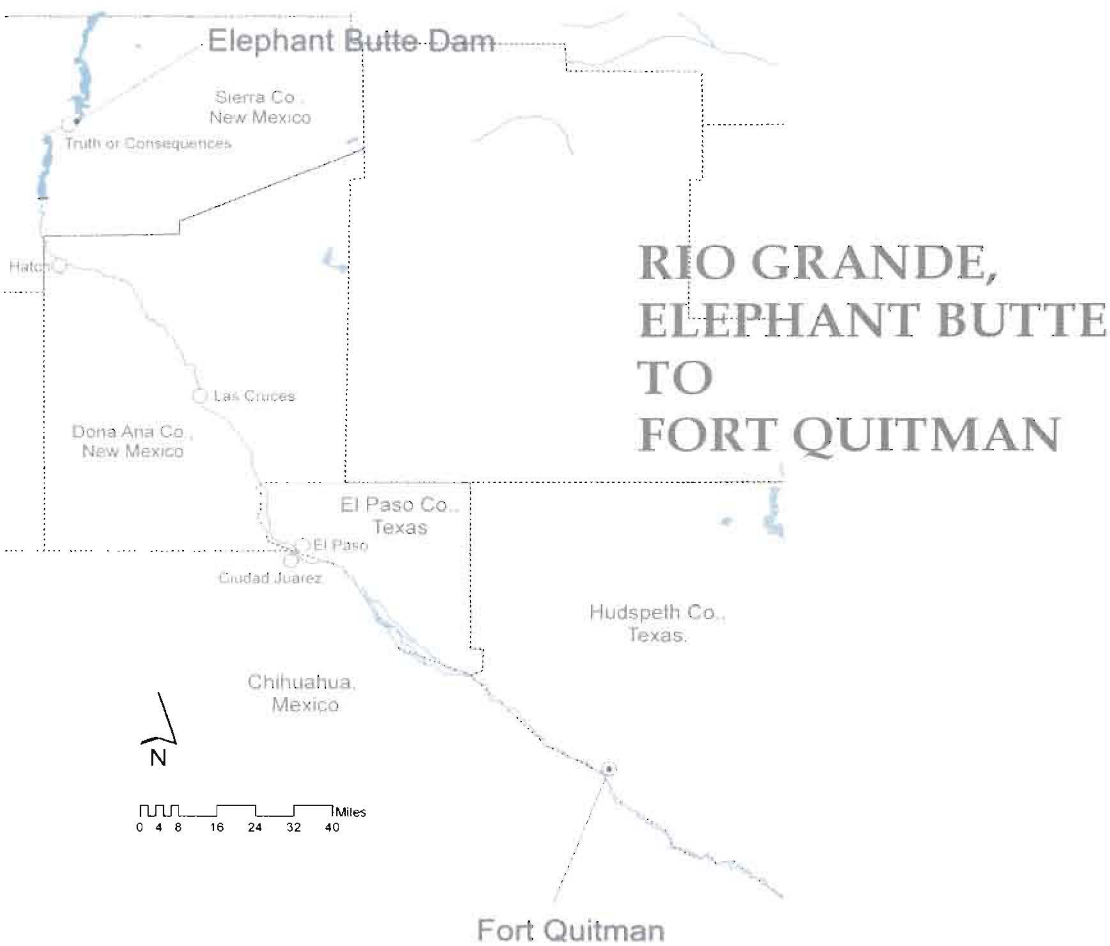
Paso del Norte Watershed Integrated River Restoration Plan

DRAFT

Proposal for Plan Development



Balancing Stakeholder Needs

ENVIRONMENT • COMMUNITIES • AGRICULTURE

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INTRODUCTION

To look at the Rio Grande between Elephant Butte Dam and Fort Quitman today is to look at a disabled ecosystem. Much like a person who has suffered terrible injury, the Rio Grande is in critical need of care and rehabilitation. The history of our relationship with the Rio Grande has been a story of maximizing its utility with little to no regard for its intrinsic value. However, we have grown culturally to recognize the intrinsic value of natural ecosystems, and it is not too late to focus our attention on the Rio Grande and begin maturing our relationship with it to one of enlightened respect and care.

> *"Clearly we do love our great water bodies: We flock to them to live, work, and to play. They are part of our heritage, part of our consciousness. Let us vow not to let their glory pass from this good Earth."*
>
> William K. Reilly, Administrator of the Environmental Protection Agency, 1990

The Paso del Norte Watershed Restoration Project Area

This proposal addresses development of a restoration plan for the Paso del Norte Watershed, which includes the segment of the Rio Grande extending from Elephant Butte Dam in Sierra County, New Mexico to Fort Quitman in Hudspeth County, Texas (Figure 1), hereinafter referred to as the project area or simply as the Rio Grande. This reach of the Rio Grande comprises about 186 miles, including about 86 river miles in New Mexico, mostly in Doña Ana County, and 100 river miles in El Paso and Hudspeth counties, Texas. The portion of the Rio Grande in Texas constitutes the international border with Mexico.

What Have We Lost?

Knowledge of the ecological status of the Rio Grande in the project area is essential to understand the degree of ecosystem degradation that has occurred.[1] Without such knowledge, one may look at the Rio Grande and think "its not that bad" or "its always been like this."

But the Rio Grande hasn't always been like this. Consider just three features of the riverine ecosystem: the fish community, riparian and wetland vegetation, and avifauna.

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[1] Discussion of the ecological status of the Rio Grande from Elephant Butte Dam to Fort Quitman is not intended to imply that restoration is defined by ecological authenticity alone. Rather, restoration, in the context of the Rio Grande, refers to balancing of ecosystem integrity with the instrumental value of the river.

Figure 1. Location of the Paso del Norte Watershed Restoration Project Area. The yellow-shaded area shows the boundaries of the watershed in the U.S.

Native Fishes The native fish fauna of the Rio Grande in the reach from Elephant Butte to Fort Quitman likely consisted of about 29 species (Table 1). This diverse fish community included species from 10 families. Included in the native fish community of the Rio Grande were big-river species such as shovelnose sturgeon, longnose gar, blue sucker, smallmouth buffalo, blue catfish, flathead catfish, and freshwater drum.

These big-river fishes required the diversity of habitats provided by an unregulated, naturally-functioning Rio Grande: deep pools, swift-flowing chutes, riffles, and quiet backwaters. The capability for these species to move throughout long stretches of the river to find preferred habitats was an essential feature for their survival, given the dynamic nature of the river channel and the natural variability in stream flows. In river ecosystems such as the Rio Grande, these big-river fishes are akin to large mammals in terrestrial ecosystems, such as grizzly bear, and may aptly be considered umbrella species.

For example, blue catfish are known to move seasonally to areas with suitable water temperature (Pflieger, 1975: 213), and shovelnose sturgeon, blue sucker, and freshwater drum all exhibit spring movements or migrations to spawning habitats (Lee *et al.*, 1980: 396; Pflieger, 1975: 325; Smith, 1979: 13, 148). Flathead catfish exemplifies the habitat requirements of native big-river fishes in the Rio Grande and the umbrella species qualities of these fishes. Flathead catfish exhibit large-scale movements on a seasonal basis and require unfragmented big-river habitats (*e.g.* Vokoun and Rabeni, 2005). Flathead catfish still occur in the project area but are uncommon. The species persists in Elephant Butte Reservoir, where the state record flathead catfish, weighing 78 pounds, was caught in 1975.

Figure 2. Flathead catfish is a large predator native to the Rio Grande. It requires deep, quiet pool habitat and tolerates turbid water.

The native fish fauna also included a suite of five minnow species (family Cyprinidae) adapted to the main-channel habitats of the Rio Grande. These species included Rio Grande silvery minnow, speckled chub, Rio Grande shiner, phantom shiner, and Rio Grande bluntnose shiner (Table 1).

Table 1. Status of the native fish fauna in the Elephant Butte to Fort Quitman reach of the Rio Grande. A blank in the "**Status**" column indicates species that still occur in the river. The note **(Caballo)** in the "**Status**" column indicates that these species may persist only in Caballo Reservoir and no longer occur in the river. The note **(Below El Paso)** in the "**Status**" column indicates that these species are native to the reach of the Rio Grande downstream from El Paso. Sources are Lee *et al.* (1980), Miller (1977), Stotz (2000), and Sublette *et al.* (1990).

COMMON NAME	SCIENTIFIC NAME	STATUS
shovelnose sturgeon	*Scaphirhyncus platorhynchus*	Extirpated
longnose gar	*Lepisosteus osseus*	Extirpated
American eel	*Anguila rostrata*	Extirpated
gizzard shad	*Dorosoma cepedianum*	
Mexican tetra	*Astyanax mexicanus*	Extirpated
red shiner	*Cyprinella lutrensis*	
roundnose minnow	*Dionda episcopa*	Extirpated
Rio Grande chub	*Gila pandora*	Extirpated
Rio Grande silvery minnow	*Hybognathus amarus*	Extirpated
speckled chub	*Macrhybopsis aestivalis*	Extirpated
Rio Grande shiner	*Notropis jemezanus*	Extirpated
phantom shiner	*Notropis orca*	Extinct
Rio Grande bluntnose shiner	*Notropis simus simus*	Extinct
fathead minnow	*Pimephales promelas*	
longnose dace	*Rhinichthys cataractae*	
river carpsucker	*Carpiodes carpio*	
blue sucker	*Cycleptus elongatus*	Extirpated
smallmouth buffalo	*Ictiobus bubalus*	
grey radhorse	*Moxostoma congestum*	Extirpated
blue catfish	*Ictalurus furcatus*	Extirpated (Caballo)
channel catfish	*Ictalurus punctatus*	(Below El Paso)
Chihuahua catfish	*Ictalurus* sp.	Extirpated
flathead catfish	*Pylodictus olivaris*	
mosquitofish	*Gambusia affinis*	(Below El Paso)
green sunfish	*Lepomis cyanellus*	(Below El Paso)
bluegill	*Lepomis macrochirus*	
longear sunfish	*Lepomis megalotis*	(Below El Paso)
largemouth bass	*Micropterus salmoides*	(Below El Paso)
freshwater drum	*Aplodinotus grunniens*	Extirpated

These five minnow species all had a similar reproductive strategy that was uniquely adapted to the fluctuating environmental conditions of the Rio Grande. All of these species were broadcast spawners, which means that eggs were released and fertilized in the water column. Furthermore, the fertilized eggs were semi-bouyant, which means that they would float downstream with the current as they developed (Platania and Altenbach, 1998).

As shown in Table 1, only 13 of the original 29 native fish species are left in the Elephant Butte to Fort Quitman reach of the Rio Grande. The big-river and the main-channel minnow groups have suffered the greatest losses, due to habitat fragmentation, channelization of the river and resulting loss of habitat diversity, and regulation of river flows. Of the big-river fishes, only flathead catfish and smallmouth buffalo remain. The main-channel minnow group, composed of five species, has been completely eliminated from this reach of the Rio Grande.

The native and introduced fish species that are common in the river today are those able to persist in reservoirs or those that are able to tolerate extreme environmental conditions such as high water temperatures, low dissolved oxygen concentrations, and high salinity levels.

Riparian and Wetland Habitats Prior to large-scale settlement and widespread conversion of land to agricultural uses, the floodplain of the Rio Grande supported extensive and diverse riparian and wetland habitats. Two notable features of the historic floodplain vegetation were cottonwood forests and palustrine wetlands (*cf.* Cowardin *et al.*, 1979: 10).

Patches of cottonwood forest of varying sizes with trees of different age classes were a common feature of the riparian vegetation along the Rio Grande. Stotz (2000: 24-27) summarized historical accounts of cottonwood forest in the project area, which included descriptions of cottonwood stands extending several hundred yards from the river bank.

Figure 3. The canopy of mature cottonwood trees in a gallery forest along the Rio Grande.

Cottonwood stand structure ranged from late-successional orchard-like woodlands with an open understory to dense, early successional stands dominated by willows and cottonwood saplings (Stotz, 2000: 27).

Oxbows, sloughs, and other floodplain wetland habitats with hydrology maintained by high groundwater levels and overflow of flood waters were a relatively common and distinctive feature along the Rio Grande. Some of these wetlands were prominent features of the valley landscape, such as an oxbow in the vicinity of the present-day community of Hatch in the Palomas Valley, which was described in 1851 as extending for more than a mile (Stotz, 2000: 21). Oxbows and sloughs were common on the floodplain in the Mesilla and El Paso valleys in the mid to late 1800s (Stotz, 2000: 21-22).

Changes in riparian and wetland vegetation along the Rio Grande have been dramatic. Cottonwood forest and palustrine wetlands have been virtually eliminated from most of the project area. For example, about 40% of the floodplain vegetation in the Mesilla Valley in 1857 consisted of cottonwood stands, palustrine wetlands, and willow thickets (Figure 4). Only about 24% of the floodplain was under cultivation in 1857, and river channel comprised another nine percent of the floodplain (Figure 4). By 1999, over 87% of the floodplain was under cultivation and cottonwood stands declined to cover only about 0.2% of the floodplain. In 1857, palustrine wetlands covered 1.9% of the floodplain, but by 1999 they had been eliminated from the Mesilla Valley.

In addition to elimination of native riparian and wetland vegetation, salt cedar was introduced into the project area and became established in the early 1900s (Stotz, 2000: 32). Salt cedar often forms dense, monotypic stands in riparian zones and eventually replaces native plant species. Salt cedar has now become a dominant woody species along the Rio Grande throughout most of the project area.

In summary, wetland and riparian habitats along the Rio Grande have been greatly diminished. Current conditions represent a significant loss of habitat diversity.

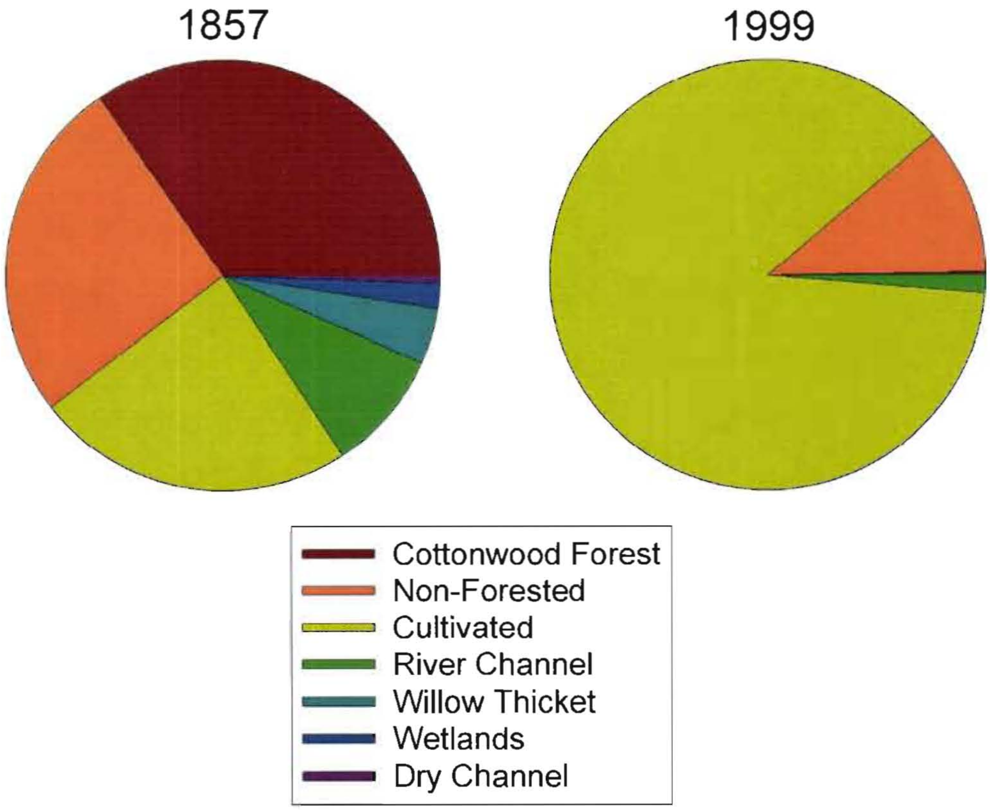


Figure 4. Changes in vegetation of the Rio Grande floodplain in the Mesilla Valley, 1859 to 1999 (data excerpted from Stotz, 2000: 33-34).

Avifauna The Rio Grande corridor is a significant migratory route for birds and native riparian and wetland habitats along the river historically provided important breeding habitat for many species (Leal *et al*, 1996; Wauer, 1977). Of the 155 species of breeding birds that may occur along the river, 37% are restricted to riparian, wetland, or aquatic habitats (Stotz, 2000). Habitats dominated by cottonwood and other native woody riparian plants, as well as emergent wetland habitats, were important habitats for breeding birds along the river (Leal *et al*., 1996).

The native avifauna of the Rio Grande included riparian-obligate breeding bird species such as Yellow-billed Cuckoo (*Coccyzus americanus*), Summer Tanager (*Piranga rubra*), Lucy's Warbler (*Vermivora luciae*), and Southwestern Willow Flycatcher (*Empidonax traillii extimus*).

Figure 5. Summer Tanager occurs in mature cottonwood forest.

These species require a variety of habitats that exemplify a healthy riparian ecosystem. For example, Yellow-billed Cuckoo occurs in later seral stages of cottonwood and willow communities with a dense understory. Summer Tanager and Lucy's Warbler are found in late-seral stage, mature cottonwood forest habitat, while Southwestern Willow Flycatcher occurs in dense, early-successional stands of willow.

Palustrine wetland habitats along the Rio Grande provided habitat for a variety of long-legged wading birds, shorebirds, waterfowl, and other species. Some characteristic birds of these palustrine wetlands include American Bittern (*Botaurus lentiginosus*), Little Blue Heron (*Egretta caerulea*), and American Avocet (*Recurvirostra americana*). American Bittern nests in tall emergent vegetation, such as cattail (*Typha angustifolia*), in wetlands with shallow water depth. Little Blue Heron is a colonial species, often found in association with Snowy Egret (*Egretta thula*), and nests in dense stands of trees or shrubs in wetland areas. In contrast, American Avocet is associated with early-successional wetland sites that are sparsely vegetated.

Widespread loss of native riparian cottonwood woodlands, willow thickets, and palustrine wetlands in the project area has caused a corresponding decline in bird species diversity and abundance. For example, mowed floodplain areas, which characterize most of the Mesilla Valley portion of the project area, support very few species of birds and have low bird abundance compared to habitats dominated by cottonwood and willow (Leal *et al.*, 1996).

The loss of ecological integrity described above, in terms of native fishes, riparian and wetland vegetation, and avifauna, is the direct result of past river management. This management has fragmented and eliminated riverine and riparian habitat, altered river flow regimes, and eliminated the channel dynamics that created and maintained habitat diversity.

Water Development Projects and Their Ecological Impacts

Water development projects have had an enormous impact on the ecological integrity of the Rio Grande in the project area. By the 1890s, diversions in the upper and middle Rio Grande began to significantly deplete river flows in the project area. This situation, together with a treaty agreement to supply 60,000 acre-feet of Rio Grande water annually to Mexico, initiated development of the Rio Grande Project in the early 1900s (Autobee, 1994).

The Bureau of Reclamation's Rio Grande Project consists of two large dams on the river, six diversion dams (four on the Rio Grande and two on tributary arroyos), 141 miles of canals, 462 miles of laterals, 457 miles of drains, and various flumes and siphons. Project features were constructed from about 1908 through 1938 (Table 2). The Rio Grande Project radically altered the natural flow regime and allowed for unprecedented control of the river. Spring snow-melt peak flows were captured and stored behind Elephant Butte Dam. Releases from the dam were metered carefully to maximize water use for irrigation. Water was withdrawn at diversion dams and conveyed away from the river channel through a complex network of canals, ditches, laterals, and drains.

Table 2. Main-stem dams of the Rio Grande Project.

Dam	Completion Date
Leasburg Diversion Dam	1908
Elephant Butte Dam	1916
Percha Diversion Dam	1918
Mesilla Diversion Dam	1919
Riverside Diversion Dam	1928
Caballo Dam	1938
American Dam	1938

With the elimination of flood events, channel-forming flows, and natural base flow conditions, the entire ecology of the river began to unravel.

The next major impact to the river came with the International Boundary and Water Commission's Rio Grande Canalization and Rectification projects. The Rio Grande Rectification Project was constructed from 1934 through 1938 to straighten and stabilize the river, which serves as the international boundary between the U.S. and Mexico, and to provide flood control for adjacent communities. The Rectification Project involved dredging of the river channel, leveling of the floodplain, and construction of levees along the river in El Paso and Hudspeth counties, Texas and along the river in Mexico..

The Rio Grande Canalization Project was constructed between 1938 and 1943 (International Boundary and Water Commission, 2003). This project involved straightening of the river channel, channel dredging, localized bank armoring using rip-rap, and construction of levees from Percha Dam downstream to American Dam (a distance of about 105 river miles). Additionally, maintenance of the project involved removal of riparian vegetation within the floodway defined by the levees.

Runoff from storm water from major tributaries to the river in New Mexico was arrested with construction of flood control and sediment retention dams. Retention dams were constructed in the 1970s on Broad Canyon, Green Canyon, Arroyo Cuervo, and Berrenda Arroyo. These structures resulted in reduction of flood peak frequency in the Rio Grande by an estimated 40%.

Construction of the Canalization and Rectification projects resulted in loss of in-stream habitat diversity through channel dredging and straightening and loss of riparian vegetation. These impacts, coupled with strict regulation of river flows and tributary inputs, left the Rio Grande ecosystem in critical condition.

Figure 6. Elephant Butte Dam.

A PLAN FOR ACTION

The previous discussion of the current ecological condition of the Rio Grande makes obvious the need for ecological restoration action. It is clear that the time for reinvesting in this neglected segment of the river has come. Despite the current condition, the potential for gradually restoring the ecological health of the river is great.

What Are the Benefits of Restoration?

> *"Ecological principles show that, for the long term, maximum productivity coincides with a healthy, esthetically pleasing environment."*
>
> Richard Carpenter, 1971

Restoring ecological health to the Rio Grande would have multiple benefits. In terms of instrumental value, ecological restoration would improve the long-term productivity of the river ecosystem. Consequently, restoration would enhance sustainable human uses of the river that pertain to water quality, recreation, bird and wildlife viewing, fishing and hunting, and aesthetic qualities of the river corridor. But perhaps more importantly, the ecological health of the Rio Grande is inextricably tied to our own health and integrity. Mark Sagoff, President of the International Society of Environmental Ethics and a senior research scholar in the environment and environmental ethics at the University of Maryland School of Public Policy, explained that ecosystem health "goes to our identity more than to our interests - to who we are, not just what we want" (Sagoff, 1992: 70).

Why Develop a Plan?

As described in the following section, stakeholders in conservation and management of the Rio Grande are many, and their objectives and interests in the river are diverse. An integrated plan is needed to coordinate restoration efforts, maximize benefits, avoid duplication, and discourage implementation of projects that work at cross-purposes.

Some of the primary reasons for developing an integrated river restoration plan are to: 1) define river restoration goals and objectives; 2) assemble initial inventories of river characteristics related to restoration; and 3) prioritize restoration strategies and tasks. Ecological restoration of the Rio Grande in the project area may be best served by adopting an incremental approach that begins with implementation of tasks to achieve widely accepted goals (*cf.* Riley, 1998: 75-82). Small actions are more readily undertaken and accomplished than large-scale, master-plan projects, and can bolster credibility and support in the overall restoration effort. However, for these small incremental actions to have a cumulative impact, they need to be coordinated and integrated. This is the primary purpose of the restoration plan.

Figure 7. Wetlands in the Rio Grande at the confluence of the Picacho Drain at Mesilla, New Mexico.

STAKEHOLDERS

Ecological restoration of the Rio Grande from Elephant Butte to Fort Quitman involves numerous stakeholders ranging from federal government agencies with well-defined management responsibilities to citizen's groups interested in the river (Table 3).

The Paso del Norte Watershed Council

The Paso del Norte Watershed Council includes many of the stakeholders in the project area. The Council was established in September 2000 to advise the New Mexico-Texas Water Commission regarding the selection, planning, and implementation of environmental enhancements and mitigation associated with the El Paso-Las Cruces Regional Sustainable Water Project . The purpose of the Council is to investigate, develop, and recommend options for watershed planning and management and explore how water-related resources can best be balanced to benefit the Rio Grande ecosystem and the interests of all watershed stakeholders.

The Paso del Norte Watershed Council aims to improve the Rio Grande ecosystem while balancing the needs of all stakeholders. It provides an open and inclusive forum for communication, collaboration, and innovative thinking among binational stakeholders to achieve a healthy watershed in the reach of the Rio Grande Elephant Butte Dam and Fort Quitman.

The primary goals of the Council are to:

- support watershed planning and management;
- select and support restoration and enhancement projects in the watershed;
- facilitate communication among stakeholders and within the Council;
- provide education and outreach to the general public and to Council members; and
- support efforts to monitor and improve water quality.

Table 3. Members of the Paso del Norte Watershed Council (marked with an asterisk) and other stakeholders in the Paso del Norte Watershed.

City of El Paso*	City of Las Cruces*
Community of El Paso*	El Paso Water Utilities*
El Instituto Municipal de Investigaciónes y Planeación (IMIP)*	El Paso League of Women Voters*
Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP)*	Environmental Defense*
International Boundary and Water Commission (U.S. and México)*	New Mexico Department of Agriculture*
New Mexico Water Resources Research Institute*	New Mexico State University*
Rio Grande/Rio Bravo Basin Coalition*	Southwest Environmental Center*
Texas A&M University Agricultural Research & Extension Center*	University of Texas at El Paso*
Texas Tech University Health Sciences Center*	Bureau of Reclamation*
Universidad Autónoma de Ciudad Juárez*	U.S. Fish and Wildlife Service*
U.S. Army - Fort Bliss Directorate of Environment*	World Wildlife Fund*
Ysleta del Sur Pueblo*	New Mexico State Parks
Hudspeth County Conservation and Reclamation District	U.S. Army Corps of Engineers
New Mexico Department of Game and Fish	Texas Parks & Wildlife
El Paso Water Improvement District #1	New Mexico Office of the State Engineer
New Mexico Department of Transportation	New Mexico Environment Department
Elephant Butte Irrigation District	Citizens in the Watershed
New Mexico-Texas Water Commission	Fort Selden Water Company
Doña Ana Mutual Domestic Water Consumers Association	Jornada Water Company
Leasburg Mutual Domestic Water Consumers Association	El Paso Water Utilities
Picacho Mutual Domestic Water Consumers Association	
Border Environment Cooperative Commission	

PREVIOUS PLANNING EFFORTS

Several planning and research efforts related to restoration of the Rio Grande have been undertaken. These efforts are very useful as contributions to restoration planning; however, none of them is sufficient to guide an integrated, watershed-scale restoration program.

Previous ecological restoration planning efforts in the project area have been associated primarily with mitigation for water development actions, such as the International Boundary and Water Commission's Environmental Impact Statement for the Rio Grande Canalization Project (International Boundary and Water Commission, 2004). The Canalization Project EIS included a "targeted river restoration alternative" that included components such as reduced mowing of the floodplain, planting of native vegetation, limited meander restoration, modified arroyo dredging, and other measures. The El Paso - Las Cruces Regional Sustainable Water Supply Project Environmental Impact Statement, completed in 2000, included mitigation measures for fish and wildlife totaling two percent of the project construction costs. A list of priority fish and wildlife enhancement projects was developed.

There are other efforts that, while not constituting restoration planning, could provide important information for developing an integrated restoration plan for the Rio Grande. The U.S. Army Corps of Engineers is currently developing the Upper Rio Grande Water Operations Model, which is a computer model for simulating water storage, delivery operations, and flood control in the Rio Grande. This project also includes two dimensional aquatic habitat modeling that will allow for an analysis of habitat conditions under various flow regimes.

The Paso del Norte Watershed Council's Coordinated Database Project synthesizes water-related data for the watershed to facilitate data sharing and access, with a goal to enhance water resources management in the project area. Currently, data from six federal, three state, and three regional/local agencies are available. The World Wildlife Fund commissioned preparation of a report titled *Historic Reconstruction of the Ecology of the Rio Grande/Rio Bravo Channel and Floodplain in the Chihuahuan Desert* (Stotz, 2000), which provides valuable information for developing reference conditions for ecological restoration. Additionally, in 2003 the Alliance for Rio Grande Heritage and the World Wildlife Fund commissioned development of a document titled *Hope for a Living River, A Framework for a Restoration Vision for the Rio Grande*, which identified issues, needs, and opportunities for restoration.

SCOPE OF WORK

An integrated restoration plan for the Rio Grande from Elephant Butte Dam to Fort Quitman would be developed that would include the following elements.

Introduction

The introduction would include a statement of the benefits of restoring the Rio Grande in the project area and a concise discussion of restoration and what it means. The geographic area addressed by the restoration plan would also be identified in the introduction.

Existing Conditions

This section would include a geographic analysis of the project area that identifies, at a coarse-grain level, floodplain vegetation communities in the project area and other important features, such as wastewater treatment facility effluent discharge points, drain returns, flood control dams on tributaries, diversion dams, siphons, etc. Appropriate base maps, such as recent aerial photography, would provide the basis for this preliminary analysis of existing conditions.

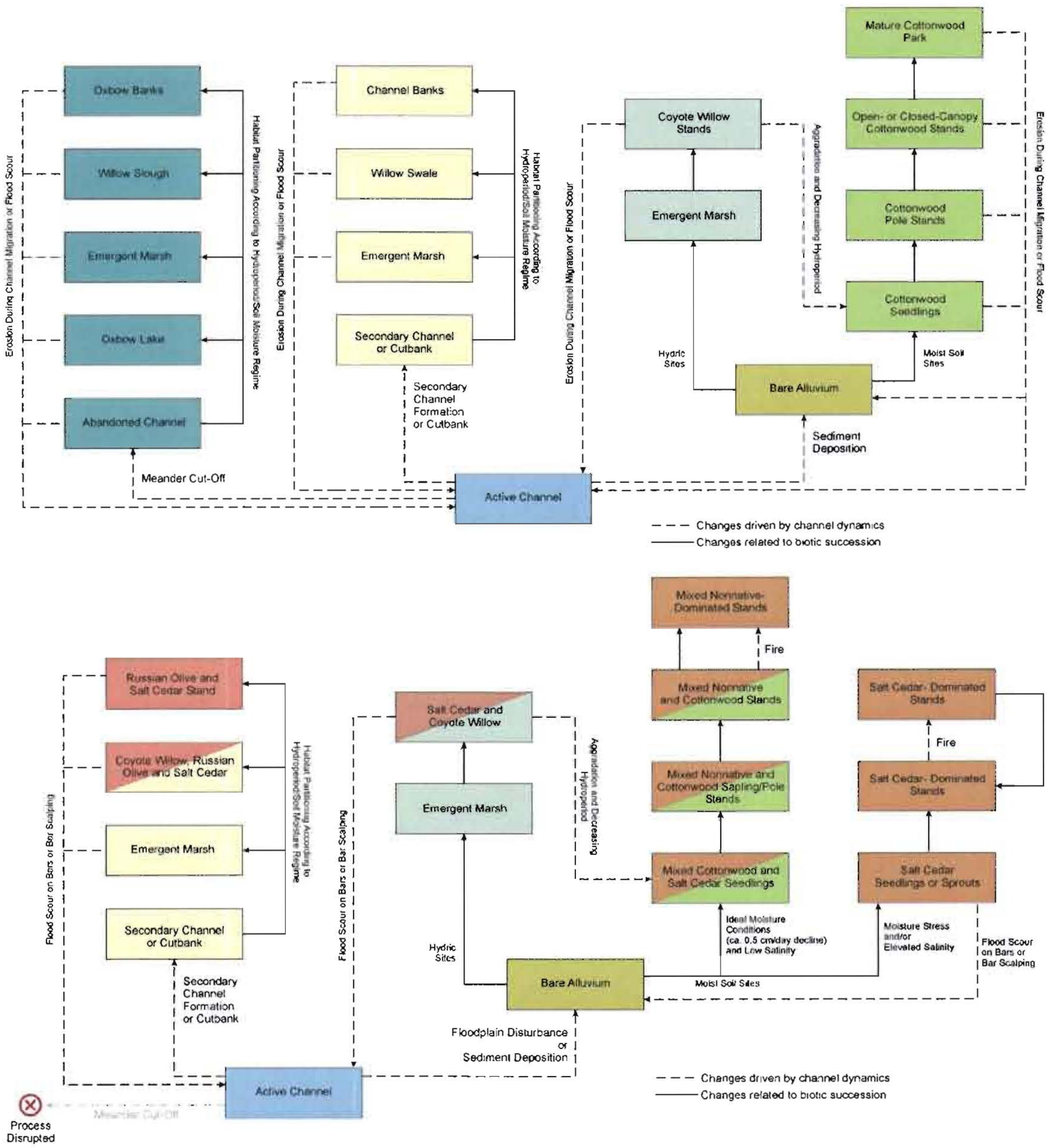
Description of Stressors

A description of the stressors to the river ecosystem that should be addressed in restoration would be presented. For example, the effect of floodplain mowing on vegetation dynamics could be discussed as an important stressor that limits potential for establishment of native riparian vegetation. Other important stressors that may be discussed could include water quality, water management and hydro-modification, physical impacts to the channel, and others.

Restoration Goals

Restoration goals would be defined as ecosystem reference conditions or a reference model of the ecosystem (*cf.* Egan and Howell, 2001: 5). Reference conditions or the reference ecosystem model would be developed using historical information and published research on similar riverine ecosystems. For example, a model of riparian vegetation patch dynamics, adapted from Richter and Richter (2000), was developed for the Rio Grande *bosque* in Albuquerque to describe how existing conditions deviated from probable natural conditions, thus providing a basis for developing goals for restoration (Figure 8; Pittenger, 2003).

Figure 8. Conceptual models of riparian vegetation patch dynamics in a naturally functioning *bosque* ecosystem (above) and in a modified *bosque* ecosystem (below) in Albuquerque, New Mexico (from Pittenger, 2003).



Identification and Prioritization of Strategies

Once goals (*i.e.* reference conditions) have been identified, strategies for achieving those goals would be defined and prioritized. Because the Rio Grande in the project area was historically a dynamic system, both spatially and temporally, an effective strategy may be to use a geographically explicit framework with categorization and delineation of river and floodplain areas into "conservation zones," such as "core zones," "habitat conservation zones," and "multiple use zones." In this example, core zones would be areas that have relatively high ecological function or have the potential to be restored to high ecological function. These "core zones" would serve as refuge sites that could provide propagules or organisms for recolonization of or dispersal to other areas. Site-specific restoration strategies could then be defined for these sites based on their individual needs. The "habitat conservation zones" could include most of the river and floodplain outside of core areas which is not developed, while the "multiple use zones" could include developed sites such as playgrounds and park facilities, bridges, diversion dams, etc.

An example of a core area is the recently designated Mesilla Valley Bosque State Park. Appropriate strategies for this site might include increasing cover by native woody riparian, palustrine emergent wetland, and saltgrass meadow habitats.

Strategies would be prioritized to indicate which areas are most important. For example, the "core zones" described above would likely be the highest priority sites targeted for restoration activities.

Development of Restoration Tasks

Specific tasks designed to implement the strategies for specific sites would be developed. For example, increasing cover by native woody riparian vegetation at the Mesilla Valley Bosque State Park site would first involve removal of salt cedar by appropriate method and maintenance of treated areas to ensure that salt cedar does not become reestablished as a dominant. A second task would involve designing and implementing a program of planting native woody riparian species. Each task would have an accompanying cost estimate, which is essential for planning.

Time Line and Milestones

A time line would be developed to ensure that the plan is developed in a timely fashion. Identification of milestones on the time line would allow for periodic assessment of the progress of plan development.

Implementation and Administration

This section would include a discussion of how the restoration program would be administered and by whom, how progress would be tracked, how specific tasks would be evaluated and monitored, and how data on the restoration program would be kept and distributed.

Literature Cited

This final section would include a list of all literature cited in the plan.

Estimated Cost of Preparing the Plan

A preliminary estimate of the cost of developing the integrated restoration plan is $60,000 to $75,000. This estimate assumes that spatially-referenced, relatively recent aerial photography is available at no cost. The estimate includes collection and synthesis of background information, delineation of floodplain vegetation communities, field assessment of the project area, developing the reference conditions, and preparation of the plan as described above by a contractor. The cost of plan development may differ substantially from this preliminary estimate depending on the entity tasked with plan development.

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