habitats with low habitat structure, it is unlikely that this project will have any impacts to this species.

DISCUSSION

Because of the long term adverse impacts to fish and wildlife due to levee construction along the Rio Grande, because of the piecemeal analysis of this proposal with respect to other Corps projects and other agencies on the river, and because of the continual modification of components of this proposal, the Service suggests alternative flood control measures be developed. A comprehensive flood control project should be developed for at least the entire stretch of the Middle Rio Grande (Cochiti Lake to Elephant Butte Reservoir) that would incorporate ecosystem health and maintenance. Similar projects have been developed in other parts of the United States that demonstrate the feasibility of this approach. The project description and analytical materials have addressed one project throughout the Middle Rio Grande Valley as if it were unrelated to other flood control measures. The potential effects on the aquatic and terrestrial resources of the Rio Grande should be addressed as one project.

The need to address the mandates of the Corps on the Rio Grande in one cohesive analysis is also supported by a review of the available up-to-date project information. The original flood control plan of which the San Acacia Levee Project is a component, dates from approximately 50 years ago. Subsequently reviewed in portions and updated in fractions of the overall plan, the levee has been analyzed only to address changes in the design or extent of structures. From project documents in 1988 and a Supplemental Environmental Impact Statement in 1992, the project is again being altered and again that alteration is to be analyzed in another Supplemental Environmental Impact Statement. This separation of project analysis into pieces should be abandoned and replaced with a comprehensive analysis of the management of the river by the Corps addressing the environmental concerns that have been omitted from past assessments.

Restoration of river-based ecosystems has occurred throughout the United States and at the same time incorporated flood control objectives. The Kissimmee River Restoration project in Florida was undertaken with the objective of restoring the natural ecological functions by reviving a natural and free-flowing river system. The goal was to restore lost environmental values by restoring and maintaining the physical, chemical, and biological integrity of the river system. Environmental losses resulted from channelization, drainage and alterations of the hydrologic flow regime. The free-flowing river and floodplain wetlands were replaced with impounded wetlands and upland. River channel habitat was eliminated. The goal of the original project was to create a canal for flood control conveyance. The Corps preferred restoration alternative would restore part of the original channel and create new river channels that would be linked to form one river. Much of the excavated canal would be filled in. Some levees, spillways, and boat locks would be removed. Flood control provisions would be maintained by land purchase, flowage easements and some structural improvements (Loftin et al. 1990).

Some areas of the United States have experienced huge property losses and damages during floods even with flood control structures. The flood of 1993 in the Mississippi River watershed in the Midwest cost $14 to $16 billion in disaster recovery payments. Two years later much of this investment was lost again during the flood of 1995. This example demonstrates that proper floodplain management could be very cost effective (Rasmussen 1996).

In Arizona, ecosystem information has been gathered during a comprehensive study of the Verde River. The Upper Verde River (125 mi [201 km]) has been studied with the goal of preventing impacts to the riparian ecosystem. Functions and values of the riparian ecosystem were determined and adverse impacts caused by land use were identified by the Service. Two direct users of the information are the Environmental Protection Agency and Corps. The two agencies will apply the information during their environmental analysis of proposed projects in the floodplain (Sullivan and Richardson 1993). This same approach could be applied to restore the Middle Rio Grande Ecosystem.

To preserve coastal ecosystems, the Service has established the Coastal Ecosystem Program. Coastal ecosystems have enormous ecological complexity and significance, yet they are faced with tremendous pressures from expanding commercial and residential development. These ecosystems are impacted and threatened with waterfront homes, marinas, highways, shopping centers, industrial developments, and runoff from watersheds that contain excessive nutrients and noxious chemicals from agriculture and industrial developments. Eleven ecosystem programs have been established with eleven more proposed (as of January 1995). The program seeks partnerships to carry out restoration projects and involves the public to solve problems. The goal of the program is to conserve biodiversity by perpetuating healthy, dynamic ecosystems. The program is guided by three ecological planning principles:

- Maintain natural ecosystem diversity functions and productivity;
- Promote free-ranging and self-sustaining populations of native species within their historic ranges; and
- Provide for ecologically sound levels of public use, economic benefits, and the enjoyment of natural values.

To achieve ecosystem goals, the Service forms partnerships with other agencies and groups, both public and private. Other Federal agencies that have critical roles in these programs include the Environmental Protection Agency, National Oceanic and Atmospheric Administration and the Corps (USFWS 1995b).

The Service has recently adopted an ecosystem approach nationwide to more effectively achieve its mission of fish and wildlife conservation. This approach will focus activities by all divisions of the Service on goals that restore, preserve, and enhance fish and wildlife and their habitats. To achieve effective organization, teams have been formed to develop goals that will be actively pursued by the Service. The team that involves the Middle Rio Grande in New Mexico is the Upper/Middle Rio Grande Ecosystem Team. The goal that has been developed by the team is to protect, restore, and maintain viable levels of biotic diversity within the Upper and

Middle Rio Grande ecosystem. The Service encourages the Corps to actively participate with the team, and coordinate and design flood control activities to achieve the above goal.

The Service, within the New Mexico Ecological Services Field Office in Albuquerque, has a full time coordinator for activities located in the Middle Rio Grande. This position was a result of the Middle Rio Grande Bosque Initiative. The initiative is a long term interagency cooperative effort which first manifested itself through the continuing support of Senator Pete Domenici (R-NM). There were several iterative stages beginning with the Rio Grande Bosque Conservation Committee. This citizen based, public involvement forum identified a number of activities in a final report submitted to Senator Domenici on June 30, 1993. This report culminated nearly 2 years of efforts of dozens of institutions, public and private, and hundreds of private citizens who participated in the committee's public involvement program.

A part of the Conservation Committee's recommendations also resulted in the development of the "Rio Grande Ecosystem: Bosque Biological Management Plan." The primary authors of the Bosque Biological Management Plan were Dr. Cliff Crawford from the University of New Mexico, and employees of the U.S. Fish and Wildlife Service, the Corps, and the Bureau. Considerable public involvement and review also occurred.

As a result of that effort, the Conservation Committee, and the authorizing agencies, agreed that additional coordination mechanisms could be formed to meet the integrated needs of management policies and practices relating to the Bosque. A group of interested agencies and individuals generally known as the "Bosque Improvement Group" has formed to address concerns in the Middle Rio Grande. The basic aspect of this organization is fostering improved management of the Bosque through traditional means in an inclusive and nonintrusive manner through cooperation.

Inherent in the initiative is the commitment on the part of all of the agencies that participated in the development of the Bosque Biological Management Plan to adopt the concept that there needs to be a substantial and fundamental shift in management approaches to the Rio Grande Ecosystem. The Executive summary stated it succinctly;

> "The Bosque Biological Management Plan was created to mitigate that stress in the Middle Rio Grande Valley from Cochiti Dam to San Marcial and to send a message to resource managers and decision makers that a new approach is needed. The plan's purpose is to determine conditions and to recommend action that will sustain and enhance the biological quality and ecosystem integrity of the Middle Rio Grande bosque, together with the river and floodplain that it integrates."

Toward this end, it is incumbent upon the Corps to seek alternative management scenarios and to incorporate innovative strategies into all of its management activities. The Corps committed to such studies and activities by its participation in the initiative.

In July 1993, four agencies, the Bureau, Service, Corps, and the University of New Mexico, signed a Supplemental Memorandum of Understanding to:

> "...reaffirm the commitment made by the signatory parties in the August 1992 Memorandum of Understanding to cooperatively support and assist in the formulation of a Middle Rio Grande Bosque Biological Management Plan (Plan). In addition it will serve to establish a relationship of continuing coordination in support of the intent of the Plan...."

Many activities that preserve, restore, and enhance habitat in the Middle Rio Grande are outlined in the Bosque Biological Management Plan (Crawford et al. 1993). Recommendations that were presented in that plan are excerpted in Appendix F.

The Service suggests the Corps intensify its coordination of flood control proposals with the Bureau and work toward preservation and enhancement of the Rio Grande ecosystem. With the combined expertise and resources of several agencies, management of the Rio Grande could result in ecosystem benefits as well as flood control and water management.

Following the proposed construction of the San Acacia Levee Project, the Bureau or the Middle Rio Grande Conservancy District would be responsible for maintenance of the levee. However, no description of maintenance criteria to address environmental concerns or river dynamics is provided in the document.

The Bureau is pursuing management options for the LFC Channel and could benefit from the Corps participation, both in the planning and construction phase. However, the Bureau's study is just beginning, and the proposed levee construction could limit future options for management of water in this stretch of the Rio Grande, both in the river and in the LFC Channel. Completion of the levee would discourage changes in the LFC Channel alignment and water operation in the future. After construction of the levee, it is unlikely that the LFC Channel would be moved or the levee would be moved. This would result in the permanent narrowing of the active floodplain.

Within the framework of a comprehensive flood control plan, the Corps should evaluate several alternatives, including at a minimum:

- Water Management - The key to a healthy ecosystem is the proper flow in the river at the correct time. Periodic high and probably low flows are very desirable.

- Floodplain Management - At a minimum, new construction and activities should meet the goals of a future healthy ecosystem, including and the prevention of development in the floodplain. The expansion of the active floodplain should also be pursued.

- Floodplain Evacuation - To prevent damage to structures and activities, human actions and structures should be moved out of the floodplain.

- Flood Proofing - Structures in the floodplain could be individually protected to allow higher flows without damage to the structure.

- Watershed Treatment - A watershed that possesses good water infiltration characteristics and reduced erosion, would reduce peak flows of water and soil. Proper grazing, proper community planning, and revegetation would reduce or eliminate the need for costly flood protection.

The San Acacia Levee Project piece of the Rio Grande flood control project is inadequately addressed in the project documentation provided to the Service. Acceptable analysis of the proposal requires the analysis of impacts not be artificially constrained to only one segment of a levee system that affects the entire Middle Rio Grande; analysis that addresses system impacts on the river from Cochiti Dam to Elephant Butte Reservoir; project evaluation that addresses the linkage of operations of upstream storage facilities with management of the river from Cochiti Dam to Elephant Butte Reservoir. Without such analyses, project documentation does not provide information to determine if adverse impacts to fish and wildlife could be realistically offset by substantial mitigation; and if the project could occur without jeopardy to federally protected and listed species.

Environmental impacts by the proposed project could be reduced if the project were changed. For example, if the length and size of the levee were reduced, then larger flows could still positively influence a larger floodplain. A modification such as this would have to include detailed planning to prevent threats to human safety, and costly damage to structures or activities. Levee overflow areas could be designed to enhance areas outside the levees. Although these outskirt areas would not receive annual hydrologic effects, flooding events may establish a wetland or bosque that could provide fish and wildlife habitat for many years.

Other alterations of levee project proposals could include realignment of the levee that would result in a larger active floodplain, gated water outlets in the levee that would convey water to desirable areas, and tributary overflow areas. The Service has studied the current levee alignment and several areas to the west of the LFC Channel offer promising possibilities for levee realignment to the west, thus resulting in a wider active floodplain. Four areas, totaling 996 ac (403 ha), that are not currently used for agriculture and owned by the government, are located between the dam and the Bosque del Apache National Wildlife Refuge. The location and size of each area is:

Distance downstream from dam	Size of area
2.5 mi (4 km) -	100 ac (40 ha)
4.5 mi (7 km) -	300 ac (120 ha)
7.0 mi (11 km) -	320 ac (130 ha)
28.5 mi (46 km) -	270 ac (110 ha)

Expansion of the active floodplain may also be possible in areas to the west of the present levee immediately downstream of Bosque del Apache National Wildlife Refuge (1,400 ac, 560 ha) and the west bank area immediately upstream of the railroad bridge at San Marcial (2,200 ac, 890 ha). These two areas are privately owned by many individuals. At the present time, salt cedar dominates the area.

Mitigation measures could also be added to the project, assuming the proposed project can be mitigated, to reduce impacts or offset fish and wildlife losses. To properly mitigate losses due to levee construction, it is likely that a combination of mitigation measures will be required. The Service has developed recommendations for this project similar to those presented in the document "Middle Rio Grande Ecosystem: Bosque Biological Management Plan", 1993 (Appendix F). A more detailed description is presented in the Discussion section of this report.

Mitigation measures could include water management, floodplain management, habitat preservation and creation, construction of water management structures, removal of exotic vegetation, controlling human use and livestock, and research.

Project data provided by the Corps have not included discussions of the potential to develop and implement floodplain protection through flow management that would result in channel stability for flood protection purposes. Present water management, including reduced peak releases, irrigation, improper timing of water releases, water salvage attempts, and water drainage has produced an overwhelmingly negative effect upon fish and wildlife and the habitat upon which they depend. Flow regimes determine the structure of the aquatic and terrestrial resources in the river and the land in proximity to a river. Flow regulation in the Rio Grande in Texas has resulted in less diverse fish assemblages and reduced fish numbers (Edwards and Contreras-Balderas 1991). If properly managed, flows have the greatest potential to preserve and create habitat of any single activity. A water regime that approximates the historic flows prior to man's impacts on the river would be beneficial. Water released from Cochiti Lake could provide natural regeneration, thus creating thousands of acres of bosque and wetland for 170 mi (274 km). This management activity would exceed any planned revegetation attempt through plantings and would certainly be less expensive.

Water management strategies to provide flows in the Rio Grande could include:

- **Acquisition of water** - The purchase of water through leases or sales for the purpose of instream flows could provide flows in the Rio Grande. This may also require State legislation changes.

- **Conjunctive ground-water and surface-water use** - The coordinated use of these two water supplies could result in more efficient use of water, thus resulting in a surplus that could be used for river flows. In addition to decreased demands on either resource, water could also be stored for future use.

- **Water use efficiency increases** - An increase in efficiency could result in surplus water that could remain in the river for ecosystem processes.

- **Water rights administration** - The monitoring of water use and water supply would assist in efficient management of water. This activity may also reduce use because of possible overuse of existing water rights.

- **Upstream water management** - Increased flexibility in water releases could occur if water releases in all upstream Rio Grande drainage reservoirs could be better coordinated. Water stored in Abiquiu Reservoir on the Rio Chama has the greatest potential for benefitting the Middle Rio Grande within present legislation. Reservoirs upstream of Abiquiu Reservoir, managed by the Bureau, El Vado and Heron, could also play a part in enhanced flows. Enhanced flows could also be provided by including increased storage and increased flexibility in water releases and storage. This could be achieved through a change in Federal and State authorities or through agreements between water owners and other groups or agencies. The Service strongly encourages the Corps to pursue improved water management to partially offset fish and wildlife losses due to the proposed project.

Presently, high flows exceeding 7,000 to 8,000 cfs (198.14-226.44 cms) would cause damage to structures in the floodplain in the Middle Rio Grande. Higher flows, if allowed to spread to the surrounding floodplain, would greatly benefit aquatic ecosystems by creating a diversity of habitat, both in the active river channel, and in adjacent floodplain areas that would be useful for certain life stages of fish. A variety of hydrologic conditions within the floodplain would also create a diversity of habitat for terrestrial wildlife. Structures that prevent high flows should be identified and appropriate measures implemented to remove them. For example, human residences on the east side of the river near Socorro are located in the 2-year floodplain and should be relocated. Another obvious impediment to high flows is the San Marcial railroad bridge. With the potential for a catastrophic spill should the bridge fail, the Service views this as a serious concern for the overall management of the Rio Grande. The bridge could be raised, or another railroad alignment selected that would allow higher nondamaging flows to pass under or flow through areas created beneath the existing railroad tracks.

Since the LFC Channel removes water from the Rio Grande by seepage or diversion, alternate management and construction activities should be selected that would reduce impacts to the Rio Grande ecosystem. Alternatives could include modification of the operations, realignment of the channel, changing the bed elevation of the channel to prevent water seepage from the river channel, lining the channel to prevent seepage to it, and construction of facilities along the channel that could return flows to the Rio Grande. This last option has been demonstrated to be successful by the Bureau. The Bureau constructed a dam with large, gated culverts in the LFC Channel and constructed a flow-through in the levee. Water was conveyed from the LFC Channel to the river during the spring and summer of 1996. Other locations along the LFC Channel may also be suitable. This suggestion could provide flows to the Rio Grande when flows are minimal or completely lacking.

The Middle Rio Grande ecosystem could benefit from increased floodplain width. Although there are opportunities for this action upstream of the project area, we will restrict our discussion to the project area. If better opportunities occur upstream, they should be pursued. An increased floodplain width could be accomplished by relocation of the proposed levee further to the west. At certain locations, developable land for wildlife is between the LFC Channel and the present levee. If the levee could be relocated to the west close to the LFC Channel, then new land would be subject to the river's hydrologic processes that could create habitat. This situation exists near San Acacia Diversion Dam and downstream near the railroad bridge crossing of the river at Tiffany.

Additional floodplain width could also result from relocation of the LFC Channel and levee to the west. Although this may entail considerable expense, a larger new floodplain area with its inherent management flexibility may make it worthwhile.

Tributary inflows to the Rio Grande provide water, soil, and nutrients to the river and adjacent terrestrial habitats. In addition to these inputs, the hydrologic actions of flow events coupled with soil, physically changed the habitat of the floodplain (Schumm 1977, Lagasse 1980 and 1981). Riverine and vegetation communities, with the associated fish and wildlife, have evolved and established themselves by adapting their life requirements to take advantage of these inputs. In many areas of the Middle Rio Grande this essential requirement of river dynamics has been prevented through flood basin construction in side arroyos, construction of residences and businesses, irrigation and drainage channels, and flood control dams. If side tributaries could be physically reconnected to the river, floodplain fish and wildlife communities would benefit. The reconnection of arroyos to the river could be possible through flow over or under the LFC Channel. The larger arroyos that could be reconnected to the river on the west side include San Lorenzo Arroyo, Canoncito del Puertecito del Lemitar, and Walnut Creek. Arroyos to the south of the project area, also on the west side, include Tiffany Canyon, Spikey Arroyo, Milligan Gulch, and Simon Canyon.

Because of many factors, the active water channel in the Rio Grande has been reduced to a narrow deep trench in many locations. This resultant condition prevents the regeneration of many floodplain-associated species such as willows and cottonwoods. In addition, aquatic organisms that rely upon shallow water habitats for specific life stage requirements can no longer exist in this environment. To restore aquatic and terrestrial habitats, constructed shallow flow-through areas within the floodplain would be very beneficial. Flow-through even for short periods of time, such as several months, could be extremely beneficial for the environment during certain years and could establish regeneration of desirable native vegetation. Areas could be prepared within the active floodplain by salt cedar clearing and providing a channel through drier areas that would allow higher flows to enter and exit. One possible site is the dry floodplain area at the Highway 380 bridge. If flows could be routed through the area to the west of the normal channel, then willows or cottonwoods may become established.

Because a good portion of irrigation water is eventually returned to the river through canals (wasteways), and drains, the water could be used to enhance fish and wildlife habitat. Depending upon water quality and management, wildlife areas could be established within the existing canals, such as riparian planting along the canal; routed to constructed wildlife areas (such as a wetland); or areas on the river bank could be manipulated to provide habitat. Aquatic species such as fish, water birds and waterfowl could benefit from quiet water areas established in the Rio Grande.

Because of the scarcity and high wildlife value of wetlands in the southwest, wetland restoration and creation is desirable. Managed wetlands in areas removed and protected from humans, pets, and livestock would be the most valuable to fish and wildlife. Wetlands established in urban areas would have to be strictly patrolled and protected requiring a substantial financial and time commitment. The easiest method to establish a wetland is to expand an existing one or to allow natural flow regimes to reestablish former wetlands. Wetlands with a variety of water depths, water movement through the wetland, small islands, an irregular water-land interface, and protection of adjacent uplands, are habitat requirements that will produce a diverse healthy wetland.

Mimicking, not duplicating, the natural historic conditions present in the floodplain would benefit fish and wildlife. An improved hydrograph and expansion of the active floodplain (discussed earlier) are critical first steps. Other individual actions such as revegetation, construction of back waters, ensuring pollutant free discharges to the river, controlling use in the floodplain, exotic vegetation removal (discussed later), fire management and revegetation of burned areas would be beneficial. The majority of areas that are burned will naturally revegetate with salt cedar, even if they were originally cottonwood dominated areas (Figure 6). Since this revegetation would eventually lead to a salt cedar dominated floodplain, it is imperative to actively revegetate with native species immediately following a fire. Actions that result in a variety of successional vegetation age classes would ensure habitat for a variety of wildlife. Areas that are owned and managed by public agencies (i.e., City, County, State, Federal) would ensure long term suitability for fish and wildlife. Private land could also provide habitat if conservation easements and deed restrictions were in effect.

Both fish and wildlife require minimum habitat sizes where they can obtain all of their life requirements. Some species require corridors for movement between habitats. If habitats are too small, or are divided by man's activities (such as bridges, roads or other developments) they cannot survive. Barriers are sometimes created that prevent movements, such as diversion dams that are often barriers to fish movement. The reconnection of habitats by expansion of habitat areas or the recreation of travel corridors would benefit fish and wildlife. Additional information on fragmentation is presented in the Impact section of this document.

Figure 6. Salt cedar will quickly colonize burn areas.

Many wildlife species live in upland areas removed from the floodplain but require visits to the river for water, food or shelter. When travel corridors are removed, they can no longer survive. Travel corridors are often vegetated arroyos and drainages that provide cover during wildlife movements to and from the floodplain. The protection and development of these areas would enhance wildlife in the upland areas and the floodplain. Because of the presence of the LFC Channel, arroyos entering the Rio Grande from the west have been blocked, except at two locations. The reconnection of arroyos to the river could be possible through flow over or under the LFC Channel. For specific sites, see the discussion above concerning tributary inflows.

The establishment of exotic plant species in the Rio Grande, primarily salt cedar, Russian olive, and Siberian elm, have altered the naturally diverse ecosystem. The characteristics of these species, especially salt cedar, have altered the channel dynamics and the resultant riparian forming processes. Salt cedar has greatly influenced water management in the Rio Grande. Historic native vegetation relies upon periodic large flow disturbances to establish and survive. Native plants would allow the active river channel to migrate within the floodplain. Salt cedar is very resistant to removal by flow processes because of its extensive root system. To proceed toward a more healthy Rio Grande ecosystem, flow management alone will not change the character of the floodplain. Mechanical removal of salt cedar will be required to establish native vegetation. As a mitigation measure, this action will have considerable benefits to wildlife. In addition to salt cedar, other exotic species such as Russian olive and Siberian elm should be removed. Revegetation with native species, through either preparation of the soil and subsequent timely flows, or actual planting, or a combination of both is required because simple removal will most likely be followed by recolonization by exotic species. Areas dominated by salt cedar could be completely revegetated and areas that contain cottonwood could be selectively cleared of salt cedar. Revegetation efforts should focus in the active floodplain since the chances of success are higher the nearer the area is to flowing water. If the active floodplain can be expanded, the new area should be revegetated with native species. The personnel at the Bosque del Apache National Wildlife Refuge have expertise concerning revegetation and salt cedar removal.

A specific site that may offer the opportunity for salt cedar clearing and revegetation is located on the east side of the river immediately below the Highway 380 bridge. The area close to the river is not used for grazing or agriculture and has an abandoned irrigation ditch (Figure 7). The old ditch could be used for a revegetation site, especially for willows. The area could be cleared and water routed through the area.

Site values for avian species, richness and abundance, are reduced in areas of excessive livestock grazing and human presence (Thompson et al. 1994). Fencing, barriers to vehicle intrusion, and patrolling of areas would improve wildlife habitat. In some cases, human use could improve habitat. For example, in areas that have a high risk of catastrophic fire, the removal of wood could be beneficial. Local groups and municipalities are becoming active in riparian restoration and protection. The Corps may be able to coordinate with these groups to cost share or participate in habitat restoration and protection. In the Socorro area, a group called "Save our Bosque" has been formed and is actively involved along the river. The purpose of the group is to initiate improvements to the Rio Grande and bosque areas within Socorro County. Participants in the group include the City of Socorro, Socorro County, Middle Rio Grande Conservancy District, Bureau of Land Management, Bureau, Service, and local groups such as Future Farmers of America and Romero Tire Company.

Improper livestock grazing can remove vegetation, cause erosion and prevent plant regeneration. Since riparian areas need continual regeneration to remain healthy, it is imperative that native vegetation be protected from livestock. Fencing, the placement of cattle guards, removal of livestock, and implementing a proper grazing plan would prevent adverse impacts.

The Rio Grande ecosystem is very complex. Therefore, to manage the area successfully, research to obtain correct information is mandatory. In addition to established planned research projects, actions that take place within the historic floodplain should be studied and monitored so that future actions can be developed that result in positive impacts to the ecosystem. The identification of the flow quantities required to provide overbank flooding for riparian regeneration at specific sites and spawning flows for the silvery minnow are two important needs.

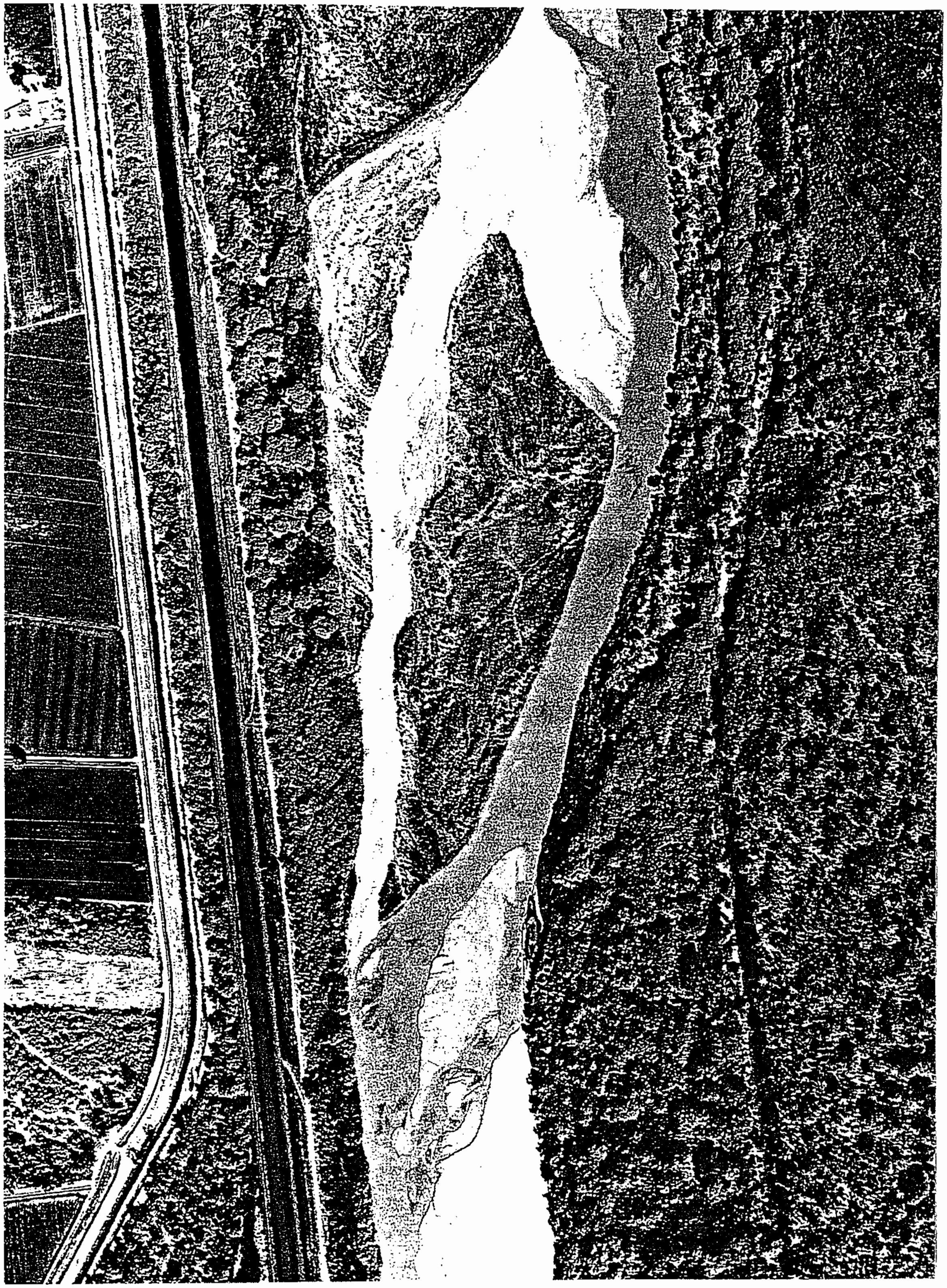


Figure 7. Potential Revegetation Area Downstream of the Highway 380 Bridge.

Additional research needs can be identified by contacting the Middle Rio Grande Coordinator, Mr. Jeff Whitney at the New Mexico Ecological Services Field Office.

Even though a recent vegetation inventory was completed for the Rio Grande in the project area, a more intense vegetation classification should be completed along with an inventory of the entire historic floodplain. For example, areas that are identified with salt cedar and cottonwood as vegetation, could be further refined to include the percent species composition so that areas dominated by salt cedar could be candidates for vegetation clearing and revegetation with native species. The current vegetation classification is limited to the area between the east side escarpment and the LFC Channel levee. If vegetation could be identified in the historic floodplain to the west, mitigation and restoration opportunities could be identified.

To our knowledge, there has been only one bird inventory (Thompson et al. 1994) in the proposed San Acacia Levee Project area. Specific impacts to wildlife cannot be predicted without current, accurate wildlife censuses. High use or unique use areas for wildlife should be identified. Studies should include the entire historic floodplain area.

Because habitat for the southwestern willow flycatcher is severely limited along the Rio Grande, nesting success is very poor, and few birds are present in New Mexico, measures should be included in any flood control project to contribute to the recovery of this species. Suitable vegetation in conjunction with flowing water should be protected and/or enhanced. Please see the Endangered Species section in this document and/or contact Mr. David Leal, New Mexico Ecological Services Field Office, for additional information.

The silvery minnow is in danger of extinction throughout all or a significant portion of its remaining range which is currently limited to the Rio Grande. Therefore, measures should be included in any flood control project to contribute to the recovery of this species. Minimum flows are necessary to support the small remaining populations. Habitat improvement should provide this species with requirements that support all the life stages of this fish, including spawning, fry, juvenile and adult. Please see the Endangered Species section in this document and/or contact the endangered fish biologist in the New Mexico Ecological Services Field Office, for additional information.

Impacts to wintering and migrating bald eagles can be reduced or minimized by avoiding unnecessary damage to the riparian area, especially cutting large trees. Disturbance to bald eagles can be avoided by specific actions. If a bald eagle is observed perching or roosting in the riparian area (usually mid November to mid-March) within 0.25 mi (0.4 km) upstream or downstream of the active project site in the morning before project activity starts, or following breaks in project activity, the contractor will be required to suspend all project activity until the bird leaves of its own volition, or the Corps biologist, in consultation with the Service, determines that the potential for harassment is minimal.

To prevent impacts to the environment, the Corps must comply with State Water Quality Standards during construction projects (New Mexico Water Quality Control Commission 1994). The Corps should consult with the Surface Water Bureau of the New Mexico Environment Department concerning compliance. Water quality should be monitored before, during, and after construction to ensure compliance.

Temporary impacts to water quality may occur due to removal of the existing levees and construction of new levees. In addition, erosion and runoff of silt-laden water into the stream or accidental discharges of uncured concrete, petrochemicals or other contaminants could degrade water quality. Dewatering construction work areas and containing and treating or removing wastewater from concrete batching, vehicle wash down, and aggregate processing would prevent water quality impacts. When dewatering construction areas, stream flow should be maintained at all times downstream of the site. A minimum of stream bed should be disturbed since disturbance could remove fish habitat, disrupt biological activity and cause elevated turbidity that may be detrimental to aquatic organisms.

Limiting construction to periods of low stream flow or low precipitation, protecting temporarily fills from erosion and containing any runoff from construction sites would minimize impacts. Storing and dispensing fuels, lubricants, hydraulic fluids and other petrochemicals above the 100-year floodplain may also reduce adverse impacts. Additional precautions should include: inspecting all equipment daily to ensure there are no leaks or discharges of lubricants, hydraulic fluids or fuels; containing and removing petrochemical spills, including contaminated soil; and, disposing of these materials at an approved upland disposal site.

Permanent structures, construction of access roads and areas for staging, borrow, parking and refueling areas, and work areas could directly impact valuable riparian habitats. Moist soils are particularly susceptible to impacts from heavy equipment. Developing these work areas above the 100-year floodplain and in habitats that are of lesser value to wildlife should decrease impacts. Long-term impacts can be avoided by limiting all permanent project features to the minimum area required, using existing access routes, and selecting less sensitive or previously disturbed areas for any new facilities. Unavoidable project impacts can be minimized by: mowing rather than blading vegetation within construction access and work areas, minimizing the area of surface disturbing activities, prohibiting off-road maneuvering and restricting vehicles from turning around except in designated areas.

Construction activities within the wetted perimeter of the river could degrade water quality. Depositing of only clean, coarse and erosion-resistant fills in the water and employing silt curtains, settling basins or other suitable means would control turbidity. Reasonable precautions, such as pouring concrete in sealed forms and/or behind cofferdams should reduce the risk of accidental discharges into the river. Surplus concrete should not be deposited within the 100-year floodplain.

The stability of the riverbank may be impacted by construction. Using only uncontaminated earth suitable for revegetation with indigenous plant species for backfills would provide more erosion resistance banks in the future. To further reduce impacts, disturbed areas not required for permanent structures nor reserved for future project maintenance should be revegetated following construction with an appropriate mixture of grasses, forbs and woody shrubs suitable to the site. Compacted soils should be scarified prior to planting to promote water retention and seed germination. Revegetation will restore valuable wildlife habitat.

RECOMMENDATIONS

The Rio Grande and adjacent bosque have been impacted and are stressed to the point that the system can no longer sustain itself. The highly controlled river flows and physically modified and reduced river and floodplain, coupled with invading exotic vegetation, have resulted in an ecosystem with reduced biotic diversity and abundance of species. The continued disjointed repair and construction of levees on the Rio Grande will continue this ecosystem degradation. Constructed levees will change the predicted future without the project because it will ensure that the floodplain remains in a severely restricted state. The past adverse impacts to fish and wildlife will continue to result in further habitat degradation. The present plans for levee work in the Corrales, Belen and the San Acacia reaches of the Rio Grande will accelerate and ensure continued degradation. This is of particular concern to the Service because of the lack of integrated analysis of these three parts in the Middle Rio Grande and the small amount of coordination with other work proposed by the Bureau in the river. The entire, complete, flood protection effort affects the Rio Grande to such a comprehensive, indivisible degree that whether the increasing degradation is due solely to one levee or either of its other two counterparts becomes almost moot. The environmental analysis must address all three, together with other aspects of Corps management of the Rio Grande (i.e., Abiquiu and Cochiti dams) in concert with the interrelated actions of Bureau and privately owned facilities.

The present project description for the San Acacia Levee Project will result in environmental degradation of the Rio Grande ecosystem. Project modifications and mitigation suggestions are addressed in detail in the previous Discussion section. The recommendations that follow summarize our concerns.

The U.S. Fish and Wildlife Service recommends that:

1. A comprehensive flood control project should be developed for the entire stretch of the Middle Rio Grande (Cochiti Lake to Elephant Butte Reservoir) that would incorporate ecosystem health and maintenance and the needs of other agencies and groups.

2. Within the comprehensive planning framework, (number 1 above) the Corps should evaluate flood control alternatives that include water management in the Rio Grande basin, floodplain management, floodplain evacuation, flood proofing, and watershed treatment.

3. An alternative, or combination of alternatives, that include levees, should include changes in project design such as (e.g., decreasing the length and size of the levee, realignment of the levee, flow control structures in the levee to convey water to areas outside of the levee, and tributary overflow areas that would transport water and silt over the low flow and levee).

Measures should be added to a modified San Acacia Levee Project that result in an environmentally acceptable project. With the exception of water management, these recommendations are tailored to the Middle Rio Grande. Mitigation recommendations should not be restricted to the physical extent of the San Acacia Levee Project area. Because the current project description would result in unacceptable impacts to fish and wildlife, we have not developed a specific mitigation plan for this project; rather a list of recommendations has been developed that would individually benefit fish and wildlife for your review. We expect to continue to coordinate with the Corps concerning a more acceptable project and will develop, in concert with the Corps, a detailed mitigation plan if an acceptable future project proposal is developed. We also earnestly recommend that the Corps intensely coordinate project analysis with the Bureau.

The single most important impact to the Rio Grande ecosystem has been the change in the flow regime. Protection and restoration of the river system will require suitable flow management. The Service recommends:

4. Water management in the Rio Grande should develop and maintain the riverine and terrestrial habitats, by mimicking the historic and achievable hydrograph. The management of flows from Abiquiu, Jemez and Cochiti reservoirs by the Corps should be pursued for the purpose of protecting and enhancing the aquatic and terrestrial habitats along the Rio Grande.

5. The Corps should coordinate flow management with the Bureau concerning operation of Heron, El Vado, Elephant Butte reservoirs, and especially the operation of the LFC Channel.

6. Physical constraints to higher flows in the Middle Rio Grande (i.e., bridges and floodplain development) should be identified and remedied.

7. Operation of the LFC Channel should be reevaluated with consideration of modified operation, abandonment and/or construction of facilities that return flows from the LFC Channel to the Rio Grande.

The second most destructive activity that has impacted the Rio Grande is the reduction in the active floodplain. The Service recommends:

8. The active floodplain of the Rio Grande should be expanded, by relocation of the levees and/or floodplain management to remove or protect valuable human resources and activities from the floodplain.

Additional recommendations, arranged in no particular order, follow:

9. Improve and/or establish historic tributary inflows (water and soil), especially from the west river bank that have been blocked by levees and/or the LFC Channel.

10. Physically create flow-through areas in the floodplain.

11. Utilize in-place water delivery systems to establish and/or improve riparian and wetland areas.

12. Create wetlands.

13. Aquatic and terrestrial habitats within the floodplain should be enhanced and/or protected.

14. Reduce fragmentation of habitat.

15. Establish travel corridors from uplands to the river for wildlife.

16. Remove exotic plant species in the floodplain and establish native species.

17. Encourage or discourage human uses of the bosque (i.e., limit human use through barriers, or encourage use to benefit wildlife such as wood removal in excessively dense down timber).

18. Control livestock grazing (i.e., construct fences).

19. Gather data and conduct research concerning species habitat requirements, and habitat restoration techniques.

20. A detailed vegetation inventory should be conducted in the San Acacia Levee Project area including the adjacent floodplain and areas upstream and downstream.

21. A wildlife inventory (fish, mammals, birds, amphibians, reptiles) should be conducted in Middle Rio Grande and especially in the San Acacia Levee Project area including the adjacent floodplain and areas upstream and downstream.

22. Recovery measures for the southwestern willow flycatcher (listed as endangered with proposed critical habitat) should be developed and implemented.

23. Recovery measures for the Rio Grande silvery minnow (listed as endangered with proposed critical habitat) should be developed and implemented.

24. If a bald eagle is present in a construction area, work should be suspended or other actions taken to avoid disturbance (see the Discussion section).

25. Impacts to water quality during construction should be avoided and monitored, ensuring compliance with State water quality standards.

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Appendix A. Common and Scientific Names of Mammals Discussed in the Text.

Common Name	Scientific Name
Desert shrew	Notiosorex crawfordi
Desert cottontail	Sylvilagus auduboni
Black-tailed jackrabbit	Lepus californicus
Colorado chipmunk	Eutamias quadrivittatus
Spotted ground squirrel	Spermophilus spilosoma
Rock squirrel	Spermophilus variegatus
Red squirrel	Tamiasciurus hudsonicus
Gunnison's prairie dog	Cynomys gunnisoni
Botta pocket gopher	Thomomys bottae
Yellow-faced pocket gopher	Pappogeomys castanops
Silky pocket mouse	Perognathus flavus
Plains pocket mouse	Perognathus flavescens
Ord kangaroo rat	Dipodomys ordii
Merriam kangaroo rat	Dipodomys merriami
Western harvest mouse	Reithrodontomys megalotis
Deer mouse	Peromyscus maniculatus
White-footed mouse	Peromyscus leucopus
Pinon mouse	Peromyscus truei
Northern grasshopper mouse	Onychomys leucogaster
Hispid cotton rat	Sigmodon hispidus
Norway rat	Rattus norvegicus
New Mexican jumping mouse	Zapus hudsonius luteus
Beaver	Castor canadensis
Muskrat	Ondatra zibethicus
American porcupine	Erethizon dorsatum
Coyote	Canis latrans
Gray wolf	Canis lupus
Gray fox	Urocyon cinereoargenteus scottii
Grizzly bear	Urus arctos
Raccoon	Procyon lotor
Long-tailed weasel	Mustela frenata
Mink	Mustela vison
Badger	Taxidea taxus
Striped skunk	Mephitis mephitis
Jaguar	Felis onca
Bobcat	Lynx rufus
Mule deer	Odocoileus hemionus

Appendix A continued. Common and Scientific Names of Mammals Discussed in the Text.

Common Name	Scientific Name
Yuma myotis	*Myotis yumanensis*
Little brown bat	*Myotis lucifugus*
Long-legged myotis	*Myotis volans*
Silver-haired bat	*Lasionycteris noctivagans*
Big brown bat	*Eptesicus fuscus*
Hoary bat	*Lasiurus cinereus*
Spotted bat	*Euderma maculatum*
Townsend's big-eared bat	*Plecotis townsendii*
Pallid bat	*Antrozous pallidus*
Brazilian free-tailed bat	*Tadarida brasiliensis*

Appendix B. Common and Scientific Names of Amphibians and Reptiles That May Occur in the Rio Grande Floodplain in Sandoval, Bernalillo, Valencia, Socorro and Sierra Counties.

Common Name	Scientific Name
Tiger salamander	Ambystoma tigrinum
Couch's spadefoot	Scaphiopus couchii
Plains spadefoot	Spea bombifrons
New Mexico spadefoot	Spea multiplicata
Great Plains toad	Bufo cognatus
Green toad	Bufo dibilis
Red-spotted toad	Bufo punctatus
Woodhouse's toad	Bufo woodhousii
Canyon treefrog	Hyla arenicolor
Western chorus frog	Pseudacris triseriata
Plains leopard frog	Rana blairi
Bullfrog (introduced)	Rana catesbeiana
Northern leopard frog	Rana pipiens
Yellow mud turtle	Kinosternon flavescens
Snapping turtle	Chelydra serpentina
Painted turtle	Chrysemys picta
Ornate box turtle	Terrapene ornata
Big Bend slider	Trachemys gaigeae
Red-eared slider (introduced)	Trachemys scripta
Spiny softshell	Trionyx spiniferus
Collared lizard	Crotaphytus collaris
Leopard lizard	Gambelia wislizenii
Greater earless lizard	Cophosaurus texanus
Lesser earless lizard	Holbrookia maculata
Texas horned lizard	Phrynosoma cornutum
Roundtail horned lizard	Phrynosoma modestum
Desert spiny lizard	Sceloporus magister
Crevice spiny lizard	Sceloporus poinsettii
Eastern fence lizard	Sceloporus undulatus
Tree lizard	Urosaurus ornatus
Side-blotched lizard	Uta stansburiana
Chihuahuan whiptail	Cnemidophorus exsanguis
Checkered whiptail	Cnemidophorus grahamii
Little striped whiptail	Cnemidophorus inornatus
New Mexico whiptail	Cnemidophorus neomexicanus
Western whiptail	Cnemidophorus tigris
Desert grassland whiptail	Cnemidophorus uniparens
Plateau striped whiptail	Cnemidophorus velox
Many-lined skink	Eumeces multivirgatus
Great Plains skink	Eumeces obsoletus

Appendix B. Continued. Common and Scientific Names of Amphibians and Reptiles That May Occur in the Rio Grande Floodplain in Sandoval, Bernalillo, Valencia, Socorro and Sierra Counties.

Common Name	Scientific Name
Texas blind snake	Leptotypholps dulcis
Western blind snake	Leptotypholps humilis
Glossy snake	Arizona elegans
Trans-pecos rat snake	Bogertophis subocularis
Racer	Coluber constrictor
Ringneck snake	Diadophis punctatus
Great Plains rat snake	Elaphe guttata
Western hooknose snake	Gyalopion canum
Western hognose snake	Heterodon nasicus
Night snake	Hypsiglena torquata
Common kingsnake	Lampropeltis getula
Milk snake	Lampropeltis triangulum
Coachwhip	Masticophis flagellum
Striped whipsnake	Masticophis taeniatus
Bullsnake or gopher snake	Pituophis melanoleucus
Longnose snake	Rhinocheilus lecontei
Big Bend patchnose snake	Salvadora deserticola
Mountain patchnose snake	Salvadora grahamiae
Ground snake	Sonora semiannulata
Plains blackhead snake	Tantilla nigriceps
Blackneck garter snake	Thamnophis cyrtopsis
Wandering garter snake	Thamnophis elegans
Checkered garter snake	Thamnophis marcianus
Common garter snake	Thamnophis sirtalis
Lyre snake	Trimorphodon biscutatus
Western diamondback rattlesnake	Crotalus atrox
Blacktail rattlesnake	Crotalus molossus
Western rattlesnake	Crotalus viridis
Massasauga	Sistrurus catenatus

* Painter, C. 1994. New Mexico Herptofauna. New Mexico Department of Game and Fish. Santa Fe, New Mexico. 12 pp.
Updated with personal communication with C. Painter March 27, 1996.

Appendix C. Common and Scientific Names of Birds Discussed in Text.

Common Name	Scientific Name
Comon loon	Gavia immer
Great blue heron	Ardea herodias
Sandhill crane	Grus canadensis
Whooping crane	Grus americana
Tundra swan	Cygnus columbianus
Mallard	Anas platyrhynchos
Gadwall	Anas strepera
Mountain plover	Charadrius montanus
Forster's tern	Sterna forsteri
Interior least tern	Sterna antillarum
Black tern	Childonias niger
Bald eagle	Haliaeetus leucocephalus
Cooper's hawk	Accipiter cooperii
American kestrel	Falco sparverius
American peregrine falcon	Falco peregrinus anatum
Gambel's quail	Callipepla gambelii
Mourning dove	Zenaida macroura
Black-chinned hummingbird	Archilochus alexandri
Northern flicker	Colaptes auratus
Western kingbird	Tyrannus verticalis
Ash-throated flycatcher	Myiarchus cinerascens
Southwestern willow flycatcher	Empidonax traillii extimus
Cliff swallow	Hirundo pyrrhonota
Barn swallow	Hirundo rustica
Bewick's wren	Thryomanes bewickii
Cactus wren	Campylorhychus brunneicapillus
American robin	Turdus migratorius
Northern mockingbird	Mimus polyglottos
Curved-billed thrasher	Toxostoma curvirostre
European starling	Sturnus vulgaris
Lucy's warbler	Vermivora luciae
Pyrrhuloxia	Cardinalis sinuatus
Black-headed grosbeak	Pheucticus melanocephalus
Blue grosbeak	Guiraca caerulea
Spotted towhee (was Rufous-sided)	Pipilo maculatus
Dark-eyed junco	Junco hyemalis
White-crowned sparrow	Zonotrichia leucophrys
Western meadowlark	Sturnella neglecta
Red-winged blackbird	Agelaius phoeniceus
Brown-headed cowbird	Molothrus ater
Great-tailed grackle	Quiscalus mexicanus
Bullock's oriole (was Northern)	Icterus bullockii
House finch	Carpodacus mexicanus

Appendix D. Common and Scientific Names of Fish Discussed in the Text.

Common Name	Scientific Name
Gizzard shad	*Dorosoma cepedianum*
Rainbow trout	*Oncorhynchus mykiss*
Kokanee salmon	*Oncorhynchus nerka*
Brown trout	*Salmo trutta*
Northern pike	*Esox lucius*
Red shiner	*Cyprinella lutrensis*
Common carp	*Cyprinus carpio*
Rio Grande chub	*Gila pandora*
Rio Grande silvery minnow	*Hybognathus amarus*
Fathead minnow	*Pimephales promelas*
Flathead chub	*Platygobio gracilis*
Longnose dace	*Rhinichthys cataractae*
River carpsucker	*Carpiodes carpio*
White sucker	*Catostomus commersoni*
Rio Grande sucker	*Catostomus plebeius*
Smallmouth buffalo	*Ictiobus bubalus*
Black bullhead	*Ictalurus melas*
Yellow bullhead	*Ictalurus natalis*
Channel catfish	*Ictalurus punctatus*
Western mosquitofish	*Gambusia affinis*
White bass	*Morone chrysops*
Green sunfish	*Lepomis cyanellus*
Bluegill	*Lepomis macrochirus*
Longear sunfish	*Lepomis megalotis*
Largemouth bass	*Micropterus salmoides*
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*
Yellow perch	*Perca flavescens*
Fish species extirpated from the Rio Grande drainage in New Mexico.	
Longnose gar	*Lepisosteus osseus*
American eel	*Anguilla rostrata*
shovelnose sturgeon	*Scaphirhynchus platorynchus*
gray redhorse	*Moxostoma congestrum*
blue sucker	*Cycleptus elongatus*
freshwater drum	*Aplodinotus grunniens*
speckled chub	*Macrhybopsis aestivalis*
Rio Grande shiner	*Notropis jemezanus*
Phantom shiner	*Notropis orca*
Rio Grande bluntnose shiner	*Notropis simus simus*

Appendix E. Common and Scientific Names of Plants Discussed in the Text.

Common Name	Scientific Name
Baccharis	Baccharis spp.
Seepwillow	Baccharis glutinosa
Coyote willow	Salix exigua
Peachleaf willow	Salix amygdaloides
Buttonbush	Cephalanthus spp.
False indigo bush	Amorpha fruticosa
New Mexico olive	Forestiera neomexicana
Black locust	Robinia pseudo-acacia
Boxelder	Acer negundo
Chinaberry	Melia azedarach
Fremont Cottonwood	Populus fremonti
Mulberry	Morus spp.
Russian olive	Elaeagnus angustifolia
Salt cedar	Tamarix pentrandra
Siberian elm	Ulmus pumila
Tree-of-heaven	Ailanthus altissima

Appendix F. Biological management recommendations, Middle Rio Grande Ecosystem, Bosque Biological Management Plan.

The following recommendations are taken directly from the document, pages 160-163 (Crawford et al. 1993).

The team foresees the boundaries of the Middle Rio Grande bosque as not only being protected from development but also expanded in the future. In addition to protection, the restoration and maintenance of ecosystem processes are fundamental to this biological management plan. We envision a perennial Rio Grande whose flows mimic the natural hydrograph to the maximum extent possible, and a river channel that is permitted maximum freedom within the floodway. The attainment of these basic conditions will facilitate the achievement of all other recommendations to enhance the biological quality and ecosystem integrity of the bosque.

Hydrology

Water is the key variable that drives the processes of the riparian ecosystem. Prior to the extensive human changes in the river system, water performed the work of providing habitat, moisture, and nutrients for riparian organisms' reproduction and survival. We believe that water can be managed to allow it to continue to do as much of this work as possible with minimal human interference. Whenever water cannot do its work, people will have to attempt to replace vital, missing functions and processes in the ecosystem. The following three recommendations are closely interrelated and deal with management of surface and ground water in the Middle Rio Grande:

1. Coordinate Rio Grande water management activities to support and improve the bosque's riverine and terrestrial habitats, with special emphasis placed on mimicking typical natural hydrographs.

2. Implement measures to allow fluvial processes to occur within the river channel and the adjacent bosque to the extent possible.

3. Reintroduce the dynamics of surface-water/ground-water exchange, manage ground-water withdrawal, and restrict contamination.

Aquatic Resources

Recommendations about aquatic resources overlap and are related to those for hydrology, but focus on communities and species that are primarily dependent on the presence of surface water either throughout or at critical times during their life history. Water must also be of high enough quality to enable organisms ranging from single-celled to more complex plants and animals to use the resource without toxic effects. In addition to this, recommendations relating to aquatic resources consider habitat and the introduction of nonnative species into the waters of the Rio Grande and associated wetlands. The recommendations are as follows:

4. Protect, extend, and enhance the structure of the aquatic habitat to the benefit of native communities.

5. Protect and enhance surface-water quality.

6. Integrate management of nonnative and native fish species in all aquatic environments in the Middle Rio Grande riparian ecosystem including wetlands, canals, and drains.

Terrestrial Resources

Recommendations affecting terrestrial resources in the riparian ecosystem focus on protection, enhancement, and restoration of communities and habitats in the riparian zone and the floodplain. Human activities have severely impacted these portions of the riparian ecosystem. The effect of water in important ecosystem processes (e.g., disturbance, nutrient cycling, reproduction of native species, etc.) has been reduced by dams and levees that protect a highly developed floodplain. In addition, introduced species have entered plant and animal communities and become major components of the ecosystem. It is in the terrestrial portion of the ecosystem that there are the most visible needs for management, in order to replace the ecosystem processes that have been eliminated or diminished in force and scale and to protect the remaining communities from detrimental human activities. The following recommendations address management needs:

7. Protect the geographic extent of the Rio Grande bosque and avoid fragmentation of the riparian ecosystem and component habitats.

8. Protect, extend, and enhance riparian vegetation in noncontiguous areas in the floodplain.

9. Manage the buffer zone of the contiguous bosque to protect ecosystem processes, enhance wildlife habitat values, and maintain rural and semirural conditions.

10. Manage livestock grazing activities in a manner compatible with biological quality and ecosystem integrity.

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

12. Manage recreational activities in the bosque in a manner compatible with biological quality and ecosystem integrity.

13. Prevent unmanaged fires in all reaches of the bosque.

14. Use native plant species and local genetic stock in vegetation establishment and management efforts throughout the bosque.

15. Protect, enhance, and extend (create) wetlands throughout the Middle Rio Grande riparian zone.

16. Sustain and enhance existing cottonwood communities, and create new native cottonwood communities wherever possible throughout the Middle Rio Grande riparian zone.

17. Contain the expansion of existing large stands of nonnative vegetation in the Middle Rio Grande riparian zone. At the same time, study the ecology of these stands and develop creative ways of maximizing their biological values.

Monitoring and Research

Monitoring to determine the effects of management actions is vital to the implementation of all recommendations included in this document. In addition, monitoring studies are needed to assess the ecological trends in the bosque over a long period of time as well as to provide information about the life histories of individual species. Monitoring information can be used in developing research goals that specifically address management problems. Research related to management questions should be pursued, but research addressing purely scientific goals should also be encouraged. Both research approaches will generate information that can be applied to management issues. We have made two recommendations relating to these topics:

18. Develop a coordinated program to monitor biological quality (with emphasis on diversity and abundance of native species) and ecosystem integrity (with emphasis on restoring the functional connection between the river and riparian zone) of the Middle Rio Grande ecosystem.

19. Develop a coordinated research program to study the ecological processes and biotic communities that characterize the Middle Rio Grande riparian ecosystem.

Implementing and Revising the Biological Management Plan

Management of the Middle Rio Grande as an ecosystem requires an integrated approach. The key factors in this approach are communication among agencies and other management entities and coordination of activities that have to do with the river, riparian zone, and floodplain. Monitoring and research generate data that need to be compiled and analyzed for application to future management activities, management plan revisions, and guidance for research.

20. Regularly review and update the Middle Rio Grande Ecosystem: Bosque Biological Management Plan.

The Middle Rio Grande—Part of a Larger Riparian System

The Middle Rio Grande is only a portion of the total river system, and includes a small fraction of the entire watershed. This part of the river is dependent on what enters the system upstream, and how we manage our section affects the river downstream. While we have attempted to take an ecosystem approach to management of the Middle Rio Grande, we recognize that to be truly comprehensive, the whole river and its watershed should be included. The final recommendation deals with how this management plan could be readily adapted to fit into a larger management scheme for the entire Rio Grande.

21. Integrate resource management activities along the Rio Grande and within the contributing watersheds to protect and enhance biological quality and ecosystem integrity.