APPENDIX L
BIOLOGICAL TECHNICAL REPORT

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Table of Contents

List of Tables

List of Figures

Figure ***Page***

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1.1 INTRODUCTION

This Biological Technical Report provides documentation of investigations into the current condition of aquatic ecological systems and riparian ecosystems, wetlands, and federally listed endangered species of the Upper Rio Grande Basin and the effects of proposed changes to federal water operations on those biological resources. It consists of both existing biological data and original studies conducted to expand the scientific knowledge of biological resources and analyze the effects of proposed changes in the Upper Rio Grande Water Operations Review and Environmental Impact Statement (URGWOPS EIS; Project). The Project is a cooperative process involving multi-disciplinary and multi-agency effort to develop integrated water operations with the goal of improving basin-wide hydrology for ecological function as well as multiple human uses.

Ecological systems in the Rio Grande Basin have evolved according to the primary influences of Rio Grande Basin climatology, hydrology and geomorphology. Human uses in the Rio Grande Basin have gradually changed the hydrology of the Basin over the past 100 years, resulting in significant changes to both the aquatic and riparian ecosystems. Water management in the upper Rio Grande Basin evolved over decades, the result of separate and distinct authorizing legislation and accumulated policies of different agencies with differing missions. Coordination among these agencies became especially critical in the mid-1990s with the designation of two endangered species known to occur in the Central and San Acacia sections of the river system: the Southwestern willow flycatcher (*Empidonax traillii estimus,* SWFL) and the Rio Grande silvery minnow (*Hybognathus amarus,* RGSM).

The Project developed new knowledge and more effective tools, including the long-term planning version of the Upper Rio Grande Water Operations Model (URGWOM) and a specific set of written operating rules and coordination procedures (the Preferred Action) as outcomes of this project. The multi-agency planning process identified improvements to ecological function as a high priority for the Project. The final phase of the Project evaluated potential adverse effects of the chosen alternative on the resources reviewed in this EIS, including the ecological processes and species identified in this Biological Technical Report.

In order to evaluate problems and flexibilities in the system and the relative effects of the proposed changes in water operations, an improved knowledge base of baseline ecological resources was developed, along with improved analytical tools (described in Section 2, below). These data and tools provide a foundation for future research, planning, and management. Several models and analysis systems were used in the evaluation of alternatives. Key tools for evaluating the future effects of proposed alternative water operations are described in Section 3, along with the results of the analysis. To assist readers in fully understanding the Project, a list of abbreviations and acronyms and an abbreviated list of technical terms are located on the inside cover of this document. Appendix C is a full glossary of technical terms and acronyms.

1.2 Upper Rio Grande Study Area

Located at the western edge of the Great Plains and 1,885 miles (3,035 km) long from its headwaters in the San Juan Mountains of southern Colorado to its terminus in the Gulf of Mexico, the Rio Grande is the fifth longest river in North America. Several tributaries in the Upper Rio Grande contribute to the flow patterns of the river, including the Conejos River in southern Colorado, the Rio Chama in northern New Mexico, the Jemez River in north-central New Mexico, and the Rio Puerco in central New Mexico. These rivers are fed primarily by melting snow pack from high elevations in northern New Mexico and southern Colorado and by seasonal precipitation.

As described in Chapter 1 of the EIS and in Appendix H, Geomorphology, the Upper Rio Grande Basin is divided into five river sections based on geomorphic reaches and hydrologic influences:

- The Northern Section (geomorphic Reaches 1–4) includes the area from Alamosa, Colorado, to the confluence with the Rio Chama at San Juan Pueblo in New Mexico. It includes the Closed Basin Project in Colorado, but consists of largely unregulated flows in New Mexico.
- The Rio Chama Section (geomorphic Reaches 5–10) includes the entire Rio Chama from Heron Reservoir to the confluence with the Rio Grande, plus the Rio Grande from the confluence with Rio Chama to Cochiti Reservoir. This section is highly regulated and influenced by the combined operations of Heron, El Vado, Abiquiu, and Cochiti Reservoirs.
- The Central Section (geomorphic Reaches 10–13) includes the Rio Grande floodplain and channel between Cochiti Dam and the confluence of the Rio Puerco south of Socorro, New Mexico. This section is regulated by flood control operations at Cochiti and influenced by rules at several other facilities, including Abiquiu and Elephant Butte Dams.
- The San Acacia Section (geomorphic Reach 14) includes the floodplain and channel of the Rio Grande from the confluence with the Rio Puerco to Elephant Butte Dam. This section receives unregulated flows from the Rio Puerco, regulated flows on the mainstem of the Rio Grande, and potential diversions at the Low Flow Conveyance Channel.
- The Southern Section (geomorphic Reaches 15–17) includes the area between Elephant Butte Reservoir in New Mexico and Fort Quitman, Texas. This section is highly regulated at Elephant Butte and Caballo Reservoirs, and the channel has been highly modified and canalized.

The Upper Rio Grande Water Operations Review and EIS identified flexibilities in and considered the potential effects of changing operations at five facilities on the Rio Grande and Rio Chama. The potential for biological effects from changing operations was limited to those areas along the Rio Chama and Rio Grande subject to changes in hydrology under the alternatives considered. Specifically, the areas considered in the study of biological effects include (1) the floodplain and channel of the Rio Chama from Heron Dam to the confluence of the Rio Grande, but excluding El Vado Reservoir, and (2) the floodplain and channel of the Rio Grande from San Juan Pueblo south to Elephant Butte Reservoir. Thus, the Northern and Southern Sections were considered in the evaluation of the biological baseline conditions but were eliminated from further analysis of impacts.

1.3 *Purpose and Organization of the Biological Technical Report*

The biological importance and sensitivity of the Upper Rio Grande is directly related to surface water hydrology in an otherwise arid region, where the presence of surface flows originating hundreds of miles away can exert fundamental control over the composition and structure of biological communities and the abundance and richness of all forms of life. New Mexico's riparian areas are the most species-rich in the state. The continual presence of water and the complex structural components of riparian zones also support the highest percentage of breeding species of any other habitat type. Due to the Project Area's north-south orientation and the fact that the Rio Grande is one of five major migratory corridors in North America, the area hosts a large and varied mix of neotropical avian species. Lastly, the project area contains several species that are on the federal list of Threatened and Endangered Species (TES) and thus receive protection under the Endangered Species Act (ESA) (Service 2003a). Changes in water operations on the Upper Rio Grande will in turn affect biological resources downstream of dams and other facilities. The timing, duration, and long-term availability of water are key factors in riparian and aquatic ecosystems that are explored in this Technical Report.

In Section 2 of this Technical Report, each biological resource within the Project Area is individually characterized, beginning with a description of specific methods used to establish a baseline for each resource. The methods used to characterize the current condition of existing resources are described quantitatively and qualitatively, and the biological trends related to hydrological change are characterized as well. Some resources considered to be fundamental to the biological ecosystem, such as aquatic and riparian habitats, required extensive original studies. The methods and results of these studies are provided.

The current biological conditions and trends in the study area form the foundation for the impact analyses presented in Section 3, which follows the same organization as Section 2, starting with the methods used to determine potential impacts and concluding with a detailed description of each alternative's potential impacts—either negative or positive—on pertinent biological resources.

Because future water operations of the Upper Rio Grande may involve adaptive management, Section 4 provides biological recommendations for the resources considered most vulnerable to ecological perturbation from those operations.

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2.0 EXISTING BIOLOGICAL CONDITIONS

2.1 *General Methods*

Section 2 of the Biological Technical Report describes current conditions and trends in aquatic and riparian ecosystems in the Upper Rio Grande study area, focusing particularly on those areas most likely to be affected by proposed changes in water operations in the Rio Chama, Central, and San Acacia Sections.

The material presented here also includes existing data and information available in scientific literature that is pertinent to the baseline biological resources, resource trends, and factors relevant to the proposed changes in water operations. An aquatic habitat model and a comprehensive vegetation survey were developed specifically for the Project to provide critical baseline information on biological resources in the Project Area. The Geographic Information System (GIS), a basin-wide system for geospatial analysis, was used for data integration across all biological resources and for referencing data points to specific geographic locations. GIS was also used as the base for managing and sharing data throughout the lifecycle of this EIS for data collection, organization, evaluation, analysis, and synthesis.

2.2 *Aquatic Ecosystems*

2.2.1 *Methods*

2.2.1.1 Modeling Baseline Aquatic Habitat

The Upper Rio Grande Water Operations Model provides basic water operations functions and codifies operating rules and existing operation criteria to allow for water accounting and unrefined evaluations of water operation alternatives on a broad scale throughout the basin. URGWOM functions as a routing and accounting model using reservoirs and pertinent gauging stations as nodes and is used to simulate reservoir elevation and river discharges at key nodes in the basin over a hydrologic period determined to be representative of the highly variable nature of the Rio Grande.

Sub-models use discharge outputs from URGWOM and allow more detailed analyses and scenario building between the nodes of the main model. The aquatic habitat sub-model is based on two-dimensional discharge (flow and depth) hydraulic models and allows integration of site-specific ecological parameters either in the model itself or through interfacing with GIS data.

2.2.1.2 Riverine Habitat Characterization Methods

In conjunction with the 17 specific study reaches identified for URGWOM, eight sites (6 on the Rio Grande and 2 on the Rio Chama) representing geomorphologic variation in the Middle Rio Grande basin have been chosen for the aquatic habitat model (Bohannon-Huston et al. 2004). Each reach was approximately 5 to 7 times the channel width at the specific location. GPS and discharge-measurement equipment were used to simultaneously collect geo-referenced topographic and hydrologic data generated from the two-dimensional hydraulic model. Two-dimensional hydraulic modeling and the Aquatic Habitat Model were used to finalize a habitat-flow model that predicts surface area of available aquatic habitat based on depth and velocity distributions for all Middle Rio Grande and Rio Chama reaches studied (**Figure L-2.1**).

Hydraulic model simulations were conducted for up to 10 flows, with the Surface Water Modeling System (SMS 8.0) and outputs prepared in a format for use in GIS to input into the Habitat-Flow Model.

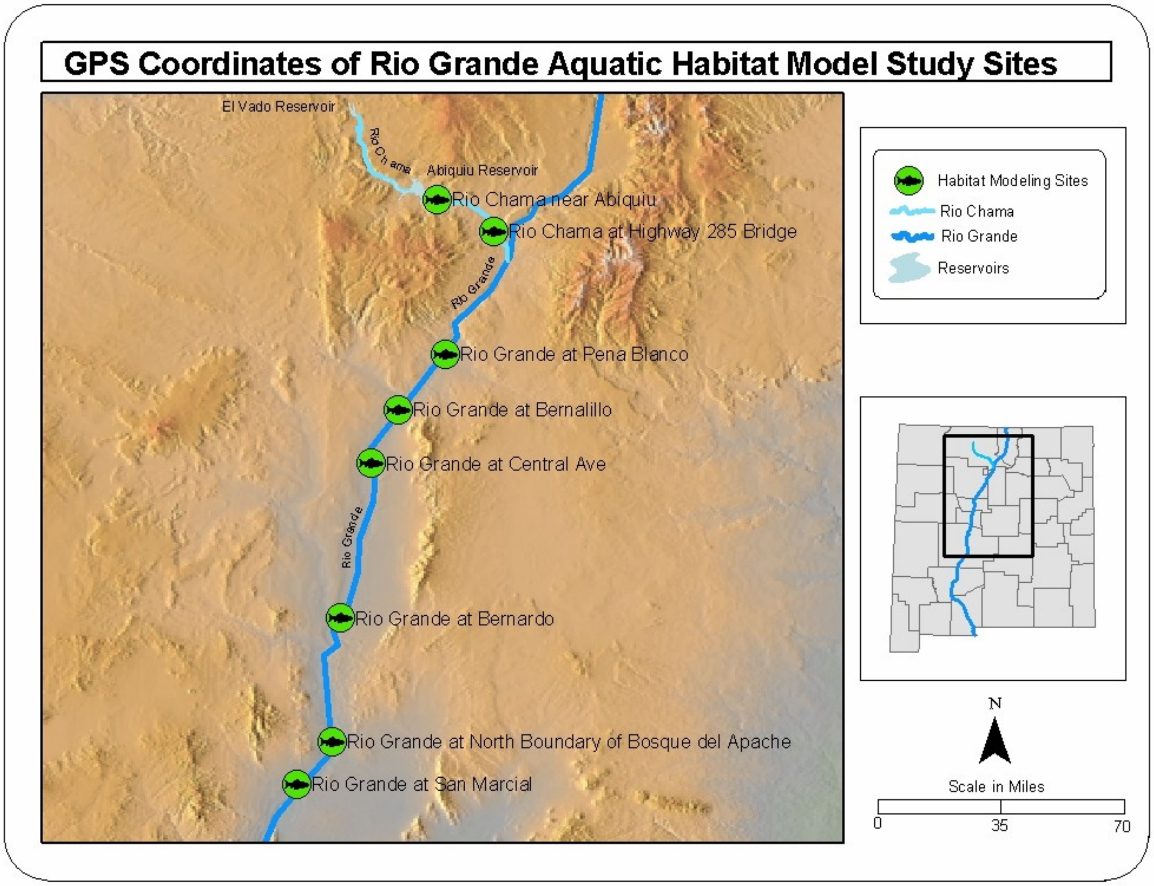


Figure L-2.1 Study Areas for Aquatic Resources.

2.2.2 *Upper Rio Grande Riverine Resources*

2.2.2.1 Riverine Habitat

Riverine habitat is the wetted area within a river channel where flowing water is discharged and includes both the surface and subsurface aquatic zones. The Project's proposed change in the quantity and quality of available riverine habitat is the factor most likely to affect species in the Rio Grande.

Limited studies have been conducted to determine the habitat needs for Rio Grande fish. Historically the Rio Grande supported over 21 native species of fish, of which over one third have been extirpated or are extinct (Propst 1999). Dudley and Platania (1997) found that five species— native red shiner, RGSM, flathead chub, longnose dace, and the introduced white sucker—were evenly represented in their samples and accounted for 77.7% of the catch. In this study, habitats collectively occupied by all species are characterized by shallow depth, low water velocity, and small substrata. The majority of individuals occupied depths of less than 30 cm, in water velocities less than 10 cm/s, and with substrata dominated by silt. The occupied depths and velocities differed significantly ($p<0.01$) from available habitats. Fish were most frequently caught in low-velocity habitats such as backwaters (17.2%), debris piles (34.0%), and pools (36.0%). This occurrence represents a marked contrast to the high abundance of deep and high-velocity habitats that dominated both of the study sites.

The availability of low-velocity habitats may also be a limiting factor for endangered species present in the Project Area. In the Rio Grande, the RGSM is the only state and federally protected species; however, the Rio Grande sucker and the Rio Grande chub may warrant state protection (Propst 1999). The RGSM was historically one of the most widespread fish in the Rio Grande basin (FR 1993; Bestgen and Propst

1996), but now only occurs from Cochiti Dam downstream to within the vicinity of Elephant Butte Reservoir, an area designated as critical habitat for the species. Dudley and Platania (1997) evaluated the habitat use for the RGSM (*Hybognathus amarus*) and the associated fish community and determined that the low-velocity habitats described above are preferred by this species.

The effects of hydrologic and physical modifications on the aquatic ecosystem and associated organisms are difficult to quantify because of the lack of comparable historical data. Surveys of the fish fauna from the Rio Grande and Rio Chama as well as the Rio Jemez began in the early 1980s. Collectively, these studies indicate that the fish communities of the Rio Grande have changed both spatially and temporally (Dudley and Platania 1997; Plateau Ecosystems Consulting [PEC] 2001). Issues of concern in recent and ongoing studies are fish distribution, abundance, and habitat associations and requirements. Without knowledge of these basic life-history principles, it is difficult to predict how various management actions would impact certain species.

2.2.2.2 Factors Affecting Riverine Habitat

Many factors affect the flow of the Middle Rio Grande. The Middle Rio Grande is now a highly regulated system subjected to numerous maintenance and management activities overseen by a vast suite of federal, state, municipal, Native American, and private agencies. Discharge in the Rio Grande fluctuates greatly between periods of high spring snowmelt runoff and summer drought conditions. High-elevation snowpack, summer rainstorm events, and a few tributaries feed the river.

Channel geomorphology has a profound effect on the types and quality of riverine habitats available for aquatic species. Bank modifications and channel stabilization have altered the hydrologic patterns of the system (Reclamation 2000a; U.S. Army Corps of Engineers [Corps] 1999). Between 1935 and 1989, there was about a 50 percent decrease in river channel area in the Middle Rio Grande. The historic Rio Grande floodplain was reduced from widths of over 4,500 feet to less than 3,250 feet, and the channel was confined accordingly. This reduction in area was manifested in a reduction in channel capacity to less than 7,000 cfs for some sections of the Middle Rio Grande, while other segments can still sustain 42,000 cfs for short periods (Crawford et al. 1993). Narrowing of the river channel greatly reduces the area of habitat available for all species and their differing life stages.

In-channel fragmentation and intermittency are important issues in riverine systems. Under most circumstances, a river in its natural state maintains flow from upstream to downstream areas, at least during critical reproductive times; this can be important in fish conservation because some fish rely on river connectivity for survival and reproduction. Major dams, several diversion dams, and the Low Flow Conveyance Channel (LFCC) are physical barriers to natural channel flow in the Rio Grande drainage, especially when their use causes channel dewatering resulting in displacement of fish and drifting insects.

The Project does not contemplate changes to the current physical infrastructure in the Project Area, or consider the impacts of diversions, except in the case of the operation of the San Acacia Diversion Dam and the LFCC. The LFCC was built to divert water to the Bosque del Apache National Wildlife Refuge (NWR) and other beneficial irrigation flows to the area and provide reliable conveyance of water to Elephant Butte Reservoir to meet requirements of the Rio Grande Compact. Reclamation shares the cost of operation and maintenance at San Acacia Diversion Dam with the Middle Rio Grande Conservancy District (MRGCD) (Reclamation 2000a; Corps 1999). Dewatering and river channel intermittency are frequent occurrences in the San Acacia Reach during low-discharge events, and current and future water operations at the LFCC are subject to mitigation measures specified in a Biological Opinion resulting from the Programmatic Biological Assessment of Bureau of Reclamation's Water and River Maintenance Operations, Army Corps of Engineers' (Corps') Flood Control Operation, and Related Non-Federal Actions on the Middle Rio Grande, New Mexico (U.S. Fish and Wildlife Service [Service] 2003b).

The degree to which river fragmentation may affect reproduction and survival of RGSM is not yet fully understood. A study conducted by Dudley and Platania (1997) suggested that Middle Rio Grande dam and diversion structures do not prohibit downstream transport of eggs and larvae, but do prevent upstream movement of fish. The inability of fish to reinvade upstream populations could be detrimental to RGSM populations because they produce semi-buoyant eggs that drift with the current for 24 to 48 hours prior to hatching (Dudley and Platania 1997).

The Bureau of Reclamation (Reclamation) has been responsible for stabilizing eroding banks along the Middle Rio Grande and since 1995 has completed many bank modifications in which riprap and jetties have been used to stabilize eroding banks. Reclamation conducted fishery surveys along Santo Domingo, Cochiti, and San Felipe Pueblos to assess effects of bank modification activities implemented along the Middle Rio Grande (PEC 2001). This study documents relatively consistent trends in catch-per-unit-effort (CPUE) at jetty and riprap sites. Variation in CPUE was observed at the natural sites from 1995 to 1999. There was not a consistent trend of higher CPUE at natural compared to jetty or riprap sites. However, a relatively greater (but not significant) number of species was observed in backwater habitats compared to all other natural habitat types. The RGSM was collected most frequently in areas of natural, unaltered banks (PEC 2001).

Habitat availability is one of the main drivers in the success or decline of a species (Carlson and Muth 1989). Other driving factors include population genetics and predation or competition by native or non-native species. Important habitat elements for survival and reproduction typically include species habitat requirements, habitat availability, environmental conditions toleration, and competition for all life stages including eggs, drifting larvae, juveniles, and adults.

Water quality also affects riverine habitat. Water temperature is a naturally controlling factor for many aquatic species, and the north-south orientation of the Rio Grande in the Project Area provides a temperature gradient that separates most cold-water species from warm-water species in Reach 10 below Cochiti Dam. Other water quality parameters—those more directly affected by human activities—have more complex effects on riverine habitat. Water operations may indirectly affect riverine habitat by decreasing flows and thereby changing the concentration of pollutants, creating thermoclines, and increasing oxygen demand. The resulting poor water quality may fragment the river by making areas temporarily unsuitable for fish or invertebrates.

Historical water operations have affected the flow, temperature, and habitat of the Rio Grande; this, in turn, may have affected larval and juvenile fish more than adults because of reduced developmental tolerances and swimming performance at these early life-history stages.

In addition to altered flow regimes and related habitat modification, many researchers have attributed the decline of native fish fauna in Southwestern riverine streams to predation and competition by non-native fish. More recently, parasitism has been also shown to contribute to declines in native fish communities (Brouder and Hoffnagle 1997).

2.2.3 *Upper Rio Grande Reservoir Resources*

2.2.3.1 Reservoir Habitat

Reservoir habitat is the wetted area within a constructed, mainly closed environment that includes both the surface and subsurface aquatic zones. Beginning in the early 1910s, a series of dams was built along the Rio Grande and its tributaries for water storage, flood and sediment control, and hydroelectric generation. Eight dams have been constructed, including Platoro Dam at the headwaters of the Conejos River; Heron, El Vado, and Abiquiu Dams on the Rio Chama; Jemez Canyon Dam on the Jemez River; and Cochiti, Elephant Butte, and Caballo Dams on the Rio Grande. These dams have altered the ecosystem in many areas of the Rio Grande drainage by creating large reservoirs that cause fisheries to be composed mainly of non-native species.

Platoro Reservoir

Platoro Reservoir is located near the headwaters of the Conejos River, a tributary of the Rio Grande, in south-central Colorado about 1 mile west of Platoro in Conejos County. Platoro Dam was constructed in 1951 to store floodwaters of the Conejos River for water release when normal flow is below irrigation requirements in the Conejos Water Conservancy District (CWCD) (Reclamation 2000a). The Reservoir is owned by Reclamation and is operated and maintained by the CWCD. Because no changes in operations beyond improved communication are proposed for Platoro Reservoir, it is not considered in detail in this study of biological resources.

Heron Reservoir

Heron Reservoir is located on Willow Creek near the confluence with the Rio Chama, a tributary of the Rio Grande. The reservoir is in north-central New Mexico, about 9 miles southwest of Park View in Rio Arriba County. Heron Dam was completed in 1971 as part of the San Juan–Chama (SJC) Project, which is a transmountain diversion that moves water from the San Juan River Basin across the continental divide to the Rio Grande basin. The reservoir is strictly for storage and delivery of SJC project water used for municipal, domestic, industrial, recreation, irrigation, and fish and wildlife purposes. Heron Reservoir contains a total storage capacity of 401,320 AF at an elevation of 7,186.1 feet and has a surface area of 5,950 acres at the top of active conservation capacity. The elevation at the top of Heron Dam is 7,199 feet, and the elevation at the streambed below the dam is 6,937 feet. The reservoir is owned and operated by Reclamation, Albuquerque Area Office. Heron Reservoir also supports a cold-water fishery managed by the U.S. Fish and Wildlife Service (Service) and the New Mexico Department of Game and Fish (NMDGF).

El Vado Reservoir

El Vado Reservoir is located on the Rio Chama in north-central New Mexico about 160 miles north of Albuquerque in Rio Arriba County. El Vado dam was built in 1934 and 1935 and was rehabilitated by Reclamation in 1954 and 1955. A new outlet works was built by Reclamation in 1965 and 1966 to accommodate the additional water from the SJC Project. The reservoir is used to store water for irrigation, recreation, incidental flood control, and sedimentation control. It is owned by the MRGCD and operated by Reclamation under agreement with MRGCD. In addition, the reservoir contains a Federal Energy Regulatory Commission–regulated hydroelectric plant owned and operated by Los Alamos County.

El Vado Reservoir supports a cold-water fishery with several warm-water species (Ortiz 2001). Because no changes in operations beyond improved communication are proposed for El Vado Reservoir, it is not considered in detail in this study of biological resources.

Abiquiu Reservoir

Abiquiu Reservoir is located in north-central New Mexico on the Rio Chama approximately 30 miles northwest of Española on U.S. highway 84 in Rio Arriba County. The U.S. Army Corps of Engineers completed Abiquiu Dam in 1963 for the purposes of flood control, sediment control, and water supply storage (Reclamation 2000a). The storage capacity of Abiquiu Reservoir is 1,369,000 acre-feet (AF) of which 565,000 AF are allocated to flood control and sediment storage (Ortiz 2001). The reservoir is at an elevation of 6,362 AF, and the total surface area is 16,480 acres (Ortiz 2001). The reservoir is owned and operated by the Corps. A hydroelectric power plant below Abiquiu Dam is owned and operated by Los Alamos County.

Abiquiu Reservoir supports a warm-water and cold-water fishery consisting of kokanee salmon, rainbow trout, brown trout, cutthroat trout, lake trout, walleye (*Stizostedion vitreum*), green sunfish, largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieui*), white crappie, channel catfish, and bluegill (Ortiz 2001).

Cochiti Reservoir

Cochiti Reservoir is located on the Rio Grande on the Pueblo of Cochiti Indian Reservation in Sandoval County, New Mexico. Cochiti Dam was completed in 1975 by the Corps and is the primary flood control structure for snowmelt runoff on the mainstem of the Rio Grande. Its designated purposes are flood and sediment control, fish and wildlife enhancement, and recreation. The storage capacity of the reservoir is approximately 771,720 AF, with a surface area of 11,176 acres at an elevation of 5,479 feet (Ortiz 2001). The dam is owned and operated by the Corps.

Cochiti Reservoir is primarily a warm-water fishery consisting of northern pike (*Esox lucius*), black bullhead (*Ictalurus melas*), channel catfish, white bass (*Morone chrysops*), striped bass (*Morone saxatillis*), smallmouth bass, largemouth bass, green sunfish, white crappie, black crappie (*Poxomis nigromaculatus*), and bluegill (Ortiz 2001). Cold-water fish species include rainbow trout and brown trout.

Jemez Canyon Reservoir

Jemez Canyon Reservoir is located on the Jemez River just upstream from its confluence with the Rio Grande in Sandoval County, New Mexico. The dam was built by the Corps for both flood and sediment control. The storage capacity for the reservoir is 259,423 AF, with a surface area of 5,300 acres at an elevation of 5,271 feet (Corps 2000). The Reservoir is owned and operated by the Corps. There is no fishing at this reservoir.

Elephant Butte Reservoir

Elephant Butte Reservoir is located on the Rio Grande approximately 4 miles east of Truth or Consequences, Sierra County, New Mexico. Elephant Butte Dam was originally completed in 1916 by Reclamation. It is the largest and most widely used reservoir in New Mexico. The designated uses for the reservoir are flood control, hydroelectric power generation, and irrigation. The storage capacity of the reservoir is approximately 1,708,200 AF, with 36,500 acres of surface area at an elevation of 4,500 feet (Ortiz 2001). The reservoir and the hydroelectric power plant are owned and operated by Reclamation.

Elephant Butte Reservoir is primarily a warm-water fishery with the exception of rainbow trout and brown trout. Warm-water fish species include white bass, largemouth bass, smallmouth bass, catfish, walleye, and rainbow trout.

Caballo Reservoir

Caballo Reservoir is located on the Rio Grande, 25 miles downstream from Elephant Butte Reservoir in Sierra County, New Mexico. The designated uses of the reservoir are irrigation and recreation. Because no changes in operations beyond improved communication are proposed for El Vado Reservoir, it is not considered in detail in this study of biological resources.

2.2.3.2 Factors Affecting Reservoir Habitat

Temperature, water quality, reservoir pool fluctuations, thermoclines, turnover, the nature of the drainage basin, and lake morphology are all contributing factors potentially affecting reservoir habitats (Wetzel 1975). For the URGWOPS EIS, only operational changes were analyzed. These operations may affect reservoir habitats by altering the pool elevation rate-of-change, the lake volume turnover, and the amount of littoral habitat available for fish and food base organisms.

Reservoir habitats important to aquatic organisms include littoral areas that provide cover for critical life stages and food supplies. Fluctuating lake levels caused by run-off inflow or water releases for irrigation and municipal water demand can significantly affect the amount of littoral habitat available for aquatic life. In addition, riparian and wetland vegetation provide important habitats in reservoirs and are also affected by fluctuating reservoir elevations. Aquatic food supply, in the form of zooplankton, may be correlated with lake level fluctuations and the amount of shallow littoral habitats. Water quality, including temperature, is another important element of reservoir habitat, and reservoir fluctuations can affect both water quality and temperature. Degraded water quality and altered temperatures can affect spawning and the development of early life stages of fish and aquatic food-base organisms. The baseline study of reservoir habitats in the Project Area therefore focuses on determining the qualitative relationship between reservoir surface-level fluctuation—both absolute change during the annual cycle and the rate of change over time—with the abundance and diversity of reservoir fish.

2.3 *Riparian Habitat*

2.3.1 *Methods*

2.3.1.1 Introduction to the Rio Grande Riparian Ecosystem

A riparian area is generally defined as a saturated or flooded transition zone between aquatic and terrestrial systems. Riparian ecosystems are those vegetated zones lying within the floodplain of rivers and affected by riverine hydrology, both the surface and subsurface processes. Riparian ecosystems are among the most productive in the world. They provide many benefits to society, including improvement and preservation of water quality, flood attenuation, habitat for wildlife, and opportunities for recreation and aesthetic appreciation. Great Basin and Chihuahuan Desert Scrub lands and desert grasslands adjoin most of the Rio Grande floodplain from northern New Mexico to the Big Bend area of Texas. Here the surrounding countryside receives less than 1 feet of rainfall per year. In this intensely arid climate, the river and its moist riparian zone and wetlands provide the only available surface water and dense woody vegetation for long distances.

The history of riparian vegetation communities along the Middle Rio Grande is summarized in Hink and Ohmart (1984) and Dick-Peddie (1993). Other significant historical studies and reviews appear in Watson (1912), Baily (1913), Burkholder (1928), Van Cleave (1935), and Ferguson (1945). The dominant vegetation type along the Middle Rio Grande is riparian forest, locally known as *bosque* from the Spanish term for woods or forest, and is characteristically dominated by cottonwood gallery forest with variable understory woody shrubs and trees. The riparian forest community of the Rio Grande exhibits a variable structural diversity. Canopy trees can obtain heights of up to 20 m (60 feet) if undisturbed by flood or fire for long periods. Depending upon disturbance history, these gallery forests have understories that range from very dense to open, grassy understories. Thus, the bosque provides the primary water and nutrient source, as well as protection and roosting sites, for numerous species of birds, small mammals, and amphibians. In general, bosque vegetation develops into mature forests when lefeet undisturbed for decades, but may be present at intermediate stages of succession where floods have scoured vegetation from the floodplain.

Riparian forests in the Project Area are dominated by Rio Grande or Fremont cottonwood (*Populus* ssp.). These riparian forests also include diverse mixtures of Goodding's black willow (*Salix gooddingii*) or other large trees as the principal species in the canopy. Cottonwood bosques occur with a variety of understory species, but most often with coyote willows (*Salix exigua*), seepwillow (*Baccharis salicifolia*), New Mexico olive (*Forestiera pubescens* var. *pubescens*), Russian olive (*Eleagnus angustifolia*), and salt cedar (*Tamarix* spp.).

The riverbank community also includes young and intermediate-aged successional vegetation on banks and bars along the main channel. Because these areas experience regular scouring, the vegetation typically does not mature and typically has similar-aged stands of young cottonwood, coyote willow, Russian olive, and/or secondary riparian forest. Various annual forbs are found in areas most frequently flooded. Marshes and emergent wetlands also occur in seasonally or perennially saturated areas. The increased diversity and productivity provided by wetland communities of the Rio Grande floodplain is particularly apparent in this otherwise highly arid environment. These marshes and wetlands are supported by groundwater and provide excellent habitat value to wildlife.

The extent and condition of mid-aged and mature stands of cottonwood, willow, and other native species are indicators of the current health of a riparian ecosystem. The frequency of successful establishment (recruitment) and the extent (acreage) of young native plants are indicators of the future condition of riparian habitat. The establishment of riparian vegetation occurs immediately following the period of peak flows from late May through June when the “cotton (seed) is flying” (Crawford et al. 1993). The flood flows prepare the seed beds by scouring existing vegetation and depositing sediment; the gradually receding waters distribute the seeds on the seedbeds and irrigate them. The seeds require bare soil substrate, and the resulting seedlings require full sun. Cottonwood and willow will not become established under dense stands of existing vegetation, but are established in high numbers on sunny bars, islands, high-flow channels, backwaters, and banks. Because of annual flow and climatic variability, conditions favorable for cottonwood and willow seedling recruitment and survival occur only once in several years (Crawford et al. 1993). Higher flows following a year of seedling establishment could scour that seedbed, causing damage or destruction to newly recruited plants.

In the early twentieth century, salt cedar escaped cultivation and began establishing along many of the rivers of the Southwest. Today, monotypic salt cedar stands constitute a major part of southwestern riparian zones. For germination, salt cedar requires the same bare, moist substrate conditions as native species. However, it can produce seeds for up to five months. These seeds remain viable for 12 weeks, thus giving salt cedars a longer seed-dispersal period than native plants and enabling the species to spread and germinate with flows that decline later in the summer, such as after late-summer monsoon flows. Along the upper Rio Grande, salt cedar stands occur throughout the floodplain and are becoming prevalent in certain reaches in the Project Area. Mature salt cedar stands typically exclude all other woody vegetation over time, but salt cedar may range from the principal component to a minor woody component in mixed forest ecosystems. Salt cedar stands are not considered the preferred habitat for much of the wildlife along the Rio Grande. Similarly, Russian olive has also become established in the Project Area. While these non-native species do not provide the same habitat quality as native trees and shrubs, they can provide habitat to some wildlife.

2.3.1.2 Methods of Characterizing Riparian Vegetation Communities

For purposes of the URGWOPS EIS, the area of potential riparian effects, and therefore the area of detailed study, was determined to include both banks of the 50-year floodplain of the Rio Chama and both banks of the 50-year floodplain of the Rio Grande from Velarde, New Mexico, to the upper extent of the reservoir pool of Elephant Butte Reservoir. For most of the Project Area, the presence of levees or bluffs defines the 50-year floodplain.

Rio Grande floodplain riparian community composition and structure has been most thoroughly classified and studied using the structural classification of Hink and Ohmart [H&O] (1984). Comprehensive description of the vegetation of the Rio Grande floodplain was last completed in 1982 (H&O 1984). Some significant vegetation change had been noted in biological studies since that time (Crawford et al. 1993; Fluder 2003). This classification scheme was also used in the Bosque Management Plan (Crawford et al. 1993). Alternative classification schemes have been used by others (Dick-Peddie 1993); however, a modified H&O system was selected for use in the current study for continuity and comparability with earlier investigations. Hink and Ohmart recognized six structural classes of riparian wetland vegetation in the Middle Rio Grande (**Figure L-2.2**), each of which was studied for associated fauna. The current study evaluating trends and impacts to riparian and wetland resources from past and proposed Upper Rio Grande water operations recognizes, uses, and builds upon this important biological classification foundation.

In order to understand the baseline conditions of the riparian community in the Rio Grande floodplain, the Project undertook a systematic and comprehensive vegetation mapping study in the central Rio Grande. The purpose of the Project was to map all vegetation within the levees between Velarde and Elephant Butte Reservoir using a modified H&O vegetation classification system assisted by color infrared aerial photography flown in 2002. The inventory of riparian vegetation took place from 2002 to 2004, from Velarde to Elephant Butte Reservoir on the Rio Grande and on the Rio Chama from Abiquiu Reservoir to the confluence with the Rio Grande.

Extensive ground-truthing of the aerial photo interpretation was conducted during the growing season wherever access was allowed. Uniform methods of visual estimation of canopy height and density were developed through multiple collaborative sessions with all field personnel. Uniform data sheets and other standardized data input strategies were employed. All areas that could be accessed in the floodplain were verified in the field, and polygon boundaries were adjusted according to the ground-truthing. Areas that could not be accessed were subject only to imagery-based delineation. Data regarding vegetation, height, density of cover in the different height classes, species composition and relative density in the different height classes, and other notes on the presence of saturated soils or recent inundation were included.

Spatial data for each polygon of vegetation were input into the Arc Info Geographic Information System at the Reclamation Technical Center in Denver.

2.3.1.3 Modified Hink and Ohmart Classification

The methods of the inventory consisted of photogrammetric vegetation classification using structural categories based upon and consistent with those used by Hink and Ohmart in their 1984 study and then expanded on the species composition to result in a modified vegetation classification. Preliminary areas were established and studied intensively to establish reliable color infrared signatures for characteristic vegetation types. In the lab, imagery was then delineated into polygons of homogeneous vegetation classification types.

The riparian forest community, particularly the native cottonwood/willow association, exhibits a variable structural diversity and provides the greatest structural and species diversity of the wetland communities along the Rio Grande. Riparian forest stands, which can reach heights of up to 20 m (60 feet), are found with dense to open understories depending on the past disturbance history of the area. The Hink and Ohmart (1984) classification scheme (**Table L-2.1** and **Figure L-2.2**) consists of six structural types based on vegetation height and density rather than species composition, plus two categories for other habitats. In the study area, cottonwood riparian forests occurred in all six structural types.

Table L-2.1 Characteristics of Hink and Ohmart Vegetation Structural Type Classification

Structural Vegetation Type	Height	Other characteristics
Type I	>40 feet (12.2 m)	Mature and mid-aged stands with well-developed understory at all heights
Type II	>40 feet (12.2 m)	Mature overstory trees with little or no understory foliage
Type III	20-40 feet (6.1-12.2 m)	Intermediate-sized trees with dense understory vegetation
Type IV	20-40 feet (6.1-12.2 m)	Intermediate-sized trees with little understory vegetation
Type V	0-15 feet (4.6 m)	Younger stands with dense shrubby growth
Type VI	0-5 feet (1.5 m)	Very young, low, and/or sparse stands, either herbaceous or woody
Marsh	0-5 feet (1.5 m)	Emergent non-woody vegetation on saturated soil or standing water
Openings/bare	N/A	Less than 25% vegetated

Source: Hink and Ohmart 1984

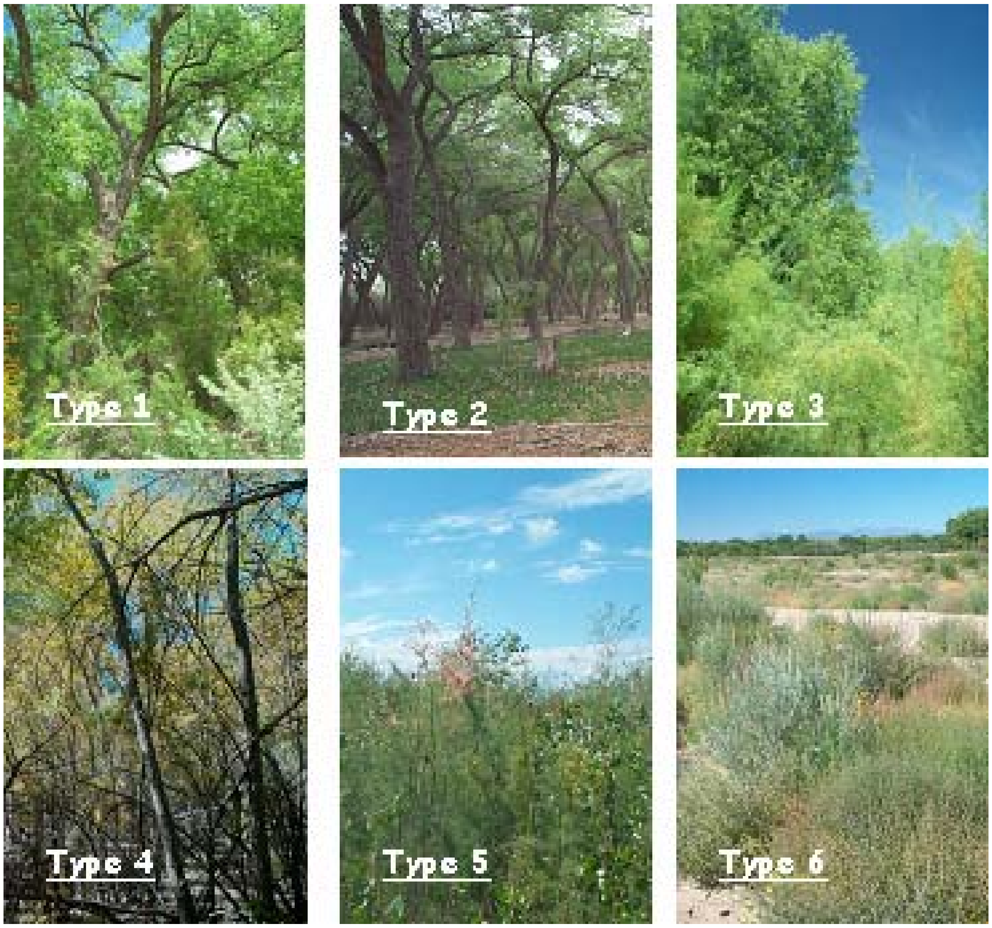


Figure L-2.2 Characteristics of Riparian Forest Vegetation Based on Hink and Ohmart 1984 Classification System.

2.3.1.4 Methods for Correlating Vegetation Types with Wildlife Use

The original Hink and Ohmart (1984) survey categorized wildlife presence within the different structural classes. Their data were particularly useful in that they established the correlation between vegetation types and terrestrial wildlife species richness, composition, and habitat associations. While all structural types have an associated faunal component, the more diverse community types also support a greater diversity of wildlife. This finding has been verified in subsequent studies (e.g., Thompson et al. 1994; Leal et al. 1996). The Riparian Team focused on distinct vegetation communities for which wildlife use was known (**Table L-2.2)**.

By establishing which Hink and Ohmart structural classes were most used by wildlife, the Riparian Team had a foundation from which to correlate alternatives impacts to vegetation types with the potential impacts to fauna.

Table L-2.2 Relative Wildlife Value of Community ─ Structure Types

Species Descriptions			Structural		Based on Annual Abundance		
Composition	**Canopy**	**Understory**	**Code***	**S-Type**	**Birds**	**Mammals**	**Herps**
Native/ Native	C	CW		1	Very low	Low	Moderate
	C	CW	E	1	Moderate	Moderate	
	C	CW		2	Very low		
	C	CW	E	3	High	High	Low
	C	CW		4	Very low	Very low	High
	C	CW	E	4	Low	Low	
	C	CW		5	Low	Moderate	Low
	C	CW	E	5	High	High	
	C	CW		6	Moderate	Low	Low
	C	CW	A	(6)			Low
	C	J		1	Low	Low	High
	C	J		4	Low	Very low	High
Native/ Exotic	C	RO		1	Low	Low	Low
	C	RO	E	1	Very high	Moderate	
	C	RO		2	Low	Low	Moderate
	C	RO	E	3	High		
	C	RO		4	Very low	Low	
Exotic		RO		5	High	Moderate	Low
		RO		6	Low		
Exotic		SC		5	Very low	Low	
		SC		6	Very low	Moderate	Low
		SC	E	6	Moderate		
		SC	A	(6)	Very low	Low	High
Native	MH	(cattail)		5	Very high	High	Low
	MH	(cattail)		6		Moderate	
	MS/MH	(saltgrass)		5	Moderate		

E = Edge; A = Large, dense, individual plants vs. low, sparse, relatively uniform
Source: Hink and Ohmart 1984

2.3.1.5 U.S. Fish and Wildlife Service Resource Categories

The Project chose to correlate the Hink and Ohmart structural classifications with the Resource Categories defined in the Service's Mitigation Policy (**Table L-2.3**). The Service's Resource Categories, defined following the table, L-2.3, closely link species diversity to specific habitat types and focus on ecological suitability of certain habitat types to their associated fauna and related mitigation goals (FR 1981). The Resource Categories were designed to assist with developing consistent and effective recommendations for the protection and conservation of fish and wildlife resources. Of particular interest to this EIS are those portions of the Mitigation Policy that address the relative value of habitat types. Each of the habitat types defined by the Service's Resource Categories supports diverse species but of descending biological value.

Table L-2.3 Correlation of Hink and Ohmart Structural Classes to Service's Habitat Resource Categories

Plant Community	Hink and Ohmart (1984) Structural Classes	Service Resource Category
Wet marsh with emergent vegetation	Marsh	1
Cattail marsh	Marsh	1
Mature native canopy/native understory	1	2
mature native canopy/exotic understory	1	2
Mature native canopy/mixed understory	1	2
Mature exotic canopy/native understory	1	2
Mature exotic canopy/exotic understory	1	3
Mature exotic canopy/mixed understory	1	2
Mature mixed canopy/native understory	1	2
Mature mixed canopy/exotic understory	1	3
Mature mixed canopy/mixed understory	1	3
Mature native canopy	2	2
Mature exotic canopy	2	4
Mature mixed canopy	2	3
Intermediate native canopy/native understory	3	2
Intermediate native canopy/exotic understory	3	2
Intermediate native canopy/mixed understory	3	2
Intermediate exotic canopy/native understory	3	2
Intermediate exotic canopy/exotic understory	3	3
Intermediate exotic canopy/mixed understory	3	2
Intermediate mixed canopy/native understory	3	2
Intermediate mixed canopy/exotic understory	3	3
Intermediate mixed canopy/mixed understory	3	3
Intermediate native canopy	4	2
Intermediate exotic canopy 25-75%	4	4
Intermediate exotic canopy 75-100% cover	4	3
Native young successional stands	5	2
Exotic young successional stands	5	4
Exotic young successional stands 75-100% cover	5	3
Mixed young successional stands	5	3
Native sparse young growth	6	2
Exotic young sparce growth	6	4
Mixed young sparce growth	6	3
Opening	OTH	4
Open water	OTH	N/A
Saltgrass Meadow	OTH	3

Resource Category 1: Habitat is of high value for evaluation of species and is unique and irreplaceable on a national basis or in the ecoregion section. The mitigation goal for habitat in Resource Category 1 is "no loss of existing habitat value."

Resource Category 2: Habitat is of high quality for evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section. The mitigation goal for habitat in Resource Category 2 is "no net loss of in-kind habitat value."

Resource Category 3: Habitat is of high to medium value for evaluation species. The mitigation goal for habitat in Resource Category 3 is "no net loss of habitat value while minimizing loss of in-kind habitat value."

Resource Category 4: Habitat is of medium to low value for evaluation species. The mitigation goal for habitat in Resource Category 4 is "minimize loss of habitat value."

These resource categories were used to provide guidance to the Project for valuing the types of riparian habitats identified and mapped in the Project Area using the modified Hink and Ohmart classification system. For purposes of assigning categories to the habitats found in the Project Area, Resource Category 1 was determined to consist of marshes, which are very rare and provide the highest biological value to wildlife resources. Resource Category 2 was determined to consist of structurally complex young successional riparian forests dominated by native species in the overstory and understory, as well as some structurally complex riparian forests composed of native overstory with exotic understory. These forest types are becoming scarce in the region and provide biological value for a diverse wildlife assemblage. Resource Category 3 was determined to consist of predominantly mixed native and exotic overstory and understory of any height class and exotic young successional stands if they were extremely dense. These forests provide important cover and food for riparian wildlife, but without the same diversity and value as forests dominated by native species. Resource Category 4 was determined to consist of sparse, thin forests of purely exotic species in all height classes. This class of vegetation provides the least value to those wildlife species dependant on riparian areas.

Each of the habitat types defined by the Policy's Resource Categories supports an associated community of biological species. The degree of effect on specific habitat types, and the potential mitigation of those effects, corresponds to the value and scarcity of the fish and wildlife habitat at risk.

2.3.1.6 Hydrologic Factors Affecting Riparian Ecosystems

Riparian and wetland ecosystems are both ground- and surface-water dependent. Riparian vegetation distribution is along ecological gradients determined by surface flows and groundwater depth. Vegetation structure and composition are affected by the seasonality, frequency, velocity, and duration of surficial flows as well as by the depth to groundwater. There is hydrological specificity for each of the different stages in an individual plant life cycle: seed germination and recruitment, seedling establishment, and plant maturation and maintenance (Kozlowski 2002; Rood et al. 2003). The changes in surface water hydrology contemplated by the Project may affect both structure and composition of riparian communities. Current operations at the various facilities—to divert water, store water, or to hold back or release floodwater—develop an overall pattern of hydrology that affects these vegetation communities. It should be noted that grazing and agricultural practices also play a role in the vegetation recruitment and biological diversity of river reaches.

Additionally, hydrology affects overall ecosystem health by promoting beneficial biological and physical processes. Most riparian forests are in various stages of succession because the frequency of disturbance by catastrophic flood events is, as a general rule, less than the life span of the dominant tree species. Seasonal overbank flooding of established riparian plant communities is necessary to release nutrients from leaf litter, add new nutrients with alluvium deposition, and generally maintain optimum ecosystem health (Kozlowski 2002). Lack of flooding in a regulated river promotes the accumulation of leaf litter and woody debris while decreasing decomposition, nutrient recycling, and plant growth. In several reaches of the Rio Grande, the bosque is never or very infrequently flooded, resulting in heavy buildup of dry leaf litter (Molles et al. 1995). Regulated flood flows may prevent overbank floods necessary to scour away existing vegetation and make new seedbeds for cottonwoods and other native trees. Ellis et al.

(1999) demonstrated that flooding significantly improves ecosystem functioning, litter decomposition, and fire resistance. Studies by Andersen and Nelson (2003) on the Yampa River in Colorado have corroborated that decomposition of cottonwood leaf litter increases with the duration of flooding.

Water operations at the various facilities on the Rio Grande produce an overall pattern of hydrology that affects riparian communities by moderating surface and groundwater available to the riparian zone. Many areas of the Rio Grande floodplain, both inside and outside the levees, contain relict stands of mature cottonwood and willow that have not flooded for several decades. Current river processes associated with the Rio Grande, such as channel narrowing, aggradation, and degradation—as well as the extensive human activities in the floodplain—affect the availability of water supplied to riparian vegetation. As a result, a significant decline in the extent and establishment of riparian communities has occurred (Crawford et al. 1993). In a recent study of surface cover changes of the Rio Grande floodplain between 1935 and 1989, Roelle and Hagenbuck (1994) documented a 55 percent decrease in wetland habitat, with the largest decrease occurring in wet meadow, marsh, and pond habitat.

Large-scale recruitment of native cottonwood and willow vegetation may occur following spring peak flows if overbank flows occurred over sparsely vegetated areas, areas buried with sediment, or recently scoured areas. In addition, successful recruitment requires successive years of slightly reduced overbank flows. That is, new seeds require high flows for irrigation, but not so high as to scour away the new seedbeds. The rate of river-stage drawdown is critical for seedling survival, especially in dry, hot summers. Adequate soil moisture must be maintained by groundwater and summer rain to allow seedling survival following germination. Studies at the Bosque del Apache NWR documented that gradual reductions in flood flows resulted in a gradual decline in the water table. Seedling survival may still occur with higher rates of groundwater decline; however, these seedlings rely on soil moisture in the unsaturated soil profile resulting from monsoonal summer rains (Sprenger et al. 2002). Rood et al. (2003) report that cottonwood recruitment occurs in a window between mid May and mid June—providing the hydrograph stage-decline remains approximately 2.5 cm per day. The specific correlation between changes in river flow and the water table and the confounding factors needs further study (Naumburg et al. 2005).

Timing of the release of stored water is another hydrologic factor affecting all riparian resources. The ability to make use of available storage options at Abiquiu Reservoir could augment downstream flows for conservation purposes. Operational flexibility in the timing and release of stored waters could offset the negative impacts of 0-flow days or days with less than 100 cfs of flow (e.g., during periods of drought). High levels of upstream storage may exist under low-flow conditions, but positive benefits only occur when operations allow downstream delivery during years with low peak flow volumes or allow augmentation of low natural peak flows.

Historically on the Rio Grande, processes of flow variability, avulsions, and lateral channel migration produced a pattern of cottonwood and willow recruitment in patches and scattered locations over a wide geographic range. Variation in a river's flow regime with both high- and low-flow events are necessary for diversity and sustainability of riparian and aquatic ecosystems, as discussed by Poff et al. (1997). Peak flow variability contributes to temporal and spatial variation of channel movement, flooding, and diversity in vegetation, which ultimately contribute to a diversity of habitat types, thereby supporting a greater biodiversity of organisms.

Periodic flooding ensured widespread patterns of establishment and seed formation and resulted in large stands of relatively young cottonwood and willow occurring near the channel, with the most mature stands occurring on the less flood-prone outer edge of the floodplain (Kozlowski 2002).

Currently there is less opportunity for recruitment, as the floodplain has narrowed, the river has become more channelized with less lateral migration, and dense stands of riparian vegetation have armored the riverbank. The introduction and spread of salt cedar, Russian olive, and other exotics during the past 80 years has significantly affected the successional stages of riparian plant communities in the Rio

Grande floodplain. These invaders readily colonize the same open sites necessary for cottonwood seed germination and seedling survival with the Rio Grande deprived of regular flood flows and scouring, cottonwood and willow recruitment has been reduced along much of the river, including the Upper Reach of the Project Area.

Existing stands of riparian vegetation obtain most of their water from the saturated capillary fringe of soil directly above the floodplain groundwater. The vigor of the riparian plants, especially cottonwood and willow, depends on maintaining groundwater levels within the range of root growth. Although groundwater fluctuates on a daily, seasonal, and annual basis with river flows, typical maximum depths to groundwater in Rio Grande cottonwood and Goodding willow communities rarely exceed 16.4 feet (Stromberg and Patten 1991a). The suggested hydrological requirements for the Hink and Omart vegetation structural types dominated by native vegetation are summarized in **Table L-2.4**.

Table L-2.4 Suggested Hydrology to Maintain H&O Vegetation Structural Types Dominated by Native Species

H & O Structural Type	Suggested Surface Hydrology	Suggested Groundwater Requirements
Type 1	Surficial inundation of soil approximately every 3-5 years to release nutrients, promote seed formation, and support native species regeneration	6-16 feet depth with mid May to mid June surface saturation and slow drawdown of capillary fringe during recruitment
Type 2	Irregular surface inundation necessary every 5-10 years to support native species regeneration, if groundwater levels do not exceed 16.4 feet in depth.	10-16 feet depth
Type 3	Surficial inundation of soil approximately every 3-5 years to release nutrients, promote seed formation, and support native species regeneration	5-10 feet depth with mid May to mid June surface saturation and slow drawdown of capillary fringe
Type 4	Irregular surface inundation necessary every 5-10 years to support native species regeneration, if groundwater levels do not exceed root zone.	5-15 feet depth, depending on age and species
Type 5	Regular inundation every 2-3 years	2-5 feet depth at all times
Type 6	Unspecified	Unspecified
Marsh	Unspecified	Groundwater at surface elevation 75% of year
Openings/bare	Seasonal rainfall or occasional scouring floods	None

Crawford et al. 1993; Graf and Andrew 1993; Stromberg and Patten 1991a,b

Willow-dominated communities require frequent surface saturation and shallow groundwater. These include low stature (Type 5) coyote willow communities, intermediate height (Type 3) communities with coyote willow or Goodding's willow in the understory, or mature (Type 1) tree willow communities. These communities thrive on lengthy periods of saturation, a depth to groundwater of 5−10 feet, and low frequency and duration of drying droughts (Crawford et al. 1993; Graf and Andrew 1993; Stromberg and Patten 1991a,b).

Cottonwood-dominated communities require spring overbank flooding every few years for natural seedling establishment and early success (Crawford et al. 1993). Cottonwood forests are, therefore, tolerant of inundation during the growing season. Once established, however, cottonwoods can maintain themselves through maturity in areas with infrequent surface inundation if they have reliable groundwater at 6–16 feet in depth (Crawford et al. 1993; Graf and Andrew 1993; Stromberg and Patten 1991a). Much of the existing mature cottonwood gallery forests in the Central Section, both Types 1 and 2, have not received overbank flooding in decades and, as a result, are not regenerating (Crawford et al. 1993). Unlike willows, however, cottonwoods do not survive year-round saturation (Kozlowski 2002).

Salt cedar generally reaches heights of 20–40 feet and does not form an overstory in structural Types 1 or 2, although it may be present in the understory. Riparian forests dominated by salt cedar, therefore, tend to be of Types 3, 4, or 5, depending on age, and may become monotypic with age as shade and accumulating debris and salt prevent other species from establishing in the understory. Dense stands of salt cedar usually occur at sites with deeper water tables than will support native cottonwoods at depths of 15 to 20, or even 30, feet (Horton 1977). As a result, salt cedar communities are able to tolerate very infrequent overbank flooding and longer periods of drought.

A decrease in annual river flows can reduce the growth of extant riparian vegetation. Studies have shown a linear relationship between the growth of native riparian trees, as measured by annual ring-width and flow volume (Stromberg and Patten 1991b). For example, during the period of record from 1950 to 1995, the average annual flow volume recorded at the San Marcial gauge was 493,421 AF. However, during the period from 1985 to 1995, the average annual flow was 885,583 AF, which represents an above-average flow as well as drainage operation of the LFCC. A significant portion of the young and mid-aged stands of cottonwood and willow developed during this period. As with other southwestern riparian systems, recruitment of cottonwood and willow plant communities of the Middle Rio Grande depend on peak flows and associated overbank flooding timed to correspond with seed dispersal in late spring.

2.3.1.7 2002–2004 Vegetation Survey Results

Beyond the inherent value of vegetation within the ecosystem, it also provides associated wildlife with habitat crucial for nesting, foraging, and protection from prey species. Hink and Ohmart's (1984) study showed that greater vegetation diversity, in both plant species and structural classes, correlates with a greater diversity of wildlife species. In general, mature and mid-aged riparian forests with a dense understory support the highest diversity of wildlife species. The survey results for vegetation classifications Types 1 thru 6 are shown in **Figure L-2.3**.

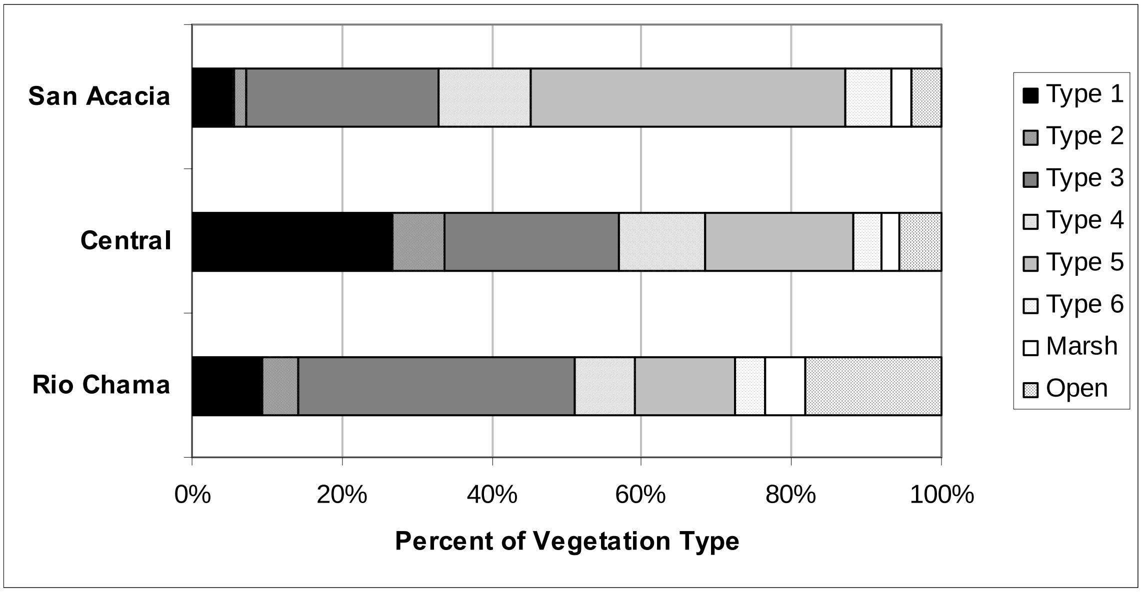


Figure L-2.3 Comparison of Hink and Ohmart structural types by river section.

Northern Section • Rio Grande from Alamosa, Colorado, to the Confluence with the Rio Chama (Reaches 1, 2, 3, and 4)

The Northern Section was not included in the 2002 vegetation surveys because it is outside the area of potential effect of the Project. Description of current vegetation is based on other field surveys and qualitative information (Larry White, Reclamation, personal communication 2004).

Reach 1 – Alamosa, Colorado, to the New Mexico State Line

The best extent and condition of riparian vegetation appears at Alamosa National Wildlife Refuge (NWR) and is composed of linear willow stands interspersed with scattered stands of cottonwoods in various age classes, along with extensive oxbow wetlands. From the south boundary of Alamosa NWR downstream to La Sauses, the floodplain supports scattered stands of willow (*Salix exigua, S. amygdaloides*), narrowleaf cottonwood (*Populus angustifolia*), and oxbow wetlands.

Reach 2 – Conejos River

From the confluence of the Rio Grande and the Rio Chama to Platoro Reservoir, the Conejos River supports an extensive area of mixed-age woody vegetation. The upper canopy is narrowleaf cottonwood and various species of montane willows (*Salix* spp.).

Reach 3 – Colorado–New Mexico Border to Rio Chama Confluence

In the Rio Grande gorge, riparian vegetation is limited to isolated stands that are restricted by the steep cliffs and deeply incised, narrow floodplain. Upstream of the gorge, the riparian area widens along sweeping meanders in the river, and the floodplain opens between rolling cold-desert terrain. The floodplain between the gorge and La Sauses, Colorado, which has been grazed by livestock for 150 to 200 years, and is devoid of woody species and is composed of a well-cropped, weedy grass and forb community. Downstream of the Rio Grande Gorge, the floodplain opens and allows for more extensive stands of riparian vegetation on bars and terraces. For several miles downstream of the gorge riparian vegetation consists of a single-canopy layer of salt cedar (*Tamarix ramosissima*), coyote willow, and boxelder (*Acer negundo*) with a few small isolated stands of cottonwood. Cottonwoods become more common near Embudo, and extensive mature cottonwood stands begin near Velarde.

Reach 4 – Velarde to Confluence of Rio Chama

From Velarde downstream to the Rio Chama the Rio Grande has been channelized, and overbank flooding is limited and confined to a narrow, active floodplain. A series of several diversion dams limits aggradation and has contributed to a degraded, cobbly riverbed. A mature cottonwood gallery forest with an understory of Russian olive (*Elaeagnus angustifolia*), New Mexico olive (*Forestiera pubescens*), and one-seed juniper grows on the upper terraces. Isolated narrow bands of coyote willow line the river in or near the limited overbank zone. A few private landowners and the Pueblo of San Juan are conducting riparian restoration efforts in Velarde, including Russian olive control and plantings of cottonwood/New Mexico olive.

Rio Chama Section • Rio Chama plus Rio Grande between Confluence and Cochiti Dam (Reaches 5, 6, 7, 8, and 9)

In New Mexico, the largest tributary to the Rio Grande is the Rio Chama. The 3.2 miles of this river between Heron Reservoir and El Vado Dam encompass Reach 5. Reach 6 is approximately 32 river-miles in length and lies between El Vado and Abiquiu Dams. Throughout the river channel, which is influenced by water fluctuation, are short-lived weedy plants such as *Xanthium strumarium, Echinochloa crusgalli, Melilotus* spp., and *Verbascum thapsus.* Situated between the river channel and the forested floodplain is the scrub-shrub zone characterized by vegetation less than 20 feet high and dominated by willows. In the upper portions of the river, woody species such as alder (*Alnus*), maple (*Acer*), and *Baccharis* may be present. Within the river's floodplain, above the scrub-shrub zone, are forested woodlands composed primarily of a mixture of cottonwood and oak (*Quercus gambelii*). As shown in **Figure L-2.3**, the Rio Chama Section supports the second-lowest percentage of desirable Type I mature riparian forest and the largest percentage of Type 3 compared to other river sections.

Reach 5 – Heron Reservoir to El Vado Dam

This stretch exhibits steep canyon walls that drop into the Rio Chama and give way to a thin, linear native vegetation riparian zone that supports willows, some cottonwood, and spruce-fir (*Picea-Abies*). Other plants include chokecherry.

Reach 6 – Rio Chama from El Vado Dam to the Monastery Subreach

Most of this stretch of the Rio Chama is in a fairly narrow and deep gorge, though the floodplain is somewhat open just below the reservoir and at the confluence with the Rio Cebolla. For the most part, the area immediately adjacent to the river consists of narrow bands and patches of coyote willow (*S. exigua*) with one to three terraces above. About 25 percent of these terraces have riparian vegetation on them, which is typically either old and dying stands of coyote willow or narrow leaf cottonwood groves.

Reach 6 – Rio Chama from the Monastery to Big Eddy Take-Out Subreach

This section of the Rio Chama is similar to the upstream stretch, though the canyon bottom is typically much wider. The coyote willow is nonetheless still primarily restricted to narrow bands and small patches immediately adjacent to the river. However, there are five or six large patches of mature coyote willow on abandoned meanders. Most of these stands are dying out because they are no longer being regenerated by occasional flooding. The exception is a large, dense stand that is being sustained by periodic flows from an adjacent wash.

Ponderosa pine (*Pinus ponderosa*) drops out about a mile above the monastery, and Fremont cottonwood (*P. deltoides*) becomes much more common. There are some fairly sizable cottonwood bosques along the upper part of this stretch. The understories of these wooded areas contain mixes of Rocky Mountain juniper (*Juniperus scopulorum*), New Mexico olive, skunk bush (*Rhus aromatica*), rabbitbrush (*Chrysothamnus* spp. *Ericameria* spp.), and other assorted shrubby species.

It is in this stretch that larger numbers of exotics, such as Russian olive and salt cedar, are encountered. This is particularly apparent in the lower segment.

Reach 6 – Rio Chama from Big Eddy Take Out to Abiquiu Dam Subreach

Big Eddy is located at the farthest upstream pooling area of Abiquiu Reservoir. It is in this region that the Rio Chama leaves the canyon and flows through a more open landscape. As in the upstream segments, very narrow bands and small patches of coyote willow characterize this stretch. The only other dominant woody species in this stretch is salt cedar. Because of fluctuating water levels and well-drained soils, the shoreline of Abiquiu Reservoir contains little vegetation and is quite barren. What vegetation there is tends to be mostly herbaceous and is found in the reservoir delta area and in isolated pockets around the water's edge. Scattered sparse stands of salt cedar and occasional small Fremont cottonwoods are found above the normal high waterline.

Reach 7 – Rio Chama from Abiquiu Dam to Rio Grande Confluence

Only the Rio Chama Section downstream from Abiquiu Dam was mapped, uielding in structural and composition data for 3,073 acres of vegetation. Areas upstream of the pool of Abiquiu Reservoir were unlikely to be affected by proposed actions. Approximately 14% of the mapped riparian vegetation is composed of mature cottonwood forest over 40 feet high, while 45% of the mapped vegetation consists of intermediate stands of mostly native trees with dense shrubby understory vegetation (H&O Types 3 and 4). Young stands of vegetation 5 to 15 feet high accounted for 13% of the vegetative cover, approximately the same percentage as the most mature class, indicating a solid base of replacement forest in this section. These riparian forest areas are interspersed with about 4% salt grass meadow and 18% openings, and sparsely vegetated with forbs and woody seedlings, as shown in **Table L-2.5**.

Mature cottonwoods dominate the canopy of Reach 7, but many of the acres of Type 1 and 2 vegetation contain an understory dominated by Russian olive. Over 60 percent of the vegetation (Hink and Ohmart Types 3 and 4) is heavily or moderately infested with non-natives (see Section 2.3.1.8).

The large percentage of intermediate and young vegetation, meadows, and sparsely vegetated openings is especially striking in the Rio Chama section. This vegetation structure indicates a pattern of periodic flood flows of high velocity that regularly disturb the riparian zone and keep it in a desirable state of dynamic succession.

Table L-2.5 Acres of Mapped Hink and Ohmart Riparian Vegetation in the Rio Chama Section

Hink and Ohmart Structural Type	Acres in Reaches 5 and 6	Acres in Reach 7	Acres in Reach 8	Acres in Reach 9	Total Acres in Rio Chama Section
Type 1	Not mapped	167	113	5	**284**
Type 2	"	85	63	0	**147**
Type 3	"	1,078	46	14	**1,138**
Type 4	"	222	0	25	**247**
Type 5	"	262	23	125	**410**
Type 6	"	89	0	36	**125**
Marsh/Wet Meadow	"	125	32	3	**160**
Openings	"	309	228	24	**561**
Totals	**N/A**	**2,337**	**505**	**231**	**3,073**

There is considerable agricultural development along the riverside throughout the majority of this segment. Alfalfa fields, pastures, occasional orchards, and residential developments have replaced most of the riparian communities, and only small areas of noncultivated vegetation remain. These sites are typically dominated by Fremont cottonwood, Russian olive, or coyote willow. As in other areas along the Rio Chama, coyote willow is restricted to small patches and narrow bands and is in many places being displaced by Russian olive. Some of this stretch could not be accessed. Accordingly, some vegetation communities had to be interpreted from aerial photographs.

Reach 8 – Rio Grande from Rio Chama Confluence to NM Highway 502 Bridge

Vegetation in this reach verified during the 2002–2004 surveys is summarized in **Table L-2.**. Reach 8 included 381 acres of riparian vegetation that were not mapped, as this stretch includes large sections of private and Pueblo lands with limited or no access. Much of the vegetation analysis for this stretch was based on photographic interpretation.

Reach 9 – Rio Grande Highway 502 Bridge to Cochiti Reservoir

Except for the extreme northern section, most of this stretch of the Rio Grande flows through the steep, cliff-lined White Rock Canyon. Much of the riparian corridor is narrow and contains scattered stands of Russian olive and dense salt cedar. Because of the confining walls, riparian vegetation is often confined to narrow riverside bands, though there are open areas, particularly around the many ephemeral tributaries.

Central Rio Grande Section • Cochiti Dam to San Acacia Diversion Dam (Reaches 10, 11, 12, and 13)

Reaches 10 and 11 are primarily tribal lands, and vegetation was not mapped. However, the mapped portions reveal that the Central Section supports by far the highest percentage of mature Type 1 riparian canopy with roughly equal portions of Types 3 and 5 vegetation classes (**Figure L-2.3**).

Reach 12 (Bernalillo to Isleta Diversion)

This is the first reach considered a warmwater reach, a condition that prevails in subsequent, downstream reaches. Vegetation mapping was conducted for 1,499 acres in this reach. Although it passes through the most heavily settled urban areas of New Mexico, the riparian forests are protected by the Rio Grande Valley State Park. This protection has provided conditions for the riparian areas to become dominated by mature and over-mature cottonwood gallery with dense understory of native and exotic species. The biomass of this reach is typically very high. Vegetation in this reach verified during the 2002–2004 surveys is summarized in **Table L-2.6**.

Reach 13 (Isleta Diversion to the Confluence with the Rio Chama)

The Central Section contains the largest vegetative component of mature riparian forest in the study area. Of the 11,380 acres of riparian vegetation mapped in the Central Section, 3,820 acres, or 34% of the total vegetation, is composed of mature cottonwood gallery forest with a high canopy (Types 1 and 2). Riparian forest of intermediate height (Types 3 and 4) accounts for 35% of the vegetative cover. Type 5 vegetation (5–15 feet) covers 2,244 acres, or 20%, of the vegetation. Openings, meadows, and marsh accounted for the remaining 12% of cover in this Section.

Regardless of height class, most of the bosque in the Central Section, at least 70 percent, has a well-developed shrubby understory. Most of the shrubby intermediate vegetation in the understory is composed of non-native species (see Section 2.3.1.8).

Because the trees in the mature cottonwood gallery forest are approximately 60 to 100 years old, the species composition of young stands (Type 5 vegetation) was evaluated to determine whether native cottonwood and willows were regenerating. Although this type of vegetation accounts for 20% of the overall vegetation in the section, it was found to consist of only about 6% of pure stands of coyote willow and young cottonwood. This distribution demonstrates that the cottonwood gallery forest is not being replaced through healthy riparian processes of flood disturbance and seedling establishment and that the current condition of this section is one of succession to a mixed native and non-native deciduous forest with a low density of cottonwoods. Without regular flood disturbances, fire and human manipulation may have become the factors that regulate the pattern of succession for this section. Vegetation in this reach verified during the 2002–2004 surveys is summarized in **Table L-2.6**.

Table L-2.6 Acres of Mapped Hink and Ohmart Riparian Vegetation in the Central Section

Hink and Ohmart Structural Type	Acres in Reach 10	Acres in Reach 11	Acres in Reach 12	Acres in Reach 13	Total Acres in Central Section
Type 1	0	Not mapped	1,644	1,399	**3,043**
Type 2	9	"	553	215	**777**
Type 3	0	"	553	2,122	**2,675**
Type 4	0	"	189	1,106	**1,295**
Type 5	0	"	598	1,646	**2,244**
Type 6	3	"	260	183	**446**
Marsh/Wet Meadow	0	"	56	211	**267**
Openings	0	"	306	327	**633**
Totals	**12**	**N/A**	**4,159**	**7,209**	**11,380**

San Acacia Section • San Acacia Diversion Dam to Elephant Butte *(Reach 14)*

The San Acacia Section (geomorphic Reach 14) lies between the confluence with the Rio Puerco and Elephant Butte Dam. It is influenced by water operations at Cochiti Dam and the Low Flow Conveyance Channel. Riparian vegetation found in this section is listed in **Table L-2.7**. The San Acacia Section contains 16,203 acres of riparian vegetation mapped within the levees, the greatest area of riparian vegetation in the study area. As shown in Figure 2.3, only 8% of the riparian vegetation in the section consists of mature cottonwood gallery forest (Types 1 and 2), mostly in the area downstream from San Marcial. Intermediate-height vegetation, 20 to 40 feet, accounts for 37% of the vegetative cover in this section. These forests are mostly dense with shrubby undergrowth. Type 5 vegetation is the most prolific in this section, with 42% of the acreage covered by stands of young vegetation from 5 to 15 feet high. Openings, meadows, and marsh accounted for the remaining 13% of cover in this section.

The distribution of structural types as shown in Figure L-2.3 indicates that the San Acacia Section is in a state of dynamic succession in which the maturation of cottonwood gallery forests is not favored and conditions for dense intermediate forests of mixed native and non-native vegetation are increasing. The San Acacia Section exhibits the highest percentage of non-native infestation (see Section 2.3.1.8).

Riparian habitats occur in the riparian zone of the Rio Grande along the shorelines of Elephant Butte Reservoir as well as at inflow areas of the Rio Grande into the reservoir. Riparian plant communities grow in exposed substrate within the floodpool of Elephant Butte Reservoir. The distribution of riparian habitats in this section varies with physical features and reservoir water levels (Reclamation 2002). The riparian-wetland plant communities occurring at the Rio Grande inflow to Elephant Butte Reservoir collectively covered 6,058 acres in 2002 (Reclamation 2002). They include 3,934 acres of tamarisk shrubland as the predominant plant community, with riparian forest, wet meadow, and marsh occurring to a lesser degree.

The native riparian forest, characterized by mature Rio Grande cottonwood and Goodding's willow is found primarily at the northern end of Elephant Butte Reservoir and above the reservoir's highest level of inundation along the Rio Grande. Riparian forest accounts for approximately 2,123 acres at the Reservoir, and there is only 1 acre of riparian grassland. When reservoir water levels recede, a mosaic of riparian-wetland plant communities, including native riparian forests, wet meadows, and cattail marshes, develops into an expanding delta.

Table L-2.7 Acres of Mapped Hink and Ohmart Riparian Vegetation in the San Acacia Section

Hink and Ohmart Structural Type	Acres in Reach 14	Acreage in San Acacia Section
Type 1	925	925
Type 2	266	266
Type 3	4,128	4,128
Type 4	2,014	2,014
Type 5	6,774	6,774
Type 6	148	148
Marsh/Wet Meadow	463	463
Openings	640	640
Totals:	**16,203**	**16,203**

From 1985 to 1995, reservoir water levels were maintained near capacity. As a result, substrates suitable for the establishment of riparian-wetland vegetation have been created at many locations where eroded sediments have been re-deposited on beaches. Beaches protected from severe wave action tend to support narrow bands (3 feet wide) of riparian habitat consisting primarily of tamarisk shrubland and willow shrubland plant communities, with riparian forest occurring less frequently. Exposed beaches cannot support any riparian-wetland vegetation. At the north end of Elephant Butte Reservoir, sediment deposition by the Rio Grande has created an expansive delta of substrate that is rapidly being colonized by riparian-wetland vegetation. This delta is increasing in size as the reservoir pool is receding, allowing more sediment substrate to become available for plant colonization. Concentric bands of tamarisk shrubland and riparian forest (as well as wet meadow) are commonly found along the shorelines of these bays.

Southern Section • Elephant Butte Dam to Fort Quitman (Reaches 15, 16, and 17)

The Southern Section was not included in the 2002 vegetation surveys because it is outside the potential impact area of the Project. The description of current vegetation is based on other field surveys (Anne Janik, Reclamation, personal communication 2002).

A narrow tamarisk shrubland community dominates the riparian zone along the reach of the Rio Grande from below Elephant Butte Dam to Caballo Reservoir. Riparian plant communities at Caballo Reservoir total 2,412 acres. Riparian forest accounts for 310 acres, riparian grassland covers 1,162 acres, and the remaining 941 acres are tamarisk shrubland (Reclamation 2002).

The northern end of Caballo Reservoir includes remnants (snags) of the cottonwood bottomland forest of the Rio Grande that have been inundated by the reservoir. Wet meadows or riparian grasslands and cattail marshes occur in shallow areas that are inundated by the reservoirs for most of the growing season. Saltgrass and Bermuda grass are the dominant species within the wet meadow complex, with some smaller areas dominated by various mixtures of stinkgrass (*Eragrostis cilianensis*), sedges (*Carex* and *Cyperus* spp.), alkali sacaton (*Sporoboltus airoides*), and sneeze-weed (*Helenium autumnale*). Other plant species of the cattail marshes include bulrushes (*Scirpus* spp.), rushes (*Juncus* spp.), reed canary grass (*Phalarus arundinacea*), common reed (*Phragmites australis*), and giant reed (*Arundo donax*). At the north ends of both reservoirs are areas where dead tamarisk, cottonwoods, or willows occur, with a sparse understory of marsh or wet meadow plant species.

Riparian plant communities occurring along the shoreline are frequently affected by water-level fluctuations, associated erosion, and desiccation of some riparian plant species. Shoreline vegetation along the reservoirs tends to support a narrow band of primarily tamarisk shrubland intermixed with mesquite in some areas. Sub-dominant willow shrubland plant species present include sandbar willow (*S. interior*), seep willow (*Baccharis glutinosa*), desert willow (*Chilopsis linearis*), Goodding's willow, and cottonwood. Although not a major component or very diverse, a variety of grasses and forbs occur in these shoreline areas, including Bermuda grass, saltgrass, stinkgrass, sedges, prostrate vervain (*Verbena bracteata*), and vine mesquite (*Panicum obtussum*). Concentric bands of wet meadow, tamarisk shrubland, and riparian forest are commonly found along the shorelines of the various bays and in the alluvial fans of several lateral drainages.

Vegetation surrounding the American and Riverside Diversion Dam is characterized as park-like, with a few scattered cottonwoods and areas of native grasses that are mowed routinely. The river corridor below American Dam is composed of *Distichlis*/*Cynodon* grassland, with the exception of a concrete-lined, channelized section just above the Bridge of the Americas and downstream for about 3 miles. The vegetative community along the Rio Grande below the Riverside Diversion Dam to Fort Quitman is predominantly a narrow band of tamarisk shrubland (*Tamarix chinensis*).

2.3.1.8 Native versus Non-Native Vegetation

Encroachment of non-native species, which began in the early twentieth century, has resulted in riparian vegetation that, while it can provide habitat to some wildlife, does not provide the same habitat quality as native trees and shrubs. The structural classification of Hink and Ohmart (1984) has provided the most thorough method to determine riparian community composition and structure within the Rio Grande floodplain. Biological studies since the 1982 surveys reveal that some significant vegetation changes have occured over the past two decades (Crawford et al. 1993; Fluder 2003). The vegetation classification system defined by Hink and Ohmart specifies dominant-species composition in the overstory and understory and their structural classes; it does not, however, easily distinguish between degrees of non-native infestation within the riparian community. Additional manipulations were required to categorize communities as to their relative cover in non-native species. The survey protocol used for the URGWOPS EIS enabled a quantitative assessment of actual acres infested by exotic species.

The non-native vegetation found in the canopy of Hink and Ohmart Types 1, 2, 3, and 4 would include species such as Siberian elm (*Ulmus pumila*), Russian olive, or mulberry (*Morus* spp.). When immature, the same species may form part of the understory of Types 1–4. Lower-stature species, the most predominant of which is salt cedar, are more likely to be found in Type 5 (5–15 feet) and Type 6 (up to 5 feet) structural classes. Acreage mapped as "Open" has a vegetation cover of less than 25 percent, and species may be native or exotic. This last fact, in particular, makes it difficult to categorically quantify acres of pure native vegetation. The category of "mostly native" seen in Figure L-2.4 represents mapped areas that appear to be purely native or where the exotic component is less than 25 percent. All non-native vegetation throughout the Project Area occurs in the Service's Resource Categories 2, 3, and 4; no habitats valued as Resource Category 1 are presently affected by exotic encroachment.

During the vegetation surveys conducted on behalf of this EIS, 30,656 acres were mapped throughout the three river sections potentially affected by changes in water management. Incidence of non-native infestation for the entire Project Area is 67% heavily infested, 6% moderately infested, and 18% areas of pure native or light infestation. The surveys also determined that the three river sections exhibit relatively the same percentages of high (mostly exotic), moderate (mixed exotic/native), and light (mostly native) infestions. This distribution is somewhat revealing when considering that the Rio Chama Section has higher elevations and more montane species, and the Central Section has been channelized and controlled within the broader floodplain, a floodplain that flattens by the time it reaches the San Acacia Section, affording overbank flooding and hydrological support not easily achieved by the northern two sections. However, there are important differences between river sections in the relative proportions of non-native communities and native species (see **Figure L-2.4**).

Non-native species are generally viewed as vegetation that should be removed from riparian ecosystems. However, riparian fauna are more associated with structural types than with plant species. (See Section 2.5.8.3, Faunal Use of Non-Native Vegetation, for additional baseline information.)

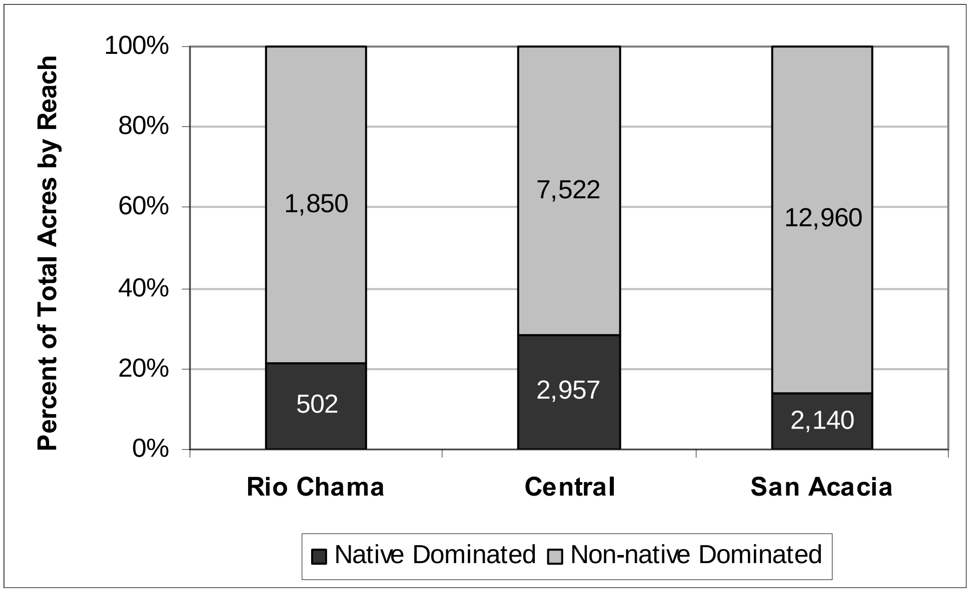


Figure L-2.4 Relative acres of non-native vs. native vegetation in the Project Area.

Rio Chama Section

This section has the lowest number of acres of heavy to moderate non-native infestation. Of additional interest is the finding that probably 99% of the exotic presence in the Rio Chama is Russian olive. The two Hink and Ohmart types most prevalent in the Rio Chama Section are intermediate Type 3 (1,138 acres) and the 5–15 feet Type 5 vegetation (410 acres). Non-native infestation is heavy in 57% of mapped vegetation and moderate in 3%, indicating that as much as 60% of native vegetation in these important structural classifications is compromised by exotic species. The third largest acreage type mapped is the openings (561 acres), areas of either bare ground or with less than 25% plant coverage. Sparsely vegetated areas are often more susceptible to exotic encroachment, particularly after periods of disturbance.

The majority of this river section has extensive agricultural development along the riverside. This fact must be considered when assessing any changes in hydrologic management, as a water regime that supports establishment or sustenance of non-natives could contribute to exotic encroachment in agricultural areas as well as in desirable riparian forests.

Central Section

The Central Section has the second-highest acreage of non-native species in the study area, with 66% dominated by moderate to heavy infestations. As in the Rio Chama Section, Russian olive is the dominant species (in both canopy and understory), but Siberian elm and mulberry begin to appear in Reach 12, along with salt cedar in the understory. By Reach 13, salt cedar becomes the dominant non-native, not only as an understory species but also in large, monotypic stands of structural Types 5 and 6. The presence of a dense, mostly non-native understory with very high biomass greatly increases the risk of fire in these forests in dry years. This risk particularly applies to salt cedar. Tamarisk has an oily component that not only makes it extremely flammable, but allows it to burn for an extended time, enabling flames to reach the canopy of mature and intermediate native species. During the period of this study, several fires occurred in the Central Section riparian forest, destroying many acres of riparian vegetation. Exotic infestation could have the highest impacts in the Central Section because this section supports the largest mature riparian forest in the study area.

San Acacia Section

Of the three river sections mapped, the San Acacia Section suffers the highest relative percentage of exotic infestation, mostly occurring in intermediate and young height classes. Over 12,000 mapped acres, approximately 74%, are dominated by heavy infestation of Russian olive (predominantly in the canopy) and salt cedar. Though salt cedar is found in the understory, the majority appears as monotypic Types 5 and 6 throughout Reach 14. These same species show moderate infestation in about 800 acres (7%). In addition, San Acacia exhibits the lowest acreage (13%) of "mostly native" acres, wherein approximately 2,000 acres are purely native or have only light occurrence of non-native vegetation.

2.3.1.9 Vegetation Trends in the Central Rio Grande Section since 1982

The 1982 Hink and Ohmart surveys covered most of the Central Section, as defined in this Project. This survey was conducted after the initial operation at Cochiti Reservoir and provides data gathered during the 2002–03 vegetation survey and mapping, allowing a direct comparison of vegetation composition classes and structural types and how they have changed during the past two decades (Figure L-2.4). Several factors can produce changes in relative cover of different vegetation types within the active floodplain of a river: decline or death of trees from desiccation, germination and rapid growth of young trees, thinning of trees by fire and mechanical clearing, or thinning or loss of trees by flood scour. Changes in hydrology and invasion and increase of rapidly growing non-native species are presumed to be the primary factors in a highly regulated river system, although some fires and mechanical thinning are known to have occurred during this time period.

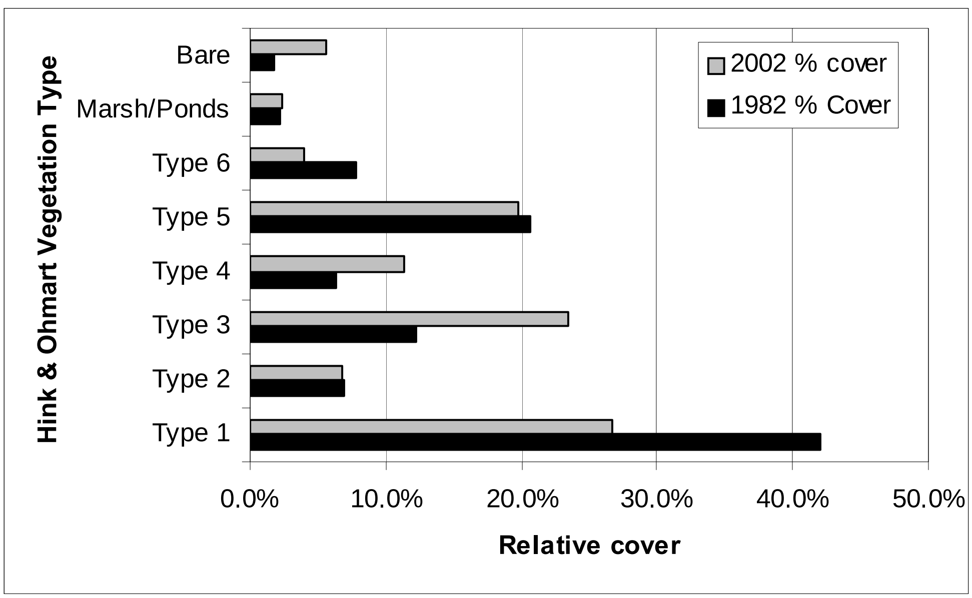


Figure L-2.4 Comparison of Relative Cover of Hink and Ohmart Vegetation Types, 1982–2002 (chi-square=1189, p<0.000).

Application of the chi-square test to the vegetation data shows that the differences are significant, with a chi-square of 1,189 with p=0.000 or less. Chi-square residual tests were applied to further understand the significance and directionality of the observed changes. The data indicate the following trends:

- The riparian zone has seen a significant change in the relative cover of Type 1 vegetation, which has declined since 1982 by 36%. These mature gallery forests with dense understory trees and shrubs provide high levels of biodiversity and valuable support for riparian fauna, particularly avifauna. Loss of this vegetation type can occur from mechanical or fire-induced clearing of the understory. Clearing of the understory of Type 1 vegetation would result in transforming it into Type 2 vegetation. The cottonwood bosque can also be lost completely to fire or mechanical clearing, resulting in Type 6 or Bare classifications; this corresponding trend is not indicated in this study. Death of the mature cottonwood gallery component of Type 1 forests can occur from senescence or drying of the root zone from a lowered water table; this would potentially leave the former understory vegetation unaffected, resulting in a Type 4 or Type 5 forest of intermediate height.

- The relative cover of structural Type 2 vegetation has stayed constant since 1982, declining by only 2%. These forests have a tall cottonwood gallery with a sparse or park-like understory. These forests are usually not the result of natural processes, but result from human-induced clearing of the understory of Type 1 or livestock grazing or both.
- Structural Type 3 has nearly doubled over the 20-year period, increasing by 92% in relative cover. This vegetation type is likely the result of natural succession of Types 4 or 5, when soil conditions are favorable and frequent inundation occurs.
- An increase of 80% in mid-aged native vegetation (Type 4) was observed. This may be the result of the loss of overstory canopy from Type 1, leaving the understory exposed, or the maturing of Type 5 vegetation in less favorable soils or with less frequent inundation. Both possibilities are supported by the trends observed in this study.
- Type 5 vegetation, the thick, shrubby growth of pure stands of young woody species, has decreased by 4% compared to 1982. This may be the result of succession to Types 3 or 4 vegetation, indicating that regeneration of young woody vegetation has decreased slightly.
- A slight increase of 8% in relative cover of non-woody types, such as cattail marshes, ponds, and saltgrass, occurred over the 20-year period.
- The relative amount of structural Type 6 has declined since 1982 by 50%, while bare soil increased by 204%. This trend may reflect drought in 2002.

Additional trends were observed in the comparison of native versus non-native composition of the riparian woody vegetation within each structural type. Evaluation of the species composition of each vegetation type indicates the following trends over the past two decades:

- Monotypic stands of non-native vegetation have not increased significantly since 1982, but mixed native and non-native vegetation has increased in most woody vegetation types.
- While Type 2 vegetation has remained constant overall, non-native infestations have increased within this type.
- Significant increases observed in Type 3 vegetation were from large increases in forests with very dense exotic and mixed understory vegetation with some native overstory.
- Significant increases have taken place in native dominated Type 4 vegetation, the only case where native vegetation has increased in actual acreage.
- Native dominated Type 5 vegetation has seen significant decreases, while young, non-native communities have increased slightly.
- Significant decreases have occurred in Type 6 native-dominated vegetation.

2.4 *Wetland Resources*

2.4.1 *Methods*

2.4.1.1 Wetland Characterization Methods

To evaluate the extent of wetland types within the study area, the Project used draft data from a National Wetlands Inventory (NWI) survey performed by the U.S. Fish and Wildlife Service in 2002. This digital coverage included the Rio Grande corridor from Velarde to Elephant Butte Lake and facilitated quantitative analysis of the Rio Grande portion of the Rio Chama Section, the Central Section, and the San Acacia Section. Existing NWI maps were used to grossly characterize the Northern and Southern Sections and the Rio Chama.

In this report, wetland-type terminology adheres to NWI definitions and Cowardin et al. (1979); however, colloquial terms such as *pond*, *marsh*, and *meadow* are used for convenience and readability.

2.4.1.2 Overview of Rio Grande Wetland Resources

Historically, the Rio Grande channel wandered widely throughout the floodplain, and abandoned channels often contained sufficient groundwater discharge to support marshes (cienegas), sloughs (esteros), and oxbow lakes (charcos; Scurlock 1998; Ackerly 1999). Widespread and frequent inundation maintained emergent, shrub, and forested wetlands outside of the channel.

Currently, the extent of wetland plant communities along the Rio Grande has been significantly reduced by direct displacement by agricultural, urban, and water resource development (Roelle and Hagenbuck 1994). Also, the groundwater elevation throughout the valley has been lowered by the construction of drains. Irrigation and flood-control operations have reduced the magnitude of discharges within the floodway, especially during the spring runoff period, and limited the extent of overbank flooding.

Wetlands have been defined as lands transitional between terrestrial and aquatic systems, where the water table is at or near the surface or the land is covered by shallow water (Cowardin et al. 1979). Wetland communities are dependent upon frequent surface-water inundation or near-surface groundwater. Water saturation influences soil development and the types of plant and animals living in these habitats. Although wetlands occur within the riparian zone and may be dominated by the same plant species common in riparian woodlands, wetlands exhibit wetter soils and support many additional plant and animal species. Because of their dependence on hydrology, wetlands are highly influenced by changes in water operations.

Wetlands occur in a variety of types that may be persistent or ephemeral. Specific wetland types can be characterized by soils, water regime, and vegetation. Along the Rio Grande corridor, soils are the least helpful criterion because of the predominance of recent alluvium with little soil horizon development and the general lack of organic material. Hydrologic factors throughout the system generally dictate the type of wetland that can be supported at a given location. The wetland type, in turn, dictates its primary function within the ecosystem.

Wetlands are important to an ecosystem. Wetlands stabilize streambanks and provide storage areas for floodwaters, protecting downstream areas. Wetlands function as important biological filters to trap sediment and nutrient runoff from surface water and upland environments. In addition, they provide areas of greater biological diversity than the surrounding riparian and upland habitats, provide breeding sites and wintering areas for numerous wetland-dependent wildlife species, and serve as migratory stop-over areas for waterfowl and shorebirds.

Channels and lakes are wetland types that are largely unvegetated or dominated by submergent plants, and are described in the Aquatic Resources section.

Pond (Palustrine Open Water and Aquatic Bed)

Ponds are shallow-water habitats that may be wet intermittently or year-round. A natural pond may result when depressions are filled by surface-water flooding or groundwater discharge. Several large open-water systems have been created adjacent to the Rio Grande floodway to enhance wildlife habitat within the floodplain. Though ponds are relatively rare along the Rio Grande, they provide essential breeding habitat for amphibians and valuable waterfowl habitat along this major migratory corridor, and the margins often support at least a narrow band of wetland vegetation.

Marsh (Palustrine Emergent Wetland)

Marshes are often permanently flooded or maintain surface water during the majority of the growing season. Surface-water depths may range from approximately 6 inches in shallow marshes to 3 feet in deeper marshes. Marshes occur in areas with a very high groundwater table or relatively frequent surface water inundation.

Stands of vegetation are often interspersed by areas of open water. Robust cattails (*Typha* spp.), the principal species of this community, and bulrushes (*Scirpus* spp.) often form dense stands that reach heights between 1 and 3 m. Shallow marshes may be dominated by shorter grasses, rushes (*Juncus* spp.), and sedges (*Scirpus* and *Carex* spp.). In addition to the relatively natural wetlands described here, very large and productive marshes are maintained through intensive management at refuges and other areas along the Rio Grande, the primary habitat for muskrats, waterfowl, rails, egrets, turtles, and frogs.

Wet Meadow (Palustrine Emergent Wetland)

Wet-meadow communities include a variety of shorter (less than 1 m) herbaceous species with occasional interspersed shrubs. They generally are flooded for only a short period during the growing season, or are in areas where the water table is very close to the ground surface. Surface water, when present, is usually 30 cm deep or less. Saltgrass meadows occur in areas that may have an elevated salt concentration within soil that may not have been inundated by surface water for several years.

Important herbaceous species found in this community include Baltic rush (*Juncus balticus*), common spike-rush (*Eleocharis palustris*), smartweeds (*Polygonum* spp.), common plantain (*Plantago major*), water speedwell (*Veronica anagallis* aquatica), and northern frog fruit (*Phyla lanceolata*). The vegetation in meadows is characterized by a shallow root system. Thus, the rate at which the river recedes and the rate of groundwater drawdown are critical for the survival of the vegetation in this community. Wet meadows (along with marshes) provide excellent nursery habitat for fish when inundated and can be important foraging and resting areas for wintering and migratory birds.

Vegetated point bars and islands within the river channel are additional examples of wet meadow wetlands. Due to variations in discharge, vegetation is often highly disturbed or ephemeral. Smartweed, beggartick (*Bidens* spp.), burdock (*Rumex* spp.), and barnyardgrass (*Echinocloa* spp.) are among the first plant species to colonize these areas. Later, a very diverse assemblage of herbaceous plants becomes established, including bermudagrass (*Cynodon dactylon*), Indiangrass (*Sorghastrum nutans*), reed canarygrass (*Phalaris arundinacea*), alkali sacaton (*Sporobolus airoides*), alkali muhly (*Muhlenbergia asperifolia*), vine mesquite (*Panicum obtusum*), Cuman ragweed (*Ambrosia psilostachya*), and western goldenrod (*Euthamia occidentalis*) (Milford and Muldavin 2004).

Forested and Shrub Wetlands

Much of the woody riparian plant community along the Rio Grande is sufficiently wet to be also classified as wetland, even though it may not meet classification criteria as jurisdictional wetlands. Close proximity to groundwater or frequent surface inundation are essential in the development of these stands into wetland communities. Shrub wetlands are typically dominated by coyote willow, seep-willow, or salt cedar and are common on point bars and islands, as well as within the overbank area. Forested wetlands in the area are dominated by Rio Grande cottonwood or Goodding's willow and may have a well-developed shrub community in the understory. Typically, the herbaceous layer in these types is dense and diverse compared to drier portions of the bosque. Yerba mansa (*Anemopsis californica*), horsetail (*Equisetum arvense*), and Baltic rush commonly occur in forested and shrub wetlands.

The naturally vegetated areas within the floodplain of the Rio Grande are mostly composed of forested, shrub/scrub, emergent, palustrine, and lacustrine wetlands, as defned by the Service (Cowardin et al. 1979). Some pockets of vegetation within the Project Area may have become so disconnected from the active channel that over time, they no longer fit wetland criteria, but nearly all vegetation in the area is dependant on groundwater and surface water for part of the growing season. The baseline vegetation survey using the modified H&O classification system roughly correlates with the Cowardian system of wetland classification in that H&O Types 1, 2, 3, and 4 are forested wetland types, Type 5 is comparable to shrub scrub wetland types, and Type 6 and marshes are generally emergent wetlands. Channels, lakes, and ponds are largely unvegetated wetlands.

2.4.1.3 Hydrologic Factors Affecting Wetlands

Marshes and emergent wetlands require the greatest hydrological support, primarily from groundwater, though most marshes are indirectly dependent on surface flows in the river and nearby unlined drains and channels to keep groundwater levels at or very near the ground surface elevation year round (Cowardin et al. 1979; Corps 1987). The water regime of a wetland depends on proximity to a river channel (a source of surface water) and depth to groundwater. Within the Rio Grande and Rio Chama channels, most of the islands and point bars are periodically inundated by river flows and thus support meadow and shrub-wetland communities. Side channels that wind through bars frequently support marsh vegetation. Surface water inundation also influences the development of backwater marshes and shrub wetlands at the deltas of reservoirs such as Cochiti Lake. Individually, wetlands within or bordering the river channel may be short-lived because high flow velocities and sediment deposition may, respectively, scour or bury vegetation.

In addition, many areas with riparian vegetation communities described in Section 2.3.1.2 may also qualify as jurisdictional wetlands as defined in the 1987 Corps of Engineers Wetlands Delineation Manual if they possess more rigorous characteristics of soil saturation, hydrophytic vegetation, and hydrology (Corps 1987). Most wetlands outside of the channel have developed in areas with a high groundwater table. Those in shallow basins or relatively far from the river may be seasonally or temporarily flooded; that is, inundated during the majority, or just a portion, of the growing season, respectively. The natural wetlands along the east bank of the Rio Grande at Bosque del Apache NWR are an example of this water regime.

Abandoned channels or depressions deep enough to intersect the regional groundwater table often support permanently or semi-permanently flooded ponds and marshes (Cowardin et al. 1979; Corps 1987). Within the Project Area, such geologic features support the largest wetland complexes along the Rio Grande. River flows during the spring runoff period have the effect of elevating the regional water table sufficiently to discharge into these wetlands. Those at Isleta Marsh and Madrone Pond are examples of large wetlands primarily influenced by groundwater discharge. During the spring runoff period, surface water also may inundate portions of these wetlands, such as those bordering the channel at San Juan Pueblo. Surface water flow from arroyos may also contribute to the wetland water regime, as in the case at the San Antonio Oxbow.

All wetland vegetation and soils in the Project Area are affected by discharge duration in the river channel. The duration of high flows (greater than the 75th percentile) contributes to groundwater recharge and the stability of groundwater elevations and is an indicator of inundation frequency of wetlands located on islands and in the overbank area. The duration of low flows in the river channel (less than the 25th percentile) reduces the capability of the river flow to maintain minimum groundwater levels in adjacent wetlands.

2.4.1.4 Distribution of Wetland Types

The areal extent of wetland types within th e Project's river sections was calculated when GIS coverage of NWI data was available and is summarized in **Table L-2.8**. This includes the majority of the river that could be affected by potential changes in water operations. In other reaches, wetland type and extent are qualitatively described. Note that the area of marsh habitat determined from NWI data may not necessarily equate to that determined from the modified Hink and Ohmart classification described earlier because of differences in the classification methodologies.

As a result of the large extent of different wetland types, whether jurisdictional or non-jurisdictional, within the Project Area, selected wetland complexes are described in **Table L-2.8** with locations shown in **Figure L-2.6**. These representative wetland complexes are singled out for evaluation of the effects of proposed changes in water operations.

Table L-2.8 Wetland Type, Acreage, and Density within the Rio Grande Floodway (Service 2003)

Wetland Type	Rio Chama Section (Rio Grande portion only)	Central Section	San Acacia Section
Pond	84	105	71
Marsh and meadow	327	2,246	737
Shrub wetland	462	457	2,469
Forested wetland	318	214	485
Total	1,191	3,021	3,762
Wetland density (acre/river-mile)	30.9	28.5	58.2

Northern Section

Upstream of La Sauses to the south boundary of Alamosa NWR, the floodplain supports oxbow wetlands. The extent and condition of riparian vegetation improves at the Alamosa NWR, which includes extensive oxbow wetlands. There are several small cattail marshes and wet meadows in this reach, with the more extensive ones in the Los Luceros area and the south end of San Juan Pueblo. These are usually associated with high groundwater in old river channels and may be supported with irrigation tailwaters and seepage from ditches. These areas provide habitat for a variety of waterfowl, amphibians, and perhaps the New Mexico jumping mouse.

Rio Chama Section

Digital NWI mapping data were available only for the Rio Grande portion of the Rio Chama Section. There is a fairly even abundance of emergent-, shrub-, and forest-dominated wetlands within this section. Nearly 75 percent of the total wetland acreage occurs between the Rio Chama confluence and Otowi Bridge, including several well-developed marshes. Vegetated wetlands are much less abundant along the narrow channel through White Rock Canyon and consist primarily of coyote willow stands along the channel margin.

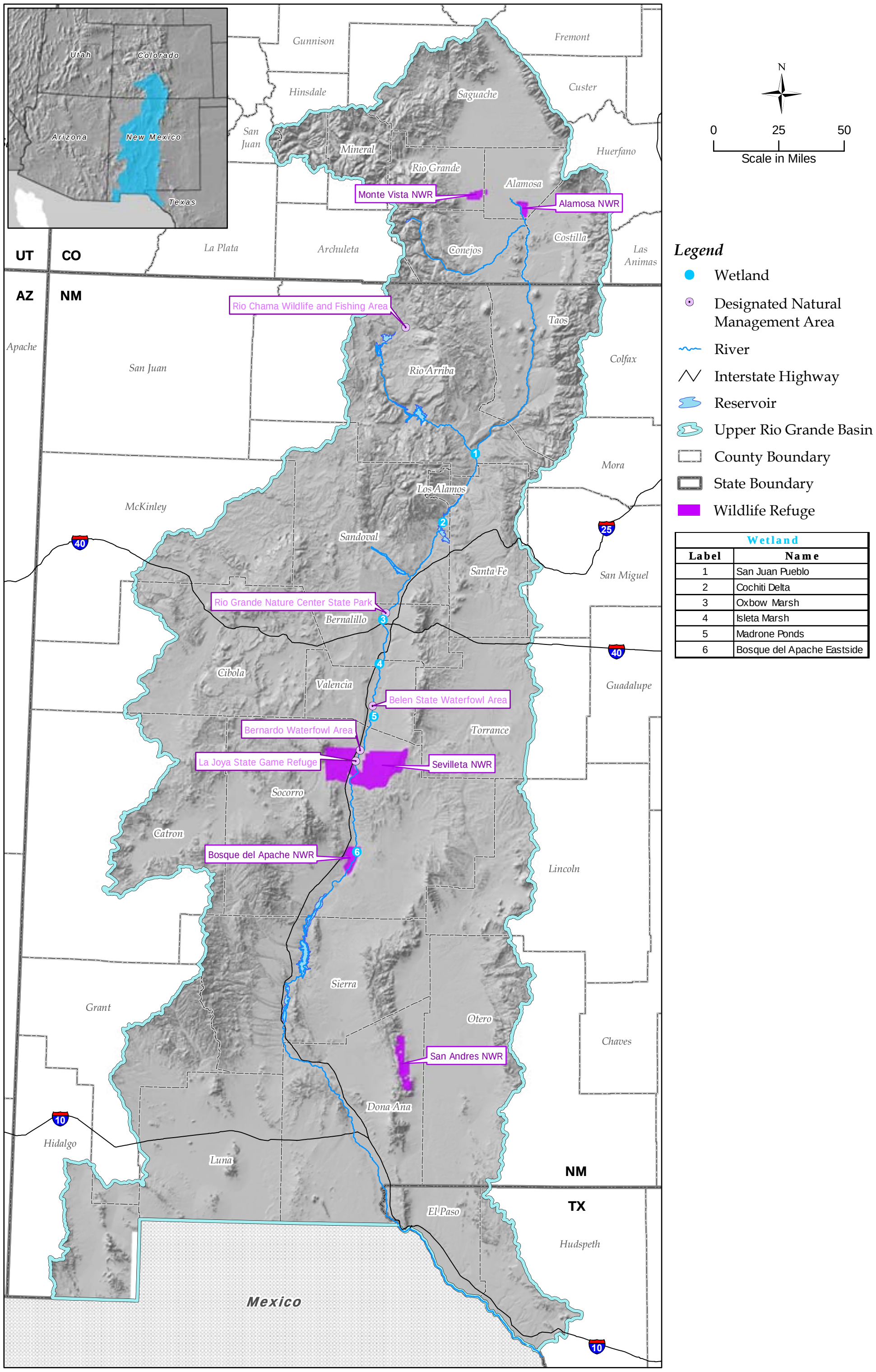
Central Rio Grande Section

The Central Section encompasses more than 3,000 acres of palustrine wetland and includes many of the larger wetland complexes such as the San Antonio Oxbow, Isleta Marsh, and Madrone Pond. About two-thirds of the wetland acreage is concentrated between Isleta Diversion Dam and the Rio Puerco confluence (Reach 13). The Central Section has the largest abundance (over 2,200 acres) of marsh and wet meadows, occurring in both relatively large stands at the locales mentioned above and on many islands and point bars within the Rio Grande channel.

San Acacia Section

Shrub wetland is the most abundant type in the San Acacia Section, accounting for about two-thirds of the 3,762 acres here. Over 60 percent of the nearly 2,500 acres of shrub wetland consists of mixed coyote willow and salt cedar stands. Marshes are concentrated adjacent to the bluff along the west side of the floodway where groundwater discharges to the river due to the absence of a riverside drain.

Of the three river sections for which acreages could be calculated, the San Acacia section contains nearly 60 acres of wetland per river-mile, nearly twice the density of the Rio Chama and Central Sections. Widespread overbank inundation occurs at relatively low discharges (approximately 3.500–4,000 cfs) in this section and likely accounts for the abundance of wetland habitat.



Label	Name
1	San Juan Pueblo
2	Cochiti Delta
3	Oxbow Marsh
4	Isleta Marsh
5	Madrone Ponds
6	Bosque del Apache Eastside

Figure L-2.6 Selected Wetlands, Refuges, and Designated/Natural Management Areas.

Southern Section

Wetland habitats occur in the riparian zone of the Rio Grande, along the shorelines and near-shore shallow areas (littoral zones) of Elephant Butte and Caballo Reservoirs, and at inflow areas of the Rio Grande into the reservoirs. The distribution of these habitats varies with physical features and water levels. Wetland plant communities occurring along the shoreline are frequently affected by water level fluctuations, associated erosion, and desiccation of some wetland plants species. Potential wetland plant communities represented include marsh, phreatophyte shrubland (primarily tamarisk), snags in wet meadows, and wet meadow (Reclamation 2002).

At the north end of Elephant Butte Reservoir, sediment deposition by the Rio Grande has created an expansive delta of substrate that is being rapidly colonized by riparian-wetland vegetation. This delta is increasing in size as the reservoir pool is receding, allowing more sediment substrate to become available for plant colonization. The size of wetland complexes associated with lateral drainages emptying into Elephant Butte Reservoir appears to be correlated with drainage basin size and isolation of the shoreline from wave erosion. The largest of these wetland complexes is about 2 ha (5 acres) and occurs in bays that have several drainage inputs. These bays provide protected coves that are not subjected to severe wave erosion. Subsequently, fine sediments deposited by lateral drainages are retained along the shoreline of these bays and provide substrates suitable for the establishment of wetland habitats. Concentric bands of wet meadow are commonly found along the shorelines of these bays, along with bands of tamarisk shrubland and riparian forest.

The Rio Grande inflow at the northern end of Caballo Reservoir is the largest wetland complex at this reservoir and includes remnants (snags) of the cottonwood bottomland forest of the Rio Grande Valley that was within the inundation limits of the reservoir. The alluvial fans of several large lateral drainages along the western shoreline also support large expanses of wetland. The 16-ha (40-acre) Palomas Marsh is typical of the wetlands that occur along the western shoreline.

2.4.1.5 Representative Wetlands

Six areas were selected as representative wetlands that might be affected by proposed changes in water operations on the basis of their geographic location, wetland type, and previous studies. **Table L-2.9** lists these six representative wetlands within the Project Area, and their locations are depicted in **Figure L-2.6**. These areas also serve as examples of the various hydrologic conditions that facilitate wetland development within the Rio Grande corridor.

Table L-2.9 Representative Wetland Complexes along the Rio Grande, with Approximate Acreages of Wetland Types

Wetland/Section	Reach	Open Water	Emergent Wetland	Shrub Wetland	Forested Wetland	Total Acres
San Juan Pueblo Northern Rio Grande Section	4	1.4	31.8	87.2	0.6	**121.0**
Cochiti Lake Delta Rio Chama Section	9	245.0	23.5	158.7		**427.2**
San Antonio Oxbow Central Rio Grande Section	12	7.2	36.3	20.2	2.3	**66.0**
Isleta Marsh Central Rio Grande Section	13	12.3	225.4	125.5	34.8	**398.0**
Madrone Pond Central Rio Grande Section	13	1.5	35.2	21.6		**58.3**
Bosque del Apache NWR (east bank) San Acacia Section	14	14.5	141.3	317.0	12.2	**485.0**

Source: National Wetlands Inventory draft mapping 2002.

2.4.2 *Designated and Natural Management Areas*

2.4.2.1 National Refuge, State, and Other Wildlife Areas by River Section

There are a variety of Natural Management Areas within the Project Area, each of which is dependent upon the availability of surface water to maintain specific wildlife habitats that are designated in its mission statement. A potential change in water operations could either benefit or adversely affect the ability of the management areas to manage wildlife habitat.

Northern Section

A number of state and federal wildlife areas provide excellent wetland habitat along the Rio Grande. In the San Luis Valley of Colorado, the Service manages 16,000 acres of wetlands, primarily for waterfowl, at the Monte Vista and Alamosa NWRs. Wetland habitats in the Monte Vista NWR include shallow wet meadows, open water, and cattail marshes, as well as grain-producing farmland, that provide feed for many waterfowl. Wetland habitats at Alamosa NWR consist mainly of wet meadows, cattail marshes, and river oxbows within the floodplain of the Rio Grande. The Colorado Division of Wildlife and the U.S. Forest Service (FS) also actively oversee the management of wetland areas at the Rio Grande and Home Lake Station Wildlife Areas and the Hot Creek Research Natural Area. The wetlands of these wildlife management areas, however, comprise less than 1,000 acres. In addition, they fall outside the Project Area and thus are not further considered in this report.

Recently, the BLM has developed the Rio Grande Corridor Coordinated Resource Management Plan to restore degraded sections of the Rio Grande in this reach. This plan proposes willow and cottonwood plantings and more intensive grazing management, with the goal of bringing degraded habitat back to a healthy, sustainable condition.

Rio Chama Section

The south side of the Rio Chama within Reach 5 is part of the Rio Chama Wildlife Management Area, managed by the State of New Mexico. The majority of Reach 6 (24.7 miles) was federally designated as "Wild and Scenic" in 1988. The designated area is co-managed by the BLM and the FS.

Central Rio Grande Section

A portion of Reach 12 includes Rio Grande Valley State Park, near the Rio Grande Nature Center. The Middle Rio Grande, the Belen State Waterfowl Area, Bernardo Waterfowl Area, and the La Joya State Game Refuge, which are managed by the NMDGF, contain wetlands crucial to many species and serve as important waterfowl refuges. The Bosque del Apache NWR, a Service-managed wildlife area located in the Middle Rio Grande 20 miles south of Socorro, covers a total of 57,191 acres, including 13,000 acres of extensive wetlands with wet meadows and cattail marshes. Other specific wetland areas were also identified by Crawford et al. (1993) for the Middle Rio Grande Valley.

Southern Section

Five special areas are located within this reach: Elephant Butte Reservoir State Park; Caballo State Park; Percha State Park; the New Mexico Game and Fish Wildlife Management Area at Mesilla Dam; and the Rio Bosque Wetland below Riverside Diversion Dam, which is managed by the City of El Paso.

The Natural Management Areas discussed here involve a variety of management agencies, mission statements, and associated wildlife. Table L-2.10 summarizes this diversity by focusing on a few representative management areas.

Table L-2.10 Selected National Wildlife Refuges and other Representative Natural Management Areas of the Upper Rio Grande

Name	Location	Size (acres)	Description/Mission
Alamosa National Wildlife Refuge	Reach 1	11,169	Natural riverbottom wetland, dissected by sloughs and oxbows of the river; wetland and wildlife habitat
Sevilleta National Wildlife Refuge	Reach 13	229,700	Habitats include bosque riparian forests and wetlands; supports four major ecological habitats; managed to maintain the natural processes of flood, fire, and succession that sustain this diverse ecosystem; vital to migrating birds and other wildlife
Bosque del Apache National Wildlife Refuge	Reach 14	57,191	Waters of the Rio Grande have been diverted to create 7,000 acres of wetlands within total acreage of vital wildlife habitat
Rio Chama Wildlife and Fishing Area	Reach 5	13,000	On the Rio Chama, one of the State's larger and better trout streams (hatchery-stocked rainbow trout)
Rio Grande Nature Center State Park	Reach 10	170	Bosque located within the Central Flyway for migratory birds; wetlands and riparian wildlife habitat
Belen State Waterfowl Area	Reach 11	230	On Rio Grande bottomland; farmed to provide waterfowl feed and resting habitat
Bernardo Waterfowl Area	Reach 12	1,573	Includes 450 acres of crops cultivated to provide winter feed for migratory and upland birds; bird watching and hunting
La Joya State Game Refuge	Reach 12	3,550	Ponds, canals, and ditches in the Central Rio Grande Valley; wildlife and waterfowl protection; bird-watching and seasonal waterfowl hunting

Sources: Service 2003a, NMDGF 2003b, New Mexico State Parks (NMSP) 2003

2.4.2.2 Key Rio Grande Restoration Projects

Central Rio Grande Section

The Albuquerque Overbank Project is a joint effort of Reclamation, the MRGCD, and the Albuquerque Open Space Division. The purpose of the project is to demonstrate the potential for overbanking, that is, clearing river bars of exotic vegetation and regarding to the water table to allow for periodic flooding and re-establishment of native woody vegetation (cottonwoods and willows) in the Middle Rio Grande bosque. Site preparation began in March of 1998.

The Middle Rio Grande Bosque Initiative (MRGBI) of the Service is an ongoing ecosystem management effort to coordinate the ecological restoration and management of the Middle Rio Grande. The Corps is also a participant. For this initiative, the Middle Rio Grande is defined as the 180-mile corridor from Cochiti Dam to the headwaters of Elephant Butte Reservoir. The objective of the MRGBI is to protect, enhance, and restore biological values by addressing ecological functions within the Middle Rio Grande based on recommendations by a Biological Interagency Team for long-term protection of the bosque.

Other projects in this section include the Pueblo of Santa Ana Riparian and Wetland Restoration Project and the Rio Grande Habitat Restoration Project at Los Lunas. The Pueblo of Santa Ana project involves rehabilitation and restoration of degraded riverine habitat along the Rio Grande through the Pueblo, stabilizing the severely entrenched riverbed, and increasing bankfull channel width. Efforts at Los Lunas included clearing the riverbed and banks of invasive salt cedar and removing jetty jacks to improve flow.

San Acacia Section

Bosque del Apache NWR—The refuge is planning and implementing several projects, which require peak flows and overbank flooding to create, enhance, and maintain high-quality riparian vegetation and wetlands in the active floodplain (Table L-2.11).

Table L-2.11 Bosque del Apache National Wildlife Refuge Restoration Projects

Projects on the Active Floodplain	Acres	Objectives
North End Avulsion – Habitat Improvement	1000	Promote the relocation of the river to the east, stabilize river bar, restore riparian vegetation, create salt grass meadow, and enhance wetland by improving connectivity to river; monitor river channel/wetland properties
High Flow Side Channel Enhancement – Phase 1	225	Reduce channel narrowing, enhance high flow channels and associated habitat in burned area, monitor channel/floodplain fluvial dynamics
High Flow Side Channel Enhancement – Phase 2	194	Reduce channel narrowing, enhance high flow channels and associated habitat in burned area, monitor channel/floodplain fluvial dynamics
ET Tower Transition Site	443	Control salt cedar in the area of an ongoing evapotranspiration research site to compare water use of salt cedar and restored native vegetation; also includes channel realignment and the creation of a backwater marsh
Channel Widening and Overbank Area Restoration	750	Widen active channel and re-establish quality riparian habitat along active floodplain
Southend Restoration – Phases I and II	1600	Remove monotypic and understory salt cedar, build water delivery system, and manage water to establish wetland, grassland, and forest habitat areas

Source: Gina Dello Russo, Bosque del Apache NWR, personal communication 2004

Floodplain Management Program

The “Save Our Bosque Task Force” is developing a voluntary program for private landowners in the San Acacia reach (in this case, from San Acacia Diversion Dam to the San Marcial Railroad Bridge) to establish conservation easements on those portions of their lands prone to flooding on the active floodplain and work with agencies toward habitat restoration. The Task Force has completed a conceptual plan to determine the mosaic of habitats that could be restored to areas of the floodplain. Approximately 7,000 acres of monotypic or mixed salt cedar would be converted to native grasslands, forests, wetlands or savannahs if the plan is fully implemented. One-third to one-half of the active floodplain in this reach is predicted to flood at or below 5,660 cfs (the historic two year return flood). The assumption in the plan is that below 5,660 cfs flood level riparian communities with willows, cottonwoods, and wetland species could be established and maintained. Above that flood level, salt cedars would be replaced with more xeric species of grasses and shrubs, resulting in open savannahs and scattered trees (Gina Dello Russo, Bosque del Apache NWR, personal communication 2003).

Southern Section

Picacho Bosque Wetlands Project

The City of Las Cruces received a U.S. Environmental Protection Agency (EPA) Sustainable Development Challenge Grant to develop a project entitled “Rio Grande Riparian Ecological Corridor Project” in the Mesilla Valley along the Rio Grande. One of the components of the project is the development of a wetland pilot project on land owned by the NMDGF. The 30-acre wetland development project was completed in 2003 with funding from the Elephant Butte Irrigation District, Reclamation, the Southwest Environmental Center, and the City of Las Cruces. The project involved removing salt cedar, revegetating with native riparian trees and shrubs, and creating wet meadows and open water wetlands.

Rio Bosque Wetlands Park
The University of Texas at El Paso manages this wildlife area along the Rio Grande in southern El Paso County for the City of El Paso. The 372-acre wetland park was established in the 1990s through the cooperation of numerous partners including the International Boundary and Water Commission, El Paso County Water Improvement District No. 1, Reclamation, Ducks Unlimited, and others. Management at the park has included removing large stands of salt cedar, planting of native vegetation, and creating numerous wetland areas.

2.5 Fauna of the Rio Grande Valley

2.5.1 Riverine Community (Fish and Foodbase)

2.5.1.1 Modeling the Riverine Fish Community

Riverine habitat use criteria were developed using five representative aquatic species for the Rio Grande: RGSM, flathead chub, longnose dace, river carpsucker, and channel catfish (Bohannan-Huston et al. 2004); for the Rio Chama, brown trout was substituted for the longnose dace. These criteria were developed according to guidelines similar to those established for the Physical Habitat Simulation Model in which a statistically based suitability is developed for each specific species and habitat type.

Fish habitat availability on the Rio Chama and Rio Grande was identified and quantified using the results of the hydraulic modeling and habitat suitability analysis and by plotting usable habitat area versus discharge. Usable habitat area was calculated for each daily discharge measurement in the 40-year period of record, and data were plotted as a series of flow duration curves for the respective nodes of the URGWOM model for various alternatives (e.g., maximize the percent of usable habitat area for RGSM juveniles following spring runoff). The daily discharge measurements were run through the habitat model to derive daily habitat availability for the 40-year period of record.

RGSM egg retention, transport, and entrainment were analyzed using the results of the FLO-2D and URGWOM models. It was assumed that RGSM spawn during flow increases in spring (May–June) and that the eggs are uniformly distributed in the water column. The average flow velocity during spawning was quantified by each reach of interest for the 40-year period of record by alternative.

The FLO-2D Model was used to predict average water velocity of the study reaches for a range of discharge events during spring runoff for each alternative. The general egg transport rate was estimated using average water velocity data for the reach of interest for a range of flows. The reaches of interest were Cochiti Dam to Angostura Diversion Dam, Angostura Diversion Dam to Isleta Diversion Dam, Isleta Diversion Dam to San Acacia Diversion Dam, and San Acacia Diversion Dam to the headwaters of Elephant Butte Reservoir.

Using the Aquatic Habitat Model, the distribution of habitat (depth and velocity) that could potentially retain eggs/larvae and support their recruitment was predicted. Shallow low-velocity habitats were assumed to provide suitable conditions for the growth and survival of young-of-year RGSM. Changes in these conditions, as predicted by the Aquatic Habitat Model, were identified by alternative, and impact criteria were developed.

A “threshold” velocity was determined that would minimize the downstream displacement of passively drifting RGSM eggs and larvae. This value was based on the developmental rate (dependent on water temperature) of RGSM and the reach length of interest. The threshold velocity determination (m/s) was expressed as length of fragmented river reach (m) divided by time to development of swim bladder.

Habitat characteristics for six species in five habitat categories were developed for incorporation into the Aquatic Habitat-Flow Model described in Section 2.2.1.2.

2.5.1.2 Estimating the Riverine Food Base

The aquatic food base in the Rio Grande comprises various algae, macrophytes, and aquatic invertebrates. Physical features such as water velocity, substrate, temperature, and sediment inputs affect these food sources. Impoundments and diversions may also affect the structure of the aquatic food base. The following discussion is based on available data from the U.S. Geologic Survey (USGS 2003a, unpublished data) and the New Mexico Environment Department (NMED 2003, unpublished data).

Functional feeding groups (FFG) are based on the River Continuum Concept (RCC), which consists of three main ideas designed to quantify insect biomass dispersion that can be used as a bio-indicator of the condition of North American streams (Thorp and Covich 1991). The assumptions are based on the concept that stream insect communities originate in response to a continuous gradient of physical variables present from the headwaters to the mouth of the stream and that the aquatic community cannot be separated from the surrounding environmental conditions that introduce water, nutrients, and other materials into the ecosystem (Thorp and Covich 1991). It is then also assumed that the entire steam community is linked, and what happens downstream is a reaction to what is happening upstream (Thorp and Covich 1991). These stream communities are made up of organisms that fulfill different roles, and it is those roles that are characterized by FFG classifications.

Establishing an FFG model involves understanding that longitudinal changes in a stream are associated with the abundance of different FFGs and the food resources associated with eacj group (Thorp and Covich 1991). The determination of an FFG for a certain species is tedious and involves detailed observation of that organism in its natural habitat and analysis of gut contents during different seasons. The actual FFG classes vary among the individuals who use them, but usually involve some basis from the general classes of shredders, collectors, scrapers, macrophyte piercers, predators, parasites, omnivores, and macrophyte herbivores (**Table L-2.19**).

Table L-2.12 Aquatic Food Base Feeding Group Descriptions (Thorp and Covich 1991)

Functional Feeding Group	Abbreviation	Food Source	Feeding Mechanism
Collector filterer	CF	Decomposing fine-particulate organic matter	Filterers or suspension feeders
Collector gatherer	CG	Decomposing fine-particulate organic matter	Gatherers or deposit feeders
Macrophyte herbivore	MH	Plants	Chewing
Omnivore	OM	Plants or animals	Various
Parasite	PA	Living animal tissue	Internal parasites: eggs, larvae, pupae External parasites: larvae, prepupae and pupae in cocoons, pupal cases, or mines
Piercing herbivore	PH	Plants	Sucking
Predator	PR	Living animal tissue	Engulfers: attack prey and ingest whole animal or parts
Scraper	SC	Periphyton – attached algae and associated material	Grazing scrapers of mineral and organic surfaces
Shredder	SH	Living or dead plant material, coarse particulate matter, and wood	Chewers of plants and coarse particulate matter; excavate and gallery wood

A concern with these general classifications is that many species will spend time in more than one group during different life stages, seasons, or environmental conditions (Thorp and Covich 1991). There are, however, general morphological traits that hold some consistency throughout the life history of most organisms, which enable predictions to be made on invertebrate assemblages.

Following is a description of Thorp and Covich's (1991) classic premise of the River Continuum Concept. The headwaters of a stream should be narrower, resulting in more coverage from the canopy and reduced light exposure, thus decreasing photosynthetic production in the water channel. This would, in turn, reduce the number of scrapers within the assemblage. However, there would be an increase in organic matter input from the surrounding foliage and an increase in the proportion of shredders within the insect assemblage. Farther downstream, the water channel widens, and a greater amount of light hits the water surface and increases photosynthetic production (generally in the form of algae), which results in an increase in scrapers and grazers. Because the vegetation along the shore provides proportionately less organic matter, the number of shredders should decrease. Farther downstream, closer to the mouth, the stream again becomes wider and deeper so that much of the substrate is below the photic zone and limits photosynthetic production, thus precluding suitable environments for scrapers. Again, there is less significant input of organic matter from shoreline vegetation, thus limiting suitable habitat for shredders. There is a larger source of fine particulate organic matter (FPOM) in the water column, creating the ideal habitat for collector-filterers and gatherers. Predators and parasite populations tend to remain constant throughout the length of the stream because there is a significant population of prey in most stream habitats.

Data for macroinvertebrates was obtained from sampling sites along the Rio Grande and major tributaries in Colorado, New Mexico, and Texas (NMED 2003; USGS 2003a), a major taxon list was established, and functional feeding groups were assigned to each. The data from each sample site was then separated into six general sections of the Rio Grande and the major tributaries, as defined in Section 1.1. The data from each river section were then sorted by FFG, and percentages of each group were determined for each section (See Figure in Section 2.5.2). No data were available for the San Acacia Section.

2.5.2 *The Riverine Fish Community*

The critical reaches for riverine aquatic habitat under the EIS are from Cochiti Dam to the inflow of Elephant Butte reservoir on the Rio Grande and the Rio Chama from Abiquiu Dam to the confluence of the Rio Grande. The Rio Grande from the confluence of the Rio Chama to the inflow to Cochiti reservoir may also be important to evaluate under the EIS because of operational changes at Cochiti Reservoir and sport fish management in the reservoir.

Structural modifications to the Rio Grande drainage have eliminated the continuity of the system and created disjointed river reaches. It is therefore important to consider river reaches within the system and their equivalent fish communities (**Table L-2.13**) separately in order to accurately analyze potential impacts to ecologically important areas. These river reaches are designated by continuous river segments, often from one structural impoundment to the next one downstream, and may combine two or more previously defined reaches into one reach.

The riverine fish community of the Rio Grande within the URGWOPS planning area consists of a diversity of native and non-native species. Rio Grande fish community data for the period from 1993 to 2002 are summarized in Section 2.5.2 (**Table L-2.13**).

Northern Section

A cold-water fishery (brown and rainbow trout) extends from the headwaters of the Rio Grande to Monte Vista (just upstream of Alamosa), below which a gradual transition occurs to a warm-water fishery. This fishery supports a variety of non-native fish, including northern pike, largemouth bass, yellow perch, black bullhead, channel catfish, green sunfish, mosquitofish, carp, and trench. The native Rio Grande sucker is no longer found in the main channel (only in major tributaries), but the river does support native populations of brook stickleback, longnose dace, Rio Grande chub, fathead minnow, red shiner, and white sucker. Lack of flow due to upstream diversions is the primary habitat threat for these species (Montgomery et al. 2001).

Reach 2 – Conejos River

Flowing from the San Juan Wilderness in southern Colorado, the Conejos River is designated from Platoro Dam to the confluence of the Conejos River with the Rio Grande. Fish species include brown, brook, and rainbow trout. The Conejos River is stocked with hatchery fish and managed as a put-and-take fishery, 4.5 miles below Platoro Reservoir after the reservoir flows settle down in late spring.

TableL-2.13 Riverine Fish Distribution in Project Area

Species	Common Name	Section					
		Northern	Rio Chama	Central	San Acacia	LFCC	Southern
Native Minnows							
Cyprinella lutrensis	Red shiner	Present	Present	Abundant	Abundant	Present	Present
Gila pandora	Rio Grande chub	Present	Present	Present		Present	
Hybognathus amarus	Rio Grande silvery minnow			Present	Present		
Notemigonus crysoleucas	Golden shiner						Present
Notropis jemezanus	Rio Grande shiner						
Notropis simus	Rio Grande bluntnose shiner						
Pimephales promelas	Fathead minnow	Present	Present	Abundant	Present	Present	Present
Pimephales vigilax	Bullhead minnow						Present
Platygobio gracilis	Flathead chub	Present	Present	Abundant	Present	Present	
Rhinichthys cataractae	Longnose dace	Present	Present	Abundant	Present	Present	Present
Native Species							
Dorosoma cepedianum	Gizzard shad			Present	Present	Present	Present
Dorosoma petenense	Threadfin shad						Present
Gambusia affinis	Mosquitofish		Present	Abundant	Present	Present	Present
Ictalurus furcatus	Blue catfish						
Ictiobus bubalus	Smallmouth buffalo			Present	Present		Present
Lepomis macrochirus	Bluegill			Present	Present	Present	Present
Carpoides carpio	River carpsucker		Present	Present	Present	Present	Present
Catostomus plebeius	Rio Grande sucker	Present	Present				
Pylodictis olivaris	Flathead catfish			Present	Present		Present
Lepisosteus osseus	Longnose gar						Present
Salmo clarki	Cutthroat trout						
Non-Native Species							
Ameiurus melas	Black bullhead		Present	Present	Present	Present	Present
Ameiurus natalis	Yellow bullhead			Present	Present	Present	Present
Catostomus commersoni	White sucker	Present	Present	Abundant	Present	Present	
Cyprinus carpio	Common carp	Present	Present	Abundant	Present	Present	Present
Ictalurus punctatus	Channel catfish		Present	Present	Present	Present	Present
Lepomis cyanellus	Green sunfish		Present	Present	Present	Present	Present

Species	Common Name	Section					
		Northern	Rio Chama	Central	San Acacia	LFCC	Southern
Lepomis megalotis	Longear sunfish				Present	Present	Present
Micropterus dolomeiui	Smallmouth bass	Present	Present	Present	Present		Present
Micropterus punctulatus	Spotted bass						Present
Micropterus salmoides	Largemouth bass		Present	Present	Present	Present	Present
Morone chrysops	White bass			Present	Present		Present
Morone saxatilis	Striped bass				Present		
Oncorhynchus mykiss	Rainbow trout	Stocked	Stocked	Stocked	Present	Present	Present
Perca flavescens	Yellow perch		Present	Present	Present	Present	Present
Pomoxis annularis	White crappie			Present	Present		Present
Pomoxis nigromaculatus	Black crappie		Present				Present
Salmo trutta	Brown trout	Stocked	Stocked	Present			Present
Salvelinus fontinalis	Brook trout	Present					
Scartomyzon congestum	Grey redhorse						Present
Stizostedion vitreum	Walleye			Present	Present		Present

Reach 3—New Mexico–Colorado State Line to Valarde, New Mexico

Brown and rainbow trout are stocked by the NMDGF at several places on the Rio Grande west of Taos from the John Dunn Bridge south to the Taos Junction Bridge off State Road 96.

Reach 4—Velarde, New Mexico, to Rio Chama Confluence

The ichthyofaunal community of this reach was assessed using data collected by Platania (1993a). The Rio Grande at Velarde, at the uppermost diversion dam, produced a total of eight species that included rainbow trout, brown trout, red shiner, Rio Grande chub, fathead minnow, flathead chub, longnose dace, and white sucker. The most abundant taxon was white sucker, followed by fathead minnow, Rio Grande chub, and longnose dace. A second site in Reach 4 (Rio Grande, about 1.6 km upstream of the State Highway 74 bridge crossing) produced a similar ichthyofaunal composition, with the exception of the loss of rainbow trout and the addition of common carp, black bullhead, western mosquitofish, and largemouth bass. The most commonly collected species was longnose dace, followed by white sucker, flathead chub, and fathead minnow.

Rio Chama Section

The fish community of the Rio Chama, the largest tributary of the Rio Grande, may be contrasted from pre- and post-impoundment periods. Prior to the construction of Abiquiu Dam in 1963, the fish community consisted primarily of native main stem cyprinids, including RGSM, Rio Grande bluntnose shiner, Rio Grande chub, and Rio Grande sucker, all of which reached the northern limit of their ranges in the Rio Chama near Abiquiu (Bestgen and Platania 1990). The RGSM is no longer found in the Chama and presently occurs only in the middle Rio Grande between Cochiti Dam and Elephant Butte Reservoir, the Rio Grande bluntnose shiner is now extinct, the Rio Grande chub occurs in low numbers, and the Rio Grande sucker is absent. Some native cyprinids, which persisted following dam construction, are generally considered headwater species adapted to cool waters with relatively high velocities. Platania (1996) compared current fish collections to those documented in 1949. Following construction of Abiquiu Dam, the community has shifted toward more headwater-type fauna. Introduced brown trout are self-sustaining in the system, and rainbow trout occur but are not self-sustaining. Some fish stocked into Abiquiu Reservoir occasionally escape into the lower reaches of the Rio Chama. Native fish present in the collections from a Rio Chama habitat availability study were Rio Grande chub, fathead minnow, flathead chub, and longnose dace. Introduced species included white sucker, rainbow trout, brown trout, western mosquitofish, yellow perch, and channel catfish (Dudley and Platania 2001).

Aquatic habitat in the Rio Chama was subjected to many incidents of low water quality, high sediment load, periods of low to zero flows, and elevated levels of hazardous materials in soil and water samples during the late 1980s and into the 1990s during projects related to Abiquiu Dam. This poor water quality, while not quantified, is thought to have had detrimental effects on the fish community (Dudley and Platania 2001).

River habitat downstream of Abiquiu dam represents an altered ecosystem, which includes alteration of the natural hydrologic pattern in terms of flow and temperature and reduction of suspended sediment. These changes have modified the distribution and abundance of aquatic habitats available to native fish.

Reach 5—Heron Reservoir to El Vado Reservoir

This is a very short river reach that extends between two major flow impoundments (Heron and El Vado Reservoirs). Flows are highly regulated because of water releases out of Heron Dam that quickly arrive in El Vado Reservoir. No published information could be found about the ichthyofaunal community that persists in this reach. However, it would seem reasonable to expect that the fish community would be similar to that found in Reach 6. Meneks' report (2002) on Reach 6 is probably a close description of the ichthyofaunal community of Reach 5 because of its close proximity to El Vado Dam. Species reported by Meneks for Reach 6 include rainbow trout, brown trout, Rio Grande chub, fathead minnow, and longnose dace (Meneks 2002).

Reach 6 – Upper Rio Chama

The Upper Rio Chama reach extends from El Vado Dam to Abiquiu Reservoir. The reach supports a cold-water game fishery in its upper 15 miles, consisting of brown trout, rainbow trout, and kokanee salmon (BLM 1992). Rainbow trout are stocked by the NMDGF immediately downstream of El Vado Dam, and natural reproduction is not likely since high flows from spring runoff occur during the spawning period (BLM 1992). Brown trout naturally reproduce in the upper 15 miles of the reach, and maintaining the brown trout fishery is an important management goal of the NMDGF (BLM 1992). Many trophy-size brown trout are caught within this portion of the river, including the New Mexico state-record brown trout (20 pounds, 4 ounces) (BLM 1992). Channel catfish are another important game fish and are found throughout the entire Wild and Scenic River (BLM 1992). Other non-native fish species that have been recorded in the stream include white sucker, common carp, black crappie, and green sunfish; native fish species documented include Rio Grande chub, flathead chub, Rio Grande sucker, river carpsucker, longnose dace, and fathead minnow (Hanson 1992). Rio Grande chub are considered a species of concern in New Mexico, Colorado, and Texas.

Meneks (2002) described the abundance of fish species at two sites downstream of El Vado Dam, one 1.6 km below the dam and the second 5 km downstream of the dam. Overall, brown trout were the most abundant species, comprising 41.95% of fish caught, followed by fathead minnow (19.07%) and longnose dace (18.64%). At the downstream site, brown trout abundance was 55.26%; longnose dace abundance was 31.58%; and rainbow trout, Rio Grande chub, and fathead minnow each represented 3.95% of the total. At the upper site, brown trout abundance was 35.85%, fathead minnow abundance was 26.42%, and longnose dace abundance was 12.58%. Rainbow trout are stocked by the NMDGF below El Vado Dam on the Rio Chama.

An in-stream flow assessment was conducted by the BLM (1992) to determine ideal flow conditions for brown trout and macroinvertebrate habitat. The flow requirements for brown trout are 150–700 cfs from October 15 through March 31, 150–300 cfs from April 1 through August 31, and 75–300 cfs from September 1 through October 15. The flow requirement for macroinvertebrate habitat was determined to be 185 cfs.

Reach 7 – Lower Rio Chama

The Lower Rio Chama Reach is from Abiquiu Dam to the confluence of the Rio Chama and the Rio Grande. Several studies have been conducted on the fish community within this reach. Hanson (1992) summarizes the findings of studies conducted from 1988 through 1991. Non-native species documented include brown trout, rainbow trout, white sucker, common carp, and green sunfish. Native species documented include Rio Grande chub, flathead chub, Rio Grande sucker, longnose dace, and fathead minnow. Platania (1991) had similar results, with the exception of brown trout, which were not captured. Platania et al. (1996) documents yellow perch within this reach, in addition to the species previously known. Dudley and Platania (2001) documented river carpsucker, black bullhead, western mosquitofish, smallmouth bass, and a longnose dace-chub hybrid in addition to those species previously documented.

In addition to fish community composition, studies have been conducted on habitat use by species and habitat flow requirements. Platania et al. (1996) found that brown trout occupy a wide range of depths (20–110 cm) but are typically found in water less than 40 cm deep and in a wide range of velocities (0–140 cm/s) but mostly occur in water velocities less than 60 cm/s. Furthermore, the majority of brown trout (71.5%) were present over gravel or cobble substrates, with a small percentage (11%) occurring over sand and silt substratas. Turner (1982) conducted a study to determine instream flow requirements for fish species in this reach. The findings state that ideal flow for juvenile and fry brown trout is 200 cfs, with at least 65% of the maximum usable area occurring at flows between 50 and 1500 cfs. The ideal flow for adult brown trout is 1500 cfs, with at least 75% of the maximum usable area occurring at flows between 100 and 750 cfs.

Rainbow trout and channel catfish were stocked periodically in the lower Rio Chama prior to 1991, within the first 7.5 miles downstream of Abiquiu Dam. A naturally reproducing brown trout fishery is managed by the NMDGF within this reach.

Reach 8 – Rio Chama/Rio Grande Confluence to Otowi Gage

The ichthyofaunal community of this reach was compiled using data collected by Platania (1993a). The upper sampling site (Rio Grande at NM State Highway 84) of Reach 8 produced a similar catch as upstream sites in Reach 4, with some exceptions. The ichthyofaunal community was composed of gizzard shad, red shiner, Rio Grande chub, fathead minnow, flathead chub, longnose dace, white sucker, Rio Grande sucker, western mosquitofish, green sunfish, and white crappie. The most abundant taxon was flathead chub, followed by longnose dace. Other species were much less abundant. Another sampling site in Reach 8 (Rio Grande, 3 km upstream of State Highway 4 Otowi bridge crossing) produced similar results. Exceptions included the absence of gizzard shad, Rio Grande sucker, green sunfish, and white crappie. The most commonly collected species included flathead chub, red shiner, and fathead minnow.

Reach 9 – Otowi Gage to Cochiti Dam

The fish community composition of this reach was assessed using data collected by Platania (1993a). The sampling site for Reach 9 (Rio Grande, 3 km upstream of State Highway 4 Otowi bridge crossing) produced a somewhat different ichthyofaunal community from sites upstream (e.g., Reach 8). Only five fish species were present, despite two separate sampling efforts. The most commonly collected species were flathead chub and longnose dace. The other three species, fathead minnow, white sucker, and western mosquitofish, were rarely collected. Narrow channel width and increased stream gradient characterize the White Rock Canyon portion of Reach 9. Increased water velocities might explain, in part, the difference in the ichtyofaunal community found in this reach compared to Reach 8.

Central Rio Grande Section

In a study conducted by Reclamation (PEC 2001), 26 fish species representing nine families were collected along the Middle Rio Grande study area from 1995 to 1999. The study area extended from Española to Socorro, with two sites above Cochiti Dam and six below. Fish diversity was greatest at the San Felipe and Paseo subreaches. Common carp (*Cyprinus carpio*) was found in all study reaches, and flathead chub (*Platygobio gracilis*) and white sucker (*Catostomus commersoni*) were fairly common and found at seven of the sites. Longnose dace (*Rhinichthys cataractae*) was observed at six sites and did not extend below the Paseo subreach (just above Albuquerque). The Rio Grande chub (*Gila pandora*) was rare within the study reach. The RGSM was observed only at the Santa Ana Pueblo, Paseo, and Rio Grande Escondida subreaches.

Reach 10 – Cochiti Dam to U.S. 550 Bridge

The Cochiti Reach extends from Cochiti Dam to the Angostura Diversion Dam. At Cochiti Pueblo in the Rio Grande and the Santa Fe River, Platania (1993b) collected 17 species. Non-native species represented 93.2% of the total catch, with white sucker being the most abundant. Of the five native species collected, the Rio Grande sucker was the most abundant. Other species collected included the gizzard shad, common carp, red shiner, fathead minnow, longnose dace, river carpsucker, white sucker, rainbow trout, brown trout, mosquitofish, white bass, green sunfish, bluegill, largemouth bass, white crappie, and yellow perch. Lang and Altenbach (1994a) found the same species present.

During September 1995 and October 1999, Plateau Ecosystems Consulting (2001) collected 14 species in this reach. The white sucker and common carp were the most abundant; the RGSM and Rio Grande chub were also present. The Rio Grande chub was found to be restricted upstream of Cochiti Dam and was observed only at the uppermost Santa Clara Pueblo Reach. PEC's data suggest that species richness in general may be greater below Cochiti Dam, but varies seasonally.

The NMDGF stocks rainbow trout in the Rio Grande in the outlet works below Cochiti Dam from the parking lots of the Al Black Recreation Area.

Platania (1993b) found seven species at the Angostura Diversion Dam. Red shiner, longnose dace, flathead chub, and fathead minnow were the most abundant native species collected. Native species represented 86% of the total species collected. Non-native species collected included the white sucker, rainbow trout, and bluegill. The Corps (2000) detected only a few individual RGSMs in the Rio Grande between Angostura Diversion Dam and Albuquerque during two years of surveys. Approximately 90% of the remaining RGSM population is found downstream of the San Acacia Diversion Dam.

Reach 11 – Jemez Canyon Dam to Confluence with Rio Grande

The lower Jemez River reach is designated from Jemez Canyon Dam to the confluence of the Jemez River with the Rio Grande. Species known to occur at the Jemez Canyon Reservoir include the following: largemouth bass, white bass, channel catfish, common carp, sunfish, crappie, white sucker, gizzard shad, and small numbers of brown and rainbow trout (Corps 2000).

A Service study (Hoagstrom 2000a) found the most common species in this reach to be common carp, red shiner, fathead minnow, white sucker, and western mosquitofish. These species represented 75.3% of all fish collected, with the red shiner and fathead minnow being the most abundant. The study found the RGSM to be the tenth most abundant species in the lower Jemez, representing 1.2% of all fish collected. The flathead chub (Federal Species of Concern) has also been found in the Jemez below Jemez Canyon Dam (Corps 2001).

Reach 12 – Bernalillo to Isleta Diversion

A Service study (Hoagstrom 2000b) found the RGSM present at the Bernalillo Waste Water Treatment Plant Outflow, La Orilla Drain Return, Belen Bridge, Abo Arroyo Confluence, and Isleta Diversion Dam. The most common species found were the red shiner, river carpsucker, and western mosquitofish.

Reach 13 – Isleta to Rio Puerco

The Isleta Reach is designated from the Isleta Diversion Dam to the San Acacia Diversion Dam. This reach combines Reach 13, running from the Isleta Dam to the confluence of the Rio Puerco as defined in the EIS, and the northern portion of Reach 14 running from the Rio Puerco confluence to the San Acacia

Diversion Dam. As defined in the EIS, Reach 14, in its entirety, runs from the Rio Puerco to Elephant Butte Reservoir.

The ichthyofaunal community of this reach was assessed using data collected by Dudley et al. (2003). Six sampling sites were monitored monthly during 2003 in Reach 13. Large numbers of red shiner, fathead minnow, and western mosquitofish dominated the fish community. These three species were found in high densities during summer months following spawning. Flows in this reach were subject to large variations, and large portions of this reach dried completely during summer low-flow periods. A large proportion of the flow in the Rio Grande is diverted at Isleta Diversion Dam, which defines the upper boundary of this reach. Overall abundance of fish was highest in this reach compared to upstream or downstream reaches. Other fish species present included common carp, RGSM, flathead chub, longnose dace, river carpsucker, white sucker, black bullhead, yellow bullhead, channel catfish, white bass, green sunfish, bluegill, largemouth bass, and white crappie.

San Acacia Section

Reach 14 – Rio Puerco to Elephant Butte Reservoir Inflow

The San Acacia Section is designated as the stretch from the San Acacia Diversion Dam to Elephant Butte Reservoir and is the southern portion of Reach 14 as designated in the EIS. It contains two distinct subsections: the main stem channel and the Low Flow Conveyance Channel. In the main stem channel, the RGSM reach their greatest abundance in the Rio Grande.

The ichthyofaunal community of this reach was compiled using data collected by Dudley et al. (2003). Ten sampling sites were monitored monthly during 2003. The fish community of the lowest portion of the Middle Rio Grande was composed of many of the same taxa that were found in Reach 13. However, several non-native taxa were notably absent from Reach 14, including black bullhead, white bass, green sunfish, bluegill, largemouth bass, and white crappie. Large numbers of red shiner dominated this ichthyofaunal community. Flows in this reach were subject to large variations, and large portions of the reach dried completely during summer low-flow periods. A portion of the flow in the Rio Grande is diverted at San Acacia Diversion Dam. Downstream portions of this reach (between Socorro and San Marcial) were particularly prone to drying during summer months, and most of the flow of the Rio Grande was diverted for agricultural uses. Large fish kills have been noted in this intermittent portion of Reach 14 in recent years, resulting in greatly depressed fish abundance. Fish species present in this reach included gizzard shad, common carp, RGSM, fathead minnow, flathead chub, longnose dace, river carpsucker, white sucker, smallmouth buffalo, yellow bullhead, channel catfish, flathead catfish, western mosquitofish, and yellow perch.

The LFCC was built as part of a comprehensive plan developed in the 1940s by the Corps to combat low water flow through the Rio Grande to Elephant Butte Reservoir in an attempt to pay an accumulated debt of 500,000 AF of water owed under by the Rio Grande Compact of 1938. The LFCC was intended to reduce depletion of water in Elephant Butte Reservoir by diverting water from the Rio Grande into a narrower, deeper, more hydraulically efficient channel (Reclamation 2000a). Also, it was used to improve drainage, supplement irrigation water supply, and deliver a dependable, year-round water supply to Elephant Butte Reservoir and water users downstream (Reclamation 2000a). The LFCC runs parallel to the western side of the Rio Grande from the San Acacia Diversion Dam to the inflow of Elephant Butte Reservoir and is capable of maintaining a water velocity of 2000 cfs. Currently, the average streamflow through the LFCC is between 200 and 300 cfs (Reclamation 2000a). In the past, the diversion dam at San Acacia fed the LFCC, but as the streamflow of the Rio Grande increased over the past 20 years, the waterline of Elephant Butte Reservoir rose to cover the LFCC outlet, clogging it with sediment, and water input from the diversion dam has ceased. However, flow in the LFCC via ground seepage from the more elevated Rio Grande main stem and returns from the canals of the MRGCD (Reclamation 2000a).

Annual mean stream flows fluctuate greatly from year to year. In 2001, the annual mean stream flow at the San Acacia gageing station was 35.5 cfs, while in 2000 it was only 0.37 cfs. The highest recorded mean stream flow at San Acacia was 1,116 cfs in 1979; the lowest recorded flow occurred in 1993 at only 0.038 cfs (USGS 2003a). In low-flow years, the LFCC may remain wetted from subsurface inflow and return flow from the MRGCD. High-flow periods such as spring runoff and the summer monsoon season help to transport sediment downstream (Reclamation 2000a). Breaches occur near the downstream end of the LFCC and form a well-developed channel connecting to the main stem that supports diverse fish communities. General aquatic habitat within the LFCC is more representative of lentic conditions, with deep, low-gradient channels and stable canal banks. The LFCC is uniformly wide at 66 feet across and has a substrate primarily of sand. Extensive stands of parrot feather are found in the channel and along the shores, but are periodically removed.

Nineteen fish species were found within the LFCC in an October 1992 inventory (Lang and Platania 1993): the 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, mosquito fish, green sunfish, bluegill, largemouth bass, yellow perch, and longeared sunfish. A subsequent survey done by Broderick (2000) in 1997 and 1998 immediately upstream of the First Breach of the LFCC found nine species in the main channel: black bullhead, bluegill, channel catfish, fathead minnow, largemouth bass, mosquito fish, red shiner, white crappie, and yellow bullhead. Broderick found thirteen species of fish within the First Breach Channel, which included black bullhead, bluegill, common carp, green sunfish, largemouth bass, mosquito fish, red shiner, warmouth, yellow bullhead, RGSM, gizzard shad, striped bass, and fathead minnow.

Southern Section

Reach 15 – Elephant Butte Dam to Fort Quitman, Texas

The Elephant Butte Reach runs from Elephant Butte Dam to Caballo Reservoir. The six native fish species known to occur within this reach are gizzard shad, red shiner, river carpsucker, mosquitofish, fathead minnow, and smallmouth buffalo. There are 22 non-native or uncertain-status fish species: channel catfish, threadfin shad, rainbow trout, brown trout, longfin dace, goldfish, common carp, bullhead minnow, yellow bullhead, plains killifish, rainwater killifish, sailfin molly, white bass, bluegill, largemouth bass, white crappie, yellow perch, walleye, green sunfish, longear sunfish, smallmouth bass, and black crappie (Desmare 1978; Propst et al. 1987).

Reach 15 – Caballo Dam to El Paso, Texas

Twenty-two species of fish are known to occur within this river reach, eight of which are native to the system (Service 2001). These species include longnose gar, gizzard shad, threadfin shad, red shiner, common carp, golden shiner, fathead minnow, bullhead minnow, longnose dace, river carpsucker, smallmouth buffalo, gray redhorse, black bullhead, flathead catfish, channel catfish, green sunfish, longear sunfish, bluegill, largemouth bass, spotted bass, white crappie, yellow perch, white bass, walleye, and western mosquitofish. The NMDGF does not manage this reach for any particular species, though protecting and enhancing the native fish community in the area is an objective of the NMDGF and the Service (Service 2001a).

Reach 17 – El Paso to Fort Quitman, Texas

The composition of the fish community in this reach was compiled using data from Bestgen and Platania (1988). Six sampling sites were monitored to produce this data set. The ichthyofaunal community was composed of 12 species that varied widely in their abundance. The most abundant taxa were gizzard shad and red shiner. Other species, collected in notably lower numbers, were common carp, bullhead minnow, longnose dace, river carpsucker, channel catfish, western mosquitofish, white bass, green sunfish, bluegill, and largemouth bass. Gizzard shad was absent from the upper portion of the reach, but quite abundant in the lower portion. Other species absent in the upper portion of the reach but present in the lower portion included white bass and largemouth bass.

2.5.3 *The Riverine Food Base*

Data for the riverine aquatic foodbase were summarized (**Figure L-2.7**) from unpublished data aquired from NMED and USGS invertebrate surveys (NMED 2003, unpublished data; USGS 2003a, unpublished data). All data used in the following sections were taken from these unpublished data sets.

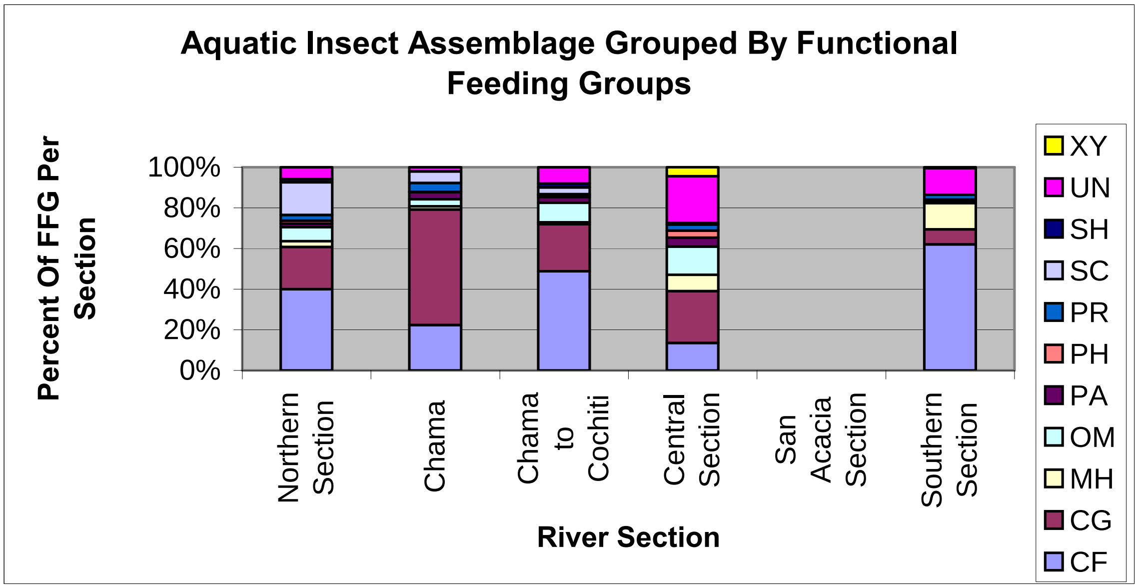


Figure L-2.7 Riverine Food Base by River Section.
***Sources*: NMED 2003, unpublished data; USGS 2003a, unpublished data**

XY – Xyliphage	SC – Scraper	OM – Omnivore
UN – Unknown	PR – Predator	MH – Macrophyte herbivore
SH – Shredder	PH – Piercing herbivore	CG – Collector gatherer
	PA – Parasite	CF – Collector filterers

Northern Section

Flood flows in the Northern Section are unregulated, but water operations of the Closed Basin Project may affect the area. The Northern Section does not include the headwaters of the Rio Grande but consist of a series of tributaries merging into the mainstem Rio Grande. None of the sampling sites were near the headwaters of any of the tributaries, and so results did not follow in direct accordance with the RCC. The highest percentage FFG in the Northern Section was collector-filterers at 39.93%, followed by collector-gatherers at 20.93%. The abundance of collectors indicates that the sample sites were far enough downstream from the headwater that FPOM makes up a significant food resource. Scrapers made up the third highest percentage of FFG at 16.01%, and macrophyte herbivores accounted for 2.69%, indicating that much of the organic input is coming from primary production. Shredders made up a very small percentage, only 1.62%, suggesting that there is not much input of organic matter from shoreline vegetation.

Rio Chama Section

Flows on the Rio Chama are controlled by water operations at Heron, El Vado, and Abiquiu Dams; none of the samples were taken near the headwaters of the Rio Chama. The presence of these dams affects the aquatic invertebrate community and corresponding predictions made by the RCC. The largest FFG in the Chama Section was collector-gatherers at 56.81%, followed by collector-filterers at 22.42%. It is possible that the overwhelming percentage of collectors is a result of FPOM accumulating and being discharged from reservoirs along the Rio Chama. Scrapers made up the third highest FFG at 5.72%, and macrophyte herbivores accounted for 1.50%, which indicates that there is far less organic input coming from macrophytes and large plants. There was no evidence of the presence of shredders, which implies that there is no input of organic matter from shoreline vegetation or that it is stored, broken down, and discharged as FPOM from the reservoirs along the Rio Chama.

The Chama to Cochiti Section is affected by the water operations taking place in both the Northern Section and the Chama Section and by the reservoir inflow of the Cochiti Reservoir, which is regulated by Cochiti Dam. The Chama to Cochiti Sections' largest FFG was collector-filterers at 48.78%, with collector-gatherers second in frequency 23.11% and omnivores third at 9.53%. Scrapers made up 3.28%, and macrophyte herbivores made up 1.09%, which suggests that there is little input of organic material from macrophytes and large plants. Shredders made up 1.80% of the FFG, indicating that there is very little organic input from shoreline vegetation.

Central Rio Grande Section

The Central Section water flow is affected by the water operations of all of the sections to the north, but is most directly affected by operations at Cochiti Dam. The largest FFG in the Central Section was collector-gatherers at 25.54%, the second highest was unknown FFG at 22.95%, and third highest FFG was omnivores at 13.89%, followed closely by collector-filterers at 13.55%. It is reasonable to assume that Cochiti Reservoir acts as a storage bank for a variety of food sources, including large amounts of FPOM, which would account for the large numbers of collectors and omnivores. Scrapers made up a very small percentage of the FFG at only 0.77%, and macrophyte herbivores accounted for 7.94%, indicating that conditions are not favorable for algae production but are for aquatic plant production. Shredders were not present in the Central Section, indicating that there is no significant input of organic matter from shoreline vegetation.

San Acacia Section

No information is currently available for the San Acacia Section.

Southern Section

The Southern Section is most directly affected by operations at Elephant Butte Dam, but is also affected by water operations occurring on all other sections north of the Southern Section. The most abundant FFG for the Southern Section was collector-filterers at 62.00%. The second-highest FFG was macrophyte herbivores at 13.04%, indicating that conditions are good for aquatic plant production. The third-highest percentage of FFG was the unknown group at 12.99%. Collector-gatherers accounted for 7.40%. Scrapers accounted for 0.06% of the FFG, indicating that there is very little production of algae. Shredders were not present, indicating that there is little to no organic input from shoreline vegetation.

The remaining FFG not emphasized in the analysis generally remained constant and insignificant throughout the length of the Rio Grande. Predators were consistent through most of the sections because there is a constant source of food, except in the Chama to Cochiti Section.

2.5.4 *Reservoir Community (Fish and Foodbase)*

2.5.4.1 Characterizing the Reservoir Fish Community

The reservoir fish community within the planning area was described using existing information obtained from various state and federal sources. These included data from the NMDGF Biota Information System of New Mexico (BISON) database (NMDGF 2004a) and staff personal communications (Richard Hansen), as well as the Service (Ortiz 2001). Fish community data on reservoirs are collected by NMDGF primarily for management purposes and are limited in geographic scope and timing.

2.5.4.2 Estimating the Reservoir Food Base: Zooplankton Sampling Methods

Zooplankton sampling of the five reservoirs of the Rio Grande was conducted over a four-year period following the New Mexico Department of Game and Fish protocol (NMDGF 2003a, unpublished data). Samples were not taken consistently from each of the five reservoirs each year.

2.5.5 *The Reservoir Fish Community*

Each reservoir and its fish community are described in the following sections. **Table L-2.14** lists each reservoir and identifies fish species known to occur within the reservoirs. **Table L-2.15** provides life history information for all species known to occur within these reservoirs and the scientific name of each species.

Table L-2.14 Distribution of Fish in Reservoirs of the Upper and Middle Rio Grande

Fish Species	Platoro	Heron	El Vado	Abiquiu	Cochiti	Jemez Canyon	Elephant Butte	Caballo
Black bullhead				Present	Present		Present	Present
Black crappie				Present	Present	Present	Present	Present
Blue catfish							Present	Present
Bluegill			Present	Present	Present		Present	Present
Brown trout		Present	Present	Present	Present	Present		
Bullhead minnow							Present	
Channel catfish		Present	Present	Present	Present	Present	Present	Present
Common carp		Present	Present	Present	Present	Present	Present	Present
Cutthroat trout								
Fathead minnow		Present	Present	Present	Present		Present	Present
Flathead catfish							Present	Present
Flathead chub				Present	Present			
Gizzard shad						Present	Present	Present
Goldfish		Present	Present	Present	Present		Present	
Green sunfish		Present	Present	Present	Present	Present	Present	Present
Kokanee salmon	Present	Present	Present	Present				
Lake trout	Present	Present	Present	Present				
Largemouth bass				Present	Present	Present	Present	Present
Mosquitofish		Present	Present	Present	Present		Present	Present
Northern pike					Present		Present	
Rainbow trout	Present	Present	Present	Present		Present		
Red shiner		Present	Present	Present	Present		Present	Present
Rio Grande chub		Present	Present	Present	Present			
River carpsucker				Present	Present		Present	Present
Smallmouth bass			Present	Present	Present		Present	Present

Fish Species	Platoro	Heron	El Vado	Abiquiu	Cochiti	Jemez Canyon	Elephant Butte	Caballo
Smallmouth buffalo							Present	Present
Striped bass							Present	Present
Threadfin shad							Present	Present
Walleye				Present	Present		Present	Present
White bass					Present	Present	Present	Present
White crappie			Present	Present	Present	Present	Present	Present
White sucker	Present	Present	Present	Present	Present	Present		
Yellow perch				Present	Present		Present	

Sources: Ortiz 2001; U.S. Fish and Wildlife Service unpublished report

Table L-2.15 Life History Information of Fish in Reservoirs of the Rio Grande

Fish Species	Scientific Name	Game Fish	NM Native	Spawning Period	Spawning Habitat	Spawning Depth	Hatch Time	Spawning Temp
Black bullhead	*Ictalurus melas*	Yes	No	spring - summer	shallow water, variety of substrates, under logs or mats of vegetation	shallow	5-10 days	+20°C
Black crappie	*Poxomis nigromaculatus*	Yes	No	late spring - early summer	mud, sand, or gravel substrates in shallow water with vegetation or overhanging cover	shallow	2-4 days	13-21°C
Blue catfish	*Ictalurus furcatus*	Yes	Yes	late spring - early summer	pools and backwaters	~2-5 m	~6-10 days	21-25°C
Bluegill	*Lepomis macrochirus*	Yes	Yes	May - mid-August	pools, backwaters with aquatic vegetation cover, and mud, silt, or sand substrate	< 1.5 m	2-10 days	19.4-26.7°C
Brown trout	*Salmo trutta*	Yes	No	late fall - early winter	gravel or rubble substrates in riffles, and tails of pools less than 46 cm deep	< 46 cm	1-2 months	2-6°C
Bullhead minnow	*Pimephales vigilax*	No	Yes	spring - summer	shallow water with low currents	shallow	4-5 days	21-26°C
Channel catfish	*Ictalurus punctatus*	Yes	Yes	spring - summer	shallow water, 2.5-4 m deep under overhead cover or depression	2.5-4 m	10 days	20-22°C
Common carp	*Cyprinus carpio*	No	No	spring - mid-summer	aquatic vegetation; shallow, weedy areas	shallow	3-16 days	16.5-28°C
Cutthroat trout	*Oncorhynchus clarki*	Yes	Yes	March - July	gravel beds in clear, silt-free water	semi-shallow	29-48 days	<15°C
Fathead minnow	*Pimephales promelas*	No	Yes	spring - summer	under rocks at depths of 30-90 cm, 5 cm from bottom in standing water	30-90 cm, 5 cm from bottom substrate	4-6 days	15.6-18.4°C
Flathead catfish	*Pylodictus olivaris*	Yes	No	summer	under logs and cut banks and in crevices	2-5 m	6-8 days	22-29°C
Flathead chub	*Platygobio gracilis*	No	Yes	late summer	seasonal low-water low turbidity and sandy	N/A	N/A	18-25°C

Fish Species	Scientific Name	Game Fish	NM Native	Spawning Period	Spawning Habitat	Spawning Depth	Hatch Time	Spawning Temp
					substrate			
Gizzard shad	*Dorosoma cepedianum*	No	Yes	spring	shallow water with sandy or rocky substrate	< 2 m	2-4 days	10-22°C
Goldfish	*Carassius auratus*	No	No	spring until temp. drops below 15 °C	aquatic vegetation	shallow	2-10 days	15-23°C
Green sunfish	*Lepomis cyanellus*	Yes	Yes	spring - late summer	gravel or sandy silt at depths of 4-355 cm	4-355 cm	3-5 days	15-31°C
kokanee salmon	*Oncorhynchus nerka*	Yes	No	September-January	shallow shorelines, cobble, or gravel substrates at depths less than 9.2 m	< 9 m	2-5 months	5-12.5°C
Lake trout	*Salvelinus namaycush*	Yes	No	fall - early-winter	shallow to relatively deep water, rubble or gravel substrate	shallow-deep	4-6 months	7-13°C
Large-mouth bass	*Micropterus salmoides*	Yes	No	late April - late June	shallow water, gravel substrate preferred; also sand, silt, or mud with boulders, ledges, slopes, or submerged vegetation	1.5-7 m	2-5 days	14-18°C
Mosquito-fish	*Gambusia affinis*	No	No	summer	warm, shallow, standing or slow-moving waters, aquatic vegetation or flooded terrestrial plants	shallow	born alive	15-30°C
Northern pike	*Esox lucius*	Yes	No	spring	flooded vegetation in shallow water, marshy inlets, and mouths of small tributaries	<0.5 m	5-26 days	6-18.5°C
Rainbow trout	*Oncorhynchus mykiss*	Yes	No	spring	gravel riffles at depths of 15 cm	15 cm	9-102 days	6-15.5°C
Red shiner	*Cyprinella lutrenis*	No	Yes	April - September	clean gravel of riffles, submerged roots, aquatic plants, and rocky shorelines in crevices	shallow	~105 hours	15.5-29.5°C
Rio Grande chub	*Gila pandora*	No	Yes	March - June	require riffles, no parental care	semi-shallow	5-7 days	14-20°C
Small-mouth bass	*Micropterus dolomieui*	Yes	No	mid-May - August	sand, gravel, or rubble near protection of rocks, logs, or dense vegetation	<4m	2-10 days	12.5-23.5°C
Small-mouth buffalo	*Ictiobus bubalus*	No	Yes	April through September	submerged terrestrial vegetation during high waters over all substrates	shallow	7-14 days	19-27.5°C
Striped bass	*Morone saxatilis*	Yes	No	spring	streams with strong, turbulent flows, rock/fine gravel substrate	near surface	34-62 hours	10-24°C
Threadfin shad	*Dorosoma petenense*	No	No	spring through summer	open water along shorelines over aquatic vegetation	shallow	3-4 days	21-26°C
Walleye	*Stizostedion vitreum*	Yes	No	mid-March through mid-	1-4 m of shallow areas, riprap on dam faces	1-4 m	6-50 days	8.9-12°C

Fish Species	Scientific Name	Game Fish	NM Native	Spawning Period	Spawning Habitat	Spawning Depth	Hatch Time	Spawning Temp
				April				
White bass	*Morone chrysops*	Yes	Yes	spring	rocky, steep shore areas and inlets	2-3 m	~2 days	13-17°C
White crappie	*Pomoxis annularis*	Yes	No	May through July	low velocity, moderate-turbidity waters with aquatic vegetation, flooded areas of reservoirs	< 1.5 m	27-93 hours	14-23°C
White sucker	*Catostomus commersoni*	No	Yes	spring through early summer	variety of substrates less than 30 cm deep, wind-swept shores	< 30 cm	4-19 days	+10°C
Yellow perch	*Perca flavescens*	Yes	No	spring	aquatic vegetation, submerged brush, or sand, gravel, or rubble substrates	shallow	8-10 days	2.8-18.9°C

Source: BISON. 2001. NMDGF, http://151.199.74.229/states/nmex_main/fish.htm.

Northern Section

Platoro Reservoir

Platoro Reservoir is located near the headwaters of the Conejos River, a tributary of the Rio Grande, in south-central Colorado about 1 mile west of Platoro in Conejos County. The Colorado Division of Wildlife stocks Platoro Reservoir with kokanee salmon, brown trout, and rainbow trout. Other fish species occurring in Platoro Reservoir include Colorado River and Rio Grande cutthroat trout, brook and lake trout, white and Rio Grande Sucker, Rio Grande chub, splake, char, and grayling.

Heron Reservoir

Heron Reservoir is located on Willow Creek near the confluence with the Rio Chama, a tributary of the Rio Grande, in north-central New Mexico about 9 miles southwest of Park View in Rio Arriba County. Heron Reservoir supports a cold-water fishery managed by the Service and the NMDGF. Important sport fish include rainbow trout, lake trout, and kokanee salmon. The Service stocks rainbow trout in the reservoir in April and August (approximately 400,000 and 200,000 fish, respectively) each year (Ortiz 2001). Rainbow trout are a put-and-take fishery at Heron Reservoir, and the Service does not expect any natural reproduction to sustain the rainbow trout population (Ortiz 2001). The NMDGF stocks approximately 475,000 kokanee salmon in the reservoir each year in January (Ortiz 2001).

El Vado Reservoir

El Vado Reservoir is located on the Rio Chama in north-central New Mexico about 160 miles north of Albuquerque in Rio Arriba County. El Vado Reservoir supports a cold-water fishery with several warm-water species (Ortiz 2001). Cutthroat trout, lake trout, brown trout, channel catfish, green sunfish, bluegill, white crappie, and yellow perch are important game species that naturally reproduce in the reservoir (Ortiz 2001). Rainbow trout and kokanee salmon are stocked annually by the NMDGF (220,000 and 100,000 rainbow trout in April and October, respectively, and 200,000 kokanee salmon in January) (Ortiz 2001). Rainbow trout in El Vado Reservoir is considered a put-and-take fishery, and natural reproduction is not required to sustain populations (Ortiz 2001).

Abiquiu Reservoir

Abiquiu Reservoir is located in north-central New Mexico on the Rio Chama approximately 30 miles west of Española on U.S. Highway 84 in Rio Arriba County. Abiquiu Reservoir supports a cold-water fishery consisting of kokanee salmon, rainbow trout, brown trout, cutthroat trout, and lake trout; and a warm-water fishery consisting of walleye, green sunfish, largemouth bass, smallmouth bass, white crappie, channel catfish, and bluegill (Ortiz 2001). All of these species except rainbow trout and walleye have populations in the reservoir that are sustained by natural reproduction. Rainbow trout are stocked by the NMDGF in April, October, and November (100,000, 290,000, and 100,000 fish, respectively) (Ortiz 2001). Walleye are occasionally stocked by the NMDGF in April, with approximately 1,000,000 fish released (Ortiz 2001).

Central Rio Grande Section

Cochiti Reservoir

Cochiti Reservoir is located on the Rio Grande near the Pueblo of Cochiti Indian Reservation in Sandoval County, New Mexico. Cochiti Reservoir is primarily a warm-water fishery consisting of northern pike, black bullhead (*Ictalurus melas*), channel catfish, white bass, striped bass, smallmouth bass, largemouth bass, green sunfish, white crappie, black crappie, and bluegill (Ortiz 2001). Cold-water fish species include rainbow trout and brown trout. Walleye is the only species stocked in the reservoir, with approximately 1,000,000 fish released in April by the NMDGF (Ortiz 2001).

Jemez Canyon Reservoir

Jemez Canyon Reservoir is located on the Jemez River just upstream from its confluence with the Rio Grande in Sandoval County, New Mexico. There is no permanent water in the reservoir and it therefore does not support a sustained fishery (E.W. Jahnke, Corps, personal communication 2002).

San Acacia Section

No reservoirs are located within this river section.

Southern Section

Elephant Butte Reservoir

Elephant Butte Reservoir is located on the Rio Grande approximately 4 miles east of Truth or Consequences, Sierra County, New Mexico. Elephant Butte Reservoir is primarily a warm-water fishery, with the exception of rainbow trout and brown trout. Warm-water fish species present are white bass, largemouth bass, smallmouth bass, northern pike, bluegill, yellow perch, green sunfish, white and black crappie, channel catfish, black bullhead, and walleye (Ortiz 2001). Striped bass are stocked in the reservoir biannually by the NMDGF, with 300,000 fish released in June or July, and yearly by the Service, with 10,000 fish released in June (Ortiz 2001).

Caballo Reservoir

Caballo Reservoir is located on the Rio Grande 25 miles downstream from Elephant Butte Reservoir in Sierra County, New Mexico. Among the designated uses of the reservoir are irrigation, recreation, and sport fishing.

2.5.6 *Zooplankton of Rio Grande Reservoirs*

The two subclasses of crustaceans that make up a significant portion of the zooplankton biomass in the reservoirs of the Rio Grande are Cladacera and Copepoda. Both range in size from 0.2 to 4 mm long and play an intricate role in the aquatic environment as a base for most food webs. Cladacerans can feed on a variety of food sources including detritus and other smaller organisms such as protozoa and rotifers, by means of filtration or by generating a current of water over a ciliated food groove. Copepods feed raptorally, either by scraping macrovegetation or by capturing prey and consuming by chewing.

Much of the biological activity of a reservoir takes place in the photic zone (the area of the water column that light is able to penetrate) because it supports primary production. This area is within the upper few meters of a water body and commonly is the most populated and diverse environment in lake systems. It is this shallow, well-lit environment that is most affected by changing water levels of a reservoir. As the water level drops, the areas become shallower and are susceptible to drastic temperature changes and sometimes complete dewatering.

Water temperature and the duration of molting periods of most crustaceans are inversely related. As temperature increases, so does an individual's metabolism, so a decrease in the time during and between molts is observed. In contrast, colder temperatures slow metabolism and increase the duration of the molting process. Eventually, this inverse relationship translates into a faster or slower rate of brood production and is a determining factor in population size.

Food availability also plays a significant role in the size and health of the population: as resources increase, so does the ability to produce offspring and thus brood size increases, leading to larger populations. Population size is regulated not only by resource availability, but by the amount of predation occurring.

Many of the fish found in the reservoirs of the Rio Grande feed on zooplankton during their larval stages. As a population of zooplankton increases, the ability of fish larvae to survive to reproductive age increases, thus causing an increase in the size of the fish population. As the population of fish increases, more larvae consume more zooplankton and thus cause a decrease in the zooplankton population. As zooplankton decline, so does the ability of the food base to support the fish populations, and the fish numbers decline.

2.5.7 *The Reservoir Aquatic Food Base*

Abiquiu Reservoir was sampled in 1998, 2000, and 2001 (NMDGF 2003a, unpublished data). The largest numbers of total Cladocera were found in 2001, and the lowest numbers of Cladocera were from 2000. Copepods in Abiquiu Reservoir were at their highest in 1998 and their lowest in 2001 (**Table L-2.16**).

Caballo Reservoir was sampled for zooplankton in 1998 and 2000 (NMDGF 2003a, unpublished data). Results indicated that the populations of Cladocera and Copepods were much greater in 2000 than in 1998 (**Table L-2.16**).

Cochiti Reservoir was sampled in 2000 and 2001 (NMDGF 2003a, unpublished data). Results indicated that populations of Cladocera and Copepods were much greater in 2001 than in 2000 (**Table L-2.16**).

Elephant Butte was sampled only in 2001 (NMDGF 2003a, unpublished data), but populations of both Cladocera and Copepods were high compared to counts at other reservoirs (**Table L-2.18**).

Heron Reservoir was sampled every year from 1998 to 2001 (NMDGF 2003a unpublished data). Results indicate that Cladocera populations were at their highest in 1998 and their lowest in 1999. Copepod populations were at their highest in 2001 and their lowest in 1999 (**Table L-2.16**).

As the only site to have samples taken consistently for four years, Heron Reservoir was most useful in looking for patterns in zooplankton population. It is assumed that the higher number of zooplankton would be able to support a larger population of fish, and so Caballo and Elephant Butte should be more productive than the other sites, given that they had among the largest numbers of plankton. Zooplankton blooms can give clues as to what is happening within a reservoir, being attributed to either an abundance of resources or the decline or removal of a predator (i.e., fish and fish larvae).

Table L-2.16 Zooplankton Populations for Five Rio Grande Reservoirs, 1998–2001

Reservoir	Adult Cladocera (Org/L)	Immature Cladocera (Org/L)	Total Cladocera (Org/L)	Adult Copepod (Org/L)	Immature Copepod (Org/L)	Total Copepod (Org/L)
Abiquiu						
1998	277,333	366,556	643,889	3,234,194	1,934,861	5,169,056
1999	Ø	Ø	Ø	Ø	Ø	Ø
2000	171,528	142,139	313,667	1,298,472	953,611	2,252,083
2001	2,728,125	822,500	3,550,625	916,875	157,500	1,074,375
Caballo						

Reservoir	Adult Cladocera (Org/L)	Immature Cladocera (Org/L)	Total Cladocera (Org/L)	Adult Copepod (Org/L)	Immature Copepod (Org/L)	Total Copepod (Org/L)
1998	735,500	526,611	1,262,111	3,807	3,733,528	3,737,334
1999	Ø	Ø	Ø	Ø	Ø	Ø
2000	940,185	1,045,741	1,985,926	1,528,148	1,515,925	3,044,074
2001	Ø	Ø	Ø	Ø	Ø	Ø
Cochiti						
1998	Ø	Ø	Ø	Ø	Ø	Ø
1999	Ø	Ø	Ø	Ø	Ø	Ø
2000	105,722	85,833	191,556	479,139	392,639	871,778
2001	1,023,854	498,993	1,522,847	1,555,910	888,333	2,444,243
Elephant Butte						
1998	Ø	Ø	Ø	Ø	Ø	Ø
1999	Ø	Ø	Ø	Ø	Ø	Ø
2000	Ø	Ø	Ø	Ø	Ø	Ø
2001	3,733,111	2,266,069	5,999,181	20,162,208	23,399,250	43,561,458
Heron						
1998	1,983,306	717,472	2,700,778	1,918,000	694,472	2,612,472
1999	108,333	5,694	114,028	584,306	146,806	731,111
2000	251,667	187,917	439,583	1,272,639	1,554,167	2,826,806
2001	1,301,892	373,646	1,675,538	3,159,878	1,634,861	4,794,740

Ø = No data available/no sampling conducted
Source: NMDGF personal communication 2003

2.5.8 *Terrestrial Riparian Fauna*

2.5.8.1 Riparian Fauna Characterization Methods

In order to establish a baseline of the general fauna within the Project Area, the Riparian Team sought prior surveys that could help identify those species known to use the riparian corridor. Most mammal, amphibian, reptile, and arthropod species are considered to be permanent residents. However, bird species include both year-round residents and neotropicals whose nesting activities may place them in the area for only three to five months each year. There are on-going, long-term studies of federally listed species, particulary those designated endangered. General wildlife usage of the area is based upon "spot" surveys throughout recent decades. These surveys include Stahlecker and Cox (1996) for bird populations, Campbell et al. (1997) for mammal information, and Hink and Ohmart (1984) for all wildlife families. The Hink and Ohmart (1984) data were particularly useful in that they establish the correlation between vegetation types (shown in Figure L-2.2) and terrestrial wildlife species richness, composition, and habitat associations (see **Table L-2.2** in Section 2.3.1.4). This knowledge of which vegetation types support the greatest biodiversity forms the baseline for assessing potential impacts on riparian fauna in Section 3.4 of this Biological Technical Report.

2.5.8.2 Overview of General Wildlife Use of Riparian Zones within the Rio Grande Floodplain

Riparian ecosystems play a vital role in determining wildlife abundance and diversity, particularly in arid areas that may otherwise be treeless and frequently devoid of surface water. The Rio Grande floodplain ecosystems included in this study contribute significantly to regional wildlife, even though they make up less than 1% of the land area of the basin (Finch et al. 1995). Also, the Rio Grande riparian ecosystems support biodiversity because they span several geophysical provinces. They also provide a valuable migratory corridor for the long-distance migration of birds.

A broad network of wildlife species contributes to the overall function of the Rio Grande floodplain ecosystem. First and foremost, the floodplain provides wildlife with a reliable source of surface water. Section 2.3.2.3 detailed the vegetation communities found along the Rio Grande corridor, most of which are diverse communities with native vegetation highly desirable to wildlife species for food and cover. A rich community of invertebrates proliferates in the moist habitats along the shoreline in the flooded areas and perennial wetlands in the floodplain corridor (Gaston 1991). The plant and insect biomass of this riparian area, in turn, attracts and supports numerous diverse higher order organisms, some obligate residents of the ecosystem, and others that use the area during their unique diurnal or seasonal cycles.

Plant species are not the only part of the ecosystem that may be obligate to riparian zones. Habitat specialists, such as the SWFL, Lincoln's sparrow, and white-crowned sparrow, depend on healthy riparian vegetation (Knopf et al. 1988a). The New Mexico meadow jumping mouse, state-listed as a threatened species, requires soil moisture and vegetation characteristics related to permanent water availability (NMDGF 2004b). While the causes for the global decline of many amphibian species are unknown, what is known is that most require permanent to semi-permanent water habitats and their associated vegetation cover. The New Mexico state-endangered lowland leopard frog (*Rana yavapaiensis*) requires such habitat at low elevations in desert scrub localities (Platz 1988). Invertebrates such as the endangered wrinkled marshsnail have been extirpated from some areas in New Mexico because of extensive wetland habitat loss and alteration (Taylor 1983) or contamination of water habitats by sewage NMDGF 2002).

Many other wildlife species rely on riparian habitats, not just those listed as threatened or endangered. Additionally, while native riparian vegetation is obligate to river corridors, this is not necessarily the case for the wildlife species associated with these habitats. Wharton et al. (1982) and Schaefer and Brown (1992) pointed out that animals do not occur in distinct zones or patterns in the same manner are vegetation zones. When factors such as bird migration are considered, it is clear that a permanent zone cannot be assigned to all wildlife species. Many terrestrial species roam over large territories and may be found in riparian zones only during certain seasons; this does not make them any less dependent upon riparian vegetation, nor does it lessen their effect upon riparian habitat.

Schaefer and Brown (1992) provide a brief, but succinct, description of riparian habitats and the wildlife that use them:

> Many wildlife species contribute to the ecological function of riparian communities, albeit very few are restricted to them. The use of riparian zones by wildlife differs by species, season, and flooding regime. Bears travel over large areas and seasonally forage on fish and aquatic plants. Most wading birds prey on aquatic organisms and nest in uplands. Many terrestrial birds nest close to streams and rivers, and forage over large areas including, but not confined to, the wetlands of these water bodies. Semiaquatic turtles typically nest in sandy uplands that can be several hundred meters from the water's edge. Other species respond to seasonal differences of plant mast production by concentrating feeding activities in wetlands during winter and spring and drier sites during summer and fall.

Collectively, mammals, reptiles, and birds eat plants, disperse seeds, and move soils—activities that alter vegetative structure, modify channel morphology, and assist in developing microtopography. An animal that forages in riparian vegetation will distribute seed via fecal material or by transporting it on their fur. This contributes to genetic diversity and range expansion of riverine plants. Fossorial mammals, reptiles, and amphibians turn the soil during burrowing activities, which helps incorporate leaves, deadfall, and other organic material into the soil, while the ground becomes more friable and receptive to scattered seeds. Such actions go far beyond mere forage or habitat needs, creating consequences at the ecosystem level (Naiman and Rogers 1997). In a cyclic manner, animal activities return nutrients to the soil, which becomes available for intake by the vegetation, which is returned to wildlife species via foliage. A symbiotic relationship exists between wildlife and riparian habitat. The cycles come full circle when riparian vegetation furnishes forage, protection, roosting, and nesting habitat for innumerable terrestrial species.

There is a large body of literature that describes the intimate relationship between riparian corridors and the wildlife that fills each available niche. A variety of studies have focused on wildlife specifically using habitat along the Rio Grande floodplain. Changing the local hydrology, as proposed by the project, would only indirectly affect wildlife by changing the hydrological support for favored vegetation communities or structure. Hink and Ohmart (1984) found that faunal abundance and composition varied with vegetation community composition and structure in the Rio Grande valley. The relationship of fauna to specific vegetation communicates in the Rio Grande valley is described here as a resource indicator.

Insects

Few data exist concerning terrestrial arthropod communities for the arid Southwest, particularly within riparian ecosystems. It is known that arthropods, both in number of species and individuals, dominate terrestrial ecosystems (Wilson 1988; Kremen et al. 1993). Terrestrial arthropods may act as pollinators, herbivores, detrivores, parasites, or predators. Their activities influence nutrient cycling and plant productivity. They also contribute to the abundance of other invertebrates as well as many vertebrates, for whom they are prey species (Ellis et al. 2000). Surface arthropods are at the foundation of vertebrate trophic levels. Studies by Knopf et al. (1988b) and Ohmart and Anderson (1982) indicate that the riparian areas in the arid southwestern United States support a disproportionately higher density and diversity of vertebrates compared with drier uplands.

The Middle Rio Grande valley has been the focus of the majority of arthropod studies. A 1994 to 1997 study (Bess et al. 2002) found 80 species on the forest floor. These species were predominantly spiders (Lycosidae, Gnaphosidae, Salticidae), beetles (Carabidae, Staphylinidae, Crytophagidae, Tenebrionidae), isopods (Armadillidae, Porcellionidae), and crickets (Gryllidae). Ellis et al. (2000) found 138 taxa from four sites along the middle Rio Grande. In a 2001 study, Ellis et al. found that the isopod *Armadillidium vulgare*, known to most as a “roly-poly bug,” was the most common taxon at their study sites. A variety of ant species are also found in riparian ecosystems (Eichhorst et al. 2000; Ellis et al. 2001; Bess et al. 2002). It is an important to note that surface arthropods can be caught in pit-fall traps, and thereby classified taxonomically, but flighted insects are not easily caught or categorized. Nonetheless, riparian ecosystems also support many flying insect species, desirable to numerous vertebrate species at higher trophic levels.

There are reptile, amphibian, mammal, and bird species that are obligate insectivores, and many others that use insects as some portion of their diet. Granivores, such as sparrows and finches, depend on insects as a source of protein to feed nestlings. Even hummingbirds, known for their attraction to nectar, depend upon insects for protein and amino acids. An adult hummingbird can ingest 400 to 600 fruit flies, midges, and leaf-hoppers each day (E. P. Elliston, Wildlife Rescue, Inc., of New Mexico personal communication 2003). In a healthy riparian ecosystem, heterogeneity of plant species, age, and height classes will support the diversity of insect life so foundational to all species that use riparian habitats. However, at present, insect abundance and diversity have not been linked to specific Hink and Ohmart vegetation communities found in the Rio Grande.

Amphibians and Reptiles

Beiswenger (1988) discussed the fact that many monitoring and assessment models were developed for either terrestrial or aquatic species and have not been adapted for species with divergent lifecycles that depend on both habitat forms. Additionally, amphibians have complex life cycles and secretive habits during the breeding season, making them relatively difficult to study. The distribution of several amphibian and reptile species in New Mexico is closely correlated to riparian vegetation communities. Degenhardt et al. (1996) stated:

> All amphibians in New Mexico except *Aneides hardii* (Sacramento mountain salamander), *Plethodon neomexicanus* (Jemez Mountains salamander), *and Eleutherodactylus augusti* (barking frog) require temporary or permanent water for breeding. All turtles in the state except *Terrapene ornate* (ornate box turtle) are aquatic or semiaquatic, and all except *Kinosternon flavescens* (yellow mud turtle) and *T. ornate* do not wander far from water. Several snakes are largely riparian… including *Nerodia erythrogaster* (plainbelly water snake), *Thamnophis cyrtopsis* (blackneck garter snake), *T. eques* (Mexican garter snake), *T. marcianus* (checkered garter snake), *T. proximus* (western ribbon snake), *T. rufipunctatus* (narrowhead garter snake), and *T. sirtalis* (common garter snake).

In their studies of wildlife use of riparian communities along the Middle Rio Grande, Hink and Ohmart (1984) identified the following class-specific pattern:

> Amphibian and reptile capture rates were highest in sites with sandy soils, sparse ground cover, and relatively open vegetation. Such sites include areas of mixed 20- to 40-foot cottonwood/coyote willow stands with sparse understory, open drain habitats dominated by cottonwoods and willows less than 15 feet tall, and small openings with little or no woody species.

Hink and Ohmart also reported that capture rates were lowest in sites with dense understories, particularly in marshy, edge, and wooded areas with stands of Russian olive or herbaceous species.

Avian

Birds are the most visible and, therefore, the most widely studied wildlife in the Rio Grande floodplain. At least 510 bird species are confirmed in New Mexico, some 300 of which breed in the state (Williams 2004). Although limited in areal extent, the riparian community along the Rio Grande is used by over 60% of the bird species known to occur in New Mexico (Hink and Ohmart 1984). Among the most common species present during the breeding season are mourning dove, black-chinned hummingbird, downy woodpecker, ash-throated flycatcher, white-breasted nuthatch, spotted towhee, black-headed grosbeak, and blue grosbeak. Common breeding raptors include great horned owl, western screech-owl, Cooper's hawk, and, in burned areas, American kestrel.

Generally, the abundance of breeding birds increases with the complexity and density of vegetation structure, which is thought to be related to the increased food, cover, or nest substrate it provides. Along the Rio Grande, the highest breeding densities typically have been found in cottonwood stands with a well-developed shrub understory (Type 1) and in tall shrub stands (Type 5), regardless of whether the shrubs are native or exotic (H&O 1984; Hoffman 1990; Thompson et al., 1994; Stahlecker and Cox 1996). Within this woodland type, avian abundance is approximately four times greater along the riverward and landward edges of the bosque than in the interior of the stand (H&O 1984). Bosque stands with a sparse understory (Type 2) generally support fewer breeding birds. Stands of intermediate age or structure (Types 3 and 4) vary widely in breeding bird use among the studies conducted (Farley et al. 1994), but, in light of the general lack of natural cottonwood and willow regeneration along the Rio Grande, are important for their potential to develop into mature stands. Salt cedar stands (with or without a cottonwood canopy) have relatively low breeding bird use.

The Rio Grande is a major migratory corridor for songbirds (Yong and Finch 2002), waterfowl, and shorebirds. Both the river channel and the drains adjacent to the bosque provide habitat for species such as mallards, wood ducks, great blue herons, snowy egrets, green herons, belted kingfishers, and black phoebes. Agricultural fields and grassy areas with little woody vegetation are important food sources for sparrows and other songbirds during migration and winter.

Monson (1946) surveyed the avifauna of the Rio Grande valley, focusing on cottonwood bosques—an early acknowledgment that certain species require distinct vegetation and habitat types. Carothers (1994) studied the social organization and population structure of riparian birds in the Southwest. Carothers found that differences in species density were, in part, related to the vegetative structure of the habitat.

Birds may be the most studied wildlife at the habitat level, perhaps because of the popularity of birding. Lying along the westernmost edge of the Central Flyway, the Rio Grande is a major migratory corridor, thus supporting both resident and neotropical species.

Some avian vegetation-use surveys focus on specific taxonomic orders. Raptors have been studied based on vegetation choices for nesting, perching, hunting territories, and even route choice between such areas. Kimsey and Conley (1986) looked at both seasonal and annual habitat selection in southwestern New Mexico. They found that the red-tailed hawk and ferruginous hawk, as well as the American kestrel, selected riparian habitats. In a survey of active nest sites in the Jemez Mountains of New Mexico, Kennedy (1986) found that about 17% of the area's Cooper's hawks chose Rio Grande cottonwood or cottonwood-ponderosa pine.

Farley et al. (1994a) stated:

> The presence of foliage in various height classes, the diversity of plant species and forms, the heterogeneous mix of open and densely vegetated areas, and the relatively high frequency of nesting cavities all combine to form a complex association that can support a variety of avian species. These corridors of woody vegetation also appear to be important for migrant landbirds, including both species that overwinter in the Neotropics and short-distance migrants that usually winter in the southern United States….

Partners in Flight (2003), dedicated to the conservation of avian diversity, confirm that New Mexico's riparian areas are among the most species-rich habitats in the state. The continual presence of water—and the resulting structural complexity—allows riparian areas to support a higher percentage of breeding species than does other habitats. The group establishes a "priority" status for birds based on vegetation type. As the largest river in New Mexico, the Rio Grande exhibits the majority of Middle-Elevation Riparian Woodland in the state. Partners in Flight have categorized the birds associated with various riparian plant species and height classes. These bird/plant associations are confirmed in a variety of studies.

The results of a 1992 study (Farley et al. 1994b) that documents vertebrate use of riparian vegetation in the Middle Rio Grande valley indicate that riparian woodlands of different age (and therefore height classes) support different assemblages of bird species. This study, and others, only confirms the findings in Hink and Ohmart's (1984) study—possibly the seminal work correlating riparian vegetation to terrestrial vertebrate habitat use that birds were the largest and most diverse group of terrestrial fauna in the riparian study area.

Hink and Ohmart (1984) used four main vegetation groups: C/CW (cottonwood/coyote willow); C/RO (cottonwood, Russian olive); RO (Russian olive); and MH (marsh). They recorded 277 avian species over the two years of the study, 60% of the number of bird species known to occur in New Mexico at that time (Hubbard 1978). Most of these species were primarily associated with riparian shrub or forest habitats. A complete listing is not warranted here; however, a sampling indicates the wide range of trophic levels represented. The most common species range from aquatic piscivores and herbivores through terrestrial granivores, omnivores, carnivores, and obligate insectivores. It must be noted that the presence of certain species may not reflect those common at present, 20years after Hink and Ohmart's study. Leal et al. (1996) found that the bird species composition in 1992 and 1993 was similar to the historically documented composition. This study found the highest species richness and abundance in cottonwood and willow, but documented considerable bird use in exotic stands.

In the context of the importance of heterogeneity of riparian plant species and height classes, Hink and Ohmart's (1984) findings can be applied to some extent outside of the Middle Rio Grande area of this study. For instance, the C/CW structure will be similar in Reaches 1 through 4, even though these northernmost areas are narrowleaf cottonwood rather than the broadleaf species seen in the Middle Rio Grande floodplain. If deciduous trees and snags afford excavation sites for cavity dwellers, various woodpecker species can be expected. Hairy and downy woodpeckers will be present, as well as various flycatchers and other birds that use cavities excavated by piciformes.

In spring and summer, Hink and Ohmart (1984) found that the two most common species in the cottonwood forest types were mourning dove and black-chinned hummingbird. Other common species included Gambel's quail, northern flicker, ash-throated flycatcher, ring-necked pheasant, the introduced European starling, American robin, northern oriole, black-headed grosbeak, lesser goldfinch, rufous-sided [spotted] towhee, and brown-headed cowbird.

Community structures that included open water also attracted a distinct set of species. In addition to mallards, the American robin and red-winged blackbird were the most common species in spring and summer, and belted kingfishers and black phoebes were also found. Black-crowned night herons, snowy egrets, green herons, and great blue herons were also associated with these areas.

Three sites were chosen along the Rio Grande at which to compare breeding birds known to use the Rio Grande migratory corridor (**Table L-2.17**). Alamosa NWR lies in Reach 1; the Bosque del Apache NWR is within Reach 14; and the Rio Bosque Wetlands Park in El Paso, Texas, is at the northernmost end of Reach 17.

Table L-2.17 Area Comparison of Breeding Bird Species Found in Riparian Zone at Three Selected Locations from Alamosa, Colorado, to El Paso, Texas

River Section		Northern	San Acacia	Southern
Family/Common Name	**Taxonomic Name**	**Alamosa NWR[1]**	**Bosque del Apache NWR[2]**	**Rio Bosque Wetlands Park[3]**
PODICIPEDIDAE				
Pied-billed grebe	*Podilymbus podiceps*	B	B	□
ARDEIDAE				
Great blue heron	*Ardea herodias*	□	B	□
Snowy egret	*Egretta thula*	B	B	B
Green heron	*Butorides virescens*	□	B	□
Cattle egret	*Bubulcus ibis*	□	□	B
Black-crowned night heron	*Nycticorax nycticorax*	B	B	B
THRESKIORNITHIDAE				
White-faced ibis	*Plegadis chihi*	B	B	□
CATHARTIDAE				
Turkey vulture	*Cathartes aura*	□	B	B
ANATIDAE				
Canada goose	*Branta canadensis*	B	B	×
Gadwall	*Anas strepera*	B	B	□
Mallard	*Anas platyrhynchos*	B	B	□
Blue-winged teal	*Anas discors*	B	B	□
Cinnamon teal	*Anas cyanoptera*	B	B	□
Northern shoveler	*Anas clypeata*	B	B	□
Northern pintail	*Anas acuta*	B	B	□
Green-winged teal	*Anas crecca*	B	B	□

River Section		Northern	San Acacia	Southern
Family/Common Name	**Taxonomic Name**	**Alamosa NWR[1]**	**Bosque del Apache NWR[2]**	**Rio Bosque Wetlands Park[3]**
Redhead	*Aythya americana*	B	B	□
Ruddy duck	*Oxyura jamaicensis*	B	B	□
ACCIPITRIDAE				
Red-tailed hawk	*Buteo jamaicensis*	B	B	×
Swainson's hawk	*Buteo swainsonii*	B	□	□
Northern harrier	*Circus cyaneus*	B	B	□
Cooper's hawk	*Accipiter cooperii*	□	B	□
FALCONIDAE				
American kestrel	*Falco sparverius*	B	B	□
PHASIANIDAE				
Ring-necked pheasant	*Phasianus colchicus*	B	B	×
ODONTOPHORIDAE				
Gambel's quail	*Callipepla gambelii*	×	B	B
RALIDAE				
Virginia rail	*Rollus limicola*	B	□	×
Sora	*Porzana Carolina*	B	B	□
Common moorhen	*Gallinula chloropus*	×	□	B
American coot	*Fulica americana*	B	B	□
CHARADRIIADAE				
Killdeer	*Charadrius vociferous*	B	B	B
RECURVIROSTRIDAE				
Black-necked stilt	*Himantopus mexicanus*	□	B	□
American avocet	*Recurvirostra americana*	B	B	□
SCOLOPACIDAE				
Spotted sandpiper	*Actitis macularia*	B	B	□
Common snipe	*Gallinago gallinago*	B	×	×
Wilson's phalarope	*Phalaropus tricolor*	B	□	□
COLUMBIDAE				
Mourning dove	*Zenaida macroura*	B	B	B
CUCULIDAE				
Greater roadrunner	*Geococcyx californianus*	×	B	B
STRIGIDAE				
Great horned owl	*Bubo virginianus*	B	□	×
Burrowing owl	*Athene cunicularia*	□	□	B
Short-eared owl	*Asio flammeus*	B	□	×
CAPRIMULGIDAE				
Lesser nighthawk	*Chordeiles acutipennis*	×	B	□
Common nighthawk	*Chordeiles minor*	B	B	□

River Section		Northern	San Acacia	Southern
Family/Common Name	**Taxonomic Name**	**Alamosa NWR[1]**	**Bosque del Apache NWR[2]**	**Rio Bosque Wetlands Park[3]**
APODIDAE				
Black-chinned hummingbird	*Archilochus alexandrii*	□	B	B
PICIDAE				
Ladder-backed woodpecker	*Picoides scalaris*	×	B	□
Northern flicker	*Colaptes auratus*	□	B	×
TYRANNIDAE				
Western wood pewee	*Contopus sordidulus*	□	B	□
Black phoebe	*Sayornis nigricans*	×	B	□
Say's phoebe	*Sayornis saya*	□	B	×
Ash-throated flycatcher	*Myiarchus cinerascens*	×	B	□
Western kingbird	*Tyrannus verticalis*	□	B	B
CORVIDAE				
Black-billed magpie	*Pica hudsonia*	B	□	×
Chihuahuan raven	*Corvus cryptoleucus*	×	B	□
ALAUDIDAE				
Horned lark	*Eremophila alpestris*	B	□	×
HIRUNDINIDAE				
Northern rough-winged swallow	*Stelgidopteryx serripennis*	□	B	□
Tree swallow	*Tachycineta bicolor*	B	B	□
Barn swallow	*Hirundo rustica*	B	B	□
Cliff swallow	*Petrochelidon pyrrhonota*	B	B	□
REMIZIDAE				
Verdin	*Auriparus flaviceps*	×	□	B
TROGLODYTIDAE				
Bewick's wren	*Thryomanes bewickii*	×	B	×
Marsh wren	*Cistothorus palustris*	B	□	×
MIMIDAE				
Northern mockingbird	*Mimus polyglottos*	□	B	B
Sage thrasher	*Oreoscoptes montanus*	B	□	□
Crissal thrasher	*Toxostoma crissale*	×	□	□
TURDIDAE				
American robin	*Turdus migratorius*	B	B	×
STURNIDAE				
European starling	*Sturnis vulgaris*	B	B	□
PARULIDAE				
Yellow-rumped warbler	*Dendroica coronata*	B	□	×
Common yellowthroat	*Geothlypis trichas*	B	B	□
Yellow-breasted chat	*Icteria virens*	×	B	B

River Section		Northern	San Acacia	Southern
Family/Common Name	**Taxonomic Name**	**Alamosa NWR[1]**	**Bosque del Apache NWR[2]**	**Rio Bosque Wetlands Park[3]**
EMBERIZIDAE				
Cassin's sparrow	*Aimophila cassinii*	□	□	□
Vesper sparrow	*Poocetes gramineus*	B	□	✕
Savannah sparrow	*Passerculus sandwichensis*	B	□	✕
Song sparrow	*Melospiza melodias*	B	□	✕
CARDINALIDAE				
Black-headed grosbeak	*Pheuticus melanocephalus*	□	B	✕
Blue grosbeak	*Guiraca caerulea*	□	B	□
Painted bunting	*Passerina ciris*	✕	✕	B
ICTERIDAE				
Red-winged blackbird	*Agelaius phoeniceus*	B	B	□
Western meadowlark	*Sturnella magna*	B	B	✕
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	B	□	□
Brewer's blackbird	*Euphagus cyanocephalus*	B	□	✕
Great-tailed grackle	*Quiscalus mexicanus*	□	B	□
Brown-headed cowbird	*Molothrus ater*	B	B	□
FRINGILLIDAE				
House finch	*Carpodacus mexicanus*	B	B	B
Lesser goldfinch	*Carduelis psaltria*	□	B	□
American goldfinch	*Carduelis tristis*	B	□	✕
PASSERIDAE				
House sparrow	*Passer domesticus*	B	B	□

Sources: [1] Service 2003a, [2] USGS 2003b, [3] Rio Bosque Wetlands Park 2003
B = Commonly breeds at site
□ = present but does not commonly breed
✕ = Not present at site during breeding season

Hink and Ohmart (1984) also categorized wintering avian species. The winter residents, arriving in the fall at cottonwood habitats, included white-crowned sparrow (*Zonotrichia leucophrys*), dark-eyed juncos (*Junco hyemalis*), hermit thrushes (*Catharus guttatus*), ruby-crowned kinglets (*Regulus calendula*), yellow-rumped warblers (*Dendroica coronata*), brown creepers (*Certhia americana*), Bewick's wrens (*Thryomanes bewickii*), song sparrows (*Melospiza melodia*), and large flocks of American crows (*Corvus brachyrhynchos*).

The majority of raptor species were fall migrants or winter residents. These include the northern harrier (*Circus cyaneus*), sharp-shinned hawk (*Accipiter striatus*), red-tailed hawk (*Buteo jamaicensis*), ferruginous hawk (*B. regalis*), rough-legged hawk (*B. lagopus*), and bald eagle (*Haliaeetus leucocephalus*). Five species were present during summer surveys: the turkey vulture (*Cathartes aura*), osprey (*Pandion haliaetus*), Mississippi kite (*Ictinia mississippiensis*), American kestrel (*falco sparverius*), and prairie falcon (*Falco mexicanus*). Cooper's hawks (*Accipiter cooperii*) were seen during all seasons.

Drain and sandbar/river channels in fall and winter showed a distinctive complement of species. Ducks included mallards (*Anas platyrhynchos*), cinnamon teal (*A. cyanoptera*), American wigeon (*A. americana*), gadwall (*A. strepera*), and northern shoveler (*A. clypeata*). Great blue herons (*Ardea herodias*), water pipits (*Anthus spinoletta*), and mountain bluebirds (*Sialia currucoides*) were found along the sandbars.

The same three sites were reviewed for avian species that were distinctly related to wintering activities. A selection of those species appears in .

It has already been pointed out that, in general, more survey information is available for avian species than any other. **Table L-2.17** and illustrate another important point: avian riparian habitat usage cannot be assigned a permanent zone. There is a distance of approximately 390 miles from the northern to the southern sites, and climatic and geomorphic differences range from the 7,500-foot San Luis Valley floor, through steep, rocky canyons such as the Rio Grande Gorge north of Taos, New Mexico, down to extremely arid high- and low-desert portions of New Mexico and Texas. Nonetheless, there is considerable similarity of breeding species at all three sites represented in. Conversely, the main wintering species shown in **Table L-2.17** clearly indicate that some species are never present at any season in the northern- and southernmost sites. The riparian habitat provided by the Rio Grande is a dynamic system along its entire length. Wildlife usage, as indicated by the avian species in **Table L-2.17** and, is dynamic as well and cannot be relegated to simple, linear territories.

Small Mammals

In riparian habitats, small mammals are generally rodents, most often mouse and rat species. In a study of desert rodent communities, Bowers et al. (1987) discuss the need to view habitat use by rodents at the microhabitat level. Beyond a preference for riparian vegetation, for instance, is their need for small areas of dense groundcover that provides more potential for escape from visually oriented predators. Such studies confirm the need for a healthy, native understory as well as for a mixed-age canopy.

Hink and Ohmart (1984) found that small-mammal capture rates were highest in sites with cottonwood and coyote willow less than 40 feet tall with a relatively dense understory. Many of these high-capture sites were in edge areas or adjacent to open water. Moderate capture rates were also achieved in these communities, as well as in dense understories along the edges of cottonwood/coyote willow woodlands taller than 40 feet, and in various open, woody, and marshy areas with woody species less than 15 feet tall and with little or no understory. Capture rates were lowest in areas where trees were over 20 feet tall with limited understory vegetation. Three years of experimental flooding had no apparent effect on the rodent population in riparian habitats within Bosque del Apache NWR (Ellis et al. 1996). During this study, white-footed mice (*Peromyscus leucopus*) were observed to occupy trees and shrubs during floods.

Large Mammals

Large animals can significantly modify the structure and function of river corridors, as discussed by Naiman and Rogers (1997). The designation of "large" should not be mistakenly limited to deer, elk, bear, cougar, and so forth. Many riparian studies, such as Campbell et al. (1997), include raccoon, beaver, coyote, and other mammals that are too large to be captured in conventional live traps. Medium-sized diurnal mammals such as cottontail rabbit or rock squirrel, which are more often seen than trapped, were also placed in the "large" category by the Campbell study. Much of the mammal diversity in riparian habitats is evidenced by sign: tracks, scat, burrows, scent, or vocalizations verify presence even if the animal itself is not observed or trapped.

Table L-2.18 Comparison of Selected Wintering Migrant Bird Species Found in the Riparian Zone at Three Selected Locations from Alamosa, Colorado, to El Paso, Texas

River Section		Northern	San Acacia	Southern
Family/Common Name	**Taxonomic Name**	**Alamosa NWR[1]**	**Bosque del Apache NWR[2]**	**Rio Bosque Wetlands Park[3]**
ARDEIDAE				
Great egret	*Ardea alba*	×	×	□
ANATIDAE				
Snow goose	*Chen caerulescens*	×	□	×
Ross' goose	*Chen rossii*	×	□	◘
Gadwall	*Anas strepera*	×	□	□
American wigeon	*Anas americana*	×	×	□
Ring-necked duck	*Aythya collaris*	×	□	×
Bufflehead	*Bucephala albeola*	×	□	×
Common merganser	*Mergus merganser*	×	□	◘
ACCIPITRIDAE				
Bald eagle	*Haliaeetus leucocephalus*	□	□	×
Sharp-shinned hawk	*Accipiter striatus*	×	□	×
Rough-legged hawk	*Buteo lagopus*	□	×	◘
GRUIDAE				
Sandhill crane	*Grus canadensis*	×	□	×
PICIDAE				
Northern flicker	*Colaptes auratus*	×	□	□
CORVIDAE				
American crow	*Corvus brachyrhynchos*	×	□	□
Chihuahuan raven	*Corvus cryptoleucus*	◘	×	□
TYRANNIDAE				
Say's phoebe	*Sayornis saya*	×	□	□
TROGLODYTIDAE				
Marsh wren	*Cistothorus palustris*	×	□	×
REGULIDAE				
Ruby-crowned kinglet	*Regulus satrapa*	×	□	□
MOTACILLIDAE				
American pipit	*Anthus rubescens*	×	□	×
PARULIDAE				
Yellow-rumped warbler	*Dendroica coronata*	×	×	□
EMBERIZIDAE				
American tree sparrow	*Spizella arborea*	□	×	◘
Savannah sparrow	*Passerculus sandwichensis*	×	×	□
Song sparrow	*Melospiza melodias*	□	□	□
White-crowned	*Zonotrichia leucophrys*	×	□	□

River Section		Northern	San Acacia	Southern
Family/Common Name	**Taxonomic Name**	**Alamosa NWR[1]**	**Bosque del Apache NWR[2]**	**Rio Bosque Wetlands Park[3]**
sparrow				
Dark-eyed junco	*Junco hyemalis*	□	□	
FRINGILLIDAE				
Pine siskin	*Carduelis pinus*	×	□	◘
American goldfinch	*Carduelis tristis*	×	□	◘

Sources: [1] Service 2003a, [2] USGS 2003b, [3] Rio Bosque Wetlands Park 2003
□ = Abundant or common during winter
× = Not present or rare at site during winter
◘ = Not present any season

For purposes of their analyses, Hink and Ohmart (1984) placed all mammal species larger than rats in the category of large mammals. Consequently, this grouping includes a sizable range of species from squirrels to domestic livestock. Of these, aquatic species such as beaver (*Castor canadensis*) and muskrat (*Ondontra zibethicus*) were naturally found near open water sources. Though rarely seen, based on the frequent occurrence of tracks and other identifiable signs, raccoons (*Procyon lotor*) were perhaps the most abundant large mammal in the Middle Rio Grande. This species was found along sandbars, drains, marshes, and ponds, as well as in mixed cottonwood bosques.

Other large mammal species that were found to be relatively common in the riparian woodlands along the Middle Rio Grande were the porcupine (*Erethizon dorsatum*) and long-tailed weasel (*Mustela frenata*). Though these species are not riparian obligates, they are frequently found in higher concentrations in areas of dense riparian vegetation. Striped skunks (*Mephitis mephitis*) were also commonly found along the Rio Grande, though their occurrence may be more of a consequence of disturbed and developed areas than the presence of riparian habitats (Findley et al. 1975). Rock squirrels (*Spermophilus variegatus*) were regularly seen in cottonwood and Russian olive trees along the levee roads, but these rodents were not as common in the less-fragmented areas within the bosque. Pocket gophers (*Thomomys bottae*) were found to be abundant in areas of mixed cottonwood and coyote willow stands with loose, sandy soils. Desert cottontails (*Sylvilagus auduboni*) were found throughout the riparian corridor in habitats ranging from cottonwood stands to grassy and herbaceous areas. Though not encountered during the Hink and Ohmart study, mule deer (*Odocoileus hemionus*) have been recorded throughout the Rio Grande valley, particularly in the White Rock Canyon area.

Domestic and feral dogs (*Canis familiaris*) and cats (*Felis domesticus*) were the most common large mammals found in Hink and Ohmart's study area. The abundance of dog and cat tracks in the area made it difficult to assess the presence of coyotes (*Canis latrans*), gray foxes (*Urocyon cinereoargenteus*), and bobcats (*Felis rufus*), all of which have tracks very similar to those of their domestic counterparts. However, coyotes, foxes, and to a lesser extent bobcats, are frequently seen and heard along the Rio Grande. Domestic livestock were also quite common in various riparian habitats, particularly on private and Pueblo lands.

2.5.8.3 Faunal Use of Non-Native Vegetation

Hink and Ohmart's 1984 study of which structural types support the greatest abundance and diversity of fauna have been verfied by later surveys (e.g., Thompson et al. 1994; Leal et al. 1996). It should be noted that these studies most specifically address structural associations. For instance, birds and some mammals are more abundant in mature forests with a varied understory because this structural type provides greater diversity of denning, nesting, and burrowing sites as well as increased forage and protection from predation. Faunal abundance does not necessarily decrease just because the vegetation happens to be non-native.

Russian olive is perhaps the best example of the impact that exotics have had on area fauna. Many species of birds and mammals rely on the fruit of Russian olive as a desirable mast crop. This is particularly true of insectivores such as robins and northern flickers during seasons when arthropods have gone to ground and are no longer available. Beyond forage, Russian olive provides an excellent nesting substrate. The structure is more solid than some native canopy species, and the thorns provide a built-in protection against nest predators like the American raccoon and large raptors. Russian olive has altered New Mexico's avifauna more than any other exotic plant; it has literally rearranged the zonal distribution of some species.

Siberian elm provides nesting sites for passeriformes such as black-headed grosbeaks and orioles, as well as sparrows and finches. It provides good roosting sites for animals including porcupine, crow, and raptor species—particularly when native deciduous trees are in limited supply.

Salt cedar is sometimes categorized as the bane of native riparian ecosystems. However, a dense stand of salt cedar is a highly desirable nesting site for mourning doves. Mature salt cedars of taller stature provide roosting for Strigiformes, particularly great-horned owls, barn owls, and the long-eared owl. Salt cedar also is highly attractive to many flying insects, which in turn produces great feeding for warblers, vireos, and a variety of small insectivores.

Though salt cedar has no correlate native species in New Mexico, both Russian olive and Siberian elm do have similar species. Wildlife here probably began adapting to their presence shortly after the arrival of exotic species in the early 1800s. Any consideration of impacts on riparian fauna should therefore include an understanding of their selective use of these non-native plant species.

2.5.8.4 Examples of Faunal Diversity in the Project Area

Northern Section

The floodplain in Reach 1 supports scattered stands of willow, narrowleaf cottonwood, and oxbow wetlands. The riparian stands within Alamosa NWR are dense enough to support a breeding population of endangered willow flycatchers.

The Conejos River (Reach 2) from the confluence of the Rio Grande to Platoro Reservoir supports an extensive area of mixed-age woody vegetation for approximately 68 river miles. The upper canopy is narrowleaf cottonwood and various species of montane willows (*Salix* sp.). There is also a breeding population of SWFL in willow stands along the lower Conejos River.

The cliffs of the Rio Grande Gorge (Reach 3) are important nesting habitat for raptors, especially for golden eagles, and serve as key roosting and hibernation sites for several bat species. BLM has determined that 21 riverine miles of the Gorge are suitable for river otter introduction, although there are no known otter populations in the area (BLM 1988).

The more extensive riparian vegetation downstream of the Gorge is habitat for breeding birds, including neotropical migrant songbirds and some waterfowl. In some of the larger willow stands near Velarde and on the San Juan Pueblo, SWFL territories have been found. During the last three years, SWFL have apparently abandoned the Velarde sites, probably due to low nesting success (Moore and Ahlers 2004). There is a colony of Lewis' woodpeckers breeding in the mature cottonwoods in the reach between Alcalde Diversion Dam and the San Juan Pueblo. Also, there is a small herd of Rocky Mountain elk in Reach 3.

Rio Chama Section

Portions of the Rio Chama exhibit the most rugged montane habitat found within the Project Area. Deer and elk are abundant along the river bottom, piñon-covered ridges, and canyon rims along some sections. Other large mammals include cougars, black bears, elk, mule deer, badgers, bobcats, coyotes, beavers, and raccoons. The walls of Rio Chama Canyon rise to over 1,500 feet and host 70 to 80 different bird varieties, including raptors such as bald and golden eagles and hawks, falcons, and owls, all of which perch along the canyon walls and surrounding trees. The river supports species such as ducks, dippers, spotted sandpipers, and Canada geese, as well as brown and rainbow trout, flathead chub, flathead minnows, white suckers, carp, channel catfish, black crappie, and longnose dace. Adjacent mountain valleys and canyons are suitable habitat for various species of rattlesnakes and copperheads.

Central Rio Grande Section

As one of the five major North American flyways, the Rio Grande supports a diversity of migratory birds. Riparian habitats within the Central Section are enhanced by several distinct wetland areas. These include Madrone Pond, the Candelaria Wetland at Rio Grande Nature Center State Park, and the San Antonio Oxbow in Albuquerque, as well as the roughly 400-acre Isleta Marsh. Wetland areas are prime habitat for many amphibian species, while associated saltgrass meadows are critical for species such as the meadow jumping mouse.

San Acacia Section

Reach 14 habitats dominated by cottonwood and willow support a high diversity and density of birds (Ahlers and White 1999). This area supports high densities of neotropical migrant landbirds during both migration and breeding periods. For example breeding birds include yellow-billed cuckoo and Arizona Bell's vireo. In addition, this habitat supports large numbers of other riparian-obligate breeding bird species such as common yellowthroat, yellow-breasted chat, Bullock's oriole, and black-headed grosbeak (Ahlers and White 1999). This habitat also provides important resting and foraging habitat for birds during the spring and fall migration (Ellis 1995).

The remnant cottonwood stands on the disconnected western floodplain of the San Marcial portion of this reach support a unique association of wildlife. Raptors use the larger trees for perch and nest sites. Wild turkeys are also known to use certain stands for roosting habitat. Cavity-nesting species such as American kestrel, ladder-backed woodpecker, white-breasted nuthatch, and ash-throated flycatcher nest in the larger trees. Neotropical migrant landbirds known to breed in these stands include summer tanager and Lucy's warbler.

Salt-cedar-dominated stands have some value for wildlife, but usually not as high as native stands. This is particularly true for native stands where foliage is mixed-aged and of high height diversity when adjacent to open weedy fields. Salt cedar stands at the Bosque del Apache NWR were found to support relatively high numbers of wintering birds that use the salt cedar for cover (Ellis 1995).

The San Marcial Reach north of Elephant Butte Reservoir (Reach 14), because of its proximity to the Bosque del Apache NWR, attracts large numbers of birds. Raitt (1980, 1981) documented more than 250 species of birds within the general area. Many of these species are associated with riparian-wetland habitats and include waterfowl, raptors, and neotropical migrant songbirds.

The various terrestrial and aquatic habitats within this reach provide for a diversity of wildlife species. Elephant Butte Reservoir provides substantial habitat for waterfowl feeding and wintering, abundant fish supply and availability of loafing sites, and limited habitat for nesting and raising young—primarily within the Low Flow Conveyance Channel outflow areas. Species known to nest in portions of the reservoir include Clark's grebe, snowy egret, cattle egret, and black-crowned night heron. In addition, the riparian forests at the north end of the reservoir provide perch sites for many raptors, as do the cottonwood snags scattered along the shoreline.

A large number of bats, mostly from caves on private lands adjacent to Elephant Butte Reservoir, may occur during migration and in years with high insect populations. At least eight bat species, including pallid bat (*Antrozous pallidus*), Mexican free-tail bat (*Taddarida brassiliensis*), and Yuma myotis (*Myotis yumanensis*), are known to occur in the area. Because of the caves, close proximity to the reservoirs, the wetland riparian communities nearby support high insect densities and may provide important foraging habitat. Bat species may also roost in large snags, cliffs, and abandoned buildings along the reservoir.

Southern Section

Approximately 4,300 acres of sensitive wildlife habitat have been documented within the Caballo Reservoir area (Reclamation 2002). The shoreline and littoral wetland vegetation is dependent on water availability, which can be extremely variable as water levels in the reservoirs increase and decrease.

2.6 *Threatened, Endangered, and Special Status Species*

The Upper Rio Grande Project Area supports wildlife species that are federally listed as threatened or endangered and are protected under the Endangered Species Act of 1973 (**Table L-2.19**). The states of Colorado, New Mexico, and Texas recognize additional threatened or endangered species not listed under the ESA. Also, species of concern are determined by state and other agencies. A baseline evaluation is desirable for all listed species that may occur within those Project Area counties transected by the Rio Grande. The baseline data and descriptions may remove many species from any further consideration. This section reviews the status and biological characteristics of these species.

As shown in **Table L-2.19**, of the 14 federally listed species protected under the ESA, only five have the potential to occur within the planning area. Three of these species have habitat preferences and behaviors that may be affected by changes to water operations on the Rio Grande: RGSM, SWFL, and bald eagle. Candidate species are not included because they are not afforded protection under the ESA.

2.6.1 *Federally Listed Species*

As shown in **Table L-2.19,** 14 species that are protected under the ESA appear on county lists for the Project Areas transected by the Rio Grande. These are federally listed as threatened or endangered species. Only three of these species commonly occur within the potential footprint of the proposed Project. This section reviews the status and biological characteristics of all 14 federal species protected under the ESA, regardless of whether or not they may occur in habitat potentially affected by Project activities.

Federal candidate species are not included in **Table L-2.19** because they are not afforded protection under the ESA. Candidate species for counties within the Project Area include the Gunnison's sage-grouse (*Centrocercus minimus*) and boreal toad (*Bufo boreas boreas*), which are listed in Colorado; the yellow-billed cuckoo (*Coccyzus americanus*), which is listed in Colorado, New Mexico, and Texas; and the black-tailed prairie dog (*Cynomys ludovicianus*), which is listed in New Mexico, though considered extirpated from the state. The Riparian Team determined that the yellow-billed cuckoo is the only candidate species that may be affected by Project activities. This candidate species is therefore included below for planning purposes.

Table L-2.19 Federal Listing of Endangered and Threatened Species and Their Evaluation Status within this EIS

SPECIES: Common Name/Scientific Name	Federal Status	EIS Evaluation Status			
		1	2	3	4
PLANTS					
Sneed pincushion cactus (*Coryphantha sneedii* var. *sneedii*)	E				
Pecos sunflower (*Helianthus paradoxus Heiser*)	T		□		
FISH					
Gila trout (*Oncorhynchus gilae*)	E		□		
Rio Grande silvery minnow (*Hybognathus amarus*)	E	■			

SPECIES: Common Name/Scientific Name	Federal Status	EIS Evaluation Status			
		1	2	3	4
AMPHIBIANS and REPTILES					
Chiricahua leopard frog (*Rana chiricahuensis*)	T		□		
BIRDS					
Bald eagle (*Haliaeetus leucocephalus*)	T	■			
Brown pelican (*Pelecanus occidentalis carolinensis*)	E				□
Interior least tern (*Sterna antillarum athalassos*)	E				□
Mexican spotted owl (*Strix occidentalis lucida*)	T			□	
Northern aplomado falcon (*Falco femoralis septentrionalis*)	E			□	
Piping plover (*Charadrius melodus circumcinctus*)	T				□
Yellow-billed cuckoo (*Coccyzus americanus*)	Canditate Only				
Southwestern willow flycatcher (*Empidonax traillii extimus*)	E	■			
MAMMALS					
Black-footed ferret (*Mustela nigripes*) ►	E			□	
Canadian lynx (*Lynx canadensis*)	T			□	

■ Will be further evaluated because species may be affected
□ Removed from further consideration because species (a) may have suitable habitat but no known records of occurrence in affected Project Area, (b) has no suitable habitat in affected Project Area, or (c) is an uncommon migrant with distribution outside Project Area – effects negligible
► Species has been extirpated from state of listing.
Source: Service 2005

2.6.1.1 Federally Listed Species Potentially Affected by the Project

Rio Grande Silvery Minnow (*Hybognathus amarus*) ■ Endangered

The RGSM was formerly one of the most widespread and abundant species in the Rio Grande basin of New Mexico, Texas, and Mexico (Bestgen and Platania 1991). At the time of its listing as endangered, the silvery minnow was restricted to the Middle Rio Grande in New Mexico, occurring in only 5% of its historic range, from Cochiti Dam downstream to the headwaters of Elephant Butte Reservoir (Platania 1991).

The RGSM was listed as endangered under the ESA in July 1994 (FR 1994). The species is listed by the State of New Mexico as an endangered species, Group II. The Service documented de-watering of portions of the Rio Grande below Cochiti Dam through water regulation activities, the construction of mainstem dams, the introduction of non-native competitor/predator species, and the degradation of water quality as possible causes for declines in RGSM abundance (FR 1993).

The first designation of critical habitat for this species was published on July 6, 1999 (FR 1999a) and included the Rio Grande corridor from the New Mexico Highway 22 Bridge (immediately downstream from Cochiti Dam) to the railroad bridge near San Marcial, New Mexico, approximately 160 miles downstream. On February 19, 2003 (FR 2003a), the final rule designated critical habitat from the Highway 22 Bridge downstream to the utility line crossing the Rio Grande, a permanent identified landmark in Socorro County, New Mexico, a distance of approximately 170 miles (see Section 2.6.4, Proposed/Existing Critical Habitat Designations, for additional information).

The RGSM is a moderately sized, stout minnow, reaching 3.5 inches in total length and spawning in the late spring and early summer, coinciding with high spring snowmelt flows (Sublette et al. 1990). Spawning also may be triggered by other high-flow events such as spring and summer thunderstorms. This species is a pelagic spawner, producing neutrally buoyant eggs that drift downstream with the current (Platania 1993b). 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. Platania (1993b) found that eggs developed in 24 to 48 hours in a laboratory experiment. Considerable distance could be traversed by the drifting developing eggs when taking into account the possible length of the drift (Sublette et al. 1990; Bestgen and Platania 1991; FR 1993, Platania 1993b; Platania and Altenbach 1998). Maturity for this species is reached toward the end of the first year. Most individuals of this species live one year, with only a very small percentage reaching age two. It appears that the adults die after spawning (Sublette et al. 1990; Bestgen and Platania 1991; FR 1993).

This reproductive strategy, where the progeny are moved downstream, may partially explain the greater abundance of the species in the San Acacia reach (San Acacia Diversion Dam to Elephant Butte Reservoir), as revealed by numerous fish collections (Bestgen and Platania 1991; Platania 1993a). During surveys in 1999, over 95 percent of the RGSM were captured downstream of San Acacia Dam (Platania and Dudley 1999; Smith and Jackson 2000). In the past, the young drifted downstream, developed to maturity, and proceeded back upstream to occupy available habitat. Mainstem dams now block upstream migration, thus restricting the species' redistribution. Concurrently, a portion of the reproductive effort upstream of each dam is distributed downstream by the drift. It is believed that RGSMs that move into the San Acacia Reach (the majority of the population) are transported by high velocities in the narrow and deep channels into Elephant Butte Reservoir, where none survive (Reclamation 2000a).

The vast majority of the annual reproductive effort of RGSM normally occurs during May, as water temperatures increase, and appears to be triggered by a large-scale increase in stream discharge (and associated suspended sediments) associated with high-mountain snowmelt (Platania and Dudley 2004; Dudley et al. 2005). During years of sufficient snowpack, flow in the Middle Rio Grande historically peaked in late spring and resulted in several months of sustained flooded habitats. However, dams and irrigation projects now moderate the magnitude, amplitude, and duration of spring discharge.

The Rio Grande is a sediment-laden river running through a steep rift valley that historically has resulted in a braided planform for the channel. The construction of several large dams on the Rio Grande has resulted in a 70 to 90 percent reduction of sediment in the river (Massong et al. 2002; Reclamation 2000a). The reduction of sediment supply has resulted in channel incision with conversion to a gravel-bedded, single-threaded channel (Reclamation 2000a). The change in planform is possibly one factor leading to a loss of nursery habitat (Porter and Massong 2004).

Artificially elevated discharge (e.g., a short-duration reservoir release in May) has also been shown to induce spawning by RGSM (Dudley et al. 2003, 2004). Although a large number of RGSM eggs were produced as a result of these "flow spikes," the production of propagules ultimately resulted in the recruitment of very few RGSM to either the 2002 or 2003 year-class (Dudley et al. 2003, 2004). Young-of-year individuals rapidly declined in abundance following extended periods of low flows that immediately followed the flow spikes. In contrast, elevated and prolonged flows (e.g., >2,000 cfs for several weeks) during spring were significantly positively correlated ($p<0.001$), and extended low flows (e.g., <100 cfs for several months) were significantly negatively correlated ($p<0.001$) with 1993 to 2004 autumnal RGSM catch rates (Dudley et al. 2004, 2005). These results suggest that inundated habitats and overbank flooding produced by prolonged and elevated flows that historically occurred as a result of spring runoff are likely quite important for the successful recruitment of larval RGSM.

These conclusions are further supported by work conducted by Reclamation on the nursery habitats of RGSM (Porter and Massong 2004). Based on those studies, the conservation water used to initiate spawning in 2002 and 2003 appears to have been below the threshold for successful recruitment. The continuing decline in RGSM populations in 2002 and 2003, with below-average spring hydrographs (Dudley et al. 2003, 2004) and increased recruitment during a near-normal spring hydrograph in 2004 (Dudley et al. 2005), support this hypothesis. The nursery habitat hypothesis predicts that recruitment will increase when flows exceed the threshold for inundating nursery habitat surfaces. It is likely that flows will have to exceed about 2,500 cfs at the Albuquerque gage and about 2,000 cfs at the San Acacia gage to create significant nursery habitat.

Early life-history studies on RGSM indicate that individuals reared at 20 to 25ºC (this temperature range is comparable to river temperatures during May) require about two weeks to reach a development stage when they were capable of exogenous feeding and when their mobility has notably improved (Platania 2000). This developmental stage was accompanied by changes in body shape and locomotion, potentially making the larvae able to move about more freely within or out of nursery habitats. However, growth was relatively slow and constant until about one month post-spawning, after which time larvae nearly doubled in size in less than one week at 20 to 25º C. Ensuring that larvae have an adequate amount of time to reach critical developmental stages in inundated habitats has been demonstrated for other fish with drifting early life stages (e.g., Coutant 2004) and is likely the case for RGSM.

Natural habitat for the RGSM includes stream margins, side channels, and off-channel pools where water velocities are lower than in the main channel. Areas with detritus and algae-covered substrates are preferred, and the lee sides of islands and debris piles often serve as good habitat. Stream reaches dominated by straight, narrow, incised channels with rapid flows would not typically be occupied by the RGSM (Sublette et al. 1990; Bestgen and Platania 1991).

In the proposed Project Area, past actions have reduced the total habitat from historic conditions and altered habitat conditions for the RGSM. Narrowing and deepening of the channel, lack of side channels and off-channel pools, and changes in natural flow regimes have all adversely affected the RGSM and its habitat. These environmental changes have degraded spawning, nursery, feeding, resting, and refugia areas required for species survival and recovery (FR 1993). Cochiti Dam acts as a fish migration barrier, and recent fish collections and habitat surveys have demonstrated that habitat below Cochiti Dam to the northern boundary of Santa Domingo Pueblo is poor for the RGSM (PEC 2001). The coarser substrate, deeper channel, and higher velocities that occur in the incised channel in this reach of the Rio Grande do not provide the conditions where greater numbers of RGSM are known to occur.

Southwestern Willow Flycatcher *(Empidonax traillii extimus)* ■ Endangered

SWFL was listed as endangered under the ESA on February 27, 1995 (FR 1995b) (see Section 2.6.4, Proposed/Existing Critical Habitat Designations, for additional information). A recovery plan for the SWFL was finalized by the Service (Service 2002), and notice of its availability was published in the Federal Register March 5, 2003 (FR 2003b).

The SWFL is one of the most important species of wildlife to occur in the streamside habitats of the Rio Grande. With its federal listing as an endangered subspecies, it is considered by biologists to be an important indicator of the overall ecological health of southwestern riparian ecosystems. As such, it is accorded the highest level of protection and recovery efforts under the ESA, and it attracts considerable public attention as a focal species for entities concerned with the broad issues of ecological conservation.

The SWFL is a late spring/summer breeder that nests in late May through July and fledges young from late June to early August. Birds may be present in breeding territories from early May to late August. The SWFL breeds exclusively in dense riparian habitat adjacent to rivers, streams, and wetlands. Along the Middle Rio Grande, most breeding territories have been found in young and mid-aged riparian vegetation dominated by dense growths of willow at least 10 feet high and often with some cottonwoods and other riparian woody species (Ahlers et al. 2002).

Within these willow patches, nests have been found in individual salt cedar trees, especially in older, taller willow patches where an understory of salt cedar provides suitable nesting substrate. Here, the vertical structure of more slender stems and twigs on younger plants in the understory vegetation is best suited for nest placement. Recently, breeding SWFLs have been found nesting in salt-cedar-dominated patches on the Sevilleta NWR.

A critical factor for nesting is the presence of water, usually from overbank flooding. Along the Rio Grande, nests have been consistently found within 150 feet of surface water, typically in river channels, sloughs, backwaters, and beaver ponds. Breeding SWFLs exhibit a strong affinity for surface water and moist soils maintained by spring flooding and high groundwater levels, and overbank flooding is essential to maintain and create the preferred willow riparian habitat.

SWFLs (and many other species of neotropical migrant landbirds) use the Rio Grande riparian corridor as stop-over habitat during migration. Studies have shown that during the spring and fall migration, SWFL are more commonly found in willow habitats than in other riparian vegetation types, including the narrow band of coyote willows that line the LFC Channel in the Socorro and Bosque Reaches (Yong and Finch 1997). Recent presence/absence surveys during May have detected migrating SWFLs throughout the study area in vegetation types that would be considered less than suitable for breeding habitat (Moore and Ahlers 2003, 2004).

Available suitable riparian habitat and overall numbers of SWFL have apparently declined on the Rio Grande during the past century. Factors that are thought to contribute to this loss and are currently threatening the SWFL are complex and interrelated (Service 2002). These factors include loss and degradation of breeding habitat due to changes in river flows, diversions, groundwater pumping, channelization, reduction of willow-dominated riparian vegetation, introduction of exotic riparian vegetation, fire, livestock grazing, agricultural development, urbanization, nest predation, and brood parasitism by brown-headed cowbirds. Habitat loss and degradation has also occurred on the winter range in Central and South America (Service 2002).

Presence-absence surveys and nest monitoring for SWFLs have been conducted along the middle Rio Grande since 1994 (Moore and Ahlers 2003, 2004; Ahlers et al. 2001, 2002; Ahlers and White 1995, 1997, 1998, 1999, 2000; Johnson et al. 1996; Mehlman et al. 1995; Mehlhop and Tonne 1994). Active territories of SWFLs are found in several locations in the Project Area, as shown in **Table L-2.20**. Over 217 active territories were identified during intensive surveys in 2002, 2003, and 2004 (Moore and Ahlers 2003, 2004; Kelly Stone personal communication 2003). Recent population expansion has occurred in the delta of Elephant Butte Reservoir as riparian vegetation has developed above the declining reservoir pool.

Territories usually occur in clusters along the riparian corridor within approximately 10 miles of each other. Flycatchers return to these sites with great fidelity to establish territories and nests year after year. The size of each territory averages approximately 1.1 ha (2.71 acres) (Service 2002), and surface water hydrology has a strong influence on nest location. During nest monitoring studies in the San Acacia Section from 1999 to 2003, 97 percent of nests were located within 164 feet (50 m) of surface water when the site was first occupied, with an average distance to surface water of 78.4 feet at active nests (Darrell Ahlers, personal communication 2004).

In order to assess progress being made toward recovery of the species relative to national and regional goals, examination of the abundance of SWFL in comparison to Recovery Goals is instructive. The Southwestern Willow Flycatcher Recovery Plan (Service 2002) has set a minimum goal of 250 territories for the Rio Grande Recovery Unit needed to warrant reclassification of this sub-species from Endangered to Threatened. The Recovery Management Units provide geographic distribution of the goals throughout the Rio Grande Basin and are to be distributed throughout the entire Rio Grande watershed in Colorado and New Mexico and include 50 territories in Colorado's San Luis Valley, 75 territories upstream of Albuquerque in the "Upper Rio Grande," 100 territories from Albuquerque to Elephant Butte Dam, and 25 territories from Elephant Butte Dam to El Paso (**Table L-2.**). Only the Central and San Acacia

Sections (Middle Rio Grande Recovery Management Unit) have achieved the goals to date. The Rio Chama and southern sections of the Project Area are the farthest from reaching Recovery goals, as shown in **Table L-2.20**, although frequency and extent of SWFL survey data varied by section. The Recovery Plan also recommends a minimum habitat restoration target of at least twice the average territory size (2.2 ha or 5.43 acres) per recovery goal territory (Service 2002:85).

Vegetation was quantified at SWFL nest sites and territories on the Rio Grande based on the 2002 to 2003 vegetation survey. This analysis shows that the species forms territories and locates nests predominantly in Hink and Ohmart vegetation structure Types 3 and 4, less frequently in Type 5, and infrequently in Type 1 vegetation; no nests were found in Type 2 vegetation. Both native and non-native overstory vegetation were used by SWFL, but native overstory with dense native understory vegetation was the predominant vegetation at nest locations, accounting for 77.6 percent of all nest locations and territories (*n*=432). Another study (Moore and Ahlers 2004) shows a definite preference for willow-dominated habitats. The structural composition and stem/twig density required by SWFL is developed and sustained by high frequency and duration of flooding. Breeding SWFLs exhibit a strong affinity for moist soils maintained by spring flooding and high groundwater levels in the overbank areas as well as for nearby availability of open water.

Table L-2.20 Known Abundance and Distribution of Southwestern Willow Flycatcher Territories along the Rio Grande

Rio Grande Section	River Reaches with Known Territories	Most Recently Known Number of Active Territories
Northern Section	1, 2, 3	40-65*
Middle Rio Grande Section	13	22**
San Acacia Section	14	149**
Southern Section	16	6*

*2002 survey data; ** 2004 survey data

Table L-2.21 Known Abundance and Distribution of Southwestern Willow Flycatcher Territories along the Rio Grande in 2002–2004 as Compared to Number of Territories Desired in Recovery Plan

<table>
<tr><th>Project River Section</th><th>Rio Grande SWFL Recovery Manageme nt Unit</th><th>River Reaches with Known Territories</th><th>Known Active SWFL Territories</th><th>Recovery Goal Territories</th><th>Minimum Recommende d Acres Suitable SWFL Habitat</th><th>2002-2004 Acres of Suitable SWFL Habitat[1] (% Recommended)</th><th>Progress Toward Recovery Goal Achievement</th></tr>
<tr><td>Northern Section (Reaches 1, 2)</td><td>San Luis Valley Unit</td><td>1 and 2</td><td>40-65*</td><td>50</td><td>271</td><td>Not mapped</td><td>Numeric goal met; habitat availability unknown</td></tr>
<tr><td>Northern Section (Reaches 3, 4, 8, 9)</td><td rowspan="2">Upper Rio Grande Unit</td><td>4</td><td>12**</td><td></td><td>407</td><td>172
Reach 4 only</td><td rowspan="2">Numeric goals not met; habitat may be adequate, additional mapping needed</td></tr>
<tr><td>Rio Chama Section</td><td>8</td><td>1</td><td>75</td><td></td><td>137
Reach 7 only (76% from limited survey data)</td></tr>
<tr><td>Central</td><td>Middle</td><td>13</td><td>10**</td><td></td><td>543</td><td>942</td><td>Numeric goals</td></tr>
</table>

Project River Section	Rio Grande SWFL Recovery Management Unit	River Reaches with Known Territories	Known Active SWFL Territories	Recovery Goal Territories	Minimum Recommended Acres Suitable SWFL Habitat	2002-2004 Acres of Suitable SWFL Habitat[1] (% Recommended)	Progress Toward Recovery Goal Achievement
Section	Rio Grande Unit						met; habitat abundant
San Acacia Section		14	149**	100		1,374 (426%)	
Southern Section	Lower Rio Grande Unit	16	6*	25	136	Not mapped	Numeric goals not met; habitat availability unknown
TOTALS:		**7**	**218-243**	**250**	**136**	**5,163 (380%)**	

[1] All suitable habitat within 50 m of open water and within 10 miles of occupied sites
Sources: *2002 survey data; ** 2004 survey data; Dale Stahlecker personal communication 2004

One SWFL territory is known to be in the Rio Chama Section of the Rio Grande (Section 8), in which only Reach 7 was surveyed for riparian vegetation (Dale Stahlecker 2004, personal communication 2004). This area contains 2,626 acres of mapped vegetation, of which 333 acres is suitable habitat for SWFL based on vegetation composition, structure, and proximity to surface water. Only 137 acres, or 5% of the total surveyed vegetation, is located within 10 miles of the nearest active SWFL territory on the Rio Grande, providing habitat immediately available for future colonization for up to 25 SWFL territories in Reach 7, according to the Recovery Plan. Additional suitable habitat may be available in the unmapped Reaches 5 and 6 of the Rio Chama.

The Central Section contains 21 known active territories, primarily in Reach 13. The Central Section has 17,498 acres of riparian vegetation mapped during this study. Of that amount, 942 acres of highly suitable SWFL habitat (5% of the total mapped vegetation) lies within 10 miles of occupied territories. This would provide colonization habitat for as many as 173 future SWFL territories, according to the Recovery Plan. An additional 1,468 acres is suitable, but occurs more than 10 miles from existing territories.

Known SWFL territories in the San Acacia Section are concentrated in Sevilleta NWR and areas south of the Bosque del Apache NWR. An expanding population and the majority of nests are located within the upper portion of the Elephant Butte Reservoir flood pool since it has been receding over the past five years. In 2004, about half of all nests known for the Rio Grande were located in the Elephant Butte flood pool. A total of 19,576 acres of riparian vegetation was mapped in this section. Of this, 1,374 acres of highly suitable habitat exists within 10 miles of occupied territories, not considering habitat within the reservoir pool area. This represents 7 percent of the total mapped vegetation of the San Acacia Section, offering habitat for future colonization of as many as 253 territories. An additional 874 acres of otherwise suitable habitat occurs more than 10 miles from occupied territories.

The action area of the Upper Rio Grande contains an important portion of active SWFL territories. Long-term continuation of beneficial streamflow and/or overbank flooding along the Middle Rio Grande establishment and maintenance of suitable vegetation are considered essential to increasing the extent of potential SWFL habitat and overall nesting success for the species.

Bald Eagle (*Haliaeetus leucocephalus*) ■ Threatened

The bald eagle was listed as endangered throughout the conterminous 48 States under the Endangered Species Act of 1966 on July 12, 1976 (FR 1976). Since that time, 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 species has been doubling its breeding population every 6 to 7 years since the late 1970s. At present and in the foreseeable future, the major threats are destruction and degradation of habitat and environmental contamination. Other threats include poisoning and illegal shooting, lead poisoning, 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 was reclassified to "threatened" on July 12, 1995 (FR 1995a). By 1999, the Service proposed that the bald eagle had undergone a sufficient recovery to propose that it be removed entirely from the list of threatened and endangered species (FR 1999b). The 1999 Proposed Rule still stands: If the bald eagle is delisted, all protections under the Endangered Species Act would be removed. However, Section 4(g)(1) of the Act requires that all monitoring be continued for at least 5 years.

Although the status of the birds in the Southwest recovery region is on an upward trend, the population remains small and under threat from a variety of factors, largely due to the proximity of bald eagle breeding areas to major human population centers.

The bald eagle is 3 feet long and has a 7-foot wingspan. Adults have a white head, neck, and tail and a large yellow beak. Their body color is dark brownish-black. While soaring, wings are kept flat. Feet are bare of feathers. Immature bald eagles are mostly dark or mottled without the characteristic white head and tail and may be confused with golden eagles. Bald eagles require large trees or cliffs near water with abundant fish for nesting. The typical nest is constructed of large sticks, with softer materials such as leaves, grass, and moss used as nest lining. Nests are often used for many years and can grow to 6 feet wide and weigh over 220 pounds. Eagles often have one or more alternative nests within their territories. Peak egg-laying occurs in December, with hatching primarily in January. The female lays a clutch of 1 to 3 eggs, and a second clutch may be laid if the first is lost. Incubation begins when the first egg is laid and usually lasts 34 to 36 days. The young generally fledge (fly from the nest) in 11 to 12 weeks, but the adults continue to feed them for another 4 to 6 weeks while they learn to hunt. Bald eagles reach sexual maturity at 4 to 6 years of age. Pairs mate for life and can live for 30 years.

Bald eagles are opportunistic feeders but prey mostly on fish and waterfowl; thus, they are associated with riparian and lacustrine ecosystems dominated by fish and waterfowl. Snags adjacent to open water are an important habitat component used for hunting perches and night roosts. The species requires wetland and aquatic ecosystems for foraging and large trees and cliffs near water for roosting. Although some breeding occurs in New Mexico, the main threats to wintering eagle populations are habitat loss or degradation, including declines in prey and availability of roost sites.

Suitable habitat for bald eagles includes areas with an adequate food base, perching areas, and nesting sites. In winter, bald eagles often congregate at specific wintering sites that are generally close to open water and that offer good perch trees and night roosts. In New Mexico habitat is found in the riparian zones along the Rio Grande and the Pecos, Chama, Gila, San Juan, and Canadian Rivers. Key habitat areas in the Project Area include winter roosts and fishing sources such as the Chama Valley, Cochiti Reservoir, Elephant Butte Reservoir, and Caballo Reservoir. In addition, bald eagles may occupy winter habitat along the main stem of the Rio Grande.

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, given that birds will choose to move to more secluded areas that may have less prey. The greatest challenge in the future will be to prevent further habitat destruction. Monitoring of nesting success is also particularly important in detecting any problems associated with contaminants in the environment. In addition, appropriate management of nesting, feeding, loafing, and wintering habitat must be a priority if we are to maintain the current upward trend in the population.

The Recovery Plan for the southwestern population was approved in 1982, and distribution is tracked (**Table L-2.2**). Captive breeding was pursued throughout the United States in the 1970s and 1980s. The eagle is protected by the State of New Mexico, where it is listed as threatened.

Table L-2.22 Summary of January Bald Eagle Morning Distribution Surveys on the Rio Grande From San Marcial to Caballo Dam

River Reach	1/23/97	1/27/98	1/27/99	1/9-10/01	2/1/02	1/16/03	1/28/04
San Marcial (active floodplain)	2 (2/0)	0	0	1 (1/0)	0	0	0
San Marcial (west side) groundwater wetlands	1 (1/0)	1 (1/0)	0	2 (2/0)	0	2(2/0)	1(1/0)
Elephant Butte Reservoir (east side) north of Dryland Road	0	4 (2/2)	6(3/3)	0	0	0	0
Elephant Butte Reservoir (west side) wetlands north of Dryland Road	1 (0/1)	5 (3/2)	3(2/1)	1 (1/0)	2(2/0)	0	0
Elephant Butte Reservoir (east side) Dryland Road to Nogal Canyon	9 (6/3)	4 (2/2)	8(5/0) *3(3/0)**	4 (1/3)	5(2/3)	1(1/0)	0
Elephant Butte Reservoir (west side) Dryland Road to Nogal Canyon	12 (8/4) *45 (30/15)**	17 (9/8)	18(11/7) *28(16/12) **	12 (7/5)	8(6/2)	8(2/6)	2(2/0)
Elephant Butte Reservoir (east side) Nogal Canyon to Narrows	6 (1/5)	0	2(1/1) *12(6/6)**	13 (8/5)	11(8/3)	6(4/2)	0
Elephant Butte Reservoir (west side) Nogal Canyon to Narrows	5 (3/2)	9 (6/3)	3(2/1)	8 (4/4)	7(5/2)	14(9/5)	3(2/1)
Elephant Butte Reservoir (east side) Narrows to Dam	NS	NS	5(3/2) *3(3/0)**	16 (10/6)	25 (14/11)	15 (12/3)	18 (13/5)
Elephant Butte Reservoir (west side) Narrows to Dam	NS	NS	9 8/1)	12 (7/5)	12 (9/3)	15 (11/4)	7 (6/1)
Rio Grande EB Dam to Caballo Delta	NS	NS	1(1/0) *1(1/0)**	1 (1/0)	0	0	1 (1/0)
Caballo Reservoir (east side)	NS	NS	5(3/2) *6(3/3)**	16 (9/7)**	7(4/3)	3(3/0)	4(4/0)
Caballo Reservoir (west side)	NS	NS	5(1/4) 2(2/0)*	8 (5/3)	1(1/0)	2(2/0)	0
TOTAL			**68 (42/26)**	**94 (56/38)**	**78 (51/27)**	**66 46/20)**	**36 (29/7)**

Numbers in parentheses (# adults/# immatures w/o white heads)
*observed during evening roost surveys
**includes eagles on east side of Rio Grande within Caballo Reservoir delta = 4 adults/1 immatures
Source: Reclamation 2004

2.6.1.2 Federally Listed Species Unlikely to be Affected by the Project

Sneed Pincushion Cactus *(Coryphantha sneedii* var. *sneedii)* ■ Endangered

This species occurs only in El Paso County, Texas, and in two counties in New Mexico. This cactus is covered with numerous needle-like spines, forms tight clumps with many branches, and may be round, cylindrical, or club shaped. It occurs in cracks of vertical cliffs or ledges of limestone mountains along with various cacti, creosote bush, ocotillo, lechuguilla, and beargrass at elevations between 3,900 and 7,000 feet. At this time, the two greatest known threats to the sneed pincushion cactus are collection by commercial and private collectors and habitat modification or destruction. The sneed pincushion cactus does not occur in riparian zones and therefore will not be affected by proposed activities

Pecos Sunflower (*Helianthus paradoxus Heiser*) ■ Threatened

The Pecos sunflower grows 1–2 m tall and prefers saturated saline soils associated with desert springs (cienegas) or the wetlands created from modifying desert springs at elevations of 1,000 to 2,000 m (3,300 to 6,600 feet). Adult plants grow well even when inundated. Activities that destroy wetland habitat necessary for the Pecos sunflower include erosion, groundwater depletion, water diversions, filling, livestock grazing, and salt cedar invasion (NMRPTC 1999). *Helianthus paradoxus* is a true wetland species, growing only in wetland habitats (NMRPTC 1999).

Gila Trout *(Oncorhynchus gilae)* ■ Endangered with no Critical Habitat

The Gila trout was listed as endangered on March 11, 1967, and the revised recovery plan was completed on May 1, 1992 (Service 1993). The Gila trout inhabits the headwaters of several streams in the Gila National Forest, New Mexico, and in Gap Creek, Prescott National Forest, in Arizona. Historically, it was found in the Verde River and its tributaries in Arizona and the headwater streams of the Gila and San Francisco Rivers in New Mexico. In New Mexico, it is presently found in the Iron, Main Diamond, South Diamond, McKenna, and Spruce Creeks of the Gila National Forest. In the Gila National Forest, it was introduced into McKnight, Little, Trail Canyon, Big, and Sheep Corral Creeks (Service 1993).

Habitat for the Gila trout is small, high-mountain streams. It faces extinction from habitat loss, hybridization with and competition by introduced nonnative trout (mainly rainbow trout), and from overfishing (Service 1993). The recovery plan calls for establishing the species in suitable streams within its historic range. The Gila trout is found in Sierra County, but is not within the Rio Grande Project Area.

Chiricahua Leopard Frog (*Rana chiricahuensis*) ■ Threatened

The Chiricahua leopard frog occupies a wide variety of habitat types. It is found in montane riverine, marsh, and lakeside habitat at higher elevations, and in playas and riparian areas in grass and scrubland environments at lower elevations (NMDGF 2004b).

The known range is divisible into two segments. One extends from montane central Arizona east and south along the Mogollon Range to montane parts of western New Mexico (Catron, Grant, and Sierra Counties). The other includes extreme southwestern New Mexico (Hidalgo County), the southeastern sector of Arizona, and south through Sonora and Chihuahua to northern Durango (Service 2004). The species does not occur in any portion of the Project Area.

Brown Pelican (*Pelecanus occidentalis)* ■ Endangered

The brown pelican, a federal- and state-listed endangered species, breeds along the eastern coast of the United States as well as the Gulf Coast. In inland areas of the United States, the brown pelican occurs as a vagrant. Only 13 occurrences have been reported from New Mexico (Service 2004). As a rare, non-breeding visitor to portions of the Project Area, it is unlikely that this species will be significantly affected by the proposed actions.

Interior Least Tern (*Sterna antillarum athalassos)* ■ Endangered

The interior least tern is an endangered species that occurs as a rare transient in the Rio Grande floodplain. This species is federal- and state-listed as endangered. The least tern nests in open sandy areas such as the river sandbars and alkali flats along the Pecos River in southeastern New Mexico. Occasional migrant least terns have been observed at Bosque del Apache NWR (Service 2004). Because least terns are rare transients and are not known to breed within the action area, no further consideration is needed.

Mexican Spotted Owl (*Strix occidentalis lucida*) ■ Threatened

The Mexican spotted owl occurs in varied habitat, primarily mature montane forest and woodland and shady wooded canyons. In forested habitat, uneven-aged stands with a high canopy closure, high tree density, multi-layered canopy structure, and a terrain with slopes greater than 15 degrees appear to be key habitat characteristics. The owl nests in snags, canyon-wall cavities, and abandoned raptor nests (Service 2004).

In New Mexico, the Mexican spotted owl has been recorded in all montane regions from the San Juan, Jemez, and Sangre de Cristo Mountains in the north to the Guadalupe and Animas Mountains in the south. Records for lowland occurrences exist for Navajo Lake, Mountainair, Lower San Francisco Valley, Estancia, Grants, Hurley, the Burro Mountains, Carlsbad Caverns National Park, and the San Andres NWR. These records probably represent dispersing individuals (Service 2004). As no suitable habitat exists within the Project Area, this species is not considered further.

Northern Aplomado Falcon (*Falco femoralis septentrionalis*) ■ Endangered with no Critical Habitat

Habitat for the northern aplomado falcon includes open terrain with scattered trees, relatively low ground cover, an abundance of small to medium-sized birds, and a supply of suitable nesting platforms, particularly yuccas and mesquite. Habitat degradation due to brush encroachment, overcollecting, and reproductive failure caused by organochlorine pesticides have led to the species decline (Service 2004).

Historically, the bird's range included the United States, southeastern Arizona, southern New Mexico, and southern Texas. No nests have been verified in the United States since 1952, when one was reported near Deming, New Mexico (Service 2004). A few migrant birds have been reported in New Mexico, but there are no known records for sightings within the Project Area.

Piping Plover (Charadrius melodus circumcinctus) ■ Threatened

The piping plover occurs on sandflats or along bare shorelines of rivers, lakes, or coasts. The piping plover forages on a variety of invertebrates, including marine worms, fly larvae, beetles, crustaceans, mollusks, and other small animals and their eggs. During the winter, piping plovers use algal, mud, and sand flats along the Gulf Coast (NMDGF 2004c).

Considered common in the 1930s, the piping plover vanished as a nesting species from many areas. In 1993, the North American population was estimated to be 5,000. Piping plovers have been reported from New Mexico on only seven occasions, most recently on April 2001. In New Mexico, this bird is a rare spring migrant that has been reported at Bosque del Apache NWR (NMDGF 2004c).

Yellow-Billed Cuckoo (*Coccyzus americanus*) ■ Candidate

The western population of the yellow-billed cuckoo experienced a severe decline in distribution and abundance throughout the western United States. This is a federally listed candidate species; candidate species have no formal protection under the ESA. However, the yellow-billed cuckoo is considered in this document for planning purposes, as it may be affected by Project activities. This species prefers riparian habitat with dense willow, cottonwood, salt cedar, and/or mesquite. Suitable breeding habitat consists of large stands of dense willow and cottonwood, but non-natives such as salt cedar are also used (Service 2001). Nesting territories in some portions of the Rio Grande are located in dense or narrow salt cedar stands or mixed salt cedar/willow habitat.

Black-Footed Ferret (*Mustela nigripes*) ■ Endangered with No Critical Habitat

The black-footed ferret is a rare mammal found in grassland plains and surrounding mountain basins to 10,500 feet in elevation. This ferret is usually found in association with prairie dogs, which are the primary food source and also provide the ferrets with abandoned burrows. A major impact has been loss of habitat due to destruction of original grasslands as well as prairie dog control programs that have eliminated the ferret's main food source and shelter. Canine distemper may also have been a factor in their decline (Service 2004).

Historically, the mammal's range included all or portions of the states of Colorado, Arizona, Utah, New Mexico, Kansas, Montana, Nebraska, Oklahoma, Texas, Wyoming, North Dakota, South Dakota, and the Provinces of Alberta and Saskatchewan, Canada. New Mexico has had no verified sighting since around 1960. The black-footed ferret may still exist in McKinley, Rio Arriba, and San Juan Counties, in New Mexico's "Four Corners" area (Service 2004).

Canadian Lynx *(Lynx canadensis)* ■ Threatened

The Canadian lynx is listed as threatened in three Colorado counties within the Project Area: Alamosa, Conejos, and Costilla; and two New Mexico counties: Rio Arriba and Taos. In the west, lynx live in subalpine/coniferous forests. Mature forests with downed logs and windfalls provide cover for denning, escape, and protection from severe weather. The same areas provide habitat for the lynx's primary prey, the snowshoe hare, and other small mammals and birds that supplement their diet (NMDGF 2004d).

According to Frey (2004), no historic specimens of this species are available in New Mexico, although its range undoubtedly included the San Juan and Sangre de Cristo Mountains based on its occurrence in contiguous habitat in these mountains in adjacent areas of Colorado.

2.6.2 *State-Listed Species*

Wildlife species listed at the state level do not carry protection under the federal ESA. However, wildlife management practices give due consideration to state-listed species that may be affected by a given project. As shown in **Table L-2.**, 42 species listed by state wildlife authorities are found in Project Area counties transected by the Rio Grande. Eight of these species may occur within the Project Area or rely on suitable habitat that occurs in the Project Area. This section reviews the biological characteristics of these eight species.

Table L-2.23 State Listing of Threatened or Endangered Species and Their Evaluation Status Within This EIS

SPECIES: Common/Scientific Name	State Status			EIS Evaluation Status			
	CO	NM	TX	1	2	3	4
PLANTS							
Pecos sunflower (*Helianthus paradoxus Heiser*)		E			□		
FISH							
Bluntnose shiner - Rio Grande ssp. (*Notropis simus simus*) ►			T		□		
Rio Grande silvery minnow (*Hybognathus amarus*)		E		■			
AMPHIBIANS and REPTILES							
Chihuahuan mud turtle (*Kinosternon hirtipes murrayi*)			T		□		
Jemez Mountains salamander (*Plethodon neomexicanus*)		T			□		
Western boreal toad (*Bufo boreas boreas*)	E	E				□	
BIRDS							
American peregrine falcon (*Falco peregrinus anatum*)		T	E			□	
Baird's sparrow (*Ammodramus bairdii*)		T				□	
Bald eagle (*Haliaeetus leucocephalus*)		T		■			

SPECIES: Common/Scientific Name	State Status			EIS Evaluation Status			
	CO	NM	TX	1	2	3	4
Bell's vireo (*Vireo bellii*)**		T		■			
Boreal owl (*Aegolius funereus*)		T				□	
Broad-billed hummingbird (*Cyanthus latirostris magicus*)		T					□
Brown pelican (*Pelecanus occidentalis carolinensis*)		E					□
Common black-hawk (*Buteogallus anthracinus anthracinus*)		T	T	■			
Common ground dove (*Columbina passerina pallescens*)		E				□	
Costa's hummingbird (*Calypte costae*)		T					□
Gray vireo (*Vireo vicinior*)		T				□	
Interior least tern (*Sterna antillarum athalassos*)		E					□
Lucifer hummingbird (*Calothorax lucifer*)		T					□
Mexican spotted owl (*Strix occidentalis lucida*)	T		T			□	
Neotropic cormorant (*Phalacrocorax brasilianus*)		T		■			
Northern aplomado falcon (*Falco femoralis septentrionalis*)		E	E			□	
Piping plover (*Charadrius melodus circumcinctus*)		E					□
Southwestern willow flycatcher (*Empidonax traillii extimus*)	E	E	E	■			
Varied bunting (*Passerina versicolor*)		T					□
Violet-crowned hummingbird (*Amazilia violiceps ellioto*)		T					□
Western burrowing owl (*Athene cunicularia*)	T					□	
White-eared hummingbird (*Hylocharis leucotis borealis*)		T					□
White-tailed ptarmigan (*Lagopus leucurus altipetens*)		E				□	
Whooping crane (*Grus americana*)	E	E	E				□
Zone-tailed hawk (*Buteo albonotatus*)			T				□
MAMMALS							
American marten (*Martes americana origenes*)		T				□	
Black-footed ferret (*Mustela nigripes*) ►	E		E			□	
Botta's pocket gopher (*Thomomys bottae*)	E					□	
Canada lynx (*Lynx canadensis*)	E					□	
Desert bighorn sheep (*Ovis canadensis mexicana*)		E				□	
Gray wolf (*Canis lupus*) ►			E			□	
Meadow jumping mouse (*Zapus hudsonius luteus*)		T		■			
Organ Mountains Colorado chipmunk (*Tamias quadrivittatus australis*)		T				□	
Oscura Mountains Colorado chipmunk (*Tamias quadrivittatus oscuraensis*)		T				□	
Spotted bat (*Euderma maculatum*)		T			□		
Wolverine (*Gulo gulo*) ►	E					□	

SPECIES: Common/Scientific Name	State Status			EIS Evaluation Status			
	CO	NM	TX	1	2	3	4

■ Will be further evaluated because species may be affected
□ Removed from further consideration because species (a) may have suitable habitat but no known records of occurrence in affected Project Area, (b) has no suitable habitat in affected Project Area, or (c) is an uncommon migrant with distribution outside Project Area – effects negligible
► Species has been extirpated from state of listing.
Source: Service 2005; NMDGF 2005

2.6.2.1 State Listed Species Potentially Affected by the Project

Rio Grande Silvery Minnow ■

See Species Account in Section 2.6.1, Federal Listed Species.

Bald Eagle ■

See Species Account in Section 2.6.1, Federal Listed Species.

Common Black-Hawk (*Buteogallus anthracinus anthracinus*) ■ Threatened

The common black-hawk may occur in the Albuquerque Reach (NMDGF 2004e). Though the common black-hawk is considered rare in Bernalillo County, nesting was observed in the Isleta Reach during the summer of 2003 (Sartor Williams, personal communication 2003). The species primarily occupies riparian woodlands, particularly areas with well-developed cottonwood galleries, or a variety of woodland and marsh habitats along permanent lowland streams. Breeding black-hawks require mature riparian forest stands near permanent water. Most birds winter south of the U.S., although some records report occurrences within southern Arizona and the Gulf coast in Texas. The diet of this riparian-obligate species consists mainly of fish, insects, crayfish, amphibians, and reptiles, but occasionally they will take small mammals and birds. Loss of riparian habitat poses the greatest risk to the species. In 1996, the NMDGF estimated 60 to 80 breeding pairs in the state.

Neotropic Cormorant (*Phalacrocorax brasilianus*) ■ Threatened

The neotropic cormorant typically inhabits areas in close proximity to large bodies of water, including reservoirs. The neotropic cormorant nests in vegetation, such as dead snags or trees, located adjacent to or over water. Nesting neotropic cormorants require stands of trees or shrubs in or near water and free from human disturbance (NMDGF 2004f). The species' range extends from southern New Mexico and southern Louisiana southward through Central America and portions of the Caribbean into South America. In New Mexico, the species occupies areas in the Rio Grande Valley at Elephant Butte and Caballo Reservoirs. It also commonly occurs at the Bosque del Apache NWR and has been reported occasionally elsewhere in the state.

Southwestern Willow Flycatcher ■

See Species Account in Section 2.6.1, Federal Listed Species.

Bell's Vireo (*Vireo bellii*) ■ Threatened

Bell's vireo is listed as threatened by the New Mexico Department of Game and Fish. Its habitat requirements appear to overlap those of the SWFL, nests are often in dense, periodically flooded stands of willows and other riparian shrubs (NMDGF 2004g). Bell's vireos were detected in young and mid-age classes of riparian habitat along the Rio Grande.

New Mexican Meadow Jumping Mouse (*Zapus hudsonius luteus*) ■ Threatened

The meadow jumping mouse is an NMDGF threatened species and is considered a species of concern. Because of its restricted range and documented loss of natural riparian habitat, it was believed that *Z.h. luteus* was approaching extinction in New Mexico; no extant populations were found along the

Rio Grande Valley between 1930 and 1976. However, the distribution and status of the genus within the Southwest had not been well documented. In addition, little was known about its habitat requirements or sensitivity to habitat loss. In 1994, it was reported that "[t]he meadow jumping mouse is uncommon in wetland impoundments and canal banks of the Bosque del Apache National Wildlife Refuge" (NMDGF 2004h). However, in a 1997 survey, biologists stated that they "found meadow jumping mice in all habitats that were surveyed at Bosque del Apache National Wildlife Refuge" (NMDGF 2004h). It appears that the taxon persists in New Mexico in fair numbers in the areas from which it has been reported, and may be expanding territories as well.

Recently, concerns had developed that isolated populations were being threatened not only by agricultural and industrial development along major rivers but also by recreational development and range management activities in montane areas (NMDGF 2004h).

The meadow jumping mouse requires dense vegetation to persist and typically occupies marshes, moist meadows, and riparian habitats. Preferred habitat is permanent streams, moderate to high soil moisture, and dense and diverse streamside vegetation consisting of grasses, sedges, and forbs (Morrison 1985, 1988). Reports indicate that the key habitat areas for the species include wetlands in the Jemez Mountains, the central Rio Grande valley, Española, Isleta Marsh, and Bosque del Apache NWR (Morrison 1985, 1988). In the Rio Grande Valley, the meadow jumping mouse prefers the edges of permanent ditches and cattail stands (NMDGF 2004h). The species has recently been found occupying man-made habitats such as irrigation drains and canals, and many have questioned if the species is threatened by habitat destruction (Morrison 1990). However, recent observations of this species by Morrison suggest it should be investigated for possible delisting when resources are available (NMDGF 2004h).

Spotted Bat (*Euderma maculatum*) ■ Threatened

Widely distributed across western North America, the spotted bat has been verified in 11 localities in New Mexico, all west of the Rio Grande. The spotted bat uses a wide variety of habitats, including ponderosa pine and spruce-fir forests, piñon-juniper woodlands, and riparian communities. Generally found in forested areas between 3,900 and 10,600 feet in elevation, they migrate through lower elevationsin all seasons outside of summer. The spotted bat uses cliff faces and rock crevices for roosting, and such rocky areas are essential habitat for the species (NMDGF 2004b).

2.6.2.2 State Listed Species Unlikely to be Affected by the Project

The five species below are not known to occur within the affected portions of the Project Area. However, they are discussed below because potentially suitable habitat is found in the Project Area.

Pecos Sunflower (*Helianthus paradoxus Heiser*) ■ Threatened

See species account under Section 2.6.1, Federal Listed Species**.**

Bluntnose Shiner—Rio Grande ssp. (*Notropis simus simus*) ■ Threatened

The bluntnose shiner is generally found in main river channels, particularly below obstructions. It appears to prefer sandy substrates, low-velocity laminar flows, and depths of 17–41 cm. After age 2, the species exhibits a strong affinity for main-channel habitats (Sublette et al. 1990). Though the subspecies *N.s. pecosensis* still survives in the Pecos River, the Rio Grande sub-species *N.s. simu*s is now extinct in New Mexico (Propst 1999). However, it remains and is listed as threatened in El Paso County, Texas, the southernmost county within the Project Area.

Chihuahuan Mud Turtle (*Kinosternon hirtipes murrayi*) ■ Threatened

The Chihuahuan mud turtle is in the *Kinosternon* genus, which has a wide distributional range from southern Canada through much of South America (Kirkpatrick 1997). This species is listed as threatened in El Paso County, Texas, the southernmost county in the Project Area through which the Rio Grande flows. In general, the semi-aquatic Chihuahuan mud turtle prefers slow-moving or still bodies of water. Preferred locations often have soft beds, consisting of either sand or mud, and support a large amount of aquatic vegetation. The species eats invertebrates and breeds from March to July (Kirkpatrick 1997). Texas Parks and Wildlife places this species near Big Bend, Texas, beyond the Project Area.

Jemez Mountains Salamander (*Plethodon neomexicanus*) ■ Threatened

The Jemez Mountains salamander is endemic to north-central New Mexico, found only in the Jemez Mountains. Though rarely observed on the surface, this salamander occurs from 7,200 to 11,256 feet elevation in mixed conifer habitats with abundant surface rocks and rotting logs. Logging, wildfires, mining, road construction, and disease are among the factors responsible for the declining populations of the Jemez Mountains salamander. Based on recent surveys, it appears this salamander is now extinct in some of its historic territories, and the NMDGF recommends that it be upgraded to endangered status within the State (NMDGF 2004b).

2.6.3 *Species of Concern*

Species of concern are not federally listed and therefore have no ESA status. However, the Service considers that further biological research and field study are needed for species of concern to resolve their conservation status. There is also the possibility that they may be considered sensitive, rare, or declining on lists maintained by other federal agencies, state wildlife agencies, Natural Heritage Programs, or professional/academic scientific societies. The Service includes species of concern for planning purposes only.

Numerous rare and specialized species occupy riparian and wetland ecosystems in the Southwest. As these ecosystems have been altered and fragmented through human uses, the species that rely on them have declined. Some species, such as the river otter, have been extirpated from the Rio Grande valley entirely. As a result, several species within the Project Area of the Upper Rio Grande are protected by various federal and state regulations.

The 52 species of concern occurring within counties in the Project Area are shown in **Table L-2.24**; the states encompassing the Rio Grande Basin are Colorado, New Mexico, and Texas. To identify the most environmentally beneficial alternative, the Riparian and Aquatic Habitat Subcommittees considered the potential Project-related impacts to species of concern and their habitats. Some of these species may be sensitive to any future conditions that include permanent or lengthy dewatering of the river channel, increased loss or fragmentation of native riparian vegetation, or drying of riparian habitats in the floodway of the Rio Grande Basin. Species were further evaluated to determine if they are actually found within the immediate Project Area. For reasons detailed below (**Table L-2.24**), an in-depth analysis was not conducted for every species of concern, only for those along the immediate riparian zone that may potentially be affected by Project activities. The biological information for these species follows **Table L-2.24**.

Table L-2.24 Species of Concern and Evaluation Standing

Species: Common/Scientific Name	State of Status			Evaluation Standing			
	CO	NM	TX	1	2	3	4
PLANTS							
Arizona willow (*Salix arizonica*)		X				□	
Bog alkaligrass (*Puccinellia parishii*)		X			□		
Gila thistle (*Cirsium gilense*)		X				□	
Mogollon Mountain ragwort (*Senecio quaerens*)		X			□	□	
Sapello Canyon larkspur (*Delphinium sapellonis*)		X			□		
Texas false saltgrass (*Allolepis texana*)			X		□		
Wright's thistle (*Cirsium wrightii*)		X			□	□	

Species: Common/Scientific Name	State of Status			Evaluation Standing			
	CO	NM	TX	1	2	3	4
INSECTS							
Anthony blister beetle (*Lytta mirifica*)		X				□	
Desert viceroy butterfly (*Limenitis archippus obsoleta*)		X		■			
New Mexico silverspot butterfly (*Speyeria nokomis nitocris*)		X			□		
San Ysidro tiger beetle (*Cicindela willistoni funaroi*)		X			□		
William Lar's tiger beetle (*Cicindela fulgida williamlarsi*)		X			□		
FISH							
Desert sucker (*Catostomus clarki*)		X			□		
Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*)		X			□		
Rio Grande sucker (*Catostomus plebeius*)		X			□		
Roundtail chub (*Gila robusta*)		X			□		
Sonora sucker (*Catostomus insignis*)		X			□		
White Sands pupfish (*Cyprinodon tularosa*)		X			□		
AMPHIBIANS AND REPTILES							
Desert kingsnake (*Lampropeltis getula splendida*)		X					□
Jemez Mountains salamander (*Plethodon neomexicanus*)		X			□		
New Mexico garter snake (*Thamnophis sirtalis dorsalis*)			X	■			
Northern leopard frog (*Rana pipiens*)	X	X	X	■			
BIRDS							
American bittern (*Botaurus lentiginosus*)		X					□
American peregrine falcon (*Falco peregrinus anatum*)		X				□	
Baird's sparrow (*Ammodramus bairdii*)		X				□	
Bell's vireo (*Vireo bellii*)		X		■			
Black tern (*Chlidonias niger surinamensis*)		X					□
Ferruginous hawk (*Buteo regalis*)	X	X				□	
(Greater) sandhill crane (*Grus canadensis tabida*)	X			■			
Gunnison sage grouse (*Centrocercus minimus*)	X					□	
Long-billed curlew (*Numenius americanus*)	X	X					□
Mountain plover (*Charadrius montanus*)		X				□	
Neotropic cormorant (*Phalacrocorax barsilianus*)		X					□
Northern goshawk (*Accipiter gentilis*)		X				□	
Western burrowing owl (*Athene cunicularia hypugaea*)		X				□	
Western snowy plover (*Charadrius alexandrinus*)	X	X					□
MAMMALS							
Allen's big-eared bat (*Idionycteris phyllotis*)		X				□	
Big free-tailed bat (*Nyctinomops macrotis*)		X	X				□
Black-tailed prairie dog (*Cynomys ludovicianus*)			X			□	
Desert pocket gopher (*Geomys bursarius arenarius*)		X				□	
Fringed myotis (*Myotis thysanodes thysanodes*)		X	X			□	
Goat Peak pika (*Ochotona princeps nigrescens*)		X			□	□	
Northern pocket gopher (*Thomomys talpoides*)	X					□	
Organ Mountains Colorado chipmunk (*Tamias quadrivittatus australis*)		X				□	
Pale Townsend's big-eared bat (*Plecotus townsendii pallescens*)		X	X			□	

Species: Common/Scientific Name	State of Status			Evaluation Standing			
	CO	NM	TX	1	2	3	4
Pecos River muskrat (*Ondatra zibethicus ripensis*)		X			□		
Southwestern otter (*Lutra canadensis sonorae*) ►		X			□		
Spotted bat (*Euderma maculatum*)		X					□
Townsend's big-eared bat (*Plecotus townsendii*)		X				□	
Yuma myotis (*Myotis yumanensis yumanensis*)		X	X		□		
Western red bat (*Lasiurus blossevillii*)		X			□		
White Sands woodrat (*Neotoma micropus leeucophaea*)		X				□	

■ Will be further evaluated because species may be affected
□ Removed from further consideration because species (a) may have suitable habitat but no known records of occurrence in affected Project Area, (b) has no suitable habitat in affected Project Area, or (c) is an uncommon migrant with distribution outside Project Area – effects negligible
► Species has been extirpated from state of listing
Source: Service 2005

2.6.3.1 Species of Concern Potentially Affected by the Project

Species of concern listed in **Table L-2.24** may occur anywhere within counties transected by the Rio Grande. The Riparian and Aquatic Teams have determined that five of these species may occur within or use the riparian zone and thus experience possible effects. Because no potential impacts will occur to the remaining 47 species of concern, no further discussion is necessary. This section reviews the status and biological characteristics of the five species potentially affected. Federal actions should meet or improve conditions for the species of concern described below.

The **desert viceroy butterfly** (*Limenitis archippus obsoleta*) is associated with a number of riparian habitats, especially willow or poplar forests occurring along stream corridors. The desert viceroy butterfly is a riparian-obligate species because the larvae of the species rely on willows. The species historically occurred in Arizona, California, Nevada, and New Mexico; complete, current distribution information for the butterfly is lacking. In New Mexico, the species survives in isolated populations in the Gila River, Rio Mimbres, Rio Grande, and Pecos River valleys (Toliver et al. 1994).

The **New Mexico garter snake** (*Thamnophis sirtalis dorsalis*) is common throughout refuge wetlands, farms, and woodlands (NMDGF 2004i). All riparian vegetation types are important to this snake, both montane and lowland. Within the Project Area, it has been recorded at several places, including the Bosque del Apache NWR. It is extremely adaptable to many habitat types and will not be negatively affected by any Project operations changes (Charles Painter, NMDGF, personal communication 2004).

The **northern leopard frog** (*Rana pipiens*) is widespread in North America. In New Mexico, this species is found along the entire length of the Rio Grande and throughout the western half of the state (Degenhardt et al. 1996). It is mainly found in streams and rivers, but also occurs in marshes, ponds, and irrigation ditches. The northern leopard frog is found in a variety of aquatic habitats along the Rio Grande. Direct impacts to any individuals of this species are not likely to result from Project activities.

Bell's vireo (*Vireo bellii*)

See Species account under Section 2.6.2, State-Listed Species.

The g**reater sandhill crane** (*Grus canadensis tabida*) migrates almost statewide and is thus considered uncommon to locally abundant. These birds are found during fall months at Sevilleta NWR and winter mainly in the middle and lower Rio Grande and lower Pecos valleys. They were documented in Rio Grande Valley State Park, Bernallilo County, New Mexico (Stahlecker and Cox 1997), and are well-known winter residents at Bosque del Apache NWR, where farm fields are maintained specifically to support wintering species. They forage in agricultural fields but also commonly forage for frogs, rodents, and insects, generally returning to water for night safety (NMDGF 2004j).

2.6.4 *Proposed/Existing Critical Habitat Designations*

2.6.4.1 Rio Grande Silvery Minnow

Critical habitat for the RGSM was originally designated in July 1999 (FR 1999a) and included the Rio Grande corridor from the New Mexico Highway 22 Bridge (immediately downstream from Cochiti Dam) to the railroad bridge near San Marcial, New Mexico, approximately 160 miles downstream. Constituent elements of critical habitat required to sustain the RGSM include stream morphology that supplies sufficient flowing water to provide food and cover needs for all life stages of the species; water quality to prevent water stagnation (elevated temperatures, decreased oxygen, etc.); and water quantity to prevent formation of isolated pools that restrict fish movement, foster increased predation by birds and aquatic predators, and concentrate disease-causing pathogens (FR 1999a).

In November 2000, the U.S. District Court for the District of New Mexico suspended the critical habitat designation pending preparation of an Environmental Impact Statement by the Service and the formulation of a new rule. On February 19, 2003, the final rule designated critical habitat from the Highway 22 Bridge downstream to the utility line crossing the Rio Grande, a permanent identified landmark in Socorro County, New Mexico, a distance of approximately 170 miles. This designation became effective March 31, 2003 (FR 2003a).

2.6.4.2 Southwestern Willow Flycatcher

The SWFL was listed as endangered under the ESA on February 27, 1995 (FR 1995b). Critical habitat for the SWFL was designated on July 22, 1997 (FR 1997), but at that time the Middle Rio Grande was not included. The 10th Circuit Court of Appeals set this critical habitat designation aside on May 11, 2001. A recovery plan for the SWFL was finalized by the Service (2002), and notice of its availability was published in the Federal Register March 5, 2003 (FR 2003b). On October 12, 2004, the Service once again published notice (FR 2004) that critical habitat was being proposed for SWFL. A draft Environmental Assessment and economic analysis were prepared and public input solicited. It is anticipated that a final decision to designate critical habitat will be made in the fall of 2005. Portions of the Upper and Middle Rio Grande are included in the proposal for critical habitat designation.

The proposed extent of critical habitat within the Project Area begins just south of the Alameda Bridge and extends southward to Elephant Butte Reservoir. The I-40 to Central and SDC subreaches fall within the proposed critical habitat area; the entire NDC subreach lies outside of the designated portion of the Rio Grande floodplain. As described in the 2003 Biological Opinion, declining SWFL numbers have been attributed to loss, modification, and fragmentation of riparian breeding habitat, loss of wintering habitat, and brood parasitism by the brown-headed cowbird. Habitat loss and degradation are caused by a variety of factors, including urban, recreational, and agricultural development; water diversion and groundwater pumping; and channelization, dams, and livestock grazing.

3.0 IMPACTS TO BIOLOGICAL RESOURCES

3.1 *Planning for Ecological Benefits*

A detailed comparison of the biological performance of each alternative was made using 10 biological resource categories. The Riparian and Aquatic Interdisciplinary Teams assigned each resource category an objective and relative weight to assess and rank the biological performance of each alternative. Resource criteria were then established to assess the relative performance of each alternative at meeting ecological objectives. Quantitative or qualitative measures were selected to represent the performance of the objective (**Table L-3.1**).

Data were collected, analyzed, weighted, and incorporated into a computerized decision support matrix that provided a final ranking of the alternatives compared to one another in order to first determine the most beneficial water operations for most biological resources.

The results of the analysis of relative benefits of the alternatives are reported in the Upper Rio Grande Water Operations Environmental Impact Statement. Following the evaluation of decision criteria, the alternatives were evaluated for impacts, both beneficial and adverse, compared to the No Action Alternative. The methods and results of the impacts analysis are reported here, along with a final ranking of the alternatives for biological benefits.

Table L-3.1 Biological Resources and Measures Used to Determine Biological Performance of Alternatives

Biological Resource and Guiding Objective		
Criteria	**Measure**	**Relative Weight (%)**
Riverine Habitats ▪ Supports river channel habitats		21
Modeled habitat for indicator species	Cubic feet	
Duration of overbank flooding	Days/year	
Area of overbank flooding	Acres	
Peak-flow magnitude and duration	cfs, days	
River Sport Fish ▪ Supports river sport fish populations		8
Modeled habitat for indicator species	Cubic feet	
Duration of overbank flooding	Days/year	
Area of overbank flooding	Acres	
Peak-flow magnitude and duration	cfs, days	
Reservoir Sport Fish ▪ Supports reservoir sport fish populations		2
Net reservoir elevation rate of change (feet/week)	Feet/week	
Area of littoral habitat	Acre-days	
Reservoir elevation rate of change	AF/year	
Riparian Habitats ▪ Provides vegetation structural and compositional diversity		14
Supports regeneration of native vegetation	Acre-days of spring overbank flooding	
Criteria	**Measure**	**Relative Weight (%)**
Supports H&O Vegetation Classification Types I and II	Average annual acre-days	

Biological Resource and Guiding Objective		
Criteria	**Measure**	**Relative Weight (%)**
Supports H&O Vegetation Classification Types III and V	Average annual acre-days	
Supports Service Vegetation Community Type 2	Average annual acre-days	
Supports Service Vegetation Community Type 3	Average annual acre-days	
Amount of overbank flooding	Mean annual max acres overbank flooding	
Frequency and timing of overbank flooding	Percent years of spring overbank flooding	
Wetlands ▪ Maintains or improves wetlands function at existing sites		9
Maintains minimum groundwater table levels	# Days <25th percentile Q of baserun	
Maintains seasonal high-water levels	# Days >75th percentile Q of baserun	
Natural management areas ▪ Support biological goals of designated natural management areas		4
Provides overbank flooding at specific locations	Mean annual acre-days flooded at specific locations	
Instream and overbank hydrologic variability ▪ Provides flow variability		16
Peak-flow variability	Peak-flow coefficient of variation	
Adaptive flexibility ▪ Conservation storage and other flexibilities		3
Ability to offset drought on low-flow days	Potential days >100 cfs supplemental water	
Aquatic and riparian fauna ▪ Supports fish and wildlife diversity		16
Supports H&O Type I	Total acre-days inundation	
Supports H&O Type II	Total acre-days inundation	
Supports H&O Type III	Total acre-days inundation	
Supports H&O Type IV	Total acre-days inundation	
Supports H&O Type V	Total acre-days inundation	
Supports H&O Type VI	Total acre-days inundation	
Threatened & Endangered Species ▪ Maintains or improves T&E [species] habitat		7
Increases riparian inundation	Mean annual acre-days of inundation	
Supports existing SWFL habitat	Maximum days OBF in existing territories	
Supports existing bald eagle habitat	Reservoir elevation and fisheries habitat	
Supports NM meadow jumping mouse habitat	Average annual acre-days of wet meadow inundation	
Supports yellow-billed cuckoo habitat	Average annual acre-days H &O Types III and V inundation	

3.2 Aquatic Resources

3.2.1 Riverine Habitat Criteria Evaluation Methods

As described in the Aquatic Habitat and Hydraulic Modeling Study for the Upper Rio Grande Water Operations Model (Bohannon-Huston et al. 2004), habitat suitability for fish species was determined by reanalyzing information and data collected in studies conducted on the Rio Grande (Dudley and Platania 1997), and on the Platte River in Nebraska and the South Platte River in Colorado.

The eight sites identified for study of impacts to riverine resources (shown in Section 2, Figure L-2.1) were sampled and calibrated with the URGWOM model. The critical flows for each sampling site included the 50% (medium flow) and 90% (low flow) occurrence of mean daily discharge, as indicated at the nearest gage to the site, at which geo-referenced x, y, and z data and velocity data within the river channel were collected. Field sampling was dependent on rainfall and runoff conditions. Staff gages were established (at a minimum) at the upper and lower extent of all study sites to enable collecting stage-level data for the 10% (high flow) occurrence level of mean daily discharge. These data would interface with high and medium flow data to develop the two-dimensional habitat model.

Due to drought conditions present in the study area during the sampling period (February 1 and 2, 2002), high-flow calibration data could not be collected. Because the emphasis in the habitat modeling is primarily on the lower flows, the absence of high-flow calibration data is not considered to be a significant limitation in the model results (see Appendix H, Section 1, page H-2).

A GIS model was developed for habitat quantification (MEC 2003a). The model uses the analytical tools in ArcView 3.2a or 8.1 to combine the habitat-use information with the habitat data that is generated from the two-dimensional hydraulic model. ArcView scripts developed in the modeling effort area are also compatible with ArcView 3.2a or 8.1 (based on Visual Basic, rather than Avenue). The modeling effort developed the interface for the model, and the inputs for the users, and the linkages to the hydraulic model for the Rio Grande. The output, or results of the model runs, as well as other geospatial data developed in the course of the model, were delivered in the form of ArcView shape files and are also compatible with Versions 3.2a or 8.1.

An aquatic habitat model was produced for the Middle Rio Grande and lower Rio Chama (Bohannan-Huston et al. 2004). The analysis used two-dimensional data (georeferenced depth and velocity data collected at six sites on the Rio Grande and two sites on the Rio Chama) to simulate hydraulic conditions for a range of flow conditions and used GIS to characterize and quantify the habitat at each flow (as shown in Section 2, Figure L-2.1). At each hydraulic simulation, habitat was quantified based on the habitat-use criteria and the amount of available habitat to determine a function of habitat availability with change in discharge. This study detailed the hydraulic and habitat model methods, results, and conclusions. The results of this study are explained in the Aquatic Habitat and Hydraulic Modeling Study for the Upper Rio Grande Water Operations Model (Bohannan-Huston et al. 2004).

The Project Area was evaluated for potential effects from changing water operations at the facilities under consideration in the Project. Because no changes are proposed by the Project for the Northern and Southern Sections of the Upper Rio Grande, only the riverine and reservoir resources of the Rio Chama, Central, and San Acacia Sections were modeled and studied.

Fish Habitat Area: This is the total suitable habitat area (in square feet) for each of the species for the 40-year hydrology data set. The area was determined by combining the hydraulic simulations for each flow with the habitat suitability function for each species and life stage. The San Acacia Section is subject to variable fish habitat area because of potential diversions from the Low Flow Conveyance Channel. The Ground Water Model (ISC 2005) was corrected to correlate with the Aquatic Habitat Model used to evaluate all other river reaches. In the San Acacia Section, three scenarios were modeled to represent the range of possible maximum diversions to the LFCC. The No Action Alternative was modeled for a cap of

500 cfs, 1,000 cfs, and 2,000 cfs in order to capture this range and provide diversion operations similar to the different action alternatives for comparative purposes. In all cases, the modeled diversions to the LFCC provide for a bypass of 250 cfs to the river channel at all times that such flows are available, with diversions to the LFCC taking place only when flows exceed 250 cfs discharge.

Duration of Overbank Flooding: This parameter is the average number of days within a year that water levels exceed normal flows and represents the number of days of floodplain inundation. Floodplain inundation provides important nursery habitat for many larval fish species.

Area of Overbank Flooding: This parameter quantifies the average annual square meters of inundated floodplain habitat. Floodplain inundation provides important nursery habitat for many larval fish species.

Average Number of Days of 0 cfs: This parameter represents the average annual number of days when particular sections of the river are dry.

Average Number of Days of <100 cfs: This parameter represents the average annual number of days where river flows are less than 100 cfs.

Average Peak-Flow Magnitude: Peak-flow magnitude is a measure of flood pulse strength. This is an important cue for many fish species to initiate spawning.

Average Peak-Flow Duration: Peak-flow duration is a measure of the number of days within a year when flood pulses are maximized. This is also an important cue for many fish species to initiate and maintain spawning activities.

Low-Flow Augmentation: Conservation capability for augmenting low flow days of < 100 cfs in the Central and San Acacia Sections was computed by using one-half the median storage available at Abiquiu Reservoir (assuming this amount is potentially available for threatened and endangered species needs). Augmentation flow is defined as an additional 150 cfs release to the particular low flow event.

Variable Diversion of Water to the LFCC: The action alternatives and the No Action Alternative test the potential effects of the full range of diversion to the LFCC; however, it cannot model for all possible operations independently of one another. With the exception of no diversion, each of the tested operations rules is actually a range of possible operations: 0–500 cfs, 0–1,000 cfs, and 0–2,000 cfs. Operation of the LFCC is independent of other operations, making it necessary to evaluate the potential impacts of the full range of diversions considered in this Project.

For the No Action Alternative and all action alternatives, the actual diversion was modeled to begin only after the flow at the San Acacia gage reached a minimum of 250 cfs. Diversion would proceed to intercept any available flow above 250 cfs until diversion reached the maximum allowable flow specified for the alternative. At that point, diversions were held steady or decreased down to zero as flow in the channel varied; thus, flows remain steady at 250 cfs at the San Acacia gage during any modeled diversion to the LFCC. Diversions to the LFCC would vary as flows permit until the specified maximum diversion is reached, with any additional available water in the system being left in the main channel after the cap is reached. For example, Alternative I-2 with a cap of 1,000 cfs would be modeled and operated so that when a discharge of 1,800 cfs occurs above the diversion, 1,000 cfs would be diverted and 800 cfs would remain in the channel. But when the discharge at the diversion is less than 1,000 cfs, 250 cfs would remain in the channel and the remainder would be diverted to the LFCC.

To fully test the entire range of possible operations of the LFCC, the No Action Alternative was modeled with zero diversion and all available flow was routed through the main channel of the river. The No Action Alternative with zero diversions models most closely the current river operations. However, there are no fully comparable model runs to accurately compare every possible LFCC diversion for zero diversions in every ction alternative.

RGSM Threshold Velocity: A "threshold" velocity was determined that would minimize the downstream displacement of passively drifting RGSM eggs and larvae. This value was based on the developmental rate (dependent on water temperature) of RGSM and the reach length of interest. The threshold velocity determination (m/s) was expressed as length of fragmented river reach (m) divided by time(s) to development of swim bladder.

3.2.1.1 Impact Analysis on Riverine Resources

Margins of error occur from the use of multiple data sets and models to generate riverine analyses for the Rio Chama and Central Sections, where the historical river gage data integral to the URGWOM and aquatic habitat models are well-calibrated and margins of error are small. Margins of error in the San Acacia Section, where the river bed is composed of shifting sand, may be greater than 10 percent due to inaccuracies introduced into the models from poor-quality historic river gage data. However, the comparative analyses are all subject to the same margin of error in each river section, providing confidence in the final ranking of the alternatives relative to one another on a section-by-section basis.

Impacts of the Alternatives on Fish Habitat Availability

The six categories of indicator fish species were chosen for the model based on distinct differences in preferred habitat. Other characters that may or may not have played a part in their choice include whether or not they are native to the drainage, whether or not they are game fish, and the portion of the river continuum that would be their normal home (from headwaters to lowland meanders). Brief descriptions for each are as follows:

Rio Grande Silvery Minnow – a native, non-game species ranging in the middle and lower areas of the river and inhabiting shallow stream margins, side channels, and lower-velocity areas of the main channel where sandy-bottomed areas with detritus and algae for food occur.

Longnose Dace – a native, non-game species ranging in the upper and middle areas of the river and inhabiting gravel and cobble runs with moderate to swift flow.

Flathead Chub/River Carpsucker – native, non-game species ranging throughout the river in areas of slower runs over sandy substrate.

Channel Catfish – a non-native (to the Rio Grande) game species ranging in the middle to lower river and occupying cool to warm water pools with sandy bottoms.

Brown Trout – a non-native game species ranging in upper reaches and occupying cold water areas in the deeper, slower pools.

All alternatives were compared to the No Action Alternative for relative impacts to fish habitat availability as modeled with the Aquatic Habitat Model. Results of the study are presented by river section for the habitat categories specific to each species studied, as measured in total square feet of habitat change, by species and alternative.

Rio Chama Section

Habitat availability in the Rio Chama Section varies only slightly among the species analyzed when viewed as percent change from the No Action Alternative. On average for all species, less than 5% difference exists between alternatives (**Table L-3.2**). The No Action Alternative performs slightly better than all action alternatives in the Rio Chama Section for RGSM habitat, but is intermediate in relative habitat available for other species. Alternative D-3 slightly outperforms the No Action Alternative in available habitat for long-nosed dace, flat head chub/carpsucker, and channel catfish, by 1.9%, 0.7%, and 1.0% respectively. Alternative I-1 outperforms the No Action Alternative and all other action alternatives for available habitat for RGSM. It also shows the highest available habitat for brown trout. The direct comparison of the alternatives requires additional manipulation to determine if these modeled changes are statistically and biologically significant.

Table L-3.2 Rio Chama Section Habitat Availability by Species and Alternative

Alternative and Percent Change	Rio Chama Section				
	RG Silvery Minnow Habitat (feet^2)	Longnose Dace Habitat (feet^2)	FH Chub/ Carpsucker Habitat (feet^2)	Channel Catfish Habitat (feet^2)	Brown Trout Habitat (feet^2)
No Action	55,026	107,530	63,158	225,331	296,685
B-3	51,020	106,293	62,080	222,602	293,476
% Change	-7.3%	-1.2%	-1.7%	-1.2%	-1.0%
D-3	53,204	109,568	63,612	227,672	294,997
% Change	-3.3%	1.9%	0.7%	1.0%	-1.0%
E-3	52,790	108,788	63,168	226,474	294,164
% Change	-4.1%	1.2%	0.0%	0.5%	-1.0%
I-1	53,522	108,144	63,261	225,807	298,709
% Change	-2.7%	0.6%	0.2%	0.2%	1.0%
I-2	52,725	108,773	62,787	226,104	297,000
% Change	-4.2%	1.2%	-0.6%	0.3%	0.0%
I-3	52,908	108,870	63,331	226,645	293,905
% Change	-3.8%	1.2%	0.3%	0.6%	-1.0%

In order to understand specific trends in vegetation change in available aquatic habitat and other important measures of ecosystem impacts, the relative performance of the action alternatives wcompared to that of the No Action Alternative using a chi-square test of significance. (Chi-square has been one of the most frequently used statistical techniques in biological studies when addressing comparing vegetative communities for similarity.) The No Action observed data are used as the expected values to generate a goodness-of-fit test. The results of a significant chi-square indicate differences between categorical data at a given confidence level, by convention 95%.

A basic chi-square does not identify the specific cells in a contingency table that are causing the significant result; thus, the adjusted chi-square residuals were examined to determine the significance of individual cells and their direction of change for understanding which specific variables are responsible for causing a chi-square to return a significant result. For each cell in a chi-square table, the adjusted chi-square residual provides a value ranging from $-\infty$ to $+\infty$. Values above +2 or below -2 indicate significant deviations from the expected value and can be read roughly as standard deviation units and are used to tease out the significant variables.

In order to evaluate changes in available aquatic habitat, the square feet of available aquatic habitat was generalized to square meter units to account for the margin of error from stream gage measurements and other modeling errors. Using the square meter units, the chi-square test returned a chi-square of 90.0, indicating that the observed differences between the action alternatives compared to the No Action were significant overall. The contribution of each type of aquatic habitat available with each alternative is illustrated by the analysis of the chi-square residuals, shown in **Figure L-3.1**.

The results of the chi-square test and analysis of the adjusted residuals indicate that every alternative would result in significantly less aquatic habitat suitable for the RGSM in the Rio Chama Section and is considered an adverse impact. Alternative B-3 would result in the largest reduction in RGSM habitat relative to No Action compared to the other alternatives for this river section, but all alternatives would result in statistically significant decreases in habitat for this endangered species. The biological importance of this impact is equally significant, although not an irreversible condition. RGSM are currently extirpated from this river section, and the area does not contain designated critical habitat for the species, as will be discussed further in Section 3.6.1.1. Three alternatives would also significantly reduce habitat for brown trout: Alternatives B-3, E-3, and I-3. The adverse impacts to RGSM and brown trout appear to be related to the high-storage and low-channel capacity proposed with these three alternatives. Other significant impacts would be experienced by channel catfish in Alternative B-3.

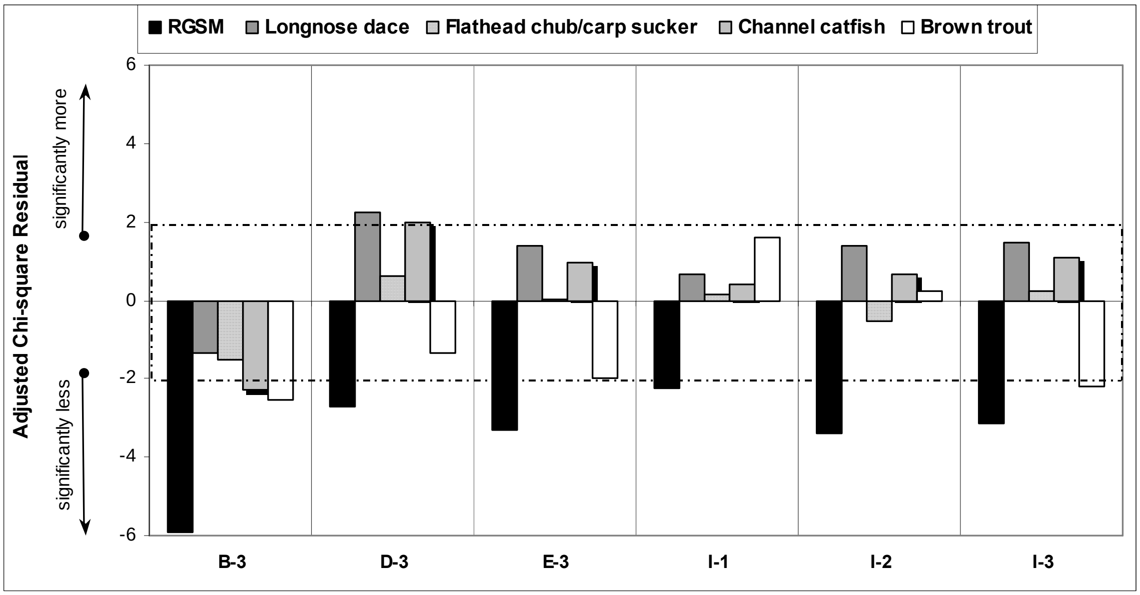


Figure L-3.1 Adjusted Chi-Square Residual Statistics for Available Aquatic Habitat in the Rio Chama Section Compared to the No Action Alternative (χ^2=90.0, p=0.05).

Central Section

Habitat availability in the Central Section varies about 2 percent or less among all species analyzed, as shown in **Table L-3.3**. Brown trout are not present in this river section. The percent change from no action may be small, but the resulting chi-square test indicates that the differences are significant for every action alternative and for every species considered, except for one minor exception. **Figure L-3.2** graphically represents the results of the chi-square test and adjusted residual analysis. As for the Rio Chama Section, the test is for a goodness of fit for each individual action alternative compared with the No Action Alternative.

Loss of available habitat for RGSM in the Central Section is particularly large compared to total available habitat under the No Action Alternative. The biological significance of the loss of critical habitat is a significant adverse impact of all alternatives that will be discussed further in Section 3.6, Threatened and Endangered Species.

In addition, all action alternatives would have significant negative effects on habitat for longnose dace, flathead chub, river carpsucker, and channel catfish. While the statistical significance of these results is certain, the biological importance of a change in available habitat ranging from approximately 1,000 square feet to 25,000 square feet is less certain. There is reason to believe that habitat availability is not the limiting factor for aquatic species in this section.

San Acacia Section

Habitat availability in this reach is more pronounced between No Action Alternative and the action alternatives. Diversions to the LFCC have a significant effect on available aquatic habitat for other species studied, since the area regularly experiences low flows and diversions reduce flows in the river channel whenever these flows are greater than 250 cfs.

The San Acacia Section does not contain suitable brown trout habitat, but all other species occur. Available habitat for all other species would be significantly reduced as a percent change from the No Action Alternative with no diversions to the LFCC, regardless of action alternative. Loss of available habitat from No Action varies between about 9 and 50 percent (Figure L-3.3). Some of the differences between alternatives in the section would be biologically significant. The No Action Alternative reduces available habitat for the species analyzed when operations include diversions to the LFCC (**Figure L-3.3**). The chi-square goodness-of-fit test for all alternatives against the No Action Alternative with zero diversions to the LFCC, including No Action Alternatives with comparable diversion levels to action alternatives, is illustrated in **Figure L-3.4**.

In addition, **Figure L-3.4** shows the comparison of the adjusted chi-square residuals for all possible alternatives in the San Acacia Section compared to one another. The chi-square statistic shows extremely high levels of significant difference among the alternatives. The adjusted residuals show that the No Action with zero diversions to the LFCC and both the No Action with 500 cfs diversions and Alternative I-1 with 500 cfs diversions yield much less than expected available habitat for RGSM and higher than expected habitat for longnose dace, compared with all other alternatives.

Table L-3.3 Central Section Habitat Availability by Species and Alternative

Alternative	RG Silvery Minnow Habitat (feet^2)	Longnose Dace (feet^2)	FH Chub/ Carpsucker (feet^2)	Channel Catfish (feet^2)
	1,224,029	544,523	786,861	1,792,051
B-3	1,200,176	532,409	781,522	1,778,215
% Change	-1.9%	-2.2%	-0.7%	-0.8%
D-3	1,206,690	534,747	781,238	1,780,089
% Change	-1.4%	-1.8%	-0.7%	-0.7%
E-3	1,204,042	533,924	781,130	1,778,830
% Change	-1.6%	-1.9%	-0.7%	-0.7%
I-1	1,217,438	543,593	782,243	1,786,409
% Change	-0.5%	-0.2%	-0.6%	-0.3%
I-2	1,204,580	536,795	778,619	1,777,911
% Change	-1.6%	-1.4%	-1.0%	-0.8%
I-3	1,203,105	533,143	780,127	1,776,604
% Change	-1.7%	-2.1%	-0.9%	-0.9%

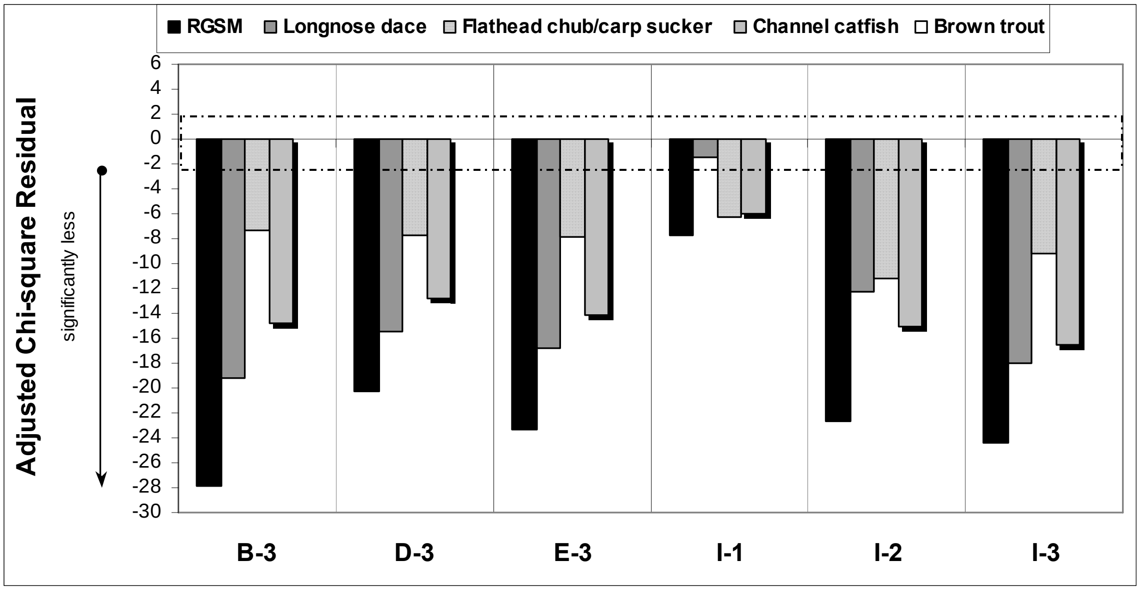


Figure L-3.2 Adjusted Chi-Square Residual Statistics for Available Aquatic Habitat in the Central Section Compared to the No Action Alternative (χ^2 = 3575.4, p=0.00).

Table L-3.4 San Acacia Section Aquatic Habitat Model with LFCC Diversions (Bosque del Apache and San Marcial Sites)

Fish Species	No Action Ground-water Corrected	No Action with LFCC Diversion of 500 cfs	Alternative I-1 with LFCC Diversion of 500 cfs	No Action with LFCC Diversion of 1,000 cfs	Alternative I-2 with LFCC Diversion of 1,000 cfs	No Action with LFCC Diversion of 2,000 cfs	Alternative B-3 with LFCC Diversion of 2,000 cfs	Alternative D-3 with LFCC Diversion of 2,000 cfs	Alternative E-3 with LFCC Diversion of 2,000 cfs	Alternative I-3 with LFCC Diversion of 2,000 cfs
[1]RGSM	511,468	460,499	458,599	422,677	425,146	434,974	406,647	405,634	406,879	405,731
% Change from comparable No Action			Ø%		+1%		-6%	-7%	-6%	-7%
[1]Longnose Dace	181,248	137,925	138,573	100,853	105,996	111,025	87,349	87,526	87,830	87,629
% change from comparable No Action			Ø%		+5%		-27%	-22%	-21%	-21%
[1]Channel Catfish	696,893	588,659	589,532	509,054	519,217	534,781	480,801	479,559	481,261	479,864
% change from comparable No Action			Ø%		+2%		-10%	-10%	-10%	-10%
[1]Flathead Chub and [2]River Carpsucker	296,372	253,103	252,771	221,554	224,589	232,052	208,223	208,176	208,789	208,257
% change from comparable No Action			Ø%		+1%		-10%	-10%	-10%	-10%

[1]Adult and juvenile; [2]Juvenile only

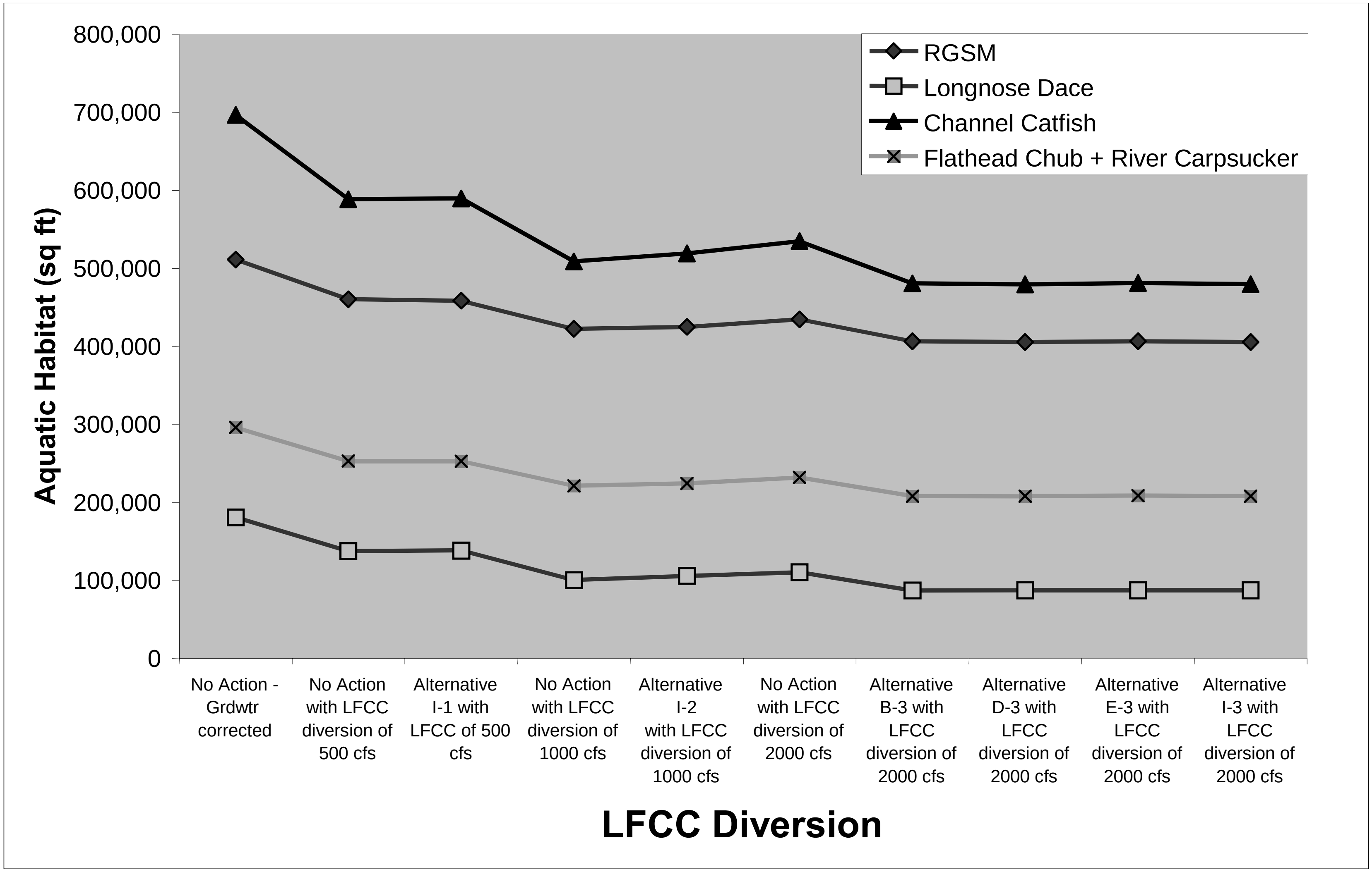


Figure L-3.3 Comparison of Aquatic Habitat Available for Indicator Species in the San Acacia Section, By Alternative.

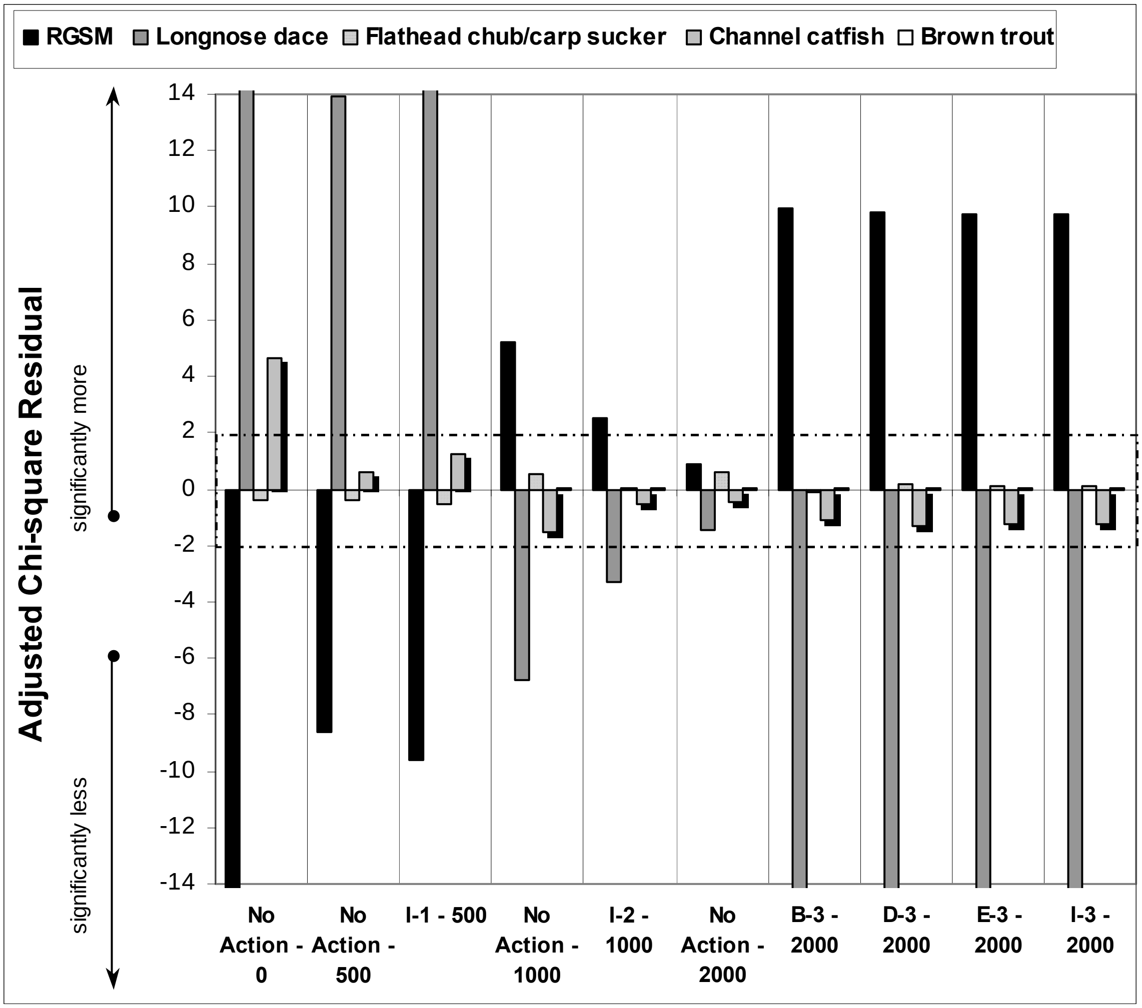


Figure L-3.4 Comparison of Adjusted Chi-Square Residuals for All Alternatives for Available Aquatic Habitat in the San Acacia Section (χ^2= 2659.4; p=0.000).

The No Action Alternative with zero diversions to the LFCC most closely models the current operations of the river in all river sections, including the San Acacia Section. The reduction in absolute available habitat for all species studied across all alternatives compared to the No Action with zero diversions at the LFCC is clear from the exceptionally large chi-square value of 2,659.4. However, the data also demonstrate that there are expected differences among alternatives with the same level of diversion to the LFCC. Impacts to aquatic habitat in the San Acacia Section from any alternative would consists of both upstream operations and the in-stream effects of LFCC diversion. In order to tease these effects apart and determine the significance of upstream impacts compared to impacts from operating the LFCC, the data were subjected to additional statistical tests, shown in **Table L-3.** and **Figure L-3.4, Figure L-3.5,** and **Figure L-3.6**.

Statistical comparisons were made with data converted to square meters to account for cumulative errors in stream gages and modeling. This also has the effect of returning more conservative chi-square test results. Summary statistics were evaluated to determine if the data were characterized by normal distributions for each habitat type. All modeled options for the No Action Alternative show normal distributions for fish habitat types studied.

A chi-square test was run on the aquatic habitat data for the No Action options to determine the level of impact of diversion to the LFCC separate from any proposed new upstream operations changes proposed in the different action alternatives. The comparison of available aquatic habitat in the San Acacia Section under the No Action Alternative options returns a chi-square of 951.1 with $p<0.001$, demonstrating significant differences among the diversion options. The adjusted chi-square residuals (Figure L-3.5) show that zero diversion to the LFCC returns significantly less than the expected value for RGSM habitat and significantly more longnose dace habitat than expected.

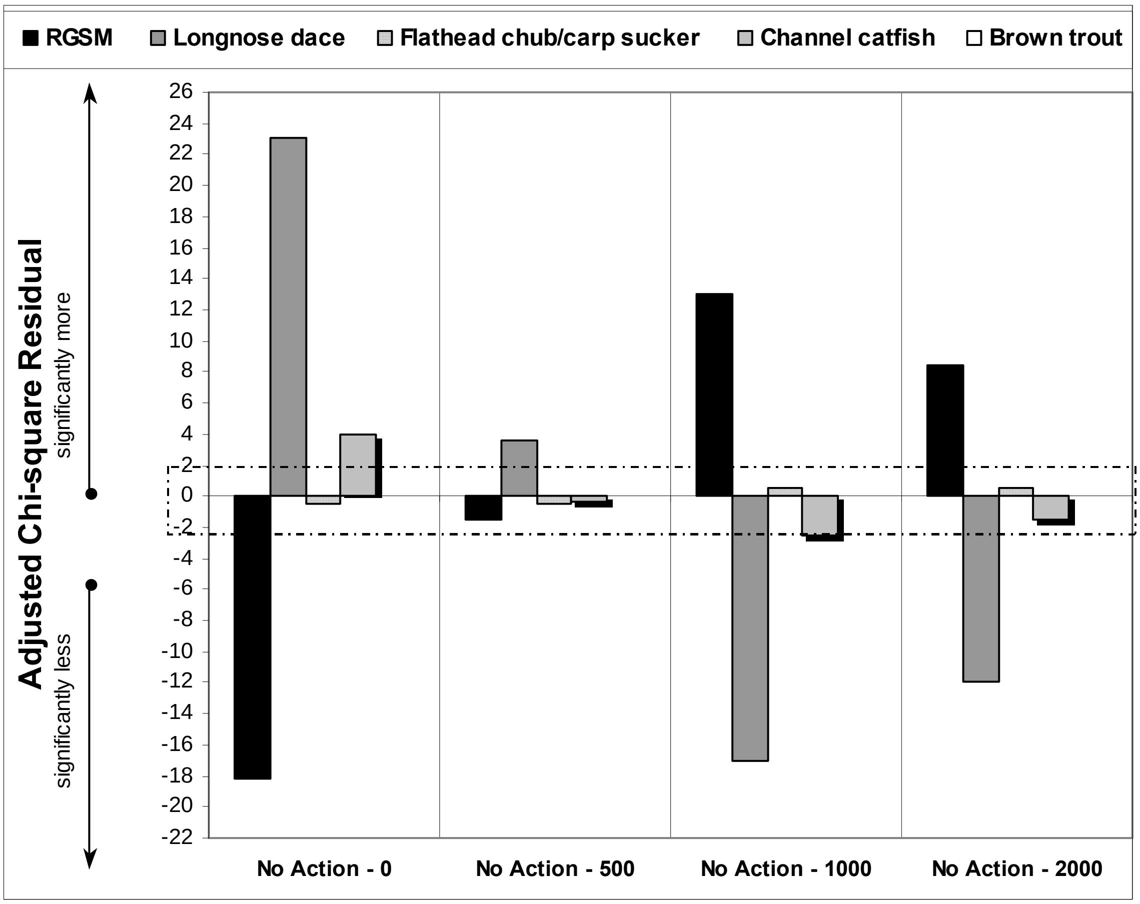


Figure L-3.5 Comparison of Available Aquatic Habitat in the San Acacia Section Under No Action Alternative With Variable Diversions to the LFCC (χ^2= 951.1, p= 0.000).

When diversions are increased to 500 cfs, the comparison still shows significantly more available longnose dace habitat than expected, but RGSM habitat is within the expected range. Increasing diversions to 1,000 cfs under the No Action Alternative returns the largest positive chi-square residual for RGSM habitat, showing that there is significantly more available RGSM habitat than would be expected. With 1,000 cfs diversions, there would be significantly less than the expected longnose dace and channel catfish habitat. No Action with 2,000 cfs diversions follows this trend, with significantly more RGSM habitat than expected and significantly less longnose dace habitat, but not to the same levels as No Action with 1,000 cfs diversions.

These results suggest that the amount of diversion from the river channel does not have a linear relationship with habitat availability for any of the species studied, but especially for RGSM habitat and longnose dace habitat. These two habitat types are affected in opposite ways when under low-flow conditions, such as when flow is decreased by diverting water to the LFCC. RGSM habitat is lower in proportion to other habitat types at high flow and longnose dace habitat is more abundant. The lower flows available in the river channel when 1,000 and 2,000 cfs diversions occur would certainly result in lower area of habitat for RGSM but would possibly create conditions that provide proportionally more RGSM habitat compared to both longnose dace and channel catfish habitat. The biological significance of the change in relative proportion of habitat area is uncertain, but may provide competitive advantages to the species with higher relative availability.

To further evaluate the interaction between complex upstream operations proposed in the action alternatives from the different diversions to the LFCC in the San Acacia Section, comparative tests were performed on each action alternative paired with the modeled No Action Alternative with equal diversions to the LFCC. The chi-square goodness-of-fit test was used to examine the available habitat data from Alternatives B-3, D-3, E-3, and I-3, which all have 2,000 cfs diversions to the LFCC, compared with equal diversions in the No Action with 2,000 cfs diversions. The results are shown in **Figure L-3.6**.

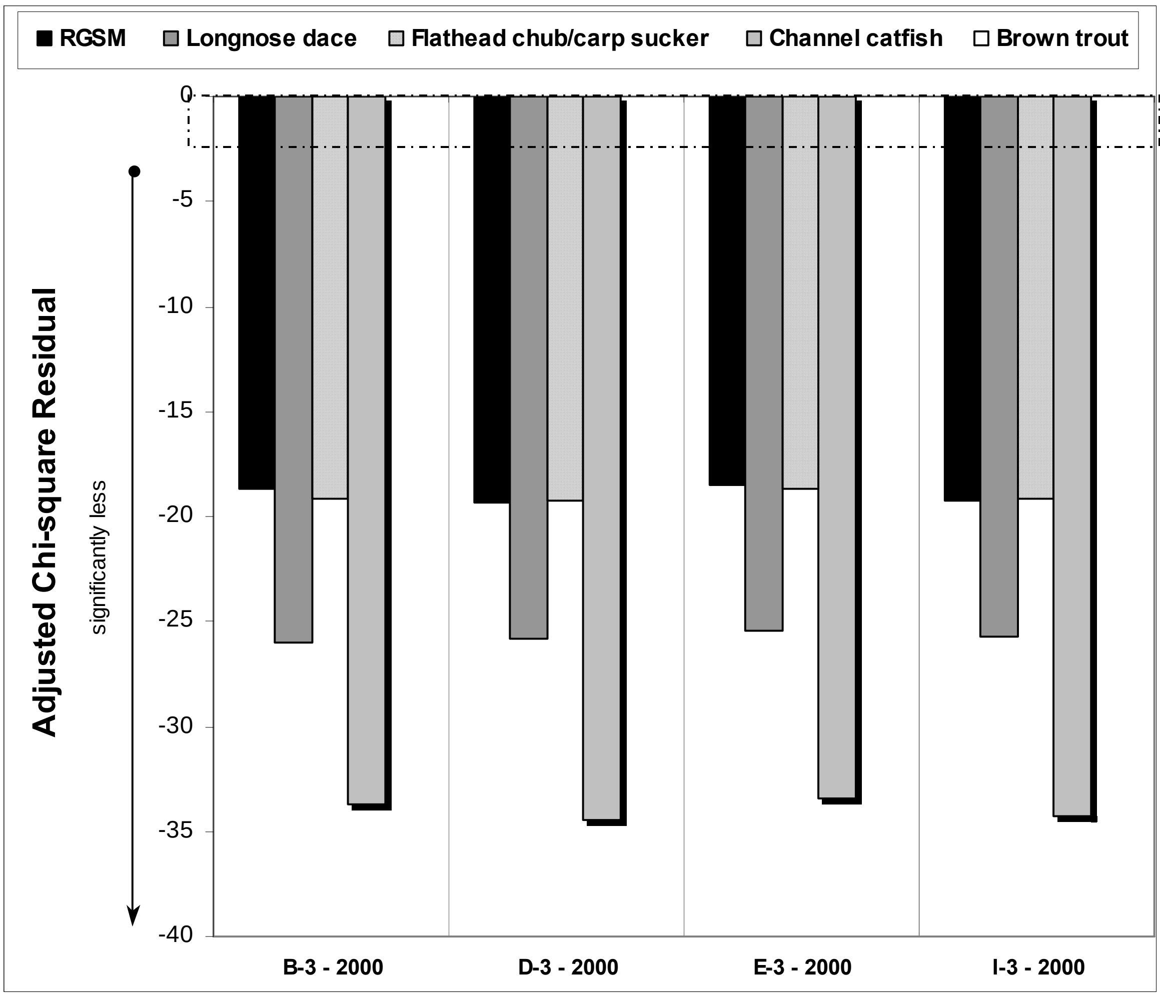


Figure L-3.6 Comparison Of Available Aquatic Habitat in the San Acacia Section Chi-Square Goodness-of-Fit Adjusted Residuals Compared to No Action With 2,000 Cfs Diversions to LFCC (X^2 = 5,502.4, P=0.000).

The No Action modeled with 500 cfs diversions at the LFCC and Alternative I-1, which caps diversions to the LFCC at 500 cfs, were compared. The comparison shows that Alternative I-1 provides similar levels of aquatic habitat for all species studied compared with No Action with equal diversions to the LFCC. The results of a chi-square goodness-of-fit test from Alternative I-1 indicate no significant difference from No Action ($\chi^2 = 1.2$, p = 0.883). Although modeled data are not available for available habitat when this or other Action Alternatives are operated with no diversions to the LFCC, it is probable that Alternative I-1 would not result in increased available habitat for these species if no diversions were made, based on the performance at 500 cfs diversions.

Alternative I-2, which caps diversions to the LFCC at 1,000 cfs but has different upstream storage and channel capacity compared with No Action and I-1, performs the best relative to the No Action Alternative when modeled with equal diversions. This alternative would provide a 1% increase in available habitat for RGSM, a 5% increase for longnose dace, a 2% increase for flathead chub and river carpsucker, and a 1% increase in habitat for channel catfish compared with similar diversions under the No Action Alternative. These increases in habitat are significant ($\chi^2 = 48.3$, $p<0.001$).

Although modeled data are not available for available habitat when this or other action alternatives are operated with no diversions to the LFCC, it is probable that Alternative I-2 would increase available habitat for these species if no diversions were made, based on the performance with diversions capped at 1,000 cfs.

Alternatives B-3, D-3, E-3, and I-3 would all significantly reduce available habitat for the species analyzed compared with the No Action Alternative with equal diversions to the LFCC, as shown in Figure L-3.6. The chi-square result shows significant changes for all action alternatives with 2,000 cfs diversions compared to no action with equal diversions.

The longnose dace incurred the highest reduction of habitat in Alternative D-3, approximately 27%, the second highest overall reduction in habitat for this species among all alternatives and river sections in this study. Available habitat for other species studied decreased by 10% compared with No Action with equal diversions to LFCC, and all losses are shown to be statistically significant. The reduction in RGSM habitat is statistically significant among these action alternatives, yielding 6 to 7% reductions compared with No Action with similar (2000 cfs) diversions. Loss of habitat may result in potentially adverse impacts to all species, although it is uncertain if habitat availability is limiting for any of the species studied. In addition, reduced habitat availability might be offset by the improved relative proportion of RGSM habitat compared to other species, shown in the analysis of the No Action Alternative with variable diversions (**Figure L-3.5**).

Impacts of Low Flow and Low-Flow Augmentation

Discharges of less than 100 cfs and zero discharge are currently experienced in the study area and are detrimental to aquatic species. Drought, diversions, and seepage contribute to low-flow conditions. Evaluation of discharges at the multiple gages during the 40-year time sequence shows that the No Action Alterrnative and the action alternatives result in different amounts of low-flow days and in different amounts of stored upstream water available for augmenting low flows and reducing adverse impacts.

The No Action Alternative would not provide low-flow augmentation during the spring and summer months due to storage and release conditions and limitations at Abiquiu and Cochiti Reservoirs. Under the No Action Alternative, storage of the current year’s spring runoff that has not been released from Abiquiu Dam by July 1 is locked as carry-over storage at Abiquiu Reservoir until October 31. This carry-over storage must be released between October 31 and March 31, when river flows are generally reliable and are least beneficial biologically. Because the No Action Alternative has no ability to augment low flow, all action alternatives offer an improvement over No Action.

Rio Chama Section

Low flow is not an issue for the Rio Chama Section, since flows are reliable in this area and carry-over storage is released as inflow to Cochiti Reservoir and stored for release to the Central Section and San Acacia Section.

Central Section

The number of days predicted for zero flow or flows less than 100 cfs in the Central Section does not vary to any extent among the alternatives. Days with zero flow in the Central Section vary from 15 in the No Action Alternative and Alternative I-1 to 16 days with all other alternatives, as shown in Figure L-3.7. Low-flow days at less than 100 cfs are 32 or 33 across all alternatives, including No Action. The ability to augment low-flow and zero-flow days, however, varies widely among the alternatives according to the storage and the channel capacity options available. The No Action Alternative performs the worst, since low-flow augmentation is not possible, and a total of 99 days with flows less than 100 cfs would be possible. Alternatives B-3, D-3, E-3, I-2, and I-3 all provide adequate opportunity, in the form of stored water in Abiquiu Reservoir, to offset all low-flow days. Only Alternative I-1 is unable to deliver sufficient low-flow augmentation, resulting in a 32-day shortfall in the Central Section.

Low-flow days are very high in the San Acacia Section, ranging from 99 days under the No Action Alternative to 110 days for some action alternatives. As modeled, only Alternative B-3 provides sufficient low-flow augmentation to completely offset the number of predicted days at 0 or less than 100 cfs in both the Central and San Acacia Sections. This alternative would provide benefits to riverine habitat and fish communities from continuous flows during the drought years modeled. All other alternatives would not have enough augmentation days to cover the predicted number of low-flow days for the San Acacia Section and would produce less mitigation to fish communities.

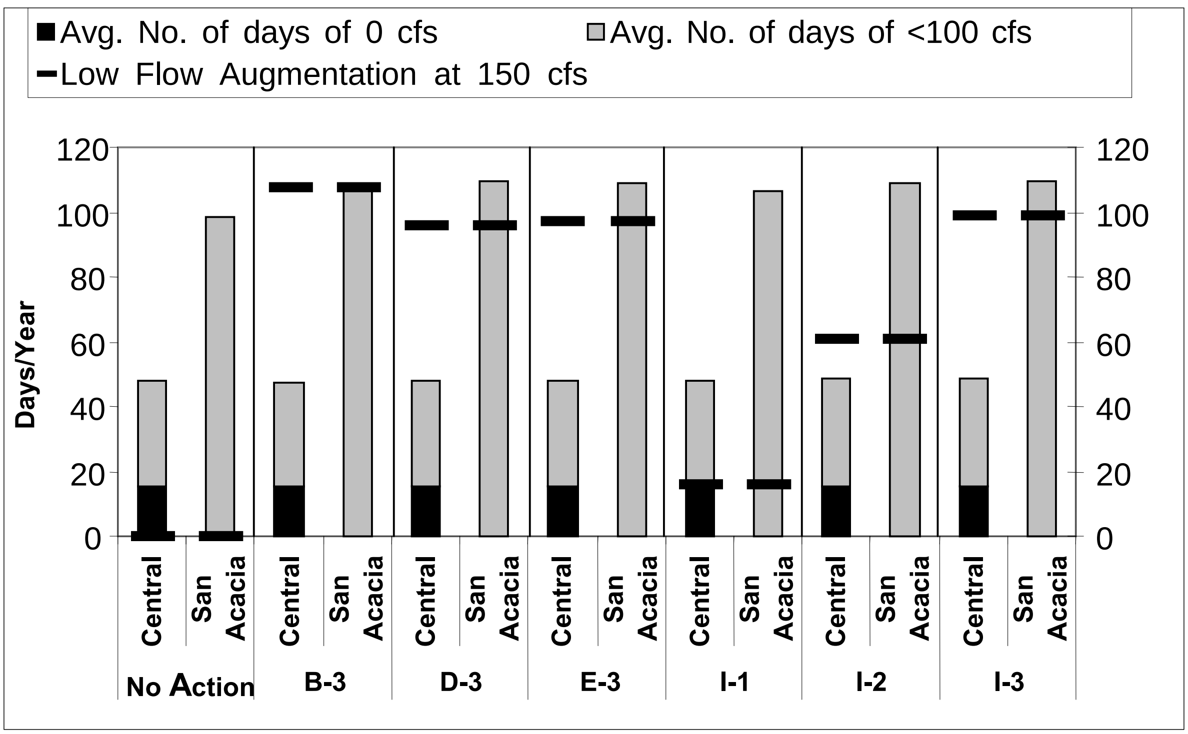


Figure L-3.7 Low-flow and Zero-Flow Days Predicted by the URGWOM Model for the Central And San Acacia Sections, With Estimated Days of Low-Flow Augmentation, by Alternative.

Impacts on Peak Flow Characteristics

Changes in the duration and magnitude of peak flows can affect the success of spawning and recruitment of aquatic species. As a result, any statistically significant differences may also have biological significance for the affected species if the baseline peak-flow condition is known to initiate spawn and produce reliable recruitment.

The No Action Alternative exhibits high average magnitude of peak flows and duration of peak flows in the Rio Chama, Central, and San Acacia sections compared with all action alternatives (**Figure L-3.8**). The chi-square goodness-of-fit test was conducted for the peak-flow magnitude and duration of the alternatives. The chi-square returned a value of 3,731.6 with $p<0.000$ for the comparison of peak-flow magnitude, indicating that significant differences occur when the alternatives are compared to the No Action with zero diversions to the LFCC. The duration of the peak flow also returned a significant chi-square value: 22.6, with $p=0.012$. As with aquatic habitat tests, the adjusted chi-square residuals were evaluated to understand the specific impacts to the fish species studied, by alternative.

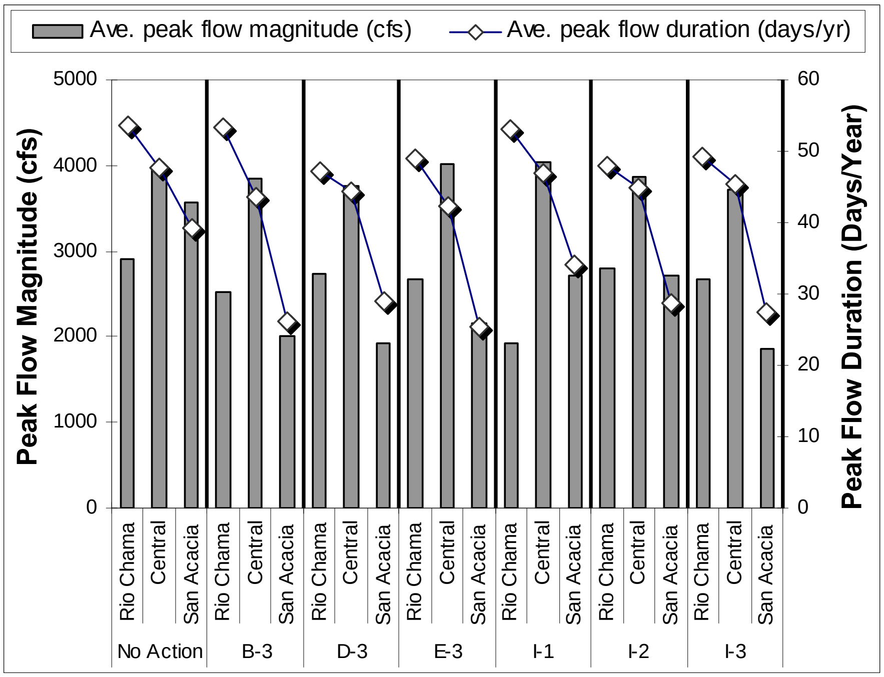


Figure L-3.8 Impacts of the Alternatives on Peak Flow Characteristics.

Duration of peak flows would not change significantly in the Rio Chama Section, regardless of alternative; but the magnitude of the peak would be reduced significantly in all alternatives. Alternative I-2 would experience peak-flow magnitude and duration most similar to the No Action Alternative in the Rio Chama. The biological effects in the Rio Chama would probably be unaffected.

Changes in the magnitude and duration of peak flows in the Central Section are statistically significant, ranging from significant reductions in Alternatives I-2, I-3, B-3, and D-3, to no significant change with Alternatives E-3 or I-1. The duration of peak flows is essentially unchanged by the alternatives, but changes in magnitude account for most of the chi-square critical value in the Central Section.

Changes in magnitude and duration of peak flows would be most pronounced in the San Acacia Section, with all alternatives returning negative values in both duration and magnitude of the peak flow compared to the No Action Alternative with zero diversions to the LFCC. Peak flow magnitude would range from a decrease of 24% with Alternatives I-1 and I-2 to a decrease of 48% in Alternative I-3. When compared to No Action with variable diversions, the alternatives all still would result in significant decreases in flow magnitude and duration, as shown in **Table L-3.**. The No Action Alternative with 500, 1,000, and 2,000 cfs diversions would also result in significant decreases in the magnitude and duration of the peak flow.

The biological effects of decreasing the magnitude and duration of peak flows in the San Acacia Section would be unpredictable and potentially adverse for the species studied. Peak-flow characteristics in the San Acacia Section are probably being influenced by the diversions to the LFCC, resulting in the large difference compared to No Action Alternative with no diversions. Peak-flow characteristics of the No Action Alternative with variable diversions to the LFCC were not modeled and therefore could not be compared to the action alternatives.

Summary of Impacts to Riverine Habitat, by Alternative

No Action

The No Action Alternative without diversions to the LFCC out-performed all alternatives for providing RGSM habitat in all areas, but would not provide proportionally as much RGSM habitat as other alternatives, as indicated by the previous discussions and summary data in **Table L-3.2** and **Table L-3.3**. Habitat availability for other species included in this study was intermediate for the No Action Alternative. The No Action Alternative with zero diversions to the LFCC also provides the highest available peak-flow magnitude and duration for all river sections, a factor that is significant for some of the species studied

Modeled for variable diversions, the No Action Alternative continues to provide statistically significant increases in aquatic habitat for the fish species studied and significantly higher levels of peak-flow magnitude and duration in all river sections compared to the action alternatives with equal diversions. In particular, the No Action Alternative with variable flows performed significantly better for aquatic habitat measures in the San Acacia Section.

Table L-3.5 Change in Peak-Flow Magnitude and Duration for the San Acacia Section with LFCC Diversions (Percent Change Relative to No Action with Equal Diversion to LFCC)

Alternative	LFCC Diversion	Peak Mag	Peak Duration
No Action	0 Diversion	3,578	39.3
No Action	500 cfs	3,205	33.6
I-1	500 cfs	2,713	34.1
	% Change from No Action with 500 cfs	-15%	-1.5%
No Action	1,000 cfs	2,774	29.0
I-2	1,000 cfs	2,703	28.8
	% Change from No Action with 1,000 cfs	-2.6%	-0.7%
No Action	2,000 cfs	2,398	26.4
B-3	2,000 cfs	2,006	26.2
	% Change from No Action with 2,000 cfs	-16.3%	-0.8%
D-3	2,000 cfs	1,922	28.9
	% Change from No Action with 2,000 cfs	-19.8%	+10.2%
E-3	2,000 cfs	2,153	25.5
	% Change from No Action with 2,000 cfs	-10.2%	-3.4%
I-3	2,000 cfs	1,860	27.5
	% Change from No Action with 2,000 cfs	-22.4%	+4.2%

Unfortunately, No Action does not provide steady flows in some sections during droughts, and the Central and San Acacia Sections would experience many low-flow or zero-flow days that could not be augmented with upstream storage, as modeled in this study.

Alternative B-3

Alternative B-3 is one of the lowest-ranked alternatives compared to the No Action Alternative because it results in a statistically significant reduction of aquatic habitat for all studied species and in all river sections. This alternative would have significant impacts on longnose dace in the San Acacia Section, based on the aquatic habitat model. It also results in significant decreases in the magnitude and duration of peak flows that provide important biological stimulus to fish species. However, this alternative significantly reduces the number of lowest low-flow and zero-flow days in the models and provides the best ability to augment flows and avoid stream intermittency in the Central and San Acacia Sections. Regardless of diversions to the LFCC, Alternative B-3 would result in adverse impacts to aquatic habitat.

Alternative D-3

Alternative D-3 is one of the highest-ranked alternatives for providing low levels of impact to aquatic habitat for studied species in the Rio Chama Section and Central Section. However, this alternative would significantly reduce habitat for longnose dace in the San Acacia Section compared to the No Action Alternative with equal diversion to the LFCC. It would also result in significant decreases in the magnitude and duration of peak flows, especially in the San Acacia Section. In addition, this alternative has more low-flow and zero-flow days than other action alternatives and the No Action Alternative. Under Alternative D-3, low-flow augmentation would not be able to offset all the low-flow days in the San Acacia Section.

Alternative E-3

Alternative E-3 provides approximately the same amount of habitat for the aquatic species studied in all sections compared with the No Action Alternative. The one exception is the aquatic habitat available in the San Acacia Section compared with No Action with equal diversions to the LFCC. In this case, Alternative E-3 would reduce RGSM habitat by 7% and reduce longnose dace habitat by 21%.

Alternative I-1

Alternative I-1 provides the best aquatic habitat for the species studied in the Rio Chama and Central Sections. In the San Acacia Section, this alternative provides the same amount of modeled aquatic habitat for all species as the No Action with equal diversions to the LFCC. I-1 did not perform well in other aquatic measures, however. This alternative would result in a significantly lower magnitude of peak flow in the Rio Chama Section and San Acacia Section, possibly resulting in adverse effects to spawning fish. In addition, this alternative would have very little opportunity for low-flow augmentation, resulting in approximately 90 low-flow days being unmitigated in the San Acacia Section, and 32 low-flow or zero-flow days in the Central Section being unmitigated with augmented flows. In addition, brown trout habitat increases slightly under Alternative I-1. Alternative I-1 performs the best among the action alternatives for the RGSM in the San Acacia Section and the Rio Chama, with neutral impacts in the Central Section.

Alternative I-2

Alternative I-2 would result in slightly lower habitat for fish species, such as RGSM and longnose dace, in the San Acacia Sections. These differences from the No Action Alternative are moderate and may not be biologically significant. In the San Acacia Section, Alternative I-2 is the best-performing alternative, providing slight increases in aquatic habitat for all studied species compared to No Action with 1,000 cfs diversions. I-2 would be able to offset predicted low-flow days in the San Acacia Section for 61 days, but an additional 48 low-flow days would not be mitigated. The primary adverse effect of this alternative is that the magnitude of the peak flow in the San Acacia Section would be significantly lower than No Action with zero diversions to the LFCC. In addition, brown trout habitat does not change under Alternative I-2.

Alternative I-3

Alternative I-3 provides approximately the same amount of habitat for the aquatic species studied in all sections compared with the No Action Alternative. The one exception is the aquatic habitat available in the San Acacia Section compared with No Action with equal diversions to the LFCC. In this case, Alternative I-3 would reduce RGSM habitat by 7% and longnose dace habitat by 21%.

3.2.2 *Reservoir Habitat Criteria Evaluation Methods*

Net Reservoir Elevation Rate of Change: The rate of change in reservoir elevation is a measure of habitat stability. Habitat stability is especially important in the spring months for successful reproduction of many fish species. These species generally spawn in the submerged vegetation along shoreline habitats (littoral zones) that are most vulnerable to drying during reservoir elevation fluctuations.

Reservoir elevation rate of change was determined for each alternative by separating the 40-year model into individual years and then extracting data for the spring months (April-June) for each reservoir. Spring averages were calculated by taking the 40-year average of each day occurring in the spring months. Values closest to zero represent reservoir stability.

Area of Littoral Habitat: The amount of littoral habitat is a measure of available shoreline zones used by reservoir fish for spawning. Littoral habitat is especially important in the spring for nursery and foraging habitats and for successful reproduction for many reservoir fish species.

Data to calculate the area of littoral habitat was available only for Abiquiu Reservoir. The bathymetry, or three-dimensional shape, of the reservoir and the reservoir elevation ranges for each alternative were determined. The resultant area of littoral habitat was extrapolated and the number of days in 10-foot reservoir elevation ranges was calculated. The value represents the maximum amount of littoral habitat in acres that is available under each alternative and the respective days at which the reservoir was within the 10-foot elevation ranges (acre-days). High values represent an increase in littoral habitat.

Reservoir Exchange Rate: The rate at which water is exchanged in a reservoir is an indirect measure of the potential productivity of the system. Low exchange rates are generally associated with higher productivity and thus better conditions for the fishery.

Exchange rates were calculated by dividing the reservoir volume by the average annual discharge. The 40-year average annual discharge was calculated by converting the average daily discharge into an average annual discharge for each year (2003–2042). These 40 values were then averaged. Low values represent lower exchange rates and higher potential productivity. The exchange rate is described in greater detail in the Biological Technical Report (2004).

3.2.2.1 Impact Analysis on Reservoir Resources

No Action

Reservoir impacts are evaluated by comparing the level of change (impact) under each action alternative to the existing conditions found under No Action. For impacts to littoral habitats, summary data are found in **Figure L-3.9**. This figure illustrates the amount of potential littoral (acres) found at different reservoir elevations. Discussions for each alternative below use this analysis for impacts to littoral habitat.

Action Alternative B-3

Platoro Reservoir

Action alternatives would have no impact on this reservoir.

Heron Reservoir

Under this alternative, the reservoir elevation is the second most stable level compared to the other action alternatives and more stable than current conditions. No data were available for this reservoir to evaluate the impact of this alternative on littoral habitat. This alternative would result in the lowest rate of water exchange in Heron Reservoir and could result in positive impacts to the fishery.

Abiquiu Reservoir
Under this alternative, the reservoir elevation would be the third most stable level compared to the other action alternatives. The impact of this alternative on littoral habitat would be minimal. This alternative would result in the lowest rate of water exchange in the reservoir compared to the other action alternatives. However, this rate would be substantially greater than the current rate of exchange and could result in negative impacts to the fishery.

Cochiti Reservoir
Under this alternative, the reservoir elevation would be the second most stable level compared to the other action alternatives and more stable than current conditions. No data were available for this reservoir to evaluate the impact of this alternative on littoral habitat. This alternative would have no impact on the rate of water exchange in the reservoir compared to current operations.

Jemez Canyon Reservoir
Action alternatives would have no impact on this reservoir.

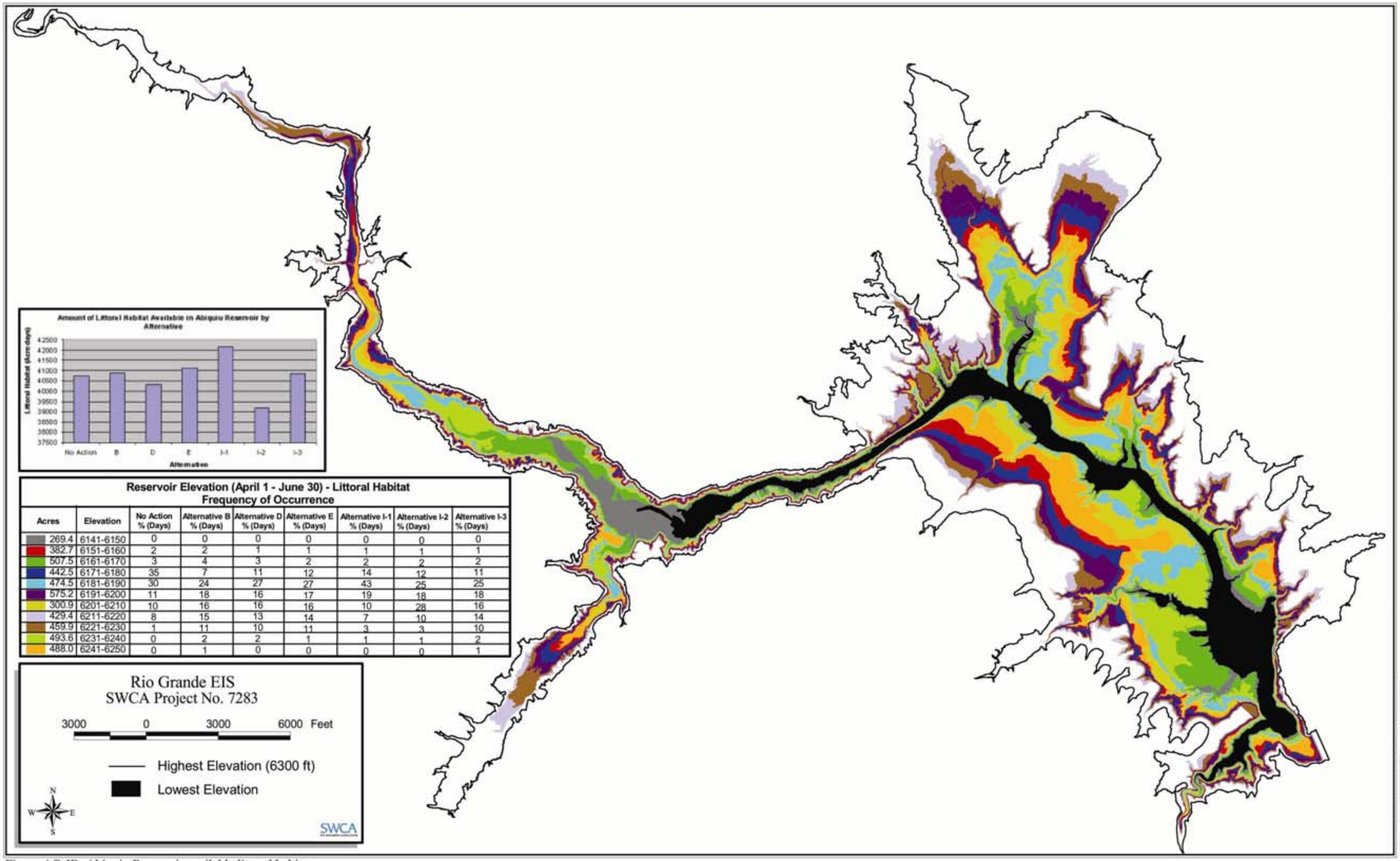
Elephant Butte Reservoir
Action alternatives would have no impact on this reservoir.

Caballo Reservoir
Action alternatives would have no impact on this reservoir.

Action Alternative D-3

Platoro Reservoir
Action alternatives would have no impact on this reservoir.

Heron Reservoir
Under this alternative, the reservoir elevation would be the most stable level compared to the other action alternatives and more stable than current conditions. No data were available for this reservoir to evaluate the impact of this alternative on littoral habitat. This alternative would result in the second lowest rate of water exchange in the reservoir and could result in positive impacts to the fishery relative to current operations.



Reservoir Elevation (April 1 - June 30) - Littoral Habitat Frequency of Occurrence

Acres	Elevation	No Action % (Days)	Alternative B % (Days)	Alternative D % (Days)	Alternative E % (Days)	Alternative I-1 % (Days)	Alternative I-2 % (Days)	Alternative I-3 % (Days)
269.4	6141-6150	0	0	0	0	0	0	0
382.7	6151-6160	2	2	1	1	1	1	1
507.5	6161-6170	3	4	3	2	2	2	2
442.5	6171-6180	35	7	11	12	14	12	11
474.5	6181-6190	30	24	27	27	43	25	25
575.2	6191-6200	11	18	16	17	19	18	18
300.9	6201-6210	10	16	16	16	10	28	16
429.4	6211-6220	8	15	13	14	7	10	14
459.9	6221-6230	1	11	10	11	3	3	10
493.6	6231-6240	0	2	2	1	1	1	2
488.0	6241-6250	0	1	0	0	0	0	1

Figure AQ-IB. Abiquiu Reservoir available littoral habitat.

Figure L-3.9 Available Habitats at Abiquiu Reservoir.

Abiquiu Reservoir
Under this alternative, the reservoir elevation would be the least stable compared to the other action alternatives and less stable than current conditions. This alternative (as well as I-3) would result in the greatest littoral habitat availability, even greater than current conditions, and could have a positive impact on the fishery. This alternative (as well as E-3) would result in the second lowest rate of water exchange in the reservoir compared to the other action alternatives. However, this rate would be greater than the current rate of exchange and could result in negative impacts to the fishery.

Cochiti Reservoir
Under this alternative, the reservoir elevation would be the third most stable level compared to the other action alternatives and more stable than current conditions. No data were available for this reservoir to evaluate the impact of this alternative on littoral habitat. This alternative would have no impact on the rate of water exchange in the reservoir compared to current operations.

Jemez Canyon Reservoir
Action alternatives would have no impact on this reservoir.

Caballo Reservoir
Action alternatives would have no impact on this reservoir.

Action Alternative E-3

Platoro Reservoir
Action alternatives would have no impact on this reservoir.

Heron Reservoir
Under this alternative (as well as I-3), the reservoir elevation would be the least stable compared to the other action alternatives and less stable than current conditions. No data were available for this reservoir to evaluate the impact of this alternative on littoral habitat. This alternative (as well as I-1, I-2, and I-3) would not impact the rate of water exchange in the reservoir relative to current operations.

Abiquiu Reservoir
Under this alternative, the reservoir elevation would be the fourth most stable compared to the other action alternatives and less stable than current conditions. This alternative (as well as I-1 and I-2) would result in the second greatest littoral habitat availability, greater than current conditions, and could have a positive impact on the fishery. This alternative (as well as D-3) would result in the second lowest rate of water exchange in the reservoir compared to the other action alternatives. However, this rate would be greater than the current rate of exchange and could result in negative impacts to the fishery.

Cochiti Reservoir
Under this alternative, the reservoir elevation would be the most stable compared to the other action alternatives and more stable than current conditions. No data was available for this reservoir to evaluate the impact of this alternative on littoral habitat. This alternative would have no impact on the rate of water exchange in the reservoir compared to current operations.

Jemez Canyon Reservoir
Action alternatives would have no impact on this reservoir.

Elephant Butte Reservoir
Action alternatives would have no impact on this reservoir.

Caballo Reservoir
Action alternatives would have no impact on this reservoir.

Action Alternative I-1

Platoro Reservoir
Action alternatives would have no impact on this reservoir.

Heron Reservoir
Under this alternative, the reservoir elevation level would be the third most stable compared to the other action alternatives and even more stable than current conditions. No data were available for this reservoir to evaluate the impact of this alternative on littoral habitat. This alternative (as well as E-3, I-2, and I-3) would not impact the rate of water exchange in the reservoir relative to current operations.

Abiquiu Reservoir
Under this alternative, the reservoir elevation would be the most stable compared to the other action alternatives but substantially less stable than current conditions. This alternative (as well as E-3 and I-2) would result in the second greatest littoral habitat availability, greater than current conditions, and could have a positive impact on the fishery. This alternative would result in the third lowest rate of water exchange in the reservoir compared to the other action alternatives. However, this rate would be substantially greater than the current rate of exchange and could result in negative impacts to the fishery.

Cochiti Reservoir
Under this alternative, the reservoir elevation would be the least stable compared to the other action alternatives and less stable than current conditions. No data were available for this reservoir to evaluate the impact of this alternative on littoral habitat. This alternative would substantially increase the rate of water exchange in the reservoir compared to current operations and could result in negative impacts to the fishery.

Jemez Canyon Reservoir
Action alternatives would have no impact on this reservoir.

Elephant Butte Reservoir
Action alternatives would have no impact on this reservoir.

Caballo Reservoir
Action alternatives would have no impact on this reservoir.

Action Alternative I-2

Platoro Reservoir
Action alternatives would have no impact on this reservoir.

Heron Reservoir
Under this alternative, the reservoir elevation level would be the fourth most stable compared to the other action alternatives but less stable than current conditions. No data were available for this reservoir to evaluate the impact of this alternative on littoral habitat. This alternative (as well as E-3, I-1, and I-3) would not impact the rate of water exchange in the reservoir relative to current operations.

Abiquiu Reservoir
Under this alternative, the reservoir elevation would be the second most stable compared to the other action alternatives but substantially less stable than current conditions. This alternative (as well as E-3 and I-1) would result in the second greatest littoral habitat availability, even greater than current conditions, and could have a positive impact on the fishery. This alternative would result in the fourth lowest rate of water exchange in the reservoir compared to the other action alternatives. However, this rate would be substantially greater than the current rate of exchange and could result in negative impacts to the fishery.

Cochiti Reservoir
Under this alternative, the reservoir elevation level would be the fifth most stable compared to the other action alternatives and more stable than current conditions. No data were available for this reservoir to evaluate the impact of this alternative on littoral habitat. This alternative would substantially increase the rate of water exchange in the reservoir compared to current operations.

Jemez Canyon Reservoir
Action alternatives would have no impact on this reservoir.

Elephant Butte Reservoir
Action alternatives would have no impact on this reservoir.

Caballo Reservoir
Action alternatives would have no impact on this reservoir.

Action Alternative I-3

Platoro Reservoir
Action alternatives would have no impact on this reservoir.

Heron Reservoir
Under this alternative (as well as E-3), the reservoir elevation level would be the least stable compared to the other action alternatives and less stable than current conditions. No data were available for this reservoir to evaluate the impact of this alternative on littoral habitat. This alternative (as well as E-3, I-1, and I-2) would not impact the rate of water exchange in the reservoir relative to current operations.

Abiquiu Reservoir
Under this alternative, the reservoir elevation would be the fifth most stable compared to the other action alternatives but substantially less stable than current conditions. This alternative (as well as D-3) would result in the greatest littoral habitat availability, even greater than current conditions, and could have a positive impact on the fishery. This alternative would result in the highest rate of water exchange in the reservoir compared to the other action alternatives. This rate of exchange could result in negative impacts to the fishery.

Cochiti Reservoir
Under this alternative, the reservoir elevation level would be the fourth most stable compared to the other action alternatives and more stable than current conditions. No data were available for this reservoir to evaluate the impact of this alternative on littoral habitat. This alternative would substantially increase the rate of water exchange in the reservoir compared to current operations, and therefore negatively impact the fishery.

Jemez Canyon Reservoir
Action alternatives would have no impact on this reservoir.

Elephant Butte Reservoir
Action alternatives would have no impact on this reservoir.

Caballo Reservoir
Action alternatives would have no impact on this reservoir.

3.3 *Riparian Resources*

3.3.1 *Methods of Assessing Impacts*

The primary tools used in the ecological analysis included vegetation inventory and classification maps from the year 2002, FLO-2D models for the Rio Chama, Central, and San Acacia Sections, an Aquatic Habitat Model developed by Miller Ecological Consultants, Inc., and other current data sets. Many of the data sets depend on modeled data or are from various sources. Therefore, the quality and limitations of each data set were determined and entered into the Decision Criteria Matrix, allowing the teams to explore the sensitivity of each measure and its relative degree of certainty.

Biological Impact Analysis Tools and Uncertainty

All of the alternatives, including No Action, were evaluated in the Decision Support Matrix to determine their positive and negative impacts to biological resources. The primary tools for estimating biological effects included the URGWOM Planning Model, Hink and Ohmart Vegetation Classification and Mapping (both 1982 data and the adapted methods applied in 2002–2003), and FLO-2D overbank inundation models for the Rio Grande and Rio Chama generated in 2004. The combined modeling and mapping efforts provided information for the analysis, but provided only one view of operations within a wide range of operations at each facility.

The FLO-2D Model of overbank inundation is the most precise and accurate for the Rio Chama and Central Sections of the Project. It is less reliable for the San Acacia Section due to streambed instability. Riparian and aquatic habitat assessments that depend on FLO-2D–modeled data are therefore less reliable in the San Acacia Section than impacts assessments elsewhere in the Project Area. A complete description of the data sources and evaluation of data accuracy is provided in Appendix R.

Finally, Reclamation hydrologists ran their Hydrologic Engineering Centers River Analysis System (HEC-RAS) model for flows between 0 and 7,500cfs (flow at the San Marcial Gage) for the reach between the south boundary of the Bosque del Apache NWR and the power lines at the full pool of Elephant Butte Reservoir. The model results provided a water surface elevation at multiple cross sections along the river. The HEC-RAS cross-sections were overlaid in a GIS on the FLO-2D grid layer and merged. GIS analysis determined at which flows the grid cells were flooded by more than half a foot to match the inundation data that was used above San Marcial in the FLO-2D model. These data was merged with the URWGOM gage flow data for the San Marcial gage for each alternative and year. The resulting data were then queried and summarized for each alternative and year from the southern end of the FLO-2D data (at about San Marcial) down to the southern boundary of the study area.

Riparian Impact Analysis

Effects of changed river operations on riparian resources are generally indirect and long term. Potential benefits and adverse impacts to riparian resources were evaluated through several quantitative measures, described below.

<u>Acre-days of Spring Overbank Flooding</u>: This measure reflects the 40-year cumulative total spring (1 April through 1 July) seasonal acreage flooded multiplied by the duration of inundation in days. Riparian resources, particularly native riparian vegetation, respond well to spring flood flows. Long-term absence of adequate spring floods in riparian areas would gradually reduce recruitment and maintenance of existing vegetation and wildlife values.

<u>Frequency of Overbank Flooding</u>: This measured is expressed as the percentage of days that a given reach or section reaches the threshold discharge required to initiate overbank flooding in some areas. Adequate flood frequency for riparian resources is at least one year in five, or 20 percent, for maintaining and regenerating native vegetation. Low frequency of overbank flooding in an area, despite the occasional large flood event, would decrease riparian ecosystem health and native vegetation.

<u>Mean Annual Maximum Acres of Overbank Flooding</u>: This measure is the 40-year mean of the highest annual acreage flooded within each river section, in acres. The average extent of overbank flooding generally defines the area of riparian health, and a shrinking mean correlates to a shrinking riparian ecosystem.

<u>Average Annual Acre-Days of Flooding in Vegetation Types</u>: This measure gives the hydrological support in extent and duration for various vegetation types and is obtained by GIS overlay analysis of current vegetation mapping data with the data from FLO 2-D. Decreased surface hydrology within native and mixed vegetation types would produce long-term adverse impacts to vegetation and wildlife, as well as create conditions that favor the increase of exotic vegetation. (Figures 3.11, 3.12, and 3.14 detail these data and will be referred to throughout this section’s impact assessments; see Sections 3.3.1.1, Impact Analysis on Riparian Habitat, and 3.5.2.1, Impact Analysis on Terrestrial Riparian Fauna.)

<u>Percentile of Inundation</u>: This measure predicts the reliability of a particular area receiving overbank flows of moderate duration, supporting stable wetland function and ecological condition. Overbank flooding of existing wetland sites should remain in the range of the 25th and 75th percentile of the reach in which it is located.

Peak-Flow Variability: Peak-flow variability was measured using the coefficient of variation, which is the ratio of the standard deviation of the 40-year time series of growing season peak flow (21 March through 31 October) compared to its mean. The larger the coefficient of variation, the greater the variability of the overbank discharge from one year to the next. Variability of flood flows would produce many beneficial effects in the riparian zone, while long-term low variability would result in adverse impacts.

Conservation Storage Capability: Conservation storage capability is a measure of the acre-feet of water available in Abiquiu Reservoir that could be carried over and released for riparian purposes.

Peak-Flow Augmentation Capability: This is a relative measure of the channel capacity below Abiquiu and below Cochiti, providing the ability to deliver additional conservation storage and augment peak flows for riparian resources.

3.3.1.1 Impact Analysis on Riparian Habitat

Impacts of the No Action Alternative

The No Action Alternative would continue operations largely unchanged, but with improved intra-agency coordination for flood control and delivery of water downstream. As modeled, with no diversions into the LFCC, the current operations would provide the best overall support for riparian resources compared with all the action alternatives (**Figure L-3.10**). The current operations demonstrated support for existing wetlands, natural management areas, riparian fauna, and threatened and endangered species. Despite overall support of riparian resources, adverse impacts would occur under the No Action Alternative, varying in significance by river section (**Table L-3.**).

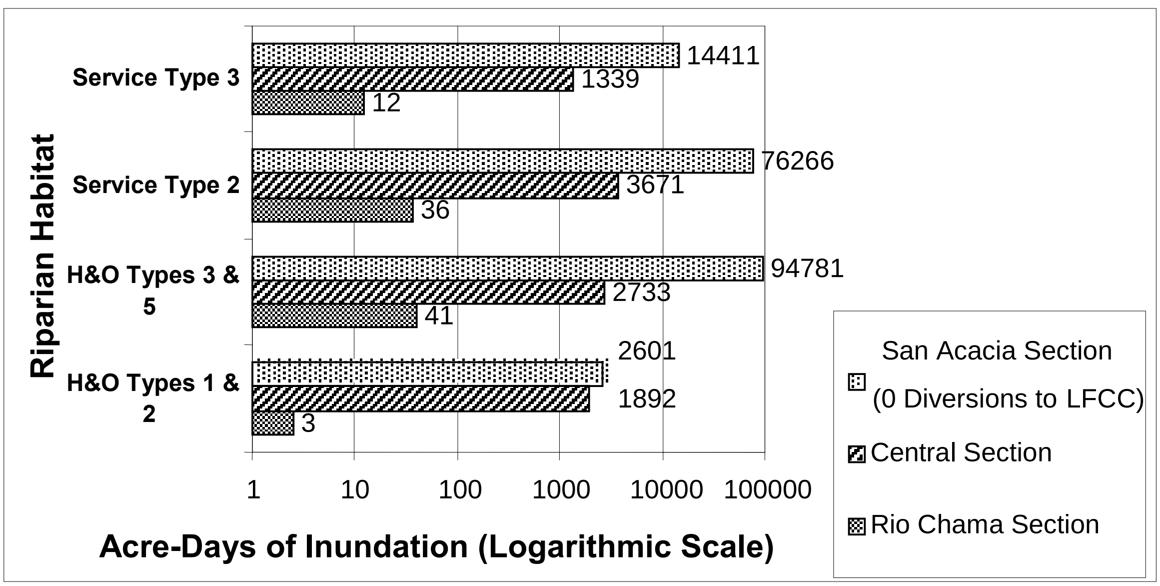


Figure L-3.10 Impacts of No Action With Zero Diversions to the LFCC on Inundation of Riparian Vegetation Types, by Section.

Table L-3.6 Impacts of No Action Alternative on Riparian Habitat Measures

Criterion	Measure	Rio Chama Section	Central Section	San Acacia with 0 cfs Diversions to LFCC*	San Acacia with 500 cfs Diversions to LFCC*	San Acacia with 1,000 cfs Diversions to LFCC*	San Acacia with 2,000 cfs Diversions to LFCC*
Supports regeneration of native vegetation	Acre-days of spring overbank flooding	1,137.0	7,646.0	132,065.0	Not modeled	Not modeled	Not modeled
Supports H&O vegetation classifications Type 1 and 2	Average annual acre-days in H&O Types 1 and 2	2.5	1,892.0	2,601.0	Not modeled	Not modeled	Not modeled
Supports H&O vegetation classifications Type 3 and 5	Average annual acre-days in H&O Types 3 and 5	40.6	2,733.0	94,781.0	Not modeled	Not modeled	Not modeled
Supports Service Resource Category 2	Average annual acre-days in Service Type 2	36.0	3,671.0	76,266.0	Not modeled	Not modeled	Not modeled
Supports Service Resource Category 3	Average annual acre-days in Service Type 3	12.0	1,339.0	14,411.0	Not modeled	Not modeled	Not modeled
Amount of overbank flooding	Mean annual maximum acres of overbank flooding	147.0	260.0	5,357.0	4,778.0	3,535.0	1,755.0
Frequency and Timing of verbank flooding	Percent years of spring overbank flooding	92.5	50.0	100.0	Not modeled	Not modeled	Not modeled

* Diversion to the LFCC would be capped at 0, 500, 1,000, or 2,000 cfs, depending on the alternative. Not all possible diversions were modeled using FLO-2D.

Rio Chama Section

According to the GIS analysis of acres of inundation shown in **Table L-3.**, very little of the overall floodplain in the Rio Chama Section would receive overbank inundation Though inundated acres would be flooded nearly 93% of the years included in the model, the area inundated is small, only 147 acres, or

5% of the total vegetated acreage mapped. Under the No Action Alternative, the acre-days of spring overbank flooding would be very low, and flooding in mature cottonwood forest and valuable riparian habitats (Service 2) is very infrequent.

Figure L-3.11 shows that the No Action Alternative provides the lowest level of average annual days of inundation in native vegetation among all alternatives. This result is especially significant in that native vegetation represents only 21% of the riparian forest in this section. Although cottonwood canopy forests can survive for many years without surface inundation, regeneration of these forests requires occasional flooding in open areas where native species can germinate. The No Action Alternative represents an adverse effect to native vegetation within the Rio Chama Section.

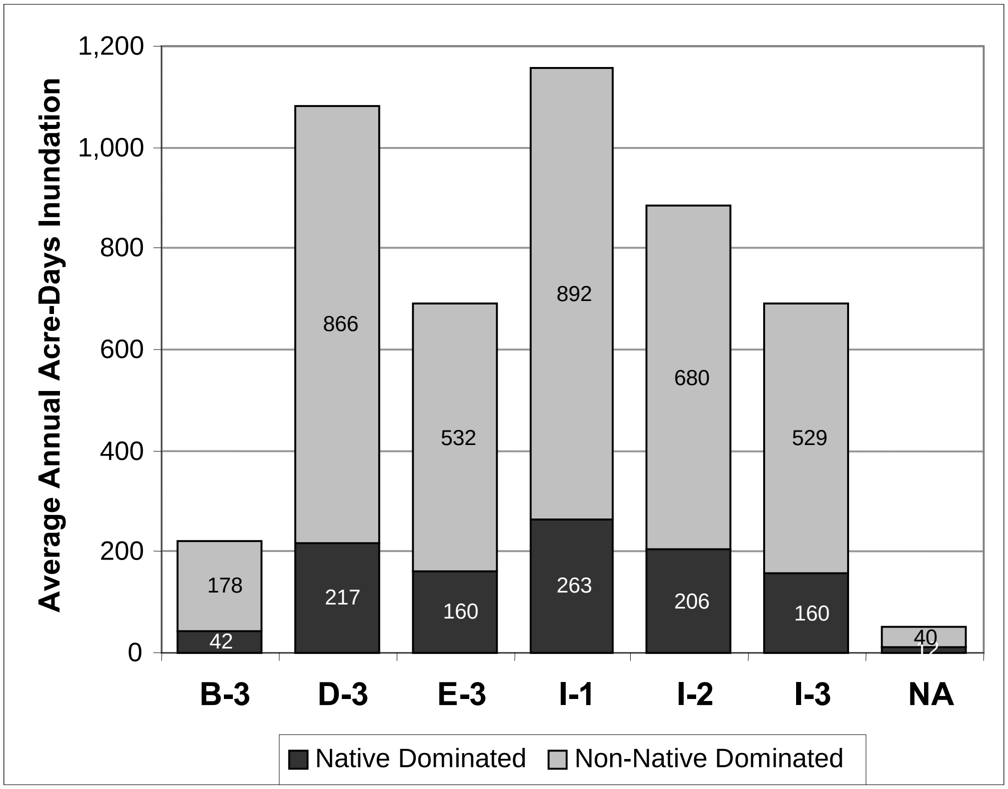


Figure L-3.11 Relative Impacts of the Alternatives on Native Vegetation Communities in the Rio Chama Section, as Total Days of Inundation (χ^2=121.1, p= 0.000).

Central Section

Adverse impacts to riparian vegetation would continue to occur in the Central Section under the No Action Alternative (**Table L-3.**). Because most facility operations remain unchanged in this alternative, negative trends in riparian ecosystem function of the Central Section identified in Section 3, such as lack of recruitment of native vegetation and lack of sediment mobilization, would continue. The No Action Alternative provides some surface hydrological support to approximately 65% of the vegetated acres in the study area. Overbank flooding would occur somewhere in the Central Section in approximately half of the years, but with only 260 acres on average receiving these flood flows.

Evaluation of the relative impacts of No Action on native vegetation communities in the Central Section indicates that these valuable communities are inundated an average of 1,306 acre-days per year, the fourth highest among all alternatives. The results of this analysis (**Figure L-3.12**) are significant, with a chi-square of 280 and p=0.00, indicating that the trends in vegetation change reported in Section 2 would continue under No Action and would represent an adverse effect.

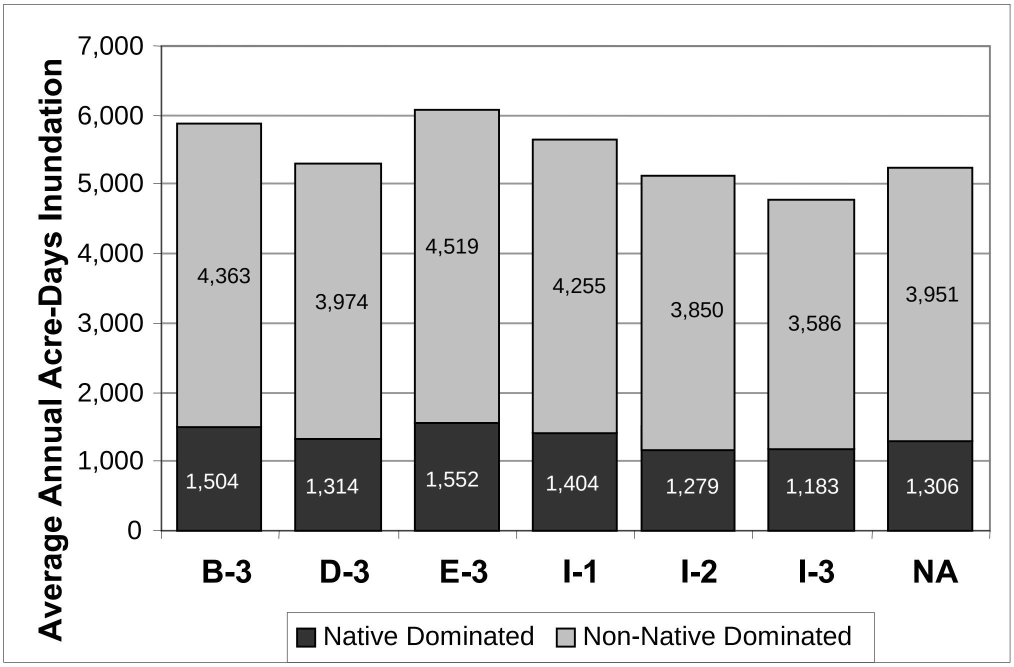


Figure L-3.12 Relative Impacts of the Alternatives on Native Vegetation Communities in the Central Section, as Total Days of Inundation (χ^2=2,084.2, p= 0.000).

San Acacia Section

The No Action Alternative has variable effects according to the level of diversion of flows to the LFCC. Though a range of diversions from 0 to 2,000 cfs is authorized for the LFCC, no diversions have been made for two decades. A FLO-2D model was developed to determine the acres, duration, and frequency of overbank flooding in the San Acacia Section without diversions to the LFCC (0 cfs). The modeled data without diversions show that very little of the acre-days of inundation would occur in mature cottonwood forests (Hink and Ohmart Types 1 and 2), and that overall, very few acres are actually inundated, as shown in **Table L-3.**. An average of 5,537 acres receive overbank flooding according to the FLO-2D model. However, those acres would receive flood flows in 100% of the modeled years, the highest frequency and area of overbank inundation in the entire study area. Inundation acres were not modeled for all possible diversions to the LFCC (Figure L-3.13). The highest value habitat types, Service Resource Categories 2 and 3, would receive approximately 70% of the acre-days of inundation.

Spatial analysis was not completed for all possible diversions to the LFCC under No Action, making it impossible to compare the effects that different diversions would have on native versus non-native vegetation, on SWFL habitats, or other specific resources in the floodplain. Such effects would probably not be linear or easily predicted. Additional testing of spatial effects of variable diversions to the LFCC is recommended should the No Action Alternative with future diversions be selected.

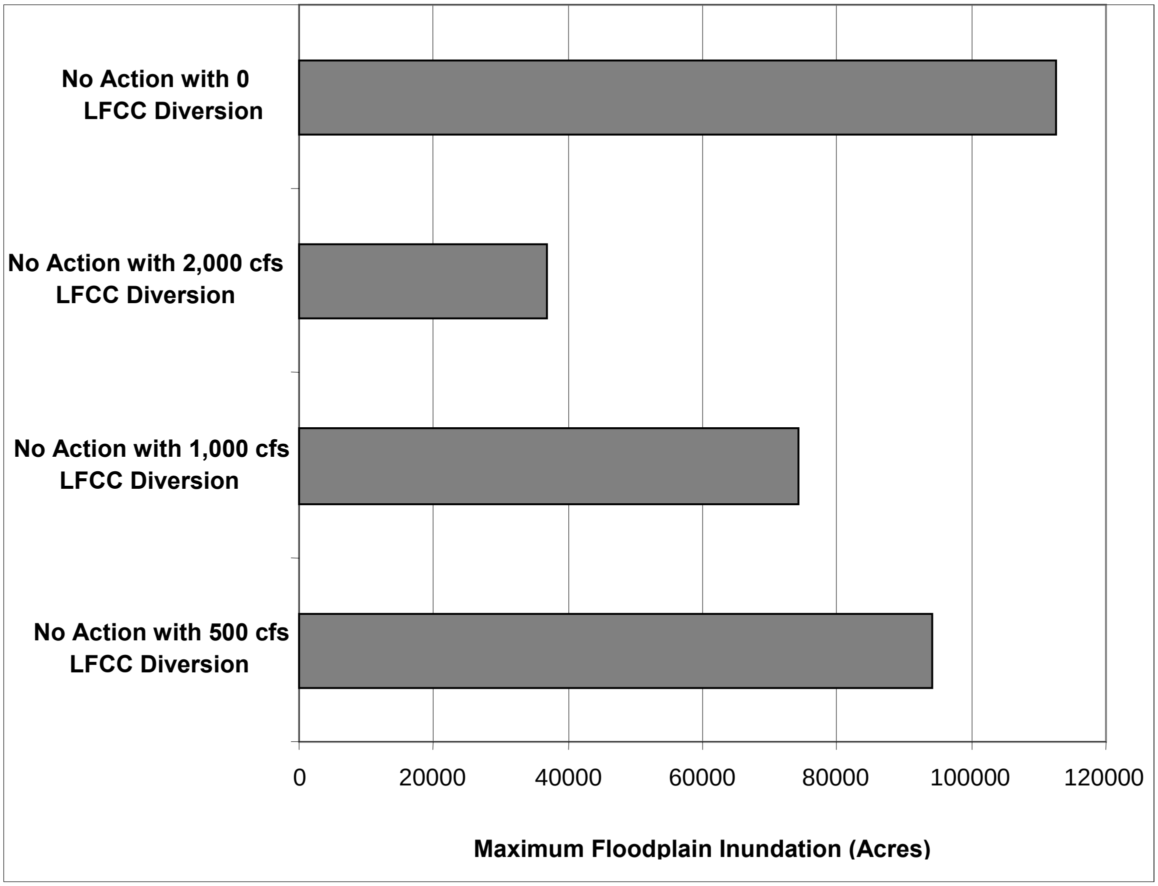


Figure L-3.13 Effects of Variable Diversions to Low Flow Conveyance Channel Under the No Action Alternative, Maximum Area Floodplain Inundation in the San Acacia Section.

The San Acacia Section contains thousands of acres of non-native vegetation, with over 80% of the total acres of woody riparian vegetation dominated by salt cedar and other non-native species. The effects of inundation in native vegetation types was investigated, and the results are shown in **Figure L-3.14**. This test shows that the No Action Alternative with zero diversions to the LFCC provides the greatest average annual acre-days of inundation in native vegetation communities compared with every action alternative. The chi-square goodness-of-fit test returned a value of 117,109, p=0.000, indicating high statistical significance. Decreasing overbank inundation by diverting water to the LFCC, even with other No Action operations, would probably result in significant decreases in inundation in native vegetation communities and give a significantly adverse effect as well. Further study of the spatial biological effects of diverting water to the LFCC is recommended should the No Action Alternative with future diversions be selected.

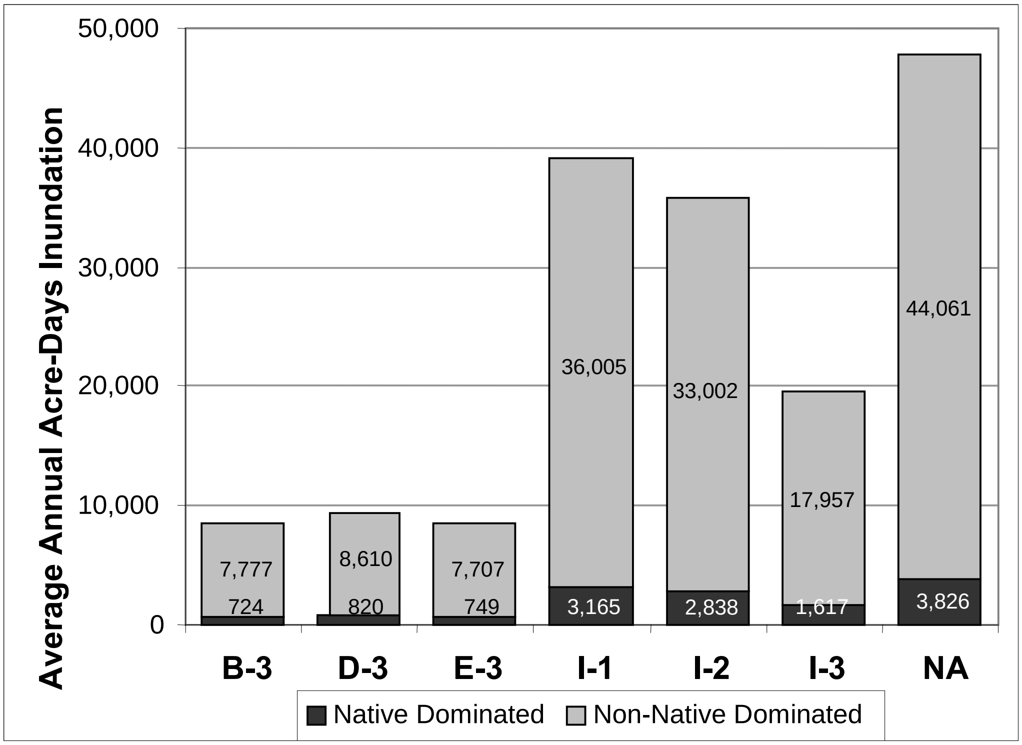


Figure L-3.14 Relative Impacts of the Alternatives on Native Vegetation Communities in the San Acacia Section, as Total Days of Inundation. (χ^2=14,791.4, p= 0.000).

Action Alternative B-3

Compared with the No Action Alternative, Alternative B-3 provides beneficial increases in inundation of valuable native vegetation types in the Rio Chama Section without resulting in the potentially adverse effects of prolonged or extensive overbank flooding (**Table L-3.7** and **Figure L-3.15**). In addition, this alternative would result in a slight improvement in riparian support in the Central Section. Compared with No Action, Alternative B-3 results in moderate improvements in peak-flow variability and average annual inundation in many valuable habitat types in the Rio Chama and Central Sections, including mature gallery cottonwood forests and intermediate and young native forest types with dense understory, thereby benefiting avian species and other fauna (**Figure L-3.11**).

Alternative B-3 included carry-over of up to 180,000 AF of native water at Abiquiu. Analysis of this alternative included an estimate of the potential benefit of partial use of carry-over storage if it were used to augment peak flows and provide additional hydrological support for riparian habitats during prolonged dry periods. The results of this study (shown in **Figure L-3.7)** indicate that the potential beneficial effect of carry-over of native water storage at Abiquiu Reservoir ranks highest for Alternative B-3 among all alternatives. This alternative would completely offset modeled days of zero or less than 100 cfs flow in both the Central and San Acacia Sections.

Table L-3.7 Impacts of Alternative B-3 on Riparian Habitat Measures Compared to No Action Alternative

Measure	Rio Chama Section	% Change Compared to No Action	Central Section	% Change Compared to No Action	San Acacia Section	% Change Compared to No Action with Zero Diversions to LFCC*	% Change Compared to No Action with Equal Diversions to LFCC*
Acre-days of spring overbank flooding	1,070	-5.9%	8,429	10.2%	47,056	-64.4%	Not modeled
Average annual acre-days in H&O Types 1 and 2	6	156.0%	2,070	9.4%	510	-80.4%	Not modeled
Average annual acre-days in H&O Types 3 and 5	189	365.5%	3,088	13.0%	34,539	-63.6%	Not modeled
Average annual acre-days in Service Type 2	158	338.9%	4,160	13.3%	33,550	-56.0%	Not modeled
Average annual acre-days in Service Type 3	44	266.7%	1,449	8.2%	3,736	-74.1%	Not modeled
Mean annual maximum acres of overbank flooding	69	-53.1%	463	78.1%	1,294	-75.8%	-5.5%
Percent years of spring overbank flooding	85	-8.1%	48	-5.0%	90	-10.0%	Not modeled

* Diversion to the LFCC would be capped at 0, 500, 1,000, or 2,000 cfs, depending on the alternative. Not all possible diversions were modeled using FLO-2D.

Rio Chama Section
The area of inundation, or mean annual maximum acres of overbank flooding, in the Rio Chama Section would decrease by over 50%, from 147 acres in the No Action Alternative to 69 acres in Alternative B-3. At the same time, the duration of inundation would increase substantially, providing better hydrological support, as shown in **Table L-3.7** and **Figure L-3.15**. Spring overbank flooding increases by 156% in Hink and Ohmart Types 1 and 2, the mature cottonwood forest. It also substantially improves the highest value vegetation type (Service Type 2) by approximately 339% compared to the No Action Alternative. Other riparian habitats of intermediate height and young vegetation less than 15 feet tall (Hink and Ohmart Types 3 and 5) also show an increase of 365% in hydrological support. Because native vegetation dominates only a small proportion (21%) of vegetation Types 1, 3, and 5 in this section, the study examined the alternatives for impacts to hydrological support in areas dominated by native vegetation. The results for the Rio Chama (shown in Figure L-3.11) indicate that Alternative B-3 would slightly increase the average annual acre-days of inundation in this valuable habitat. The increased inundation would benefit both exotic and native vegetation (**Figure L-3.15**).

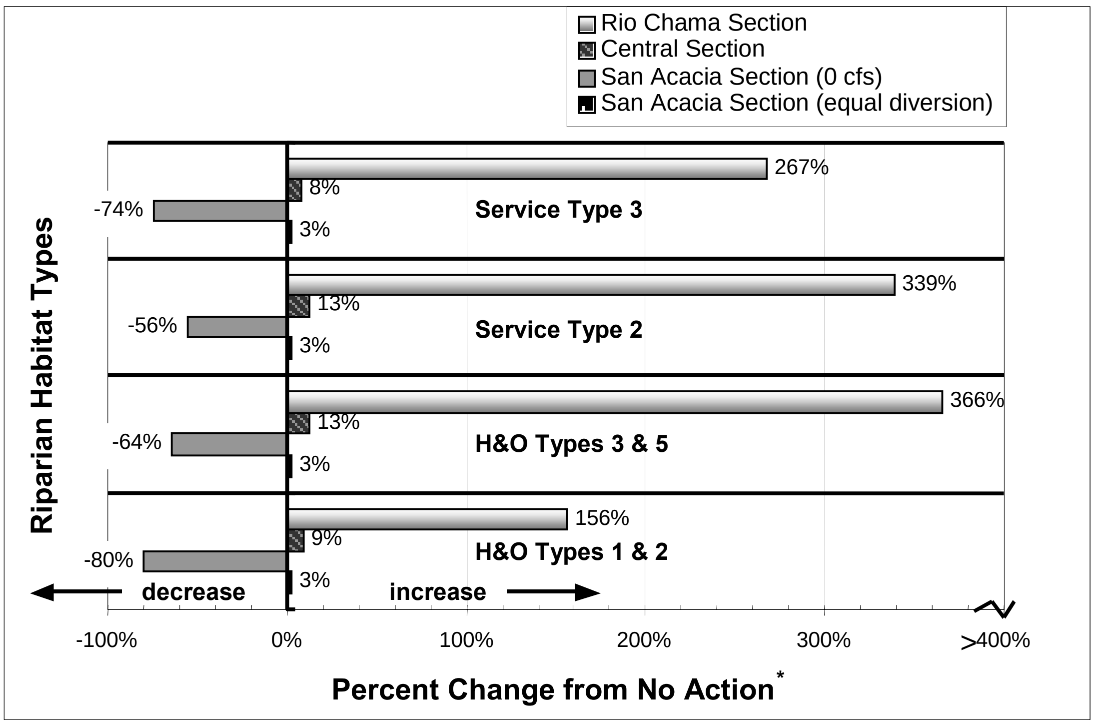


Figure L-3.15 Impact of Alternative B-3 on Riparian Habitat Support.

* No Action has variable diversions to LFCC, 0–2,000 cfs

Central Section
In the Central Section, Alternative B-3 would provide an overall improvement in many measures of riparian health, as shown in **Table L-3.7** and **Figure L-3.15**. The most significant increase would be a 78% projected increase in the maximum acres flooded in an average year, a change from 260 acres in No Action to a projected 463 acres in Alternative B-3. Increases in inundation would be felt disproportionately in lower-value habitats with primarily non-native vegetation, but the mature cottonwood gallery forests (Hink and Ohmart Types 1 and 2) and the Intermediate forest types (Types 2 and 4) would have a 13% improvement in surface hydrology. Changes of less than 20% from the No Action Alternative are inside the margins of error for the study and are therefore not significant. Improved surface hydrology in the Central Section would probably also result in slightly higher groundwater to

support native forests in the area. **Figure L-3.12** shows that Alternative B-3 offers the second-highest average annual acre-days of inundation for support of native vegetation in the Central Section.

San Acacia Section

Alternative B-3 would have an overall adverse effect on riparian vegetation in the San Acacia Section (**Table L-3.7** and **Figure L-3.15**). While the frequency of inundation would decrease only slightly (10%) compared to No Action, all other measures of riparian health would experience significant decreases of 50% to 80% compared to No Action. One of the most significant adverse effects would be felt in the mature cottonwood gallery forest (Hink and Ohmart Types 1 and 2). Spring inundation in these forest types would decrease by 80% over the No Action Alternative, according to the study. The overall areas of inundation would decrease from 5,334 acres in No Action to 1,294 acres in Alternative B-3. When compared to the No Action Alternative with similar 2,000 cfs diversions to the LFCC, the number of acres of inundation would be approximately the same. This indicates that, with Alternative B-3, the primary adverse effects in the San Acacia Section come from diversions to the LFCC, not the upstream operations proposed in the alternative.

Action Alternative D-3

Alternative D-3 included carry-over of up to 180,000 AF of native water at Abiquiu. The analysis included an estimate of the potential benefit of carry-over storage if it were used to augment peak flows and provide additional hydrological support for riparian habitats during prolonged dry periods. The results of this study show that the potential beneficial effect of carry-over of native water storage in Abiquiu Reservoir is high in the Central Section, where days of both zero and less than 100 cfs flow are fully covered. Use of carry-over storage would not fully augment flows of less than 100 cfs in the San Acacia Section, but would cover approximately 90% of the shortfall (**Figure L-3.7**).

Rio Chama Section

The area of inundation, or mean annual maximum acres of overbank flooding, in the Rio Chama Section would decrease 8.8%, from 147 acres in the No Action Alternative to 134 acres in Alternative D-3. At the same time, the duration of inundation in native-dominated vegetation types would decrease a small amount, from approximately 92% to 85%, as shown in **Table L-3.** and **Figure L-3.16**. It is the duration of overbank flooding that would produce the greatest effects with Alternative D-3 (as shown in **Figure L-3.11**). Spring overbank flooding would increase by 1,180% in Hink and Ohmart Types 1 and 2, the mature cottonwood forest. It also would substantially improve the highest value vegetation type (Service Type 2) by approximately 1,861% compared to the No Action Alternative. Other riparian habitats of intermediate height and young vegetation less than 15 feet tall (Hink and Ohmart Types 3, 4, and 5) show an increase of over 2,000 acre-days of inundation, although these vegetation types are dominated by non-native vegetation.

Table L-3.8 Impacts of Alternative D-3 on Riparian Habitat Measures Compared to No Action Alternative

Measure	Rio Chama Section	% Change Compared to No Action	Central Section	% Change Compared to No Action	San Acacia Section	% Change Compared to No Action with Zero Diversions to LFCC*	% Change Compared to No Action with Equal Diversions to LFCC*
Acre-days of spring overbank flooding	2,643	132.5%	7,606	-0.5%	48,756	-63.1%	Not modeled
Average annual	32	1,180%	1,875	-0.9%	546	-79.0%	Not modeled

Measure	Rio Chama Section	% Change Compared to No Action	Central Section	% Change Compared to No Action	San Acacia Section	% Change Compared to No Action with Zero Diversions to LFCC*	% Change Compared to No Action with Equal Diversions to LFCC*
acre-days in H&O Types 1 and 2							
Average annual acre-days in H&O Types 3 and 5	857	2,010.8%	2,771	1.4%	36,789	-61.2%	Not modeled
Average annual acre-days in Service Type 2	706	1,861.1%	3,688	0.5%	34,159	-55.2%	Not modeled
Average annual acre-days in Service Type 3	266	2,116.7%	1,345	0.4%	4,137	-71.3%	Not modeled
Mean annual maximum acres of overbank flooding	134	-8.8%	280	7.7%	1,233	-77.0%	-10.5%
Percent years of spring overbank flooding	85	-8.1%	48	-5.0%	90	-10.0%	Not modeled

* Diversion to the LFCC would be capped at 0, 500, 1,000, or 2,000 cfs, depending on the alternative. Not all possible diversions were modeled using FLO-2D.

Because native vegetation dominates only a small proportion (21%) of vegetation Types 1, 3, and 5 in this section, the study examined the alternatives for impacts to hydrological support in vegetation dominated by native vegetation. The results for the Rio Chama (**Figure L-3.11**) show that Alternative D-3 provides the second-highest support for native vegetation types by increasing the average annual acre-days of inundation in this valuable habitat by over 200% compared to No Action. The increased acre-days of inundation would also benefit exotic Russian olive communities.

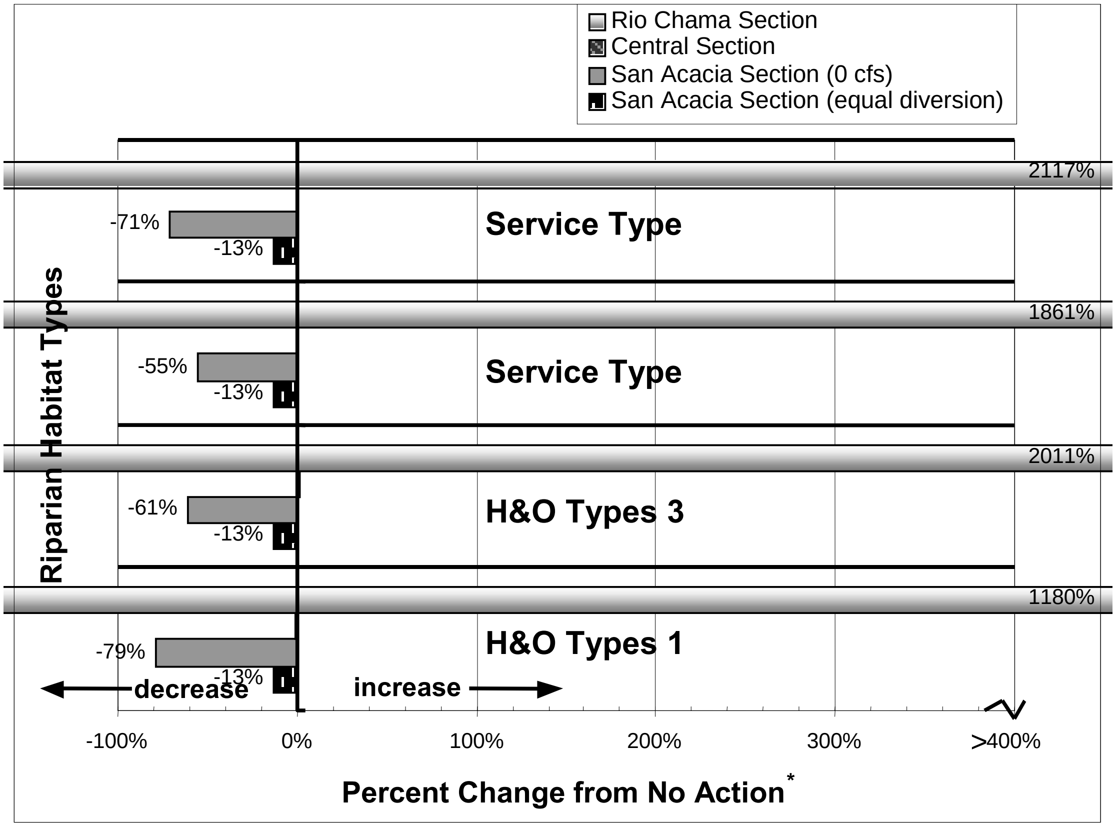


Figure L-3.16 Impact of Alternative D-3 (0–2,000 cfs diversion) on Riparian Habitat Support.

* No Action Has Variable Diversions to LFCC of 0–2,000 cfs

Central Section
In the Central Section, Alternative D-3 would provide virtually no change from the No Action Alternative in all measures of riparian health, including average annual acre-days of inundation in native vegetation (**Figure L-3.12**).

San Acacia Section
Alternative D-3 would have an overall adverse effect on riparian vegetation in the San Acacia Section compared with the No Action Alternative with zero diversions to the LFCC. While the frequency of inundation would decrease only slightly (10%) compared to No Action, all other measures of riparian health would experience significant decreases of 55% to 79%, as shown in **Table L-3.** and Figure L-3.16. One of the most significant adverse effects would be felt in the mature cottonwood gallery forest (Hink and Ohmart Types 1 and 2). Spring inundation in these forest types would decrease from 2,601 acre-days in the No Action Alternative to 546 acre-days in D-3. However, compared to the No Action Alternative with similar 2,000 cfs diversions to the LFCC, the number of acres of inundation would be approximately the same. This indicates that, with Alternative D-3, the primary adverse effects in the San Acacia Section come from diversions to the LFCC rather than from the upstream operations proposed in the alternative. Alternative D-3 would significantly decrease support for native vegetation as well as decreasing inundation to non-native-dominated communities (**Figure L-3.14**).

Action Alternative E-3

Alternative E-3 included carry-over of up to 180,000 AF of native water at Abiquiu. The analysis included an estimate of the potential benefit of partial use of carry-over storage if it were used to augment peak flows and provide additional hydrological support for riparian habitats during prolonged dry periods. The results of this study show that the potential beneficial effects of carry-over of native water storage at Abiquiu Reservoir fully offset any low- or zero-flow days in the Central Section. It also offsets about 90% of low-flow days in the San Acacia Section (**Table L-3.** and **Figure L-3.7**).

Table L-3.9 Impacts of Alternative E-3 on Riparian Habitat Measures Compared to No Action Alternative

Measure	Rio Chama Section	% Change Compared to No Action	Central Section	% Change Compared to No Action	San Acacia Section	% Change Compared to No Action with Zero Diversions to LFCC*	% Change Compared to No Action with Equal Diversions to LFCC*
Acre-days of spring overbank flooding	2,006	76.4%	8,733	14.2%	46,859	-64.5%	Not modeled
Average annual acre-days in H&O Types 1 and 2	22	780.0%	2,123	12.2%	542	-79.2%	Not modeled
Average annual acre-days in H&O Types 3 and 5	542	1,235.0%	3,209	17.4%	35,764	-62.3%	Not modeled
Average annual acre-days in Service Type 2	470	1,205.6%	4,294	17.0%	33,585	-56.0%	Not modeled
Average annual acre-days in Service Type 3	164	1,266.7%	1,499	11.9%	3,662	-74.6	Not modeled
Mean annual maximum acres of overbank flooding	108	-26.5%	496	90.8%	1,285	-76.0%	18%
Percent years of spring overbank flooding	88	-5.4%	40	-20.0%	90	-10.0%	Not modeled

* Diversion to the LFCC would be capped at either 0, 500, 1000, or 2000 cfs, depending on the alternative. All possible diversions were not modeled using FLO-2D.

Rio Chama Section

Alternative E-3 would decrease the mean annual maximum acres of overbank flooding in the Rio Chama Section from 147 acres in the No Action Alternative to 108 acres. At the same time, the frequency of inundation would decrease a small amount, from approximately 92% to 88% (**Table L-3.**). The duration of overbank flooding would produce the greatest effects with Alternative E-3 (**Figure L-3.17**). Spring overbank flooding would increase by 780% in Hink and Ohmart Types 1 and 2, the mature cottonwood forest. E-3 would also substantially improve the highest-value vegetation type (Service Type 2) by approximately 1,205% compared to the No Action Alternative. Other riparian habitats of intermediate height and young vegetation less than 15 feet tall (Hink and Ohmart Types 3 and 5) show an increase of over 1,235 acre-days of inundation.

Because native vegetation dominates only a small proportion (21%) of Types 1, 3, and 5 vegetation in this section, the study examined the alternatives for impacts to hydrological support in vegetation dominated by native species. The results for the Rio Chama Section (**Figure L-3.17**) show that Alternative E-3 would have significant beneficial effects on native vegetation types by increasing the average annual acre-days of inundation in this valuable habitat compared to the No Action Alternative. The increased acre-days of inundation would benefit both exotic and native species and result in long-term improvement of native plant communities. However, this alternative shares a ranking of fourth with Alternative I-3 among all action alternatives.

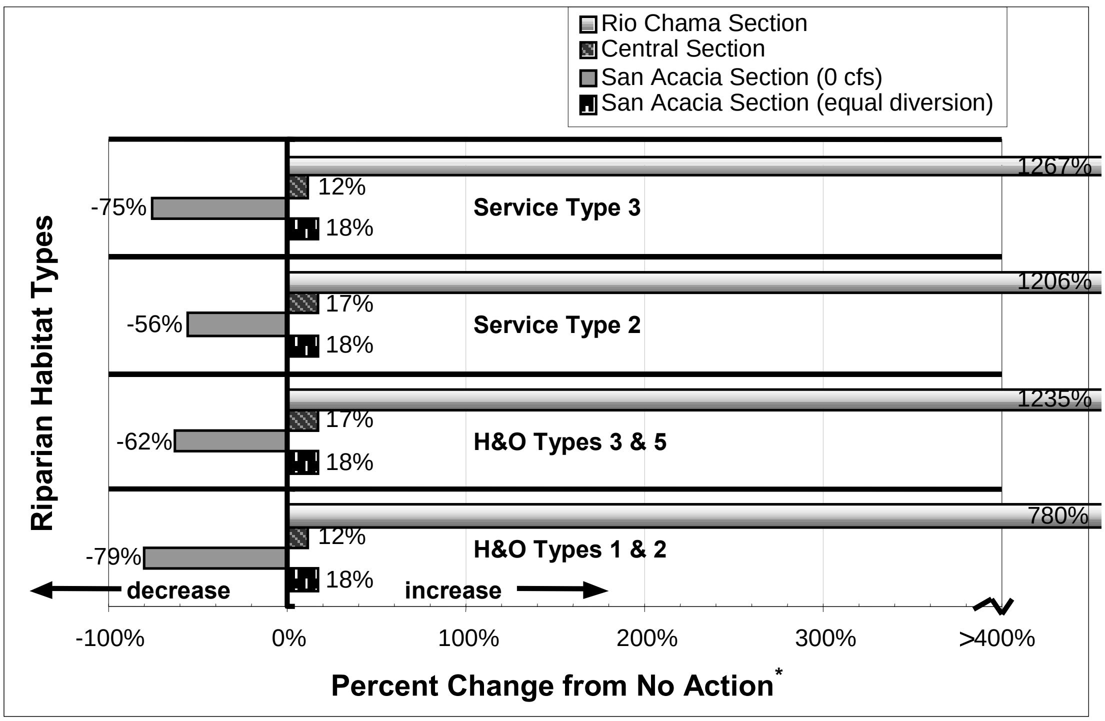


Figure L-3.17 Impact of Alternative E-3 (0–2,000 cfs diversion) on Riparian Habitat Support.

* No Action has variable diversions to LFCC of 0–2,000 cfs

Central Section

In the Central Section, Alternative E-3 would provide the highest support for native plant communities. However, the percent change from No Action is within our margin of error, so the alternative statistically provides virtually no change from the No Action Alternative in all measures of riparian health, as shown in **Table L-3.** and **Figure L-3.17**. Because all measures of riparian health are less than 10% compared to No Action, and changes this small are inside the margins of error for the study, the changes would be undetectable.

San Acacia Section

Alternative E-3 would have an overall adverse effect on riparian vegetation in the San Acacia Section compared with the No Action Alternative with zero diversions to the LFCC. While the frequency of inundation would decrease only slightly (10%) compared to No Action, all other measures of riparian health would experience significant decreases of 56% to 79% (**Figure L-3.17**). One of the most significant adverse effects would be felt in the mature cottonwood gallery forest (Hink and Ohmart Types 1 and 2). Spring inundation in these forest types would decrease from 2,601 acre-days in the No Action Alternative to 542 acre-days in E-3. However, compared to the No Action Alternative with similar 2,000 cfs diversions to the LFCC, the number of acres of inundation would be 18% greater in E-3.

Action Alternative I-1

Alternative I-1 included carry-over of up to 20,000 AF of native water at Abiquiu. The analysis included an estimate of the potential benefit of partial use of carry-over storage if it were used to augment peak flows and provide additional hydrological support for riparian habitats during prolonged dry periods. The results of this study show that the use of carry-over of native water storage in Abiquiu Reservoir under this alternative would provide coverage for zero-flow days in the Central Section, but does not support the less than 100 cfs flows in the Central Section. This Alternative also does not support the less than 100 cfs flows in San Acacia at any significant level (**Table L-3.** and **Figure L-3.7**).

Rio Chama Section

Alternative I-1 would have a profound effect on the riparian vegetation of the Rio Chama Section. The percent of years and average acres receiving overbank flooding would remain the same in this alternative as in the No Action Alternative. **Figure L-3.10** and **Figure L-3.18** show that the duration of inundation would increase significantly, resulting in an over 2,000% change from No Action. It is not clear if these increases in inundation duration would be beneficial to native species or if the duration would exceed the physiological ability of cottonwoods to grow with anoxic root conditions.

Because native vegetation dominates only a small proportion (21%) of Types 1, 3, and 5 vegetation in this section, the study examined the alternatives for impacts to hydrological support in areas dominated by native vegetation. The results for the Rio Chama Section (**Figure L-3.11**) show that Alternative E-3 would adversely affect native vegetation types significantly by reducing the total days of inundation in this valuable habitat compared to the No Action Alternative. The increased acre-days of inundation would benefit primarily exotic species and result in long-term loss of native plant communities.

Table L-3.10 Impacts of Alternative I-1 on Riparian Habitat Measures Compared to No Action Alternative

Measure	Rio Chama Section	% Change Compared to No Action	Central Section	% Change Compared to No Action	San Acacia Section	% Change Compared to No Action with Zero Diversions to LFCC*	% Change Compared to No Action with Equal Diversions to LFCC*
Acre-days of spring overbank flooding	3,004	164.2%	8,255	8.0%	111,901	-15.3%	Not modeled
Average annual acre-days in H&O Types 1 and 2	39	1,460.0%	2,050	8.4%	2,129	-18.1%	Not modeled
Average annual acre-days in H&O Types 3 and 5	902	2,121.7%	2,929	7.2%	80,685	-14.9%	Not modeled

Measure	Rio Chama Section	% Change Compared to No Action	Central Section	% Change Compared to No Action	San Acacia Section	% Change Compared to No Action with Zero Diversions to LFCC*	% Change Compared to No Action with Equal Diversions to LFCC*
Average annual acre-days in Service Type 2	782	2,072.2%	3,959	7.8%	65,491	-14.1%	Not modeled
Average annual acre-days in Service Type 3	272	2,166.7%	1,434	7.1%	12,156	-15.6%	Not modeled
Mean annual maximum acres of overbank flooding	147	0.0%	303	16.5%	2,601	-51.4%	-3%
Percent years of spring overbank flooding	93	0.0%	53	5.0%	95	-5.0%	Not modeled

* Diversion to the LFCC would be capped at 0, 500, 1,000, or 2,000 cfs, depending on the alternative. Not all possible diversions were modeled using FLO-2D.

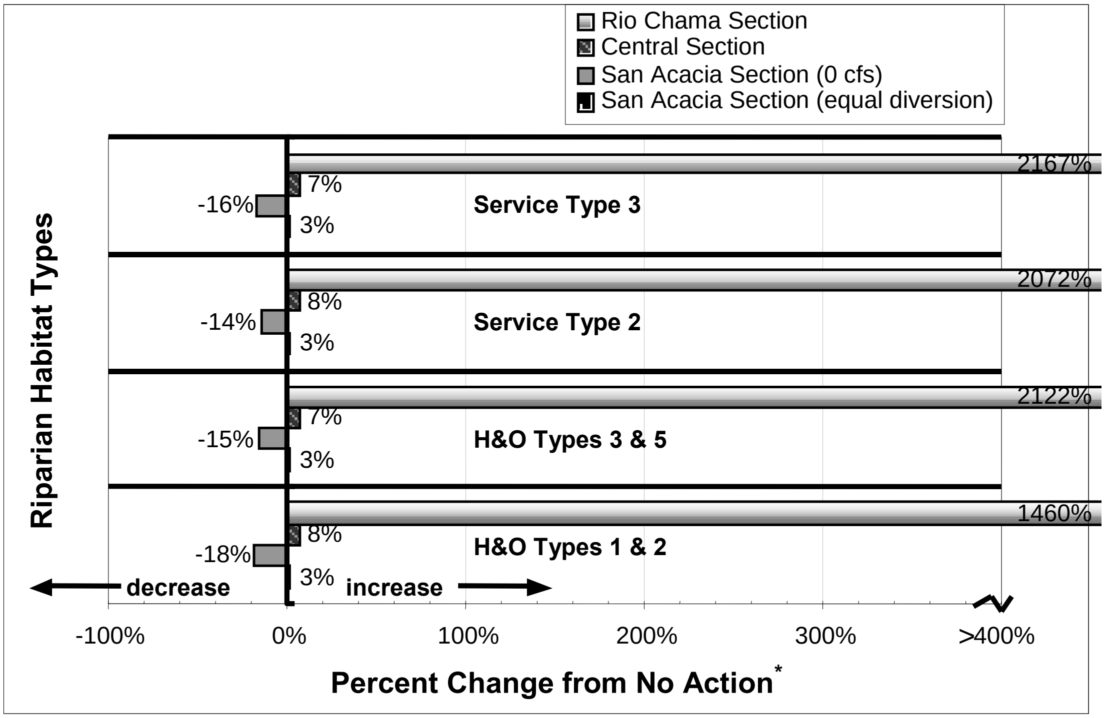


Figure L-3.18 Impact of Alternative I-1 (0–500 cfs diversion) on Riparian Habitat Support.

* No Action has variable diversions to LFCC of 0–2,000 cfs

Central Section
In the Central Section, Alternative I-1 would produce slight increases in all measures of riparian health compared to No Action. This includes a 16% increase in mean annual maximum acres of overbank flooding and an increase in the frequency of overbank flooding. Improvements would be slight and would be in all valuable types of riparian vegetation in equal measure. The observed change is small, as shown in **Figure L-3.18**, but is consistent across all valuable riparian habitat measures.

San Acacia Section
Alternative I-1 would have a moderate adverse effect on the San Acacia Section, primarily in the reduced mean annual maximum acres of overbank flooding. This area of overbank flooding would decrease by 51% compared to the No Action Alternative with zero diversions to the LFCC, as shown in **Table L-3.** and **Figure L-3.18**. When compared to No Action with similar levels of diversion, in this case a cap of 500 cfs, Alternative I-1 is the same as the No Action Alternative. Decreased hydrological support of mature cottonwood forest types (Hink and Ohmart Types 1 and 2) and intermediate vegetation structures (Types 3 and 4) would range from 15 to 18% compared to No Action with zero diversions, levels that also fall inside the margins of error for the study and are therefore not significant.

Action Alternative I-2

Alternative I-2 included carry-over of up to 75,000 AF of native water at Abiquiu. The analysis included an estimate of the potential benefit of partial use of carry-over storage if it were used to augment peak flows and provide additional hydrological support for riparian habitats during prolonged dry periods. The results of this study show that the potential effects of carry-over of native water storage at Abiquiu Reservoir are only somewhat supportive. Both zero and less than 100 cfs flows in the Central Section are fully covered under this alternative, but only about 60% of the less than 100 cfs flows are supported in the San Acacia Section (**Table L-3.** and **Figure L-3.7**).

Table L-3.11 Impacts of Alternative I-2 on Riparian Habitat Measures Compared to No Action Alternative

Measure	Rio Chama Section	% Change Compared to No Action	Central Section	% Change Compared to No Action	San Acacia Section	% Change Compared to No Action with Zero Diversions to LFCC*	% Change Compared to No Action with Equal Diversions to LFCC*
Acre-days of spring overbank flooding	2,450	115.5%	7,424	-2.9%	91,773	-30.5%	Not modeled
Average annual acre-days in H&O Types 1 and 2	28	1,020.0%	1,827	-3.4%	1,861	-28.5%	Not modeled
Average annual acre-days in H&O Types 3 and 5	692	1,604.4%	2,678	-2.0%	65,443	-31.0%	Not modeled
Average annual acre-days in Service Type 2	599	1,563.9%	3,575	-2.6%	50,871	-33.3%	Not modeled
Average annual acre-days in Service Type 3	210	1,650.0%	1,307	-2.4%	10,814	-25.0%	Not modeled
Mean annual maximum acres of overbank flooding	125	-15.0%	268	3.1%	2,464	-54.0%	32%
Percent years of spring overbank flooding	90	-2.7%	50	0.0%	90	-10.0%	Not modeled

* Diversion to the LFCC would be capped at 0, 500, 1,000, or 2,000 cfs, depending on the alternative. Not all possible diversions were modeled using FLO-2D.

Rio Chama Section
Alternative I-2 would have a profound effect on the riparian vegetation of the Rio Chama Section. The percent of years and average acres receiving overbank flooding would decrease slightly but not significantly compared to the margins of error for the study, as shown in **Table L-3.** and **Figure L-3.19**. However, the duration of inundation would increase significantly, resulting in changes in acre-days of inundation of 115% and increased inundation of Hink and Ohmart Types 1 and 2 vegetation and Types 3 and 5 vegetation of 1,020% and 1,604%, respectively. Duration of the spring inundation would be beneficial to native species as long as it does not exceed the physiological ability of cottonwoods to grow with anoxic root conditions.

Because native vegetation dominates only a small proportion (21%) of Types 1, 3, and 5 vegetation in this section, the study examined the alternatives for impacts to hydrological support in vegetation dominated by native vegetation. The results for the Rio Chama Section (**Figure L-3.11**) show that Alternative I-2 would inundate native vegetation types with nearly the same number of total inundation days during the 40-year period of study. This would result in a neutral effect to this valuable habitat compared to the No Action Alternative. The slight increase in total acre-days of inundation would benefit both native and exotic plant communities in approximately the same way as the No Action Alternative.

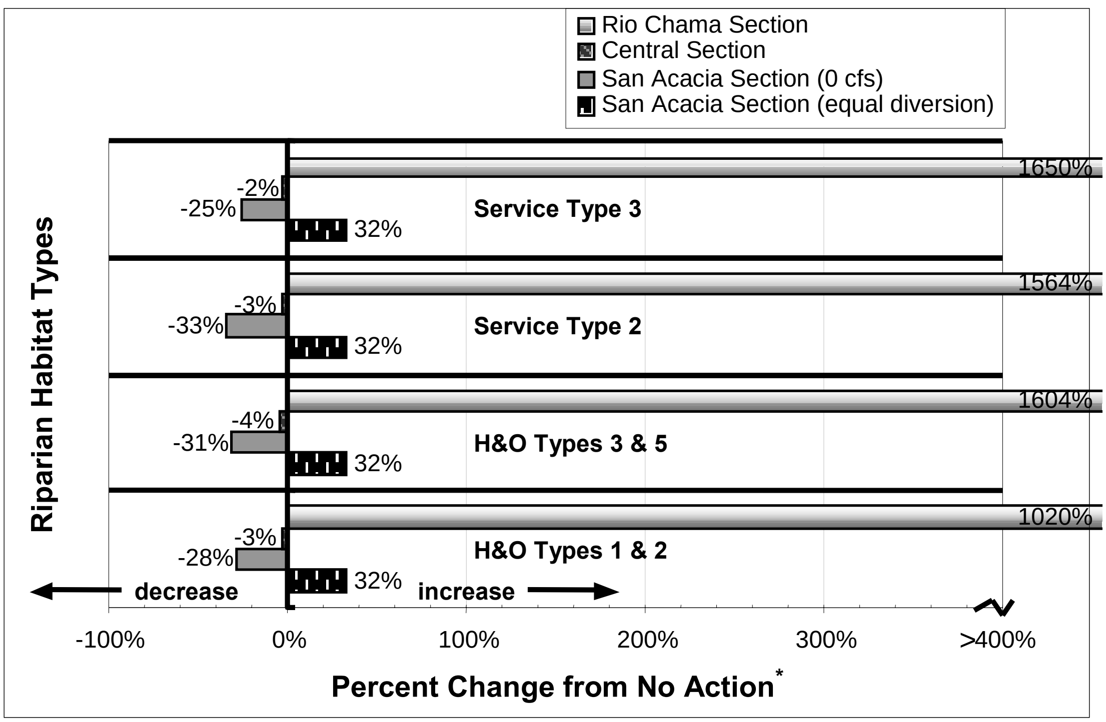


Figure L-3.19 Impact of Alternative I-2 (0–1,000 cfs diversion) on Riparian Habitat Support.

* No Action has variable diversions to LFCC of 0–2,000 cfs

Central Section
In the Central Section, Alternative I-2 has a neutral effect on riparian habitats and is virtually indistinguishable from the No Action Alternative. No change would be anticipated for the Central Section riparian vegetation (**Table L-3.** and **Figure L-3.19**). Current trends in vegetation would be expected to continue with this alternative.

San Acacia Section
Alternative I-2 would have an adverse effect on the San Acacia Section compared to the No Action Alternative with zero diversions to the LFCC (**Figure L-3.19**). Decreased hydrological support (28%) of mature cottonwood forest of Hink and Ohmart Types 1 and 2 and 31% decrease in support of Hink and Ohmart Types 3 and 5 compared to No Action with zero diversions would be significant and adverse. This area of overbank flooding would decrease by 54%, and the acre-days of spring overbank flooding would decrease by over 30%. However, compared to No Action with similar levels of diversion, in this case a cap of 1,000 cfs, Alternative I-2 would actually increase the mean annual maximum acres of inundation by 32% and probably result in some general riparian improvements.

<u>Action Alternative I-3</u>

Alternative I-3 included carry-over of up to 180,000 AF of native water at Abiquiu. The analysis included an estimate of the potential benefit of partial use of carry-over storage if it were used to augment peak flows and provide additional hydrological support for riparian habitats during prolonged dry periods. The results of this study show that the potential beneficial effects of carry-over of native water storage at Abiquiu Reservoir under Alternative I-3 ranks second among all alternatives. This alternative fully offsets any low- or zero-flow days in the Central Section. It also covers about 90% of low-flow days in the San Acacia Section (**Table L-3.** and **Figure L-3.7**).

Rio Chama Section
Alternative I-3 would probably result in improvements in riparian habitat in the Rio Chama Section compared to the No Action Alternative (**Table L-3.** and **Figure L-3.20**). The mean annual maximum acres of inundation would decrease slightly, from 147 to 108 acres, but the expected inundation in the most valuable habitat types would increase substantially, though not so much that it would lead to declines. For example, the acre-days of inundation in Hink and Ohmart Types 1 and 2 would increase by 780%, an amount that would probably be well-tolerated by the mature cottonwood forests represented by these types. Support of Hink and Ohmart Types 3 and 5 would increase by 1,227%, a level that would lead to habitat improvements. The percent of years receiving overbank flooding would decrease slightly, but not significantly compared to the margins of error for the study.

Because native vegetation dominates only a small proportion (30%) of Types 1, 3, and 5 vegetation in this section, the study examined the alternatives for impacts to hydrological support in areas dominated by native vegetation. The results for the Rio Chama Section (**Figure L-3.11**) show that Alternative I-3 would adversely affect native vegetation types significantly by reducing the total days of inundation in this valuable habitat compared to the No Action Alternative. The increased acre-days of inundation would benefit primarily exotic species and result in long-term loss of native plant communities.

Table L-3.12 Impacts of Alternative I-3 on Riparian Habitat Measures Compared to No Action Alternative

Measure	Rio Chama Section	% Change Compared to No Action	Central Section	% Change Compared to No Action	San Acacia Section	% Change Compared to No Action with Zero Diversions to LFCC*	% Change Compared to No Action with Equal Diversions to LFCC*
Acre-days of spring overbank flooding	2,073	82.3%	6,886	-9.9%	60,994	-53.8%	Not modeled
Average annual acre-days in H&O Types 1 and 2	22	780.0%	1,696	-10.4%	992	-61.9%	Not modeled
Average annual acre-days in H&O Types 3 and 5	539	1,227.6%	2,495	-8.7%	44,663	-52.9%	Not modeled
Average annual acre-days in Service Type 2	467	1,197.2%	3,319	-9.6%	36,903	-51.6%	Not modeled
Average annual acre-days in Service Type 3	163	1,258.3%	1,219	-9.0%	6,470	-55.1%	Not modeled
Mean annual maximum acres of overbank flooding	108	-26.5%	241	-7.3%	1,645	-69.3%	55%
Percent years of spring overbank flooding	88	-5.4%	48	-5.0%	90	-10.0%	Not modeled

* Diversion to the LFCC would be capped at 0, 500, 1,000, or 2,000 cfs, depending on the alternative. Not all possible diversions were modeled using FLO-2D.

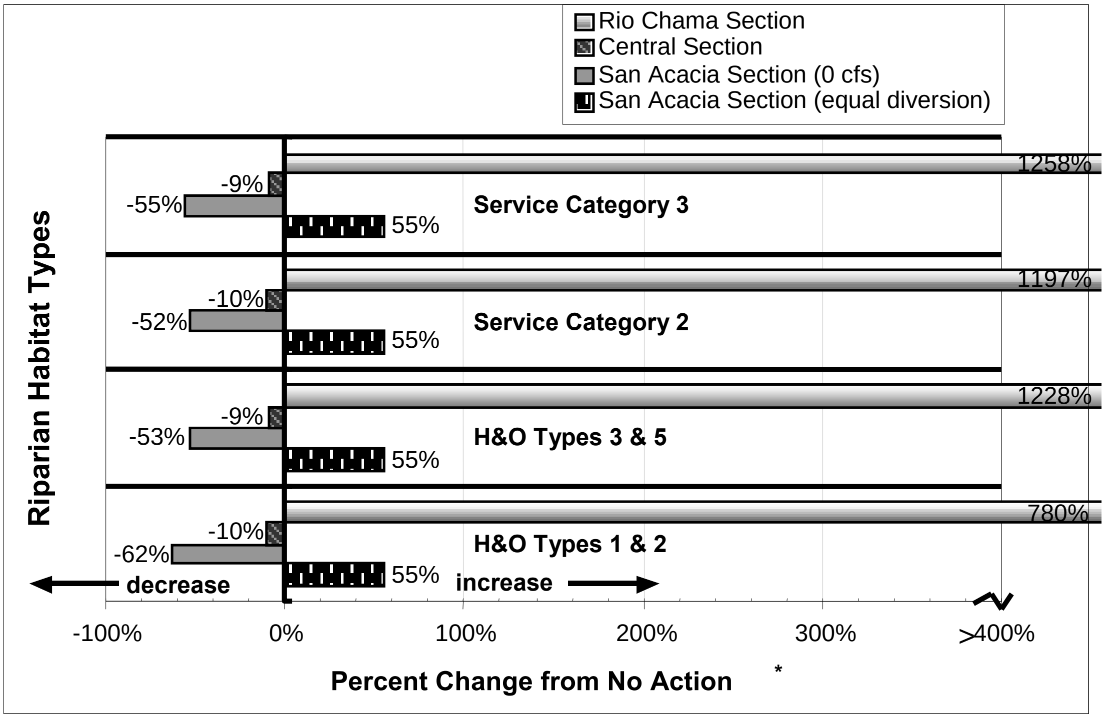


Figure L-3.20 Impact of Alternative I-3 (0–2,000 cfs diversion) on Riparian Habitat Support.

* No Action has variable diversions to LFCC of 0–2,000 cfs.

Central Section

In the Central Section, Alternative I-3 shows slight decreases in most measures of riparian health. As shown in **Table L-3.**, most riparian measures would be approximately 5–10% less with this action alternative than with No Action. These changes are significant and adverse, given the long-term trends of this river section. Current adverse trends in vegetation would be expected to continue with this alternative.

San Acacia Section

Alternative I-3 would have an adverse effect on the San Acacia Section compared to the No Action Alternative with zero diversions to the LFCC (**Figure L-3.20**). Decreased hydrological support of mature cottonwood forest of Hink and Ohmart Types 1 and 2 of nearly 62% would be expected with this alternative. In addition, a 53% decrease in support of Hink and Ohmart Types 3 and 5 would be expected compared to No Action with zero diversions. These changes would be significant and adverse. Overbank flooding in this area would decrease by 69%, and the acre-days of spring overbank flooding would decrease by nearly 54%. However, compared to No Action with similar levels of diversion, in this case a cap of 2,000 cfs, Alternative I-3 would increase the mean annual maximum acres of inundation by 55%.

Impacts of LFCC Diversions on Riparian Habitats in the San Acacia Section

Variable diversions to the LFCC in the San Acacia Section contribute most of the modeled impacts of the No Action and Action Alternatives. **Figure L-3.21** demonstrates that all modeled alternatives with diversions above zero would decrease the overbank inundation in the San Acacia Section.

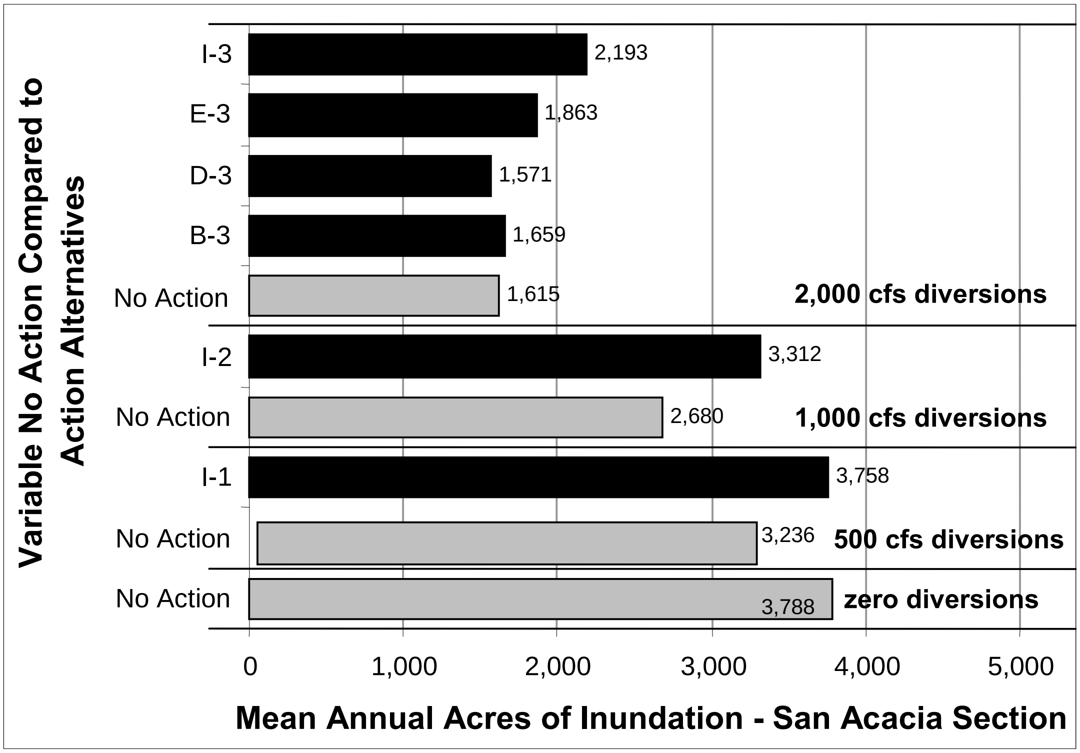


Figure L-3.21 Comparison of Impacts from Variable Diversions to the LFCC in the San Acacia Section.

Variation in the diversions to the LFCC for the No Action Alternative is very linear (**Figure L-3.13**). The No Action Alternative does not have flexibility in the form of upstream storage and changed channel capacity to moderate flows, retain flows, or augment low-flow years. The action alternatives show the effects of these additional flexibilities and can provide additional support to the San Acacia Section riparian resources. This support is shown in **Figure L-3.21**, which compares each action alternative to the No Action with equal diversions to the LFCC. All action alternatives except D-3 show relative improvements in overall hydrologic support to San Acacia Section vegetation (and associated wildlife) compared to the No Action Alternative with similar diversions to the LFCC.

The No Action Alternative and Alternatives I-1 or I-2 with diversion ranges of 0 to 1,000 cfs provide around 3,000 mean annual acres of inundation to support riparian vegetation in this section. At 2,000 cfs diversion to the LFCC, Alternatives B-3 and D-3 provide hydrologic support similar to or lower than the No Action at 2,000 cfs, but only approximately 1,500 mean annual acres are affected. Alternatives E-3 and I-3 show respectively higher levels of support than the No Action, with inundation in approximately 2,000 mean annual acres.

Although most of the action alternatives moderate the adverse effects of diversions to the LFCC on riparian resources, they provide much lower support compared to No Action without diversions. Only Alternatives I-1 and I-2 would provide overbank inundation sufficient to prevent long-term adverse effects to riparian vegetation should the LFCC operations be implemented in the future. These two alternatives would also provide additional groundwater to riparian areas that occur between the river channel and the LFCC, supporting vegetation in these areas.

Impacts of the Alternatives on Native Vegetation within Each River Section

The amount of hydrological support for distinct vegetation classifications that would be provided by each action alternative was shown in **Figure L-3.15** through **Figure L-3.20**. The relative impacts of the alternatives on vegetation communities in each river section (as total days of inundation) was detailed in **Figure L-3.11**, **Figure L-3.12**, and **Figure L-3.14**. As already discussed, only 20% of the total mapped acres in all river sections combined are purely native stands. Native dominance ranges from 28% in the Rio Chama and 21% in the Central Section to only 14% in the San Acacia Section. Determining which alternative is most beneficial *only* on the basis of total acres inundated does not address the question of support for purely native vegetation.

Annual acres inundated under each action alternative were compared to the No Action Alternative to determine the percent change from current annual acres inundated (**Table L-3.**). A chi-square goodness-of-fit analysis was performed to determine acre-days of inundation within all mapped acres (**Figure L-3.11**, **Figure L-3.12**, and **Figure L-3.14**). The chi-square residual was then used to determine how much of the average annual acre-days of inundation are actually supporting native vegetation as opposed to the 72 to 86% exotic acreage. Adjusted chi-square residuals <2 are not significant changes from No Action.

Rio Chama Section

The Rio Chama Section currently supports the highest percentage of native-dominated vegetation (28%) in the study area. There would be a significant increase in hydrological support of native species under all action alternatives. Alternative I-1 provides the best support in the Rio Chama Section, with a +2,052% change from acres inundated under No Action (χ^2=15,295; p=0.00). Alternative B-3 would provide the least support, but even this alternative shows a +247% improvement over the No Action Alternative.

Central Section

While only 21% of the Central Section is pure native vegetation, it contains the largest amount of desirable mature cottonwood gallery within the entire system studied. This river section requires the greatest hydrological support to inundate native communities. Examination of the chi-square analysis indicates that native acres inundated under Alternatives D-3 and I-2 do not vary significantly from No Action, and Alternative I-3 provides less support than No Action. All remaining action alternatives perform better than No Action; Alternative E-3 shows the greatest improvement, with a +19% change over No Action (χ^2=96, p=0.00).

San Acacia Section

This section contains only 14% native-dominated vegetation communities. The remaining 86% is predominantly salt cedar. Examination of the chi-square analysis indicates that significant decreases in inundation of native vegetation would occur in all action alternatives. Alternative B-3 is the poorest performer, with a –81% change from No Action. The best performer, Alternative I-1, is still at a significant –17% change from No Action (X^2=8,995 p=0.00).

Table L-3.13 Hydrological Support for Native-Dominated Vegetation under Each Alternative

Alternative	No Action Native Annual Acres Inundated	Native Annual Acres Inundated	Percent Change from No Action
RIO CHAMA SECTION			
Alt B-3	12	42	246.5%
Alt D-3	12	217	1678.1%
Alt E-3	12	160	1212.6%
Alt I-1	12	263	2052.0%
Alt I-2	12	206	1582.7%
Alt I-3	12	160	1207.5%
CENTRAL SECTION			
Alt B-3	1,306	1,504	15.2%
Alt D-3	1,306	1,314	0.6%
Alt E-3	1,306	1,552	18.8%
Alt I-1	1,306	1,404	7.5%

Alternative	No Action Native Annual Acres Inundated	Native Annual Acres Inundated	Percent Change from No Action
Alt I-2	1,306	1,279	-2.1%
Alt I-3	1,306	1,183	-9.4%
SAN ACACIA SECTION			
Alt B-3	3,826	724	-81.1%
Alt D-3	3,826	820	-78.6%
Alt E-3	3,826	749	-80.4%
Alt I-1	3,826	3165	-17.3%
Alt I-2	3,826	2838	-25.8%
Alt I-3	3,826	1617	-57.7%

3.4 *Wetland Resources and Designated and Natural Management Areas*

3.4.1 *Measures of Impacts on Wetlands and Designated and Natural Management Areas*

Discharge Duration: These measures assess wetland habitat impacts by the change in duration of the 25th and 75th percentile flows of the No Action condition. The elevation of the water table in wetlands within the floodway correlates with the surface water elevation in the channel. The duration of low flows (less than the 25th percentile) is a measure of the capability of river flow to maintain minimum groundwater levels in adjacent wetland. The duration of high flows (greater than the 75th percentile) is an indicator of inundation frequency of wetlands located on islands and in the overbank area. The duration of high flows also contributes to groundwater recharge and the stability of groundwater elevations.

Summary Data: Discharge frequencies were calculated from average monthly discharge data from URGWOM. The period of analysis included all 40 years of each model run but was limited to April 1 through September 30, an approximation of the regional growing season. **Table L-3.** gives the 25th- and 75th-percentile flows at selected gages in each river section under the No Action Alternative. The No Action Alternative in the San Acacia Section includes consideration of 0, 500, 1,000, and 2,000 cfs discharges to the LFCC. The 25th and 75th percentile flows shown for varying discharges to the LFCC are flows remaining in the river following diversion to the LFCC. Comparison of impacts from alternatives in this section requires comparison against a similar level of discharge to the LFCC.

Average Annual Acre-Days of Inundation Data: Designated wildlife management areas are found throughout the Project's watershed (**Table L-2.17**), and all require groundwater support. Their missions range from Alamosa NWR's "to support wetland and wildlife habitat" (Reach 1); to the Belen State Waterfowl Area, which provides forage and resting habitat to waterfowl (Reach 11); to the Bosque del Apache NWR, which has created 7,000 acres of wetlands vital to wildlife habitat (Reach 14). Representative wetland vegetation includes cattail marshes and the saltgrass meadows found in emerging wetlands. Hydrologic support of wetland areas would, by default, generally support Hink and Ohmart's categories of marsh or saltgrass meadow. Therefore, average annual acre-days of inundation in marsh and meadow habitats is used herein as a surrogate for support of designated and natural management areas.

3.4.1.1 Impact Analysis on Wetlands and Designated and Natural Management Areas

The duration (days) of flows that were less than or greater than these reference flows were calculated for all action alternatives by river section (**Table L-3.** and **Table L-3.**). Because the Rio Chama Section is influenced by flow from two discrete drainages, durations calculated at the Chamita and Otowi gages were averaged to characterize this section. The Chamita gage contributes about one third of the total flow at Otowi.

Table L-3.14 River Flows for the No Action Alternative at Selected Frequencies (April–September)

Section	Gage	25th Percentile Flow (cfs)	75th Percentile Flow (cfs)
Rio Chama Section	Chamita	394	1095
Rio Chama Section	Otowi	867	2,343
Central Section	Central Avenue	360	1,908
San Acacia Section	San Acacia		
LFCC = 0 cfs		41	1,756
LFCC = 500 cfs		104	1,233
LFCC = 1,000 cfs		128	733
LFCC = 2,000 cfs		128	250

Table L-3.15 Duration (Days) with Flow Less than the 25th-Percentile Discharge of No-Action Hydrograph

Section	No Action	B-3	D-3	E-3	I-1	I-2	I-3
Rio Chama Section							
Rio Chama-Chamita	1830	2074 (+13%)	1952 (+7%)	2013 (+10%)	1983 (+8%)	1922 (+5%)	2013 (+10%)
Rio Chama-Otowi	1830	1922 (+5%)	1891 (+3%)	1891 (+3%)	1891 (+3%)	1922 (+5%)	1891 (+3%)
Central Section	1830	1853 (+1%)	1845 (+1%)	1835 (0%)	1875 (+2%)	1877 (+3%)	1853 (+1%)
San Acacia Section							
LFCC = 500 cfs	1830						
LFCC = 1,000 cfs	1830				1854 (+1%)	1852 (+1%)	
LFCC = 2,000 cfs	1830	1827 (0%)	1859 (+2%)	1840 (+1%)			1851 (+1%)
Mean	1830	1884 (+3%)	1872 (+2%)	1869 (+2%)	1883 (+3%)	1884 (+3%)	1878 (+3%)
Proportion of No Action duration	1.00	0.97	0.98	0.98	0.97	0.97	0.97

Note: Values in parentheses are the percent change from the No Action duration.

Table L-3. summarizes the duration of flows less than the 25th percentile flow and the percent change from the No Action duration at the reference flow. Durations that are appreciably greater than those of the No Action Alternative indicate that river flows are lower for a longer period and may adversely affect the minimum groundwater level in wetlands adjacent to the river channel. Generally, durations differed significantly (>10%) from the No Action Alternative only in the Rio Chama Section for Alternatives B-3, E-3, and I-3. This difference is largely attributed to the combined effects of Heron Reservoir waivers, native conservation water storage at Abiquiu Reservoir, and changes in channel capacities below Abiquiu Reservoir. Below the confluence of the Rio Chama with the Rio Grande, with flows measured at Otowi gage, flow differences decrease to less than 5%, dampened by the two-thirds greater flow volume along the mainstem of the Rio Grande.

The proportional difference from the No Action duration was used to evaluate the alternatives, with a greater duration of low flows being the less desired condition. The Rio Chama Section score weighted the Chamita gage equal to one-third and the Otowi gage equal to two-thirds based on proportion of flow. Thereafter, each section was weighted equally to determine the index value in the Decision Matrix.

Overall, there was no significant difference in duration of days with flows less than 25% of those expected under No Action.

Table L-3. summarizes the duration of flows greater than the 75th percentile flow and the percent change from the No Action duration at the reference flow. Durations that are significantly less than those of the No Action alternative indicate that river flows are less likely to inundate wetlands within the floodway.

Upstream storage appears to have the greatest impact on 75th-percentile flows along the Rio Chama, with alternatives B-3, D-3, E-3, and I-3 all showing decreases in duration of higher flows ranging from 37 to 39%. Alternatives I-1 and I-2 show proportionately lesser impacts of storage due to limitations on storage capacity imposed by the alternative. These proportional differences are dampened by the time the Rio Chama flows into the Rio Grande. The 75th percentile flows decrease by only 12% for Alternatives D-3, E-3, and I-3. The 75th percentile flows at Otowi are higher than expected for Alternative B-3, probably due to a higher duration of high-flow days casued by the lesser channel capacity below Abiquiu allowed under this alternative. Changes in 75th percentile flows at Otowi are insignificant for Alternatives I-1 and I-2. Changes in 75th percentile flows in the Central Section are similar to those observed at Otowi, with the exceptions of Alternatives B-3 and E-3, which offer higher channel capacities below Cochiti. Flows among alternatives for the San Acacia section were compared to the corresponding LFCC diversion for No Action. Typically, alternatives with higher upstream storage and higher channel capacities offered 13 to 18% greater durations of higher flow days. There were no significant differences in 75th-percentile flows at San Acacia under Alternatives I-1 and I-2.

The proportional difference from the No Action duration was used to evaluate the alternatives, with a greater duration of higher flows being the desired condition. The Rio Chama Section score weighted the Chamita gage equal to one-third and the Otowi gage equal to two-thirds based on proportion of flow. Thereafter, each section was weighted equally to determine the index value in the Decision Matrix. All alternatives were within 6% of the higher flow durations expected under No Action. Despite the slightly lesser performance in duration of 75th percentile flows under Alternative E-3, this alternative offers the maximum peak flows attained in the San Acacia and Central Sections compared to any other alternative due to the increased channel capacity below Cochiti.

Table L-3.16 Duration (Days) with Flow Greater than 75th-Percentile Flow for the No Action Hydrograph

Section	No Action	B-3	D-3	E-3	I-1	I-2	I-3
Rio Chama Section							
Rio Chama–Chamita	1830	1129 (-38%)	1129 (-38%)	1129 (-38%)	1769 (-3%)	1464 (-20%)	1159 (-37%)
Rio Grande–Otowi	1830	1739 (-5%)	1617 (-12%)	1617 (-12%)	1800 (-2%)	1769 (-3%)	1617 (-12%)
Central Section	1830	1647 (-9%)	1586 (-13%)	1556 (-15%)	1769 (-3%)	1739 (-5%)	1617 (-12%)
San Acacia Section							
LFCC = 0 cfs	1830	2074 (+13%)	2166 (+18%)	2166 (+18%)	1830 (0%)	1891 (+3%)	2166 (+18%)
LFCC = 500 cfs	1830						
LFCC = 1,000 cfs	1830						
LFCC = 2,000 cfs	1830						
Mean	1830	1753(-4%)	1736 (-5%)	1726 (-6%)	1796 (-2%)	1766 (-3%)	1750 (-4%)
Proportion of No Action Duration	1.00	0.96	0.95	0.94	0.98	0.97	0.96

Note: Values in parentheses are the percent change from the No Action duration.

No Action

The No Action Alternative would continue operations largely unchanged, but would allow for diversions up to 2,000 cfs in the LFCC with improved intra-agency coordination for flood control and delivery of water downstream. The No Action Alternative best supports wetlands in the Rio Chama and Central Sections because it provides the highest river flows and stores the least water in upstream reservoirs. As shown in the groundwater elevation maps along the San Acacia Section (**Figure L-3.22** to **Figure L-3.28**), active diversions to the LFCC under No Action better support wetland resources west of the Rio Grande and adjacent to the LFCC because they support higher and more stable groundwater elevations and increase the areal extent of high water table conditions during the April 1 to September 30 period. LFCC diversions greater than 1,000 cfs cause groundwater elevations to decrease and result in steeper groundwater elevation declines east of the Rio Grande. Operation of the LFCC has the potential to shift the extent and location of wetland resources supported, especially in the southern areas of the section near Fort Craig.

As shown on **Figure L-3.29** (GIS-based analysis), the areal extent of wetlands is anticipated to be maximal under LFCC diversions near 1,000 cfs. This level of diversion supports approximately 16,500 acres of wetlands along the east side of the river as well as adjacent to the LFCC structure. Zero diversion to the LFCC supports about 14,500 acres but does not support wetlands on the west side of the river. The 2,000 cfs diversions to the LFCC support about 13,100 acres of wetlands but draw water away from wetlands east of the river.

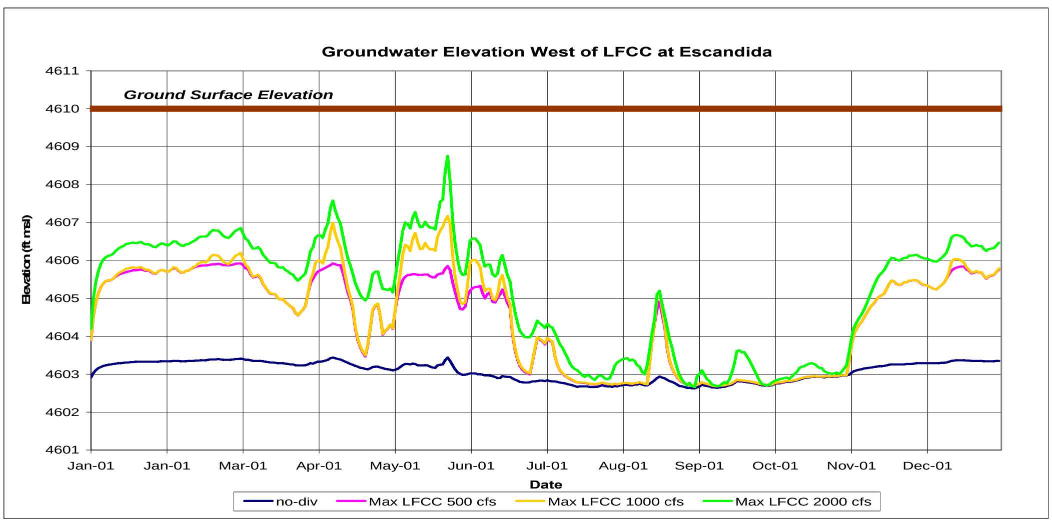


Figure L-3.22 Modeled Seasonal Groundwater Elevations at a Cross Section West of LFCC at Escondida With Variable LFCC Diversions.

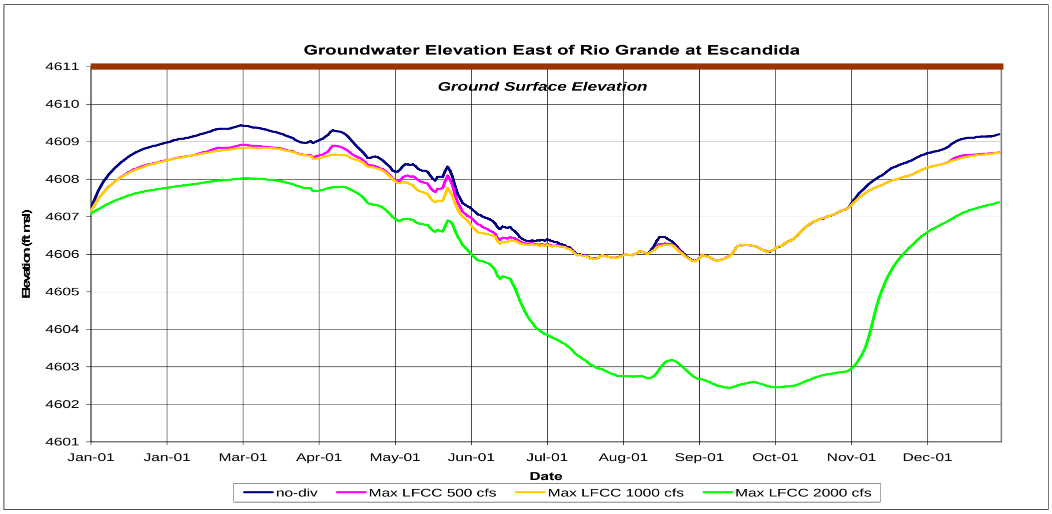


Figure L-3.23 Modeled Seasonal Groundwater Elevations at a Cross Section East of The Rio Grande at Escondida With Variable LFCC Diversions.

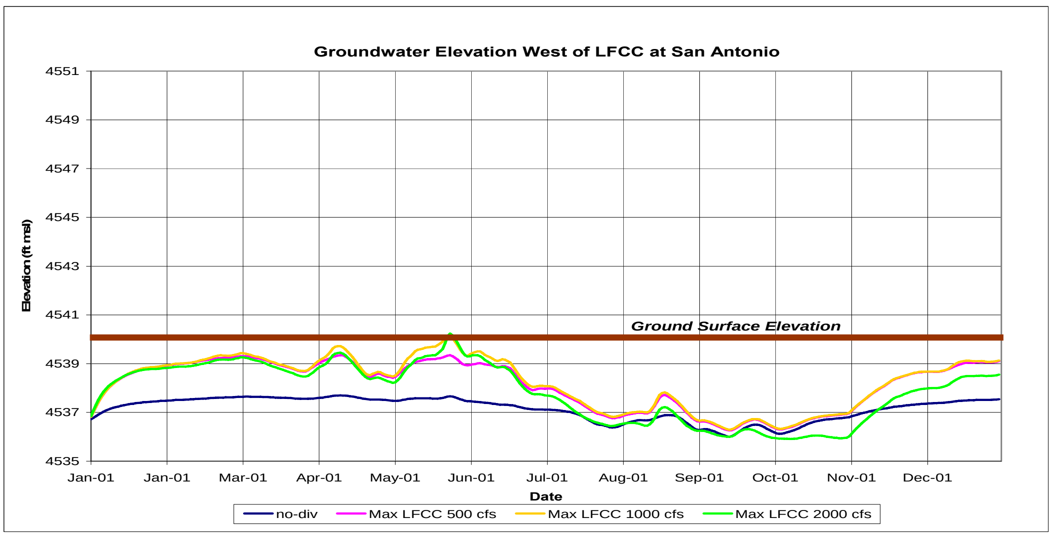


Figure L-3.24 Modeled Seasonal Groundwater Elevations at a Cross Section West of LFCC at San Antonio, With Variable LFCC Diversions.

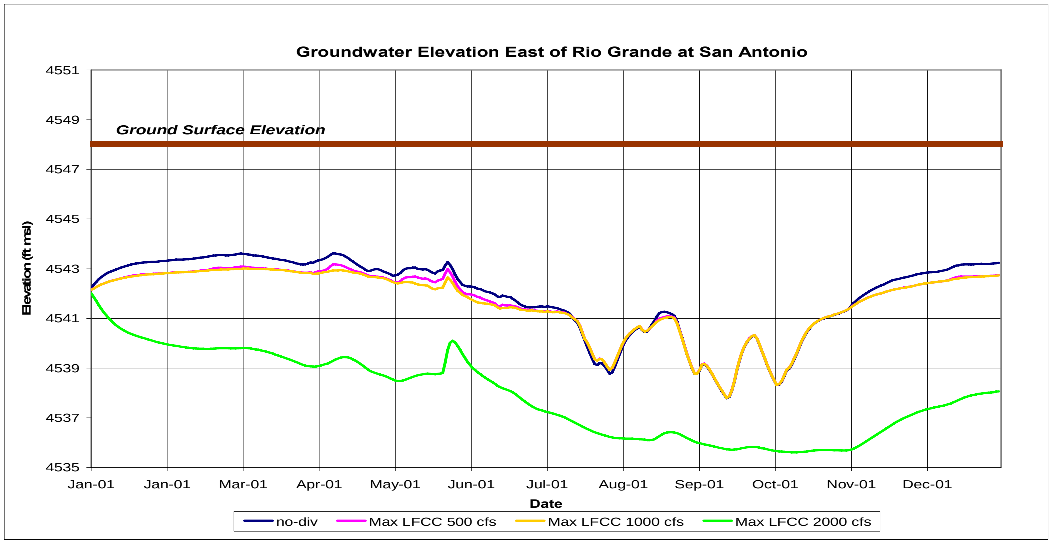


Figure L-3.25 Modeled Seasonal Groundwater Elevations at a Cross Section East of the Rio Grande at San Antonio, With Variable LFCC Diversions.

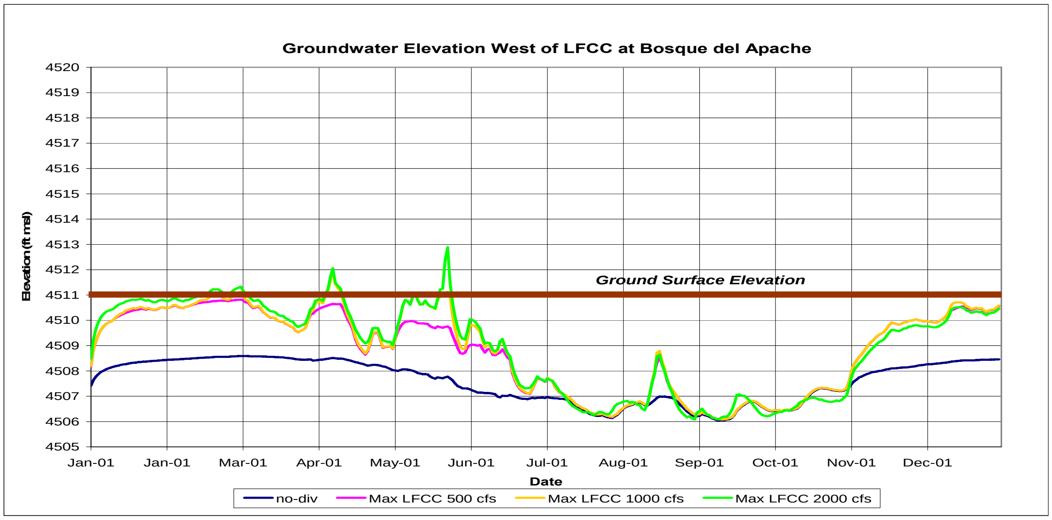


Figure L-3.26 Modeled Seasonal Groundwater Elevations at a Cross Section West of the LFCC at Bosque Del Apache NWR, With Variable LFCC Diversions.

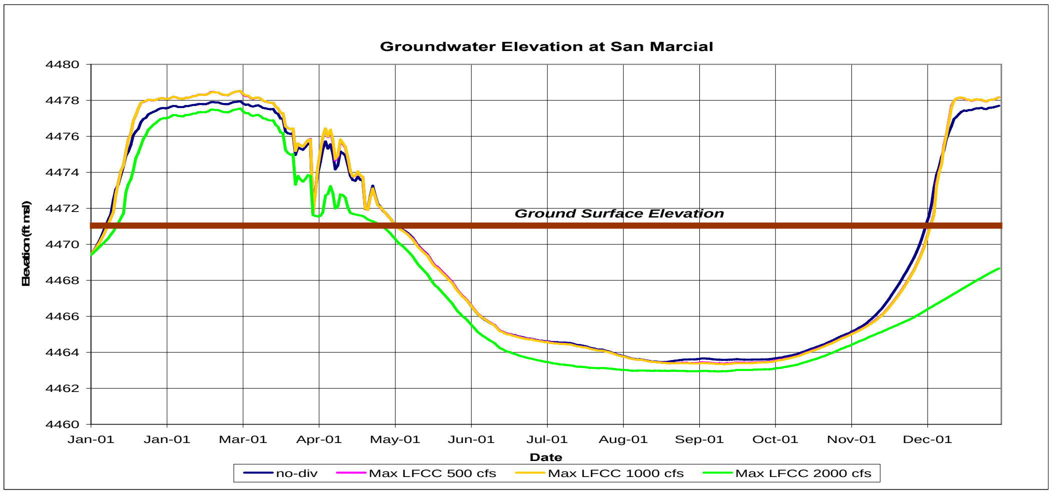


Figure L-3.27 Modeled Seasonal Groundwater Elevations at a Cross Section West of the LFCC at San Marcial, With Variable LFCC Diversions.

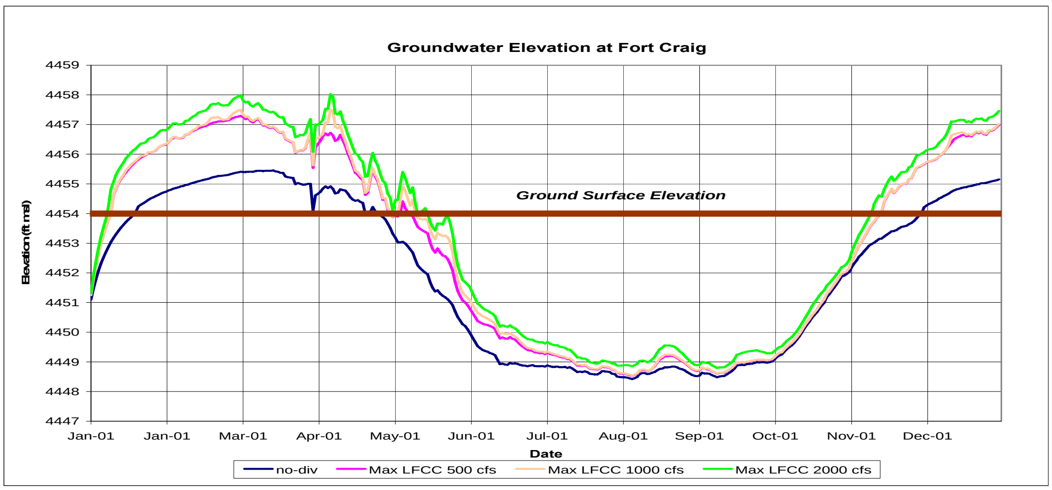


Figure L-3.28 Modeled Seasonal Groundwater Elevations at a Cross Section West of the LFCC at Fort Craig, With Variable LFCC Diversions.

Action Alternatives B-3, D-3, E-3, and I-3

These four alternatives showed very similar effects in both trend and magnitude in the three affected river sections. Features in common among these four alternatives include up to 180,000 AF of annual storage at Abiquiu Reservoir and up to 2,000 cfs diversion to the Low Flow Conveyance Channel. The four alternatives differed in terms of Heron waiver dates and channel capacities below Abiquiu and Cochiti Dams. Alternatives with increases in channel capacity typically had increased peak flows and 75th percentile flows at gages within and downstream of the channel section with the higher capacity. Performance of these alternatives was compared to performance under No Action with 2,000 cfs diversions to the LFCC.

Low-Flow Duration

Each of the four alternatives exhibited small (+3% to +4%) increases in the duration of low (less than the 25th percentile) flows. These slight changes in discharge duration would not appreciably affect the minimum ground water levels in wetlands within the floodway.

In both the Central and San Acacia Sections, changes in low-flow duration were negligible (0% to +4%) among the four action alternatives. In the Rio Chama section, however, the duration of low flows increased from 8% to 10% among these alternatives. While this changes is greater than changes in the other sections, it does not quite reach the threshold for a significant impact (10%). The storage of native water at Abiquiu Reservoir is the activity that most likely explains the observed increase in low-flow durations in the Rio Chama section; Rio Grande mainstem flows dampen these effects, as observed in data from the Otowi gage, extending downstream to the Central and San Acacia Sections.

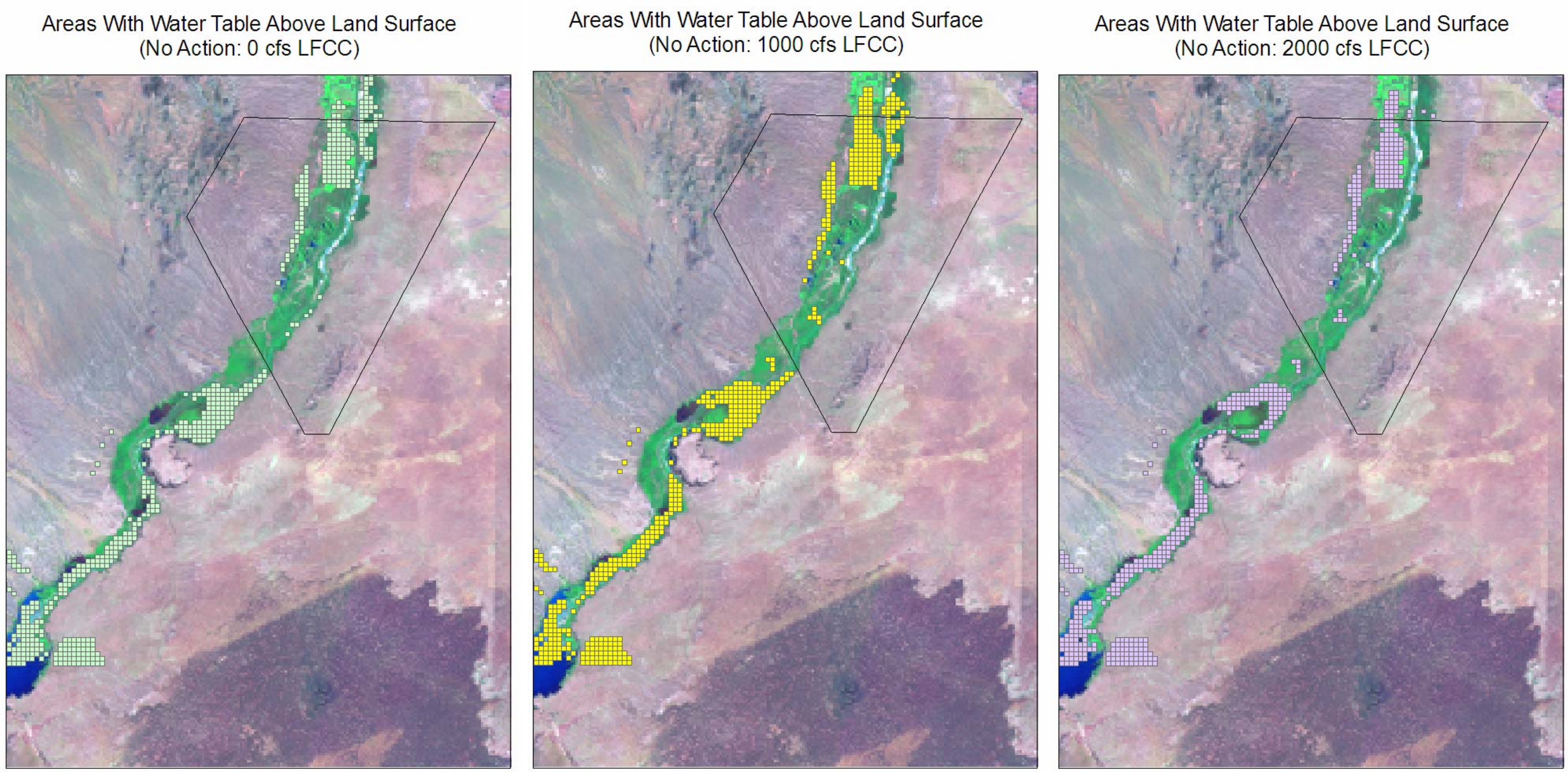


Figure L-3.29 GIS Spatial Analysis: Water Table Greater Than Land Surface from Bosque Del Apache NWR to Elephant Butte Reservoir.

High-Flow Duration
Alternatives, B-3, D-3, E-3, and I-3 all reduced the duration of high flows in the Rio Chama Section by 37% to 38%, reflecting the impact of upstream storage. This reduction in the frequency and magnitude of flow would likely reduce the frequency, duration, or extent of inundation in wetlands within the floodway. As was observed for the low-flow durations, storage effects along the Rio Chama are dampened below the confluence with the Rio Grande. The impacts at Otowi gage are reduced, differing only 5–12% from No Action. Alternative B-3, with a lesser channel capacity below Abiquiu, offers the potential for sustained higher flow durations due to an extended period of time needed to move water from upstream storage. Central Section impacts are similar to those observed at Otowi. Flows in the San Acacia Section increased by 13–18% for the high-storage alternatives. Overall, the duration of the 75th percentile discharge of the No Action hydrograph was reduced by 4% to 6% in Alternatives B-3, D-3, E-3, and I-3 (**Table L-3.17**).

The impact of LFCC diversions under these alternatives would mimic the effects shown under No Action at 2,000 cfs. The magnitude and location of wetlands support changes with operation of the LFCC. Areas immediately adjacent and parallel to the LFCC are increasingly supported by operation of the LFCC, resulting in higher groundwater elevations and longer durations of high water tables. The areal extent of wetlands near the LFCC would advance. Areas east of the Rio Grande would be adversely affected by diversions of 2,000 cfs as groundwater elevations decline and move below the root zone (**Table L-2.8**).

Action Alternative I-1

Overall, this alternative exhibited the least change from the No Action Alternative. Alternative I-1 includes up to 20,000 AF annual storage in Abiquiu Reservoir and LFCC diversions up to 500 cfs. Low-flow durations increased by 8% in the Rio Chama Section, but were less than 3% in other river sections. There was no significant change in the duration of high flows when considering all sections individually or combined. Wetlands in the San Acacia Section east of the Rio Grande would see no significant changes, with a slight increase in wetlands support expected along the LFCC based on limited diversions.

Action Alternative I-2

This alternative included moderate levels of both storage at Abiquiu Reservoir (up to 75,000 AF annually) and LFCC diversions (up to 1,000 cfs). The increase in duration of low flows—and, therefore, the potential for impact on wetland resources—was relatively small among river sections (1% to 5%) and overall (3%).

The duration of high flows was decreased by 20% only in the Rio Chama Section, presumably related to the intermediate level of storage in Abiquiu Reservoir. No other significant changes in high flows were observed under this alternative. Similar to the No Action at 1,000 cfs diversions to the LFCC, wetlands in the San Acacia Section would be enhanced adjacent to and along the LFCC, and supported with no significant changes in areas east of the Rio Grande.

Designated and Natural Management Areas

It is important to note that though many management areas lie along the Rio Grande, large portions are outside of the levees mapped for this review and EIS. The vegetation surveys show that between 3% and 5%of mapped acreage represents this important habitat type (**Table L-3.17**). However, marsh and wetland habitats extend into the floodplain adjacent to the direct footprint of potential water management changes. Appropriate hydrological support would therefore sustain and improve a larger amount of acres than those represented by the 2002–2004 surveys.

The Rio Chama Section supports the smallest acreage of marsh and wetland habitat, 18% of the total in the Project Area, followed by the Central Section with approximately 30% of the marsh acreage in the Project Area, while the San Acacia Section contains over half of the studied marsh and wetland habitats. As shown in **Table L-3.17** and **Figure L-3.30**, Alternative I-1 provides the best hydrological support throughout the Project Area. The No Action Alternative exhibits the largest number of average annual acre-days of inundation in the San Acacia Section, but is basically neutral in the Central Section and performs poorest of all alternatives in the Rio Chama, where this vital habitat type is most in need of continued support.

Table L-3.17 Average Annual Acre-Days of Inundation, by Alternative, for Marsh Habitats

River Section	Mapped Acres	Acres of Marsh	Percent Total Acres	No Action	B-3	D-3	E-3	I-1	I-2	I-3
Rio Chama	3,073	160	5%	5	11	101	69	114	89	69
Central	11,378	267	4%	146	152	141	153	159	138	127
San Acacia	16,203	463	3%	8128	1777	2038	1535	6833	6357	3653

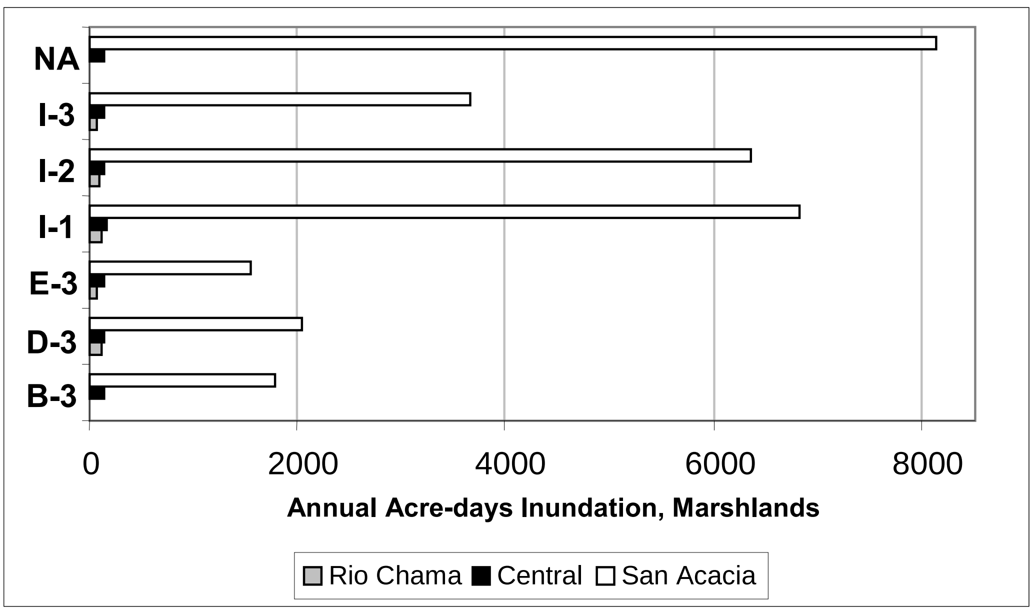


Figure L-3.30 Support of Wetland/Marsh Habitats by Alternative, as a Surrogate For Designated and Natural Management Areas.

3.5 *Fauna of the Rio Grande Valley*

3.5.1 *Methods of Aquatic Fauna Analysis*

The Aquatic Team used available fisheries survey data to establish a baseline condition for both native and non-native fish in the Rio Grande Project Area. These data have not been consistently collected over time or by gear type. Therefore, correlations between fish community structure and abundance could not be made against variables such as river flow or monthly or annual release volume. The Aquatic Team used the Aquatic Habitat Model (Bohannon-Huston et al. 2004) output to determine impacts to physical habitat of selected fish species as a surrogate for the general fish community. Additionally, the Team used other instream physical characteristics such as peak-flow duration and magnitude, and extent of low-flow periods to estimate impacts of action alternatives.

3.5.1.1 Impact Analysis on Aquatic Fauna

As described in the Methods section above, impacts to both riverine and reservoir habitat were used as a surrogate to assess potential impacts to correlated fauna. Therefore, all impact analyses for aquatic fauna are discussed under Section 3.2.1.1 (Impact Analysis on Riverine Resources) and 3.2.2.1 (Impact Analysis on Reservoir Resources).

3.5.2 *Methods of Terrestrial Wildlife Analysis*

As described in Section 2.3.1.4, the Riparian Team used prior wildlife surveys to establish a baseline of the general fauna within the Project Area. Unfortunately, there are no annual wildlife surveys that can verify ongoing effects of the No Action Alternative, against which all action alternatives are measured. Therefore, a surrogate was required to assess impacts on riparian fauna. The Hink and Ohmart (1984) data established the correlation between vegetation types and terrestrial wildlife species richness, composition, and habitat associations. Based on those data, the Team determined that vegetation classification Type 3 supported the greatest biodiversity, followed by Type 1, Type 5, and lastly, Type 2. These important faunal-usage structures were therefore given the highest weights when determining impacts to riparian fauna: Type 3 = 21.5%, Type 1 = 20.7%, Type 5 = 19.0%, and Type 2 = 14.5%. The correlated Service Resource Categories are 2 and 3, with Resource Category 2 supporting the highest quantity and diversity of wildlife species. Our criteria thus became an evaluation of which alternative best supports the chosen Hink and Ohmart/Service Resource Category vegetation types. In addition, because overbank flooding is essential to support riparian habitat, our assessment measure is the average acre-days of inundation under each alternative for water operations throughout the Project Area.

3.5.2.1 Impact Analysis on Terrestrial Riparian Fauna

Analyses Applied to all Alternatives

For each alternative, potential impacts to riparian fauna were weighted according to their hydrological support of Hink and Ohmart structural types known to support the greatest wildlife abundance (**Table L-2.2**, Section 2.3.1.4). Structural Types 3 and 5 (dense, intermediate height and young vegetation from 5 to 15 feet) are the vegetation classes exhibiting “high” to “very high” usage by birds. The second of only two “very high” bird abundance findings is in Type 1, the mature cottonwood forest with a dense, diverse understory. A high avian abundance indicates that these preferred habitats offer the greatest avian support for roosting, nesting, foraging, and lowered predation risks.

Mammal species appear in high abundance *only* in Types 3 and 5, with moderate to low abundance in Types 1 and 2. These dense structural types afford ideal den or burrow sites for small mammals, as well as protection from predators, particularly raptor species. Types 3 and 5 also support large, diverse invertebrate populations that provide forage for insectivorous mammals, as well as woody species that produce important mast crops.

Reptiles and amphibians were most abundant in Type 4 forest (intermediate height with little to no understory) and Type 6, wherein most vegetation is 5 feet or under and predominantly forbs, grasses, or immature riparian species such as coyote willow. Reptile and amphibian species are moderate to mostly low in abundance in structural types with dense, diverse understories; ectotherms require areas open to the sun for control of body temperature.

No Action Alternative

Rio Chama Section

Although the total days of inundation in native vegetation communities for the No Action Alternative are highest among all alternatives in the Rio Chama Section (as shown in Figure L-3.11), the total support to structural types supporting fauna would continue to be low. The acre-days of spring overbank flooding would continue to be very low under No Action. Flooding in Types 1 and 2 mature cottonwood forest and high-value Service Resource Category 2 riparian habitats is very infrequent. This lack of support may have contributed to the increase of non-native infestation in the Rio Chama because of the continuing adverse pattern of decline in healthy native forest in this river section. Overall, No Action would have an adverse impact on the vegetation types required to support healthy populations of associated wildlife and may promote succession to forests with exotic Russian olive and salt cedar canopy. There would be continued avian presence, but there could be a reduction in mammal, reptile, and amphibian numbers.

While Russian olive is considered a nondesirable exotic, it should be pointed out that this tree provides a high-quality mast crop to wildlife. This is particularly true of insectivorous birds such as robins and northern flickers, who switch to berries, nuts, and olives when insects become seasonably unavailable. No Action would not adversely impact, and could actually benefit, the health of Russian olive and the wildlife species that rely on it for fall and winter forage.

Central Section

Under No Action, overbank flooding would occur somewhere in the Central Section in approximately half of the 40 years modeled. However, only a small acreage on average would receive these flood flows. Vegetation surveys show that both native and exotic vegetation have declined in Hink and Ohmart structural Types 1, 5, and 6. Mixed (native/non-native) species in Types 1 and 4 have also declined.

No Action would provide surface hydrological support to approximately 65% of the vegetated acres in the Central Section. Increases have occurred in mixed vegetation for Types 2, 5, and 6. However, all changes described in the Central Section, whether adverse or beneficial, are inside the determined 15% margin of error and therefore not statistically significant in correlated impacts to riparian fauna.

No Action has supported the largest component of mature riparian forest in the Project Area, 34% of which is mature cottonwood gallery forest with a high canopy (Types 1 and 2). Native vegetation in Type 4 has experienced a statistically significant increase under No Action, as has mixed vegetation in Type 3, which supports a high abundance of birds and mammals. These intermediate-height riparian forests (Types 3 and 4) account for 35% of the vegetative cover. The Central Section consequently exhibits the vegetation types shown by Hink and Ohmart to contain higher abundance of wildlife species. Type 5 vegetation (5–15 feet), which shows high abundance for birds and mammals, is 20% of the vegetation.

Overall, the No Action Alternative would be neutral to somewhat beneficial for riparian fauna in the Central Section.

San Acacia Section

Under No Action, the highest-value wildlife habitat in Service Categories 2 and 3 would receive approximately 70% of the acre-days of inundation. However, this is not significant because, overall, very few of the total acres in this section are actually inundated. In addition, very little of the acre-days of inundation would occur in mature cottonwood forests (Hink and Ohmart Types 1 and 2). Approximately 37% of vegetated acres would receive flood flows in 100% of the modeled years, the highest frequency and area of overbank inundation in the entire study area. In addition, No Action with zero diversions to the LFCC (**Figure L-3.14**) provides the greatest number of total days of inundation in native vegetation communities of all structural types.

The San Acacia Section suffers the highest infestation of exotic plant species of the three river sections. Heavy infestation by Russian olive (in the canopy) and salt cedar occurs mostly in intermediate and young height classes, structural types that support a higher abundance of wildlife families. The overall impact of the No Action Alternative on San Acacia wildlife would be neutral to slightly beneficial, but not at a significant level.

Action Alternatives

Rio Chama Section

Alternatives B-3, E-3, I-2, and I-3 offer moderate improvements in hydrological support in the Rio Chama Section. Overbank flooding would increase for desirable Hink and Ohmart Types 1 and 2 and for the highest-value Service Resource Category 2 habitat. H&O Types 3 and 5 also receive increased hydrological support, indicating that Alternatives B-3, E-3, I-2, and I-3 would continue to provide habitat support for most wildlife species associated with the highest-use habitat types. However, reptiles and amphibians are moderate to low in abundance for any structural type with Russian olive as a dominant species. The Rio Chama is the riparian section most heavily infested by this exotic; thus, though both birds and mammals would be well-supported by these three alternatives, hydrological support may sustain or increase Russian olive, indicating low habitat provision for reptiles and amphibians.

Alternatives D-3 and I-1 would have a profound, positive impact on the Rio Chama Section due to high inundation of possibly extended duration. The percent change in acre-days of inundation compared to No Action on these two alternatives ranges from +1,861% to +2,167%. Figure L-3.11 indicates that these alternatives would significantly increase the total days of inundation for both, but never exceed thresholds of either. The number of days of floodplain indundation per year and the mean annual acres of inundation would increase, without resulting in anoxic conditions. Change in these vegetation structures would be likely, with additional density of understory vegetation and possible increases in native vegetation expected. The associated fauna is likely to change as well. However, the existing dominance of Russian olive would continue to provide the essential food base for the faunal community.

Central Section

All action alternatives show basically no change from the No Action Alternative in the Central Section. Percent change may be slightly negative or beneficial, but most changes are inside the 15% margin of error and therefore insignificant in their impacts to the vegetation types that support the highest faunal diversity. Alternatives E-3 and I-1 would provide an overall improvement in riparian health for the Central Section via increases in mean annual maximum acres of overbank flooding. Overall, beneficial impacts are probably only statistically significant under Alternatives E-3 and I-1. Improved surface hydrology in the Central Section under these alternatives would probably also result in slightly higher groundwater to support native forests in the area and adjacent wetlands, a change that should support all wildlife and could benefit amphibian species in particular.

San Acacia Section

Alternative I-1 would have a moderate adverse effect on fauna within the San Acacia Section compared to No Action. This is primarily because of reduced mean annual maximum acres of overbank flooding. Alternative I-1 is the same as No Action when both are modeled with a 500 cfs diversion to the LFCC.

All other action alternatives have an overall adverse effect on the riparian vegetation and the associated wildlife within the San Acacia Section.

3.6 *Threatened and Endangered Species*

3.6.1 *Methods of Evaluation*

Three federally listed species and one state-listed species were considered in the impacts analysis based on their known occurrence in areas most likely to be affected by the project. A combined quantitative and qualitative approach was taken in the impact analysis. Quantitative measures focused on long-term changes in available suitable habitat compared with current trends under the No Action Alternative. The significance of adverse effects could be determined only through qualitative assessment of the context of the species' status and the intensity of the measurable impacts. For example, endangered species within designated critical habitat are considered to have the most sensitive context, and even minor adverse impacts to designated critical habitat would be considered a significant adverse impact.

3.6.1.1 Rio Grande Silvery Minnow Habitat Criteria Description

Riverine Habitat

The change in area and percent changes for RGSM habitat were ranked by alternative for duration of overbank flooding, average number of days of 0 cfs flow, average number of days of flow less than 100 cfs, the average peak-flow magnitude, and the average peak-flow duration.

The threshold velocity for hatching and retention of RGSM eggs for the reach from Angustura to Elephant Butte Reservoir was calculated to be 1.85 feet per second. Any velocities in excess of this threshold result in increased egg and larval mortality as they drift into the reservoir, and the frequency of exceeding this velocity threshold was calculated for each alternative.

Reservoir Habitat

Reservoirs are not suitable habitat for RGSM. Impacts of all alternatives on reservoir habitat have been excluded from this section

3.6.1.2 Impact Analysis on Rio Grande Silvery Minnow

Rio Chama Section Overview

Under No Action the Rio Chama Section would provide the greatest area for potential RGSM habitat over all other alternatives (**Table L-3.2**, and **Table L-3.**). Although no RGSM currently occupy this reach, the habitat does exist. For flow-related criteria (duration and area of overbank flow, peak-flow magnitude and durations, and number of zero-flow and low-flow days), the impacts of no action vary (**Table L-3.** through **Table L-3.**). No action would provide substantially fewer days of overbank flooding, but a greater area of overbank flooding compared to most action alternatives. Peak magnitude and duration of flows would be generally greater for No Action, and low-flow days are similar to the action alternatives. Riverine habitat for the RGSM would be reduced under all alternatives in the Rio Chama Section. Although the modeled RGSM habitat loss in the San Acacia Section and other sections may be within the margins for error in the study, further habitat reduction should be avoided, as it could lead to further declines in this endangered species.

Central Section Overview

Less than a 2% reduction in available habitat for RGSM exists between No Action and the action alternatives (**Tabl L-3.2**, **Table L-3.3,** and **Table L-3.**); it is likely that no biological significance exists with this small difference. Duration of overbank flows would be generally greater under No Action than under all but three action alternatives (**Table L-3.** thru **Table L-3.**). Overbank area would be equal to or less than most action alternatives. Peak flow magnitude and duration would be higher than most action alternatives, while low-flow days would be about equal.

San Acacia Section Overview

No Action provides the greatest amount of available habitat for RGSM (**Table L-3.2**, **Table L-3.3**, and **Table L-3.**) in this section No Action would provide between 9% and 20% more available habitat for RGSM than the action alternatives. Duration and area of overbank flows for the San Acacia Section would be greater under No Action (**Table L-3.** thru **Table L-3.**). Peak-flow duration and magnitude would be greater under No Action. Low-flow days would be fewer under No Action.

Rio Chama Section

Alternative B-3 would result in the greatest amount of RGSM habitat loss for this river section (**Table L-3.**). The duration of overbank flooding ranked third-highest in magnitude compared to the other alternatives for this river section and would result in an increase in RGSM habitat compared to present conditions. The area of overbank flooding ranked sixth in comparison to other alternatives and would reduce RGSM habitat with the No Action Alternative. There would be no impact of Alternative B-3 on the average number of no-flow days relative to the No Action Alternative. This alternative would result in the second-lowest average number of days less than 100 cfs of the action alternatives and would decrease the number of days less than 100cfs compared to current conditions; this would positively impact RGSM habitat in the Rio Chama. Average peak-flow magnitude ranked fourth compared to the other alternatives. However, this alternative would result in a reduction of magnitude relative to the No Action Alternative and have a negative impact on RGSM. This alternative ranked first in peak-flow duration compared to other alternatives and would not impact the current level of RGSM habitat.

Table L-3.18 Impacts of the Action Alternatives on RGSM Habitat Measures in the Rio Chama Section,as Rank (Measure) and Percent Change Relative to the No Action Alternative

Alternative	Rio Chama Section						
Parameter/ Rank	RGSM Habitat Area (sq feet)	Duration Overbank (days/year)	Area Overbank (sq m)	0 cfs (days/ year)	<100 cfs (days/ year)	Peak Magnitude (cfs)	Peak Duration (days/ year)
No Action	55,026	2	477,529	0	9.2	2,900	53.5
B-3	51,021	29	137,593	0	9.1	2,523	53.3
% Change	-7%	1350%	-71%	0	1%	-13%	NI
D-3	53,204	28	489,670	0	9.8	2,744	47.1
% Change	-3%	1300%	2%	0	-6%	-5%	-12%
E-3	52,790	26	323,749	0	9.4	2,665	49.1
% Change	-4%	1200%	-32%	0	-2%	-8%	-8%
I-1	53,522	28	331,842	0	8.9	1,915	53.0
% Change	-3%	1300%	-30%	0	3%	-34%	-1%
I-2	52,725	31	396,592	0	9.2	2,789	48.0
% Change	-4%	2275%	-17%	0	NI	-4%	-10%
I-3	52,909	37	477,529	0	9.9	2,665	49.1
% Change	-4%	1750%	0%	0	-8%	-8%	-8%

Alternative D-3 would have the highest area of overbank flooding in the Rio Chama Section, resulting in an increase in RGSM habitat compared to the No Action Alternative. This alternative would have no impact on the average number of no-flow days relative to the No Action Alternative. This alternative would result in the second-highest average number of days less than 100 cfs of the action alternatives and would increase the number of days less than 100 cfs compared to current conditions, which would negatively impact RGSM habitat. Average peak-flow magnitude ranked second compared to the other alternatives, and peak duration ranked fifth. However, this alternative would reduce these parameters relative to the No Action Alternative and would have a negative impact on RGSM habitat.

Alternative E-3 would result in the fourth-greatest amount of RGSM habitat loss compared to other alternatives in the Rio Chama Section. Although the duration of overbank flooding ranked fifth among the alternatives, this still represents a positive increase in this parameter of RGSM habitat. The area of overbank flooding would decrease from the No Action Alternative (fifth among the alternatives) and would result in a reduction in RGSM habitat. This alternative would have no impact on the average number of no-flow days relative to the No Action Alternative. This alternative would result in the fourth-highest average number of days less than 100 cfs of the action alternatives and would increase the number of days less than 100 cfs compared to current conditions, which would negatively impact RGSM habitat. Average peak-flow magnitude for this alternative (as well as I-3) ranked third compared to the other alternatives. Average peak-flow duration would also be ranked third. Both alternatives would reduce these parameters relative to the No Action Alternative and would reduce RGSM habitat.

Alternative I-1 would result in the least amount of RGSM habitat loss compared to other alternatives for the Rio Chama Section. Duration of overbank flooding ranked fourth-highest among the alternatives, representing an increase in this parameter compared to the No Action, and would have a positive impact on aquatic resources. Area of overbank flooding would decrease from current conditions under this alternative, which would negatively impact riverine resources. Although less than the No Action and first among the action alternatives, there would be no significant reduction of the average number of no-flow days and the average number of days less than 100 cfs. Average peak-flow magnitude ranked fifth for this alternative, which is a reduction in this parameter from the No Action, which would result in reduced RGSM habitat. Peak-flow duration ranked second compared to other alternatives and would result in no impact to RGSM habitat compared to the No Action Alternative.

Alternative I-2 ranked second in the duration of overbank flooding compared to other alternatives in the Rio Chama. This parameter was greater in magnitude than the No Action Alternative and would result in improved RGSM habitat. The area of overbank flooding ranked third in comparison to other alternatives, which would result in a decrease in RGSM habitat from the No Action Alternative. This alternative would have no impact on the average number of no-flow days. This alternative ranks third for average number of days less than 100 cfs compared to the other action alternatives and would result in no change from present conditions. Average peak-flow magnitude for this alternative ranked first and average peak-flow duration ranked fourth compared to the other alternatives. These parameters would be reduced relative to the No Action Alternative, which would result in a reduction in RGSM habitat.

Alternative I-3 would result in the least amount of RGSM habitat loss compared to other alternatives for the Rio Chama Section. This alternative ranked first in duration of overbank flooding among the alternatives and would result in an increase in RGSM habitat in comparison to the No Action Alternative. The area of overbank flooding for this alternative equaled the No Action Alternative, which would result in no habitat change for the RGSM. This alternative would have no impact on the average number of no-flow days relative to the No Action Alternative. This alternative would result in the greatest average number of days less than 100 cfs of the action alternatives and would negatively impact RGSM habitat compared to current conditions. Average peak-flow magnitude and average peak-flow duration for this alternative both ranked third. However, this alternative would reduce these parameters relative to the No Action Alternative and would have a negative impact on RGSM habitat.

Central Section

For this river section, Alternative B-3 would result in the greatest amount of RGSM habitat loss (**Table L-3.**). Overbank flooding duration would be the fourth highest of the alternatives and would result in a decrease in overbank flooding and would have a negative impact on RGSM habitat relative to current conditions. Beneficial effects of this alternative include increases in the area of overbank flooding, which would result in a positive increase in RGSM habitat from the No Action Alternative. This alternative would also result in the least number of no-flow and less than 100 cfs days and would reduce these parameters relative to current conditions, with a positive impact on RGSM habitat. Average peak-flow magnitude ranked third compared to the other alternatives but would result in a reduction of RGSM habitat compared to current conditions. Average peak-flow duration ranked fifth and would result in a reduction of current peak-flow durations negatively affecting RGSM habitat.

Alternative D-3 would result in decreased duration but increased area of overbank flooding compared to the No Action Alternative for the Central Section. This alternative (as well as E-3, I-1, I-2, and I-3) ranked second for the number of no-flow days among the alternatives. However, this alternative would result in a small increase in the number of no-flow days compared to the No Action Alternative and have a slightly negative impact on RGSM habitat. This alternative had the same number of less than 100 cfs days as the No Action Alternative (along with E and I-1) and therefore would have no affect on RGSM habitat in this section of the river. Average peak-flow magnitude and duration ranked fourth compared to the other alternatives and would result in a reduction of RGSM habitat relative to the No Action Alternative.

Table L-3.19 Impacts of the Action Alternatives on RGSM Habitat Measures in the Central Section, as Rank (Measure) and Percent Change Relative to the No Action Alternative

Alternative	Central Section						
Parameter/ Rank	**RGSM Habitat Area (sq feet)**	**Duration Overbank (days/year)**	**Area Overbank (sq m)**	**0 cfs (days/ year)**	**<100 cfs (days/ year)**	**Peak Magnitude (cfs)**	**Peak Duration (days/ year)**
No Action	1,224,029	15	1,545,899	15.4	32.8	3,969	47.8
B-3	1,200,176	11	2,731,628	15.3	32.3	3,847	43.6
% Change	-2%	-27%	+77%	+1%	+2%	-3%	-9%
D-3	1,206,690	13	1,663,258	15.5	32.8	3,768	44.4
% Change	-1%	-13 %	+8%	-1%	NI	-5%	-7%
E-3	1,204,042	9	2,938,018	15.5	32.8	4,011	42.3
% Change	-2%	-40%	+90%	-1 %	NI	+ 1%	-12%
I-1	1,217,438	12	1,424,493	15.5	32.8	4,045	46.9
% Change	-0%	-20%	-8 %	-1%	NI	+ 2%	-2%
I-2	1,204,580	13	1,598,508	15.5	33.1	3,868	45.0
% Change	-2%	-13%	3 %	-1%	-1%	-3%	-6%
I-3	1,203,105	16	1,800,851	15.7	33.1	3,715	45.5
% Change	-2%	+6.7%	-16%	-2%	-1%	-6%	-5%

Alternative E-3 (as well as I-2) would result in the second-greatest amount of RGSM habitat loss compared to other alternatives in this section. Overbank flooding duration ranked fifth and overbank flooding area ranked first in comparison to the other alternatives. However, both would be a reduction in these parameters from the No Action Alternative and would therefore decrease RGSM habitat in this river section. This alternative (as well as D-3, I-1, and I-2) ranked second for the number of no-flow days compared to the other action alternatives. The alternative would result in a slight increase in the average number of no-flow days compared to No Action and would reduce RGSM habitat. This alternative would have no impact on the average number of less than 100 cfs days compared to current conditions and would not affect RGSM habitat. Average peak-flow magnitude ranked second compared to the other alternatives, which would result in an increase in RGSM habitat. Average peak-flow duration ranked sixth compared to the other alternatives and would result in a reduction in RGSM habitat relative to the No Action Alternative.

Alternative I-1 results in the least amount of RGSM habitat loss compared to other alternatives. Overbank flooding duration would be reduced compared to the No Action Alternative and ranks third compared to the other alternatives. Area of overbank flooding would also be reduced from the current conditions and ranks fifth compared to the other alternatives; these reductions would adversely affect RGSM habitat. This alternative would result in no change in the average number of no-flow days and average number of days less than 100 cfs relative to the No Action Alternative; both criteria rank second compared to the other action alternatives. Average peak-flow magnitude ranked highest compared to the other alternatives, which would result in an increase in average magnitude relative to current conditions and positively affect RGSM habitat. Average peak-flow duration ranked greatest compared to the other alternatives. However, this alternative would result in a reduction of peak-flow duration relative to the No Action Alternative and would negatively affect RGSM habitat.

Alternative I-2 (as well as E-3) would result in the third-greatest amount of RGSM habitat loss compared to other alternatives for this section of the river. Overbank flooding duration for this alternative (as well as D-3) ranked second in magnitude compared to the other alternatives; this parameter would be reduced relative to current flooding conditions and would have a negative impact on RGSM habitat. Overbank flooding area for this alternative ranked fifth among the alternatives; this parameter, however, would be increased relative to current flooding conditions and would have a positive impact on the RGSM habitat. Average number of no-flow days ranked second (along with three other alternatives) and would result in no impact to habitat compared to present conditions. The average number of less than 100 cfs days, average peak-flow magnitude, and average peak-flow duration for this river section would each be ranked third compared to the other action alternatives. However, these parameters for this alternative would reduce RGSM habitat relative to the No Action Alternative.

Alternative I-3 ranks fourth in the amount of RGSM habitat loss compared to other alternatives. Duration of overbank flooding duration ranked first compared to other alternatives and would increase RGSM habitat over present conditions. This alternative ranked third in comparison to other alternatives for area of overbank flooding and would increase RGSM habitat over current conditions. This alternative ranked last for the number of no-flow days compared to the other action alternatives and would result in an increase in the number of no-flow days; this would have negative impacts on RGSM habitat. The average number of days less than 100 cfs for this alternative (as well as I-2) ranked third compared to the other alternatives, which would increase this parameter compared to current conditions; this would negatively impact RGSM habitat. Average peak-flow magnitude ranked fifth and average peak-flow duration ranked second compared to the other alternatives. However, this alternative would result in a reduction in these parameters relative to the No Action Alternative and would have a negative impact on RGSM habitat.

San Acacia Section

Alternative B-3 would result in negative impacts on RGSM habitat for the San Acacia Section. Overbank flooding duration for Alternative B-3 is the fourth highest of the alternatives for this section of the river (**Table L-3.20**). This alternative ranked fifth in area of overbank flooding. Both of these parameters would be reduced relative to current flooding conditions and would have a negative impact on RGSM habitat. Data were not available on no-flow days for this reach. This alternative (as well as I-3) ranked fourth for the number of days less than 100 cfs compared to the other action alternatives and would result in a decrease in this parameter relative to current conditions, which would have negative impacts on RGSM habitat. Average peak-flow magnitude ranked fourth compared to the other action alternatives. This alternative ranked second in average peak-flow duration compared to the other alternatives.

Alternative D-3 would result in the greatest amount of RGSM habitat loss compared to other alternatives. Overbank flooding duration for this alternative is the fourth highest of the alternatives for this river section. This alternative ranked fifth in area of overbank flooding. Both of these parameters would be reduced relative to current flooding conditions and would have a negative impact on RGSM habitat. Data were not available on no-flow days for this river reach. This alternative (as well as I-3) ranked fourth for the number of days at 100 cfs compared to the other action alternatives and would result in a decrease in this parameter relative to current conditions, which would have negative impacts on RGSM habitat. Average peak-flow magnitude ranked fourth compared to the other action alternative. This alternative is ranked second in average peak-flow duration compared to the other alternatives. However, both of these parameters would be reduced and result in negative impact on RGSM habitat for the San Acacia Section under this alternative.

Alternative E-3 would result in the third-greatest amount of RGSM habitat loss compared to other alternatives in this section of the river. Overbank flooding duration for this alternative ranked last among the alternatives. This alternative (as well as B-3) ranked fourth for the area of overbank flooding. Both of these parameters would be reduced relative to current flooding conditions and would have a negative impact on RGSM habitat. Data were not available on no-flow days for this reach. The number of less than 100 cfs days for this river section ranked third compared to the other action alternatives, resulting in an increase in this parameter relative to current conditions that would have negative impacts on RGSM habitat. Average peak-flow magnitude ranked second and average peak-flow duration ranked fifth compared to the other alternatives. However, these parameters would be reduced and would result in negative impacts to RGSM habitat.

Alternative I-1 would result in the least amount of RGSM habitat loss compared to other alternatives. Overbank flooding duration and area ranked third for this alternative, which represents a reduction in both of these parameters compared to the No Action Alternative. The changes would result in negative impacts to RGSM habitat. Data were not available on no-flow days for this reach. The number of less than 100 cfs days for this river section ranked first compared to the other action alternatives and would result in an increase in this parameter relative to current conditions, with negative impacts for this parameter on RGSM habitat. Average peak-flow magnitude and average peak-flow duration for this alternative int his reach ranked first compared to the other alternatives. However, this alternative would reduce these parameters relative to the No Action Alternative and would have a negative impact on RGSM habitat.

Alternative I-2 would result in the second-least amount of RGSM habitat loss compared to other alternatives. Overbank flooding duration and area for this alternative ranked second compared to the other alternatives. Both of these parameters would be reduced relative to current flooding conditions and would have a negative impact on RGSM habitat. Data were not available on no-flow days for this reach. The number of less than 100 cfs days for this alternative (as well as D-3 and I-3) ranked fourth compared to the other action alternatives and would result in an increase in this parameter relative to current conditions, which would have negative impacts on RGSM habitat. Average peak-flow magnitude for this alternative (as well as I-1) ranked first compared to the others. Average peak-flow duration for this alternative (as well as D-3) ranked second. However, this alternative would reduce these parameters relative to the No Action Alternative and would have negative impacts on RGSM habitat.

Alternative I-3 ranks fifth in the amount of RGSM habitat loss compared to other alternatives. Overbank flooding duration and area for this alternative ranked first compared to the other alternatives. However, these parameters would be reduced relative to current flooding conditions and have a negative impact on RGSM habitat. Data were not available on no-flow days for this reach. Average number of days less than 100 cfs for this alternative (as well as D-3 and I-2) ranked fourth compared to the others and would increase this parameter compared to current conditions, negatively impacting RGSM habitat. Average peak-flow magnitude ranked fifth and average peak-flow duration ranked third compared to the other alternatives. However, this alternative would result in a reduction in these parameters relative to the No Action Alternative and have a negative impact on the RGSM habitat.

Table L-3.20 RGSM Impacts in the San Acacia Section by Alternative and Measure Compared to No Action Alternatives with Equal Diversions to the LFCC

San Acacia Section with Diversions		RGSM Measure with Percent Change from No Action with Equal Diversion to LFCC						
Alternative	LFCC Diversion	RGSM habitat area (sq feet)	Duration Overbank (days/year)	Area Overbank (sq m)	0 cfs (days/ year)	<100 cfs (days/ year)	Peak Magnitude (cfs)	Peak Duration (days/ year)
No Action	0 Diversion	511,468	33	8,789,772	0	98.7	3,578	39.3
No Action	500 cfs	460,499	No data	7,119,713	69	214	3,205	33.6
I-1	500 cfs	458,599	16	4,386,792	No data	106.4	2,713	34.1
% Change		0%		-38%		-49%	-15%	-1.5%
No Action	1,000 cfs	422,677	No data	5,361,761	69	214	2,774	29.0
I-2	1,000 cfs	425,146	27	7,952,073	No data	109.2	2,703	28.8
% Change		+1%		+48%		-49%	-2.6%	-0.7%
No Action	2,000 cfs	434,974	No data	2,461,136	69	214	2,398	26.4
B-3	2,000 cfs	406,647	10	2,679,019	No data	107.8	2,006	26.2
% Change		-6%		+9%		-50%	-16.3%	-0.8%
D-3	2,000 cfs	405,634	11	2,375,505	No data	109.6	1,922	28.9
% Change		-7%		-3%		-49%	-19.8%	+10.2%
E-3	2,000 cfs	406,879	8	2,606,176	No data	109.0	2,153	25.5
% Change		-6%		+6%		-49%	-10.2%	-3.4%
I-3	2,000 cfs	405,731	29	8,251,540	No data	109.6	1,860	27.5
% Change		-7%		+235%		-49%	-22.4%	+4.2%

RGSM Juvenile and Adult Habitat Impacts during Spring Only

Habitat availability data for each alternative were separated into adult and juvenile habitat (square feet) for spring months (April 1–June 30) and compared to the No Action Alternative for RGSM habitat availability for both life stages combined on an annual basis. **Table L-3.** summarizes the data for this discussion.

No Action

Rio Chama Section

Spring-period habitat for RGSM juvenile and adults was equal to or slightly lower for the No Action Alternative. RGSM are not currently found in the Rio Chama at this time. The 5% to 6% differences may not be biologically significant.

Central Section

Spring period habitat for RGSM is similar under the No Action Alternative and the action alternatives.

San Acacia Section

Spring-period habitat for RGSM is greater under No Action by about 4% to 16% compared to action alternatives. This difference may be biologically significant.

Table L-3.21 RGSM Riverine Spring Habitat Percent Change Relative to No Action for Adult and Juvenile RGSM by Alternative

Alternative	Rio Chama Section			Central Section			San Acacia Section		
	Juvenile Habitat – Spring	Adult Habitat – Spring	Adult & Juvenile Habitat – Annual	Juvenile Habitat – Spring	Adult Habitat – Spring	Adult & Juvenile Habitat – Annual	Juvenile habitat – Spring	Adult Habitat – Spring	Adult & Juvenile Habitat – Annual
B-3	1.7	3.9	-7.3	0.6	-1.5	-1.9	-15.4	-15.6)	-19.7)
D-3	5.2	6.1	-3.3	0.7	-1.1	-1.4	-15.9	-16.5	-19.9
E-3	4.7	6.0	-4.1	0.8	-1.2	-1.6	-15.1	-15.5	-19.6
I-1	0.3	0.3	-2.7	-0.2	-0.1	-0.5	-4.0	-4.5	-9.4
I-2	1.9	2.3	-4.2	0.4	-0.6	-1.6	-8.8	-9.4	-16
I-3	5.0	6.3	-3.8	0.5	-1.3	-1.7	-15.8	-16.3	-19.8

Alternative B-3

Rio Chama Section

All of the alternatives in this section gained juvenile and adult RGSM habitat relative to the No Action Alternative. This alternative ranks fifth in the amount of spring habitat gained for both adult and juvenile RGSM.

Central Section

Juvenile spring habitat area created by this alternative ranks third among the other alternatives. This alternative results in an increase in juvenile RGSM spring habitat but would have the greatest reduction in adult habitat compared to the other alternatives for this section.

San Acacia Section

All of the alternatives in this river section lost significant amounts of juvenile and adult RGSM habitat in comparison to the No Action alternative. This alternative ranks fourth for the least adult and juvenile spring habitat loss for this section.

Alternative D-3

Rio Chama Section

RGSM juvenile and adult habitat area would not be reduced by this alternative relative to the area of habitat for the No Action Alternative. Juvenile habitat area would be greatest for this alternative and ranks second in the amount of spring habitat gained for adult RGSM for this section.

Central Section

This alternative would result in the second greatest increase in juvenile RGSM spring habitat. The third-highest adult habitat reduction in this section would be incurred under this alternative.

San Acacia Section

Spring RGSM juvenile and adult habitat area would be reduced relative to the availability of habitat for the No Action Alternative. This alternative would result in the greatest amount of adult and juvenile spring habitat loss for this reach and alternative.

Alternative E-3

Rio Chama Section

RGSM juvenile and adult habitat area would not be reduced by this alternative relative to the area of habitat for the No Action Alternative. Juvenile and adult habitat area rank third in the amount of spring habitat that would be gained.

Central Section

This alternative would result in the greatest increase in juvenile RGSM spring habitat but would have the fourth-greatest reduction in adult habitat for this reach of the river.

San Acacia Section

Spring RGSM juvenile and adult habitat area would be reduced relative to the availability of habitat by the No Action Alternative. This alternative ranks third in the amount of adult and juvenile spring habitat that would be lost for this reach.

Alternative I-1

Rio Chama Section

RGSM juvenile and adult habitat area would not be reduced for this alternative relative to the area of habitat for the No Action Alternative. This alternative would result in the least amount of juvenile and adult habitat area gained for this section among all alternatives.

Central Section

This alternative would result in adult and juvenile habitat loss relative to the No Action Alternative. This alternative would result in the only loss of juvenile RGSM spring habitat among the alternatives for this section. All alternatives would cause the loss of adult habitat in this section, but this alternative recorded the lowest reduction.

San Acacia Section

This alternative would result in the least amount of adult and juvenile spring habitat loss of all alternatives in this section relative to the No Action Alternative.

Alternative I-2

Rio Chama Section

RGSM juvenile and adult habitat area would increase under this alternative relative to the area of habitat under the No Action Alternative. This alternative would result in the fourth-greatest amount of juvenile and adult habitat area gained.

Central Section

This alternative would result in the fifth-greatest increase in juvenile RGSM spring habitat but would result in the second-lowest reduction in adult habitat.

San Acacia

This alternative would result in the second-least amount of adult and juvenile spring habitat loss relative to the No Action Alternative.

Alternative I-3

Rio Chama Section

RGSM juvenile and adult habitat would increase under this alternative relative to the area of habitat under the No Action Alternative. This alternative would result in the second-greatest gain of juvenile habitat and would result in the greatest amount of adult habitat area gained.

Central Section

This alternative would result in the fourth-greatest increase in juvenile RGSM spring habitat but the fifth-greatest loss in adult habitat for this section in comparison to the No Action alternative.

San Acacia Section

This alternative would result in the fifth-greatest amount of adult and juvenile spring habitat loss relative to the No Action Alternative for this section.

RGSM Velocity Impacts

Analysis of RGSM egg retention, transport, and entrainment was accomplished using the results of the FLO-2D and the URGWOM model. It was assumed that RGSM spawn during flow increases in spring (May–June) and that its eggs are uniformly distributed in the water column. The average flow velocity during spawning was quantified by each reach of interest for the 40-year period of record by alternative.

The FLO-2D Model was used to predict average water velocity of the study reaches for a range of discharge events during spring runoff by alternative. The general egg transport rate was estimated using average water velocity data for the reach of interest for a range of flows. The reach of interest was Angostura Diversion Dam to the headwaters of Elephant Butte Reservoir. **Figure L-3.31** shows the frequency (by percent) at which the threshold velocity, under each alternative, would exceed 1.85 fps for that river reach.

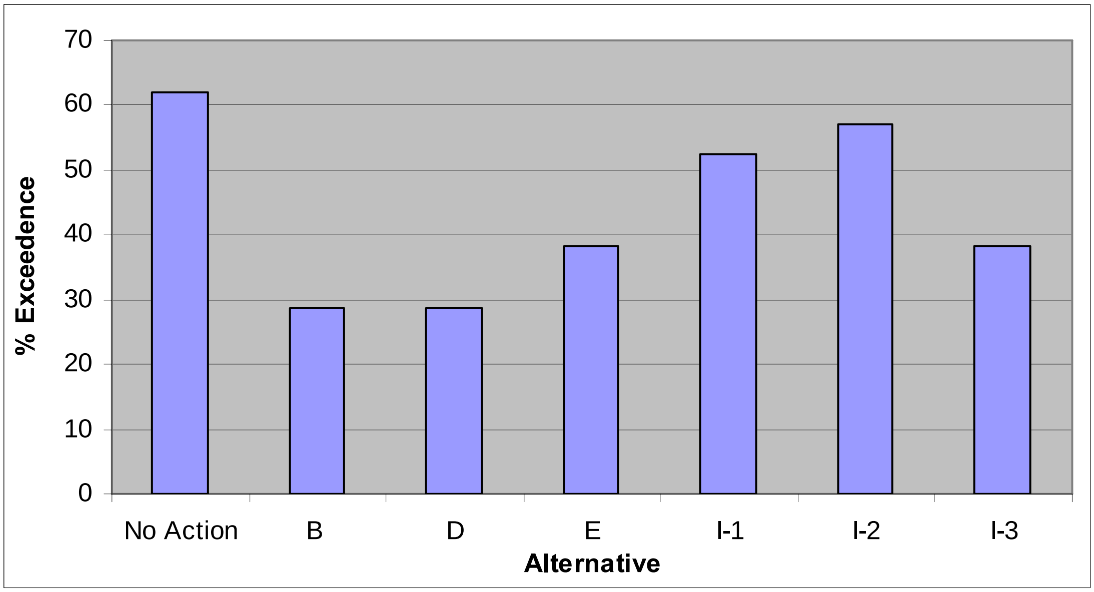


Figure L-3.31 Percent Frequency of Exceedance of Threshold Velocity for All Alternatives.

No Action
Current operations would result in velocities surpassing the threshold velocity 62% of the time, resulting in the greatest frequency of threshold velocity exceedance of all the alternatives.

Alternative B-3
This alternative (as well as D-3) would produce velocities that surpass the threshold velocity 28.5% of the time and result in the least frequent exceedance of the threshold velocity.

Alternative D-3
This alternative (as well as B-3) would produce velocities that surpass the threshold velocity 28.5% of the time and result in the least frequent exceedance of the threshold velocity.

Alternative E-3
This alternative (as well as I-3) would produce velocities that surpass the threshold velocity 38% of the time and result in the second least frequent exceedance of the threshold velocity.

Alternative I-1
This alternative would produce velocities that surpass the threshold velocity 52% of the time and result in the third least frequent exceedance of the threshold velocity.

Alternative I-2
This alternative would produce velocities that surpass the threshold velocity 57% of the time and result in the fourth least frequent exceedance of the threshold velocity.

Alternative I-3
This alternative (as well as E-3) would produce velocities that surpass the threshold velocity 38% of the time and result in the second least frequent exceedance of the threshold velocity.

3.6.1.3 Southwestern Willow Flycatcher Habitat Criteria Description

Criteria for SWFL Habitat Suitability Determination

Vegetation maps using the modified Hink and Ohmart vegetation classifications along with classifications of occupied SWFL breeding sites were used to determine unoccupied areas that have a higher probability to support breeding SWFLs based on vegetation structure, composition, height, and density (**Table L-3.22** and **Table L-3.23**). All polygons were classified as suitable if the structure type classification was 1, 3, 4, or 5 and if the understory was dominated by riparian plants—willow, cottonwood, salt cedar, or Russian olive. Polygons were considered to have very low potential to be suitable and were excluded if the structure type was 2 and 6, the understory vegetation was not dominated by willow, cottonwood, salt cedar, or Russian olive, or the understory was sparse. In subsequent analysis, all polygons that were more than 50 m from the river channel or ponds were excluded and determined to be unsuitable.

In many cases, areas within certain polygons classified as suitable may not be dense enough to support breeding SWFLs. However, because the classifications often represent average vegetation structure within the polygon and may contain micro-sites of denser vegetation that were too small for our mapping to detect, we classified a broader range of polygons as suitable and probably overestimated the extent of suitable habitat. Polygons that were exceptionally dense or had a high proportion of willow in both the overstory and understory were classified as most suitable.

Vegetation Characteristics

SWFL breeding territories are established in dense riparian vegetation, ranging in height from about 6 to 98 feet, usually with dense foliage in the lower shrub layer (Service 2002). The lower heights of SWFL habitat (6–10 feet) are more characteristic of montane SWFL habitat. The height of occupied SWFL habitat on the Middle Rio Grande always exceeds 10 feet and is often higher, averaging from 12 to 29 feet (Ahlers and White 1997; Moore and Ahlers 2004).

Breeding SWFLs on the Rio Grande demonstrate a preference for willow-dominated habitat, although they will breed in salt cedar. For SWFL nests found from 1999 to 2003, 79.4% were in willow-dominated habitat, 11.2% were found in mixed habitat, and 9.4% were in salt-cedar-dominated habitat *(n=*267*)* (Moore and Ahlers 2004). However, when considering nest substrate, the same study found that 56.2% of the nests were placed in a willow plant, 39.7% were placed in a salt cedar, and 4.1% were placed in a Russian olive. There were no significant differences between vegetation type and nest success.

Table L-3.22 and **Table L-3.24** list modified Hink and Ohmart vegetation classifications where nests have been found since 2000. These classifications often represent average vegetation structure within a delineated polygon, but SWFLs appear to select microhabitat features with a patch for nesting. For example, preliminary nest-site quantification have revealed that SWFLs prefer to nest in micro-sites with the highest foliage density in the vertical zone from 6 to 20 feet above the nest (Moore and Ahlers 2004).

Hydrology

Nesting SWFLs prefer areas near surface water or in flooded vegetation, at least early in the breeding season or during initial establishment of nesting territories. Overbank flooding is an essential function of a healthy riparian ecosystem and is necessary to establish and maintain suitable SWFL habitat. However, site fidelity compels certain nesting SWFLs to return to dry, previously occupied sites that are farther away from surface water during dry periods. It is unknown how many years a site would have to remain dry or at an increased distance from surface water to cause SWFLs to abandon it.

During nest monitoring studies on the Middle Rio Grande from 1999 to 2003, the vast majority of nests were found within 164 feet (50 m) of surface water (Darrell Ahlers, personal communication 2003). The average distance to water was 78.4 feet and the range was from 0 to 482 feet. About 41% of the nests were in flooded habitat, 90% of nests were less than 164 feet from surface water, and 95% were less than 328 feet from water. About 97% of nests were within 164 feet of surface water when the site was first occupied by nesting SWFLs in previous years, and all the sites have experienced flooding sometime in the past.

Table L-3.22 Native-Dominated Riparian Vegetation Communities with Known SWFL Territories and Nests, 2000–2004 (Modified Hink and Ohmart Vegetation Classifications)

Native Overstory/ Native Understory	Number of Nests & Territories	Native Overstory/ Exotic Understory	Number of Nests & Territories
TW4	149	TW-C/SC-CW3	8
TW/TW-SC3	59	TW-C/SC3	4
TW/TW-CW3	49	C/SC-RO1	2
C-TW/SC-TW3	33	TW/SC3	2
TW4F	15	C/RO-CW1F	1
C-TW/CW-TW3	8	C/SBM-SC3	1
TW5	6	C/SC1	1
C4	5	C/SC3	1
CW5	3	C/SC-B/RO3	1
CW5F	3	C-SC/SC-NMO1	1
C/TW3S	1	TW/SC1	1
C-CW5	1	TW-C/SC1	1
C-SBM-SC5	1		
CW-SC5F	1		
TW-C/TW-SC-CW3	1		
Total	**335**		**24**
Percent	**77.55%**		**5.56%**

B = Baccharis
C = Cottonwood
CW = Coyote willow
NMO = New Mexico olive
RO = Russian olive
SBM = Screwbean mesquite
SC = Salt cedar
TW = Tree willow

Table L-3.23 Non-Native-Dominated Riparian Vegetation Communities with Known SWFL Territories and Nests, 2000–2004 (Modified Hink and Ohmart Vegetation Classifications)

Exotic Overstory/ Native Understory	Number of Nests & territories	Exotic overstory/ exotic understory	Number of Nests & territories
RO/CW3	8	SC4F	34
		RO/SC3	10
		RO4	6
		RO-C/SC3	4
		SC4	4
		RO-CW-C5	2
		SC5	2
		SC-TW-C/SC-B3	2
		SC-RO-B5	1
Total	**8**		**65**
Percent	**1.85%**		**15.05%**

B = Baccharis
C = Cottonwood
CW = Coyote willow
NMO = New Mexico olive
RO = Russian olive
SBM = Screwbean mesquite
SC = Salt cedar
TW = Tree willow

Notes:

A forward slash (/) indicates separation between overstory species/understory species

A hyphen (-) separates species, in order of prevalence, within either the over- or understory

Numbers indicate Hink and Ohmart structural Types 1 thru 6

SWFL Analysis Assumptions

- Riparian vegetation at least 6 feet high (10 feet or more is preferred for the Middle Rio Grande) with dense vegetation (>74% cover) in the understory could offer suitable SWFL breeding sites.
- Suitable breeding sites are within 164 feet of surface water (Rio Grande channels, ponds, wetlands, etc.).
- Overbank flooding of suitable habitat greatly increases its habitat value and sustainability.
- SWFLs are more likely to disperse and establish new breeding sites closer to existing breeding sites than farther away.
- Overbank flooding is essential to create new habitat.

SWFL Analysis Methods

- Overlay all known current and recent SWFL-occupied habitat patches (1999–2004) on the vegetation maps and FLO-2D inundation maps (not including the occupied habitat within the pool of Elephant Butte Reservoir).
- The FLO-2D model was used to determine the following indicators of SWFL habitat quality for the occupied sites for each reach:
  - 40-year frequency of inundation
  - Mean/maximum duration of non-inundation (years)
  - Mean annual acre-days of inundation
  - Maximum annual acre-days of inundation

Based on synthesis of knowledge of SWFL habitat use in the Middle Rio Grande and habitat requirements described by the Service in the 2002 Recovery Plan, it was determined which Hink and Ohmart Vegetation types have the best potential to be suitable SWFL breeding habitat (**Table L-3.24**). Conversely, **Table L-3.25** displays the mapped vegetation classifications that are least likely to provide suitable SWFL habitat.

Occupied SWFL breeding sites and Hink and Ohmart polygons determined to be suitable SWFL habitat and that are within 164 feet (50 m) of surface water were incorporated into the FLO-2D model to determine the degree of inundation as an index of habitat quality and sustainability. Those polygons were separated into two zones: within 10 miles of habitat that has been occupied for the last 5 years, and more than 10 miles from previously occupied habitat. For each of the two zones and for each reach, the following indicators were determined from the FLO-2D model.

- 40-year frequency of inundation
- Mean/maximum duration of non-inundation (years)
- Mean annual acre-days of inundation
- Maximum annual acre-days of inundation

In our assessment, more value was given to inundation of suitable habitat within 10 miles of currently occupied habitat because of the increased probability of SWFLs moving into suitable habitat in proximity to occupied habitat.

Table L-3.24 Hink and Ohmart Vegetation Codes Selected as Having Best Potential to be Suitable SWFL Breeding Habitat

Selected Vegetation Types for Suitable SWFL Breeding Habitat				
B-C5	C/SC-CW3	C-SC5	Q-TW4	SC-CW5
B-C-RO5S	C/SC-CW5	C-SC-RO5	RO/C-SC3	SC-CW-C5
B-CW5	C/SC-CW-MB3	C-SE/CW3	RO/CW3	SC-CW-TW-B5
B-CW5F	C/SC-HMS3	C-SE/RO1	RO/CW3F	SC-R04
B-CW-C5	C/SC-MB1	C-SE/RO-CW1	RO/CW-B3	SC-RO/SC3
B-CW-SC5	C/SC-NMO1	C-SE/SC1	RO/CW-B-SBM3F	SC-RO/SC-RO3
B-SC5	C/SC-NMO3	C-SE/SC-SE1	RO/CW-C3	SC-RO/TW-SE3
B-SC5S	C/SC-RO1	C-TW/CW3	RO/CW-SC3	SC-RO4
B-SC-CW5	C/SC-RO3	C-TW/CW-SC1	RO/NMO-RO3	SC-RO5
B-SC-RO5S	C/SC-RO-CW1	C-TW/CW-TW3	RO/RO3	SC-RO-B5
C/C-CW3F	C/SC-RO-CW3	C-TW/MB-SC1	RO/RO-CW3	SC-RO-C5
C/C-CW-SC3	C/SC-RO-CW-B3	C-TW/NMO3	RO/RO-CW5	SC-RO-CW5
C/CW1	C/SC-RO-MB1	C-TW/RO3	RO/RO-SC3	SC-RO-SE/SC-RO3
C/CW3	C/SC-RO-SBM3	C-TW/RO-SC3	RO/SC3	SC-SB5
C/CW3F	C/SC-RO-TW1	C-TW/SC1	RO/SC5	SC-SBM5
C/CW-MB1	C/SC-RO-TW3	C-TW/SC3	RO/SC-CW3	SC-SS5
C/CW-NM03	C/SC-SBM1	C-TW/SC-CW3	RO/SC-RO3	SC-TW5
C/CW-NMO3	C/SC-SBM3	C-TW/SC-RO1	RO3	SC-TW5F
C/CW-RO1	C/SC-TW1	C-TW/SC-TW3	RO4	SC-TW-C/SC-B3
C/CW-RO3	C/SE-MB-RO1	C-TW/TW-SC3	RO5	SC-TW-NMO/ SC-TW-NMO3
C/CW-RO-SC3	C/SE-RO1	C-TW4	RO5F	SE/CW3
C/CW-RO-TW1	C/TH-SE-CW3	C-TW5	RO5S	SE/RO-CW5
C/CW-SC1	C/TW-CW-RO1	C-TW-CW5	RO-ATX-SC5	SE/SC3
C/CW-SE-MB1	C/TW-RO-SC1	CW4	RO-C/B-SC-RO3	SE-C/RO-SC3
C/ERNA-CW3	C/TW-SC3	CW5	RO-C/CW3	SE-C/SC3
C/MB-RO1	C4	CW5F	RO-C/CW-SC3	SE-C/SC-TH3
C/NMO-CW3	C5	CW-B5	RO-C/RO-C3	SE-CW5
C/NMO-CW4	C5F	CW-B5F	RO-C/SC3	SE-RO/RO3
C/NMO-RO1	C-B-CW5	CW-B-C5	RO-C/SC-B-C3	SE-RO/SC3
C/NMO-SC-RO1	C-B-RO5	CW-B-C5F	RO-C4	SE-RO/SC-CW5
C/R01	C-CW4	CW-B-RO-C5	RO-C5	SE-RO-TW5
C/RO/SC1	C-CW5	CW-C5	RO-C-SC5	SE-TW-C/SC-RO3
C/RO1	C-CW5F	CW-C5F	RO-C-TW/CW3	TW/CW3
C/RO1F	C-CW-B5	CW-C-B5F	RO-CW5	TW/CW-NMO3
C/RO3	C-CW-RO5	CW-C-CAT5	RO-CW5F	TW/CW-SC3
C/RO5	C-CW-RO5F	CW-C-RO5	RO-CW-C5	TW/CW-TW3
C/RO-CW1	C-CW-RO-SC5	CW-C-RO-SC5	RO-CW-CAT5	TW/NM04
C/RO-CW1F	C-CW-SC5	CW-C-SC5	RO-CW-SC5	TW/NMO3
C/RO-CW3	C-CW-TW5	CW-C-SE-SC5	RO-CW-SE5	TW/NMO-CW3
C/RO-CW-B5	C-CW-TW5F	CW-ERNA5	RO-SC/CW-SC3	TW/SC1
C/RO-MB1	C-J/CW3	CW-NMO/ERNA3	RO-SC/RO-CW3	TW/SC3

Selected Vegetation Types for Suitable SWFL Breeding Habitat				
C/RO-MB3	C-J/CW-ERNA3	CW-NMO3	RO-SC/SC3	TW/SC-TW3
C/RO-MB-CW3	C-MB-SE/ CW-MB-SC3	CW-NMO4	RO-SC3	TW/TW3
C/RO-MB-SC1	C-Q/CW4	CW-NMO5	RO-SC3F	TW/TW3F
C/RO-NMO1	C-R04	CW-NMO-ERNA5	RO-SC4	TW/TW-CW3
C/RO-NMO1	C-RO/B-SC3	CW-NOW5	RO-SC5	TW/TW-SC3
C/RO-SBM-SC1	C-RO/C-B-CW3	CW-RO5	RO-SC5F	TW4
C/RO-SC1	C-RO/CW3	CW-RO5F	RO-SC-B5	TW4F
C/RO-SC3	C-RO/CW-B3	CW-RO-C-SC5	RO-SC-C5	TW5
C/RO-SC3S	C-RO/CW-RO3	CW-RO-SC5	RO-SC-CW5	TW5F
C/RO-SC-CW1	C-RO/CW-RO-SC3	CW-RO-SC5S	RO-SC-SBM5	TW5-SC5
C/RO-SC-CW3	C-RO/CW-SC3	CW-SC5	RO-SC-TW5	TW-B5
C/RO-SC-SE1	C-RO/CW-TW3	CW-SC5F	RO-SE/CW3	TW-C/CW3
C/RO-SC-TW1	C-RO/RO3	CW-SC-B5	RO-TW-CW5	TW-C/CW3F
C/RO-SC-TW3	C-RO/RO-B1	CW-SC-C5	RO-TW-SE-C5F	TW-C/CW-SC3
C/RO-SE1	C-RO/RO-C3	CW-SC-RO5	SC/CW5	TW-C/SC1
C/RO-SE-CW3	C-RO/RO-CW1	CW-SC-SE5	SC/SC3	TW-C/SC3
C/RO-TW-CW1	C-RO/RO-CW3	CW-SC-TW5	SC/SC3F	TW-C/SC-CW3
C/SBM-SC3	C-RO/RO-SC3	CW-SE5	SC/SC-B3	TW-C/TW-SC3
C/SC1	C-RO/SC3	CW-SE-C5F	SC/SC-CW3	TW-C/TW-SC-CW3
C/SC3	C-RO/SC-B-TW3	CW-TW5	SC3	TW-C4
C/SC3F	C-RO/SC-C-B3	CW-TW-C5	SC4	TW-C5
C/SC-A1	C-RO/SC-CW3	J/CW3	SC4F	TW-C-CW5
C/SC-ATX3	C-RO/SC-CW-RO3	J-C/CW3	SC5	TW-C-RO/CW3
C/SC-B1	C-RO/SC-RO3	J-RO/CW3	SC5F	TW-CW4
C/SC-B3	C-RO3	NMO/CW3	SC-ATX5	TW-CW-C5
C/SC-B3F	C-RO4	NMO-CW3	SC-B5	TW-NMO4
C/SC-B-A3	C-RO-TW/SC-B3	NMO-CW4	SC-B-C5	TW-Q4
C/SC-B-C3	C-RO-TW5	NMO-CW5	SC-B-C-RO5	TW-RO/CW3
C/SC-B-RO3	C-SBM-SC5	NMO-CW5F	SC-B-CW5	TW-SC/SC-RO3
C/SC-B-SBM3	C-SC/C-SC3	NMO-CW-ERNA5	SC-B-TW5	TW-SC5
C/SC-B-SBM-NMO1	C-SC/SC3	Q/CW3	SC-C5	TW-SC-C5
C/SC-C3	C-SC/SC-NMO1	Q/NMO-CW3	SC-C-CW5	
C/SC-C3F	C-SC/SC-RO3	Q-RO/CW3	SC-C-RO5	
C/SC-CW1	C-SC4	Q-TW/NMO3	SC-C-TW5	

Legend for Tables L-3.23 and L-3.24:		
A = False indigobush ATX = Fourwing daltbush B = Baccharis BD = Broom falea C = Cottonwood	JUSC = Rocky Mountain juniper MB = Mulberry NMO = New Mexico olive Q = Oak (*Quercas* spp.) RO = Russian olive SB = Silver buffaloberry	*Habitat Type or Land Feature:* LFCC = Low Flow Conveyance Channel RI = River channel RO = Road

Legend for Tables L-3.23 and L-3.24:		
CAT = Cattail CW = Coyote willow ERNA = Rabbitbrush HL = Honey locust HMS = Honey mesquite J = Juniper	SBM = Screwbean mesquite SC = Salt cedar SE = Siberian elm SS = Sand sage TH = Tree of heaven TW = Tree willow	OP = Open area OW = Open water *Last letter on selected codes:* F = Potentially suitable SWFL habitat S = sparse or scattered

Notes:

A forward slash (/) indicates separation between overstory species/understory species
A hyphen (-) separates species, in order of dominance, within either the over- or understory
Numbers indicate Hink and Ohmart structural Types 1 thru 6

Table L-3.25 Vegetation Types Excluded as not Suitable for Southwestern Willow Flycatcher Breeding Habitat

Excluded Vegetation Types Not Suitable SWFL Breeding Habitat				
ATX6	C/SC-CW3S	C-SC-B5S	NMO-CW6	RO-TW-CW5S
ATX-SS5	C/SC-NMO1S	C-SC-CAT6	NMO-ERNA5	SBM5
ATX-SS6	C/SC-RO1S	C-SC-SE5S	NMO-ERNA6	SBM6
B5	C/SC-RO3S	C-SC-TW6	NMO-MH6	SBM-C6
B6	C/SC-TW-RO1S	C-SE/A4	NMO-Q4	SBM-SC5S
B-C-CW6F	C/SE1S	C-SE/NMO3S	NMO-SB5	SC/C3S
B-CW6	C/SE-A1	C-SE/SE1	NMO-SC5	SC/SC3S
B-CW-RO-C6	C/TW3S	C-SE2	OP	SC3S
B-CW-SC6	C/TW-CW3S	C-TW/SC-B3S	OW	SC5S
BD6	C2	C-TW/SC-CW3S	OW – LFCC	SC6
BD-CW6	C2S	C-TW2	OW – Rio Grande	SC6S
B-SC6	C5S	C-TW-CW6	Q/NMO3	SC-ATX6
C/ATX-SS1S	C5S	CW6	Q/RO3	SC-B5S
C/B-A-C3S	C6	CW6S	Q2	SC-B6
C/B-CW-SC3S	CAT-C6	CW-B5S	Q4	SC-C5S
C/B-SC1S	CAT-CW6	CW-B-CAT6	Q-C/NMO1	SC-C6
C/B-SC3S	C-B5S	CW-B-SC6	Q-C1	SC-C6S
C/CW1S	C-B6F	CW-C6	Q-C2	SC-C-CAT5S
C/CW3S	C-B-CW6	CW-CAT6	Q-C4	SC-CW5S
C/CW-RO1S	C-CW2	CW-C-B6	Q-J/RO3	SC-CW6
C/CW-RO3S	C-CW6	CW-ERNA6	Q-J4	SC-CW-B6
C/CW-RO-TW3S	C-CW-B6	CW-MH6	Q-NMO3	SC-HMS6
C/CW-TW-RO1S	C-CW-TW5S	CW-NMO6	Q-NMO4	SC-NMO5S
C/ERNA3	C-J2	CW-NMO-ERNA6	RIVER	SC-RO
C/MB1	C-NMO1	CW-RO5S	RO/CW3S	SC-RO5S
C/MB-SE1	C-NMO2	CW-RO6	RO/RO3S	SC-RO6
C/NMO1	C-NMO4	CW-SC6	RO/SC3S	SC-RO-B5S
C/NMO1S	C-Q/NMO1	CW-SC6S	RO6	SC-RO-C5S

Excluded Vegetation Types Not Suitable SWFL Breeding Habitat				
C/NMO2	C-Q/NMO3	CW-SC-B6	ROAD	SC-RO-C6
C/NMO3	C-Q1	CW-SC-C6	RO-B-SC5S	SC-SBM5S
C/NMO4	C-Q4	ERNA6	RO-C/RO-CW3S	SC-SE-RO
C/NMO-HMS-SC1S	C-RO	ERNA-CW6	RO-C6	SC-TW5S
C/RO1S	C-RO/C-B3S	HMS-CR5S	RO-CW5S	SC-TW-CW-NMO5S
C/RO2	C-RO/C-RO-B3S	J/CW6	RO-CW6	SE/MB-TH3
C/RO3S	C-RO/CW-SC3S	J-C4	RO-CW-C5S	SE/SE-TH-HL1
C/RO-CW1S	C-RO/SC-RO3S	J-C5	RO-CW-C6	SE/TH3
C/RO-NMO-SC1S	C-RO2	J-CW6	RO-CW-SE5S	SE-MB4
C/RO-SC1S	C-RO2S	LC-C-SE4	RO-J4	SS6
C/RO-SC-TW3S	C-RO5S	MB5	RO-JUSC4	TH5
C/RO-TW3S	C-RO6	MH	RO-MB/MB-RO-CW3S	TW6
C/SBM3S	C-RO-CW-B6	MS	RO-SBM-SC6	TW-C2
C/SC1S	C-RO-SBM-SC5S	NMO/ERNA3	RO-SC5S	TW-C-CW6
C/SC3S	C-RO-SC2	NMO4	RO-SC6	TW-CW6
C/SC-B1S	C-RO-SC-B5S	NMO5	RO-SC-C6	TW-SC5S
C/SC-B3S	C-SC/CW-B-C3S	NMO5S	RO-SE-C4	
C/SC-B-A3S	C-SC5S	NMO6	RO-SE-SC5S	

Note: Legend with Table L-3.23.

3.6.1.4 Impact Analysis on Southwestern Willow Flycatcher

No Action

The effects of the No Action Alternative on the endangered SWFL are not uniform in the Project Area, as shown in **Table L-3.**. For example, in the San Acacia Section, the No Action Alternative (no diversions to LFCC) provides an annual average of 462 days of flooding in occupied SWFL territories; the average frequency of flooding of all occupied sites is 53%. Suitable habitat within 10 miles of occupied territories receives an annual average of 20,374 acre-days and 345 acres of inundation, and flooding occurs in suitable habitat during 100% of the modeled years. The maximum consecutive non-inundation period in the 40-year period of study is 5 years under this alternative in the San Acacia Section. This alternative provides the best hydrological support to occupied SWFL sites and suitable habitat in the San Acacia Section, with the greatest number of occupied sites and largest acreage of suitable habitat within 10 miles of occupied sites.

Table L-3.26 Performance Measures for Impacts of No Action on Southwestern Willow Flycatcher

No Action	SWFL Habitat Class	Rio Chama Section	Central Section	San Acacia Section
Mean annual days inundation at occupied sites (days)	Occupied Sites	No territories	9.5	462
Mean annual acre-day inundation (acre-days)	Suitable habitat <10 mi from core areas	11	888	20,374
Mean annual acre-day inundation (acre-days)	Suitable habitat >10 mi from core areas	21	584	3,476
Mean annual acres inundation (acres)	Suitable habitat <10 mi from core areas	14	33	345
Mean annual acre inundation (acres)	Suitable habitat >10 mi from core areas	5	22	106
40-year frequency of inundation (%)	Occupied sites	No territories	17	53
40-year frequency	Suitable habitat <10 mi from core areas	90	50	100
% Years dry inundation	Occupied sites	N/A	0.7	0.2
Mean duration of non-inundation (years)	Suitable habitat <10 mi from core areas	0.3	0.8	0.2
Mean duration of non-inundation (years)	Suitable habitat >10 mi from core areas	0.4	0.5	0.1
40-yr frequency	Suitable habitat >10 mi from core areas	90	50	53
Maximum duration of non-inundation years	Occupied sites	No Territories	11	5
Maximum duration of non-inundation years	Suitable habitat <10 mi from core areas	1	5	0
Maximum duration of non-inundation (years)	Suitable habitat >10 mi from core areas	1	5	5

By contrast, the No Action Alternative provides less hydrological support to the Rio Chama and Central Sections. Suitable habitat within 10 miles of occupied sites in the Rio Chama Section receives inundation during 90% of years, with an annual average of 11 acre-days of inundation. In the Central Section, flooding occurs in at least one occupied SWFL site in 17% of the years, with an annual average of 9.5 days of flooding in occupied sites. (All of the alternatives provide minimum flooding to Central Section occupied sites, which range from annual averages of 9 to 39 days compared to 100 to 462 days in the San Acacia Section.) Suitable habitat less than 10 miles from occupied territories in the Central

Section receives an annual average of 888 acre-days of flooding during 50% of years. The maximum periods of consecutive non-inundation in occupied and nearby suitable habitat are 11 and 5 years, respectively. Overall, this alternative provides the least support of any of the alternatives to suitable habitat in the Rio Chama Section in terms of acre-days of flooding.

The overall average performance of the No Action Alternative is beneficial to SWFL, given the large areas of habitat supported in the San Acacia Section. It provides flows necessary to maintain and expand the population in the Middle Rio Grande SWFL recovery unit in an area with the highest population levels and most extensive suitable habitat adjacent to the possibly vulnerable occupied sites in the pool of Elephant Butte Reservoir. However, this alternative does not assist in reaching SWFL Recovery Plan goals for expanding the population by increasing the extent and duration of overbank flooding and by establishing and supporting suitable habitat in the Upper Rio Grande Unit, as described in Section 3.6.1.3.

If diversions into the LFCC would occur, overbank flooding in the San Acacia Section would be reduced by the amount shown in Figure 3.21. However, additional flows into the LFCC, up to 500 cfs, would likely improve the SWFL habitat that currently exists in the Elephant Butte Reservoir pool. Although not quantifiable, these additional flows would also likely contribute to the expansion of suitable SWFL habitat as more surface area is flooded; these benefits would be direct and measurable. Diversions between 500 and 1000 cfs would likely provide both positive and potentially negative impacts to the occupied SWFL habitat in the reservoir pool. Beneficial impacts would be similar to Alternative I-1 in that additional surface area would be inundated thereby providing a potential increase in suitable SWFL habitat in the delta area. Potentially negative impacts could occur if flows were sufficiently high to cause scouring or damage to existing occupied habitat. The timing and duration of high flows would dictate the extent of adverse affect to SWFL habitat. If existing occupied habitat is flooded for extensive periods of time, then adverse impacts to the riparian vegetation may be observed. If this were to occur, it would be over a period of time (years) and indirect. Goodding's willow is tolerant of longer-term inundation, so this potential adverse affect would be gradual and would also be dependent on other factors, such as reservoir pool levels. It is quite possible that the benefits would outweigh the adverse impacts in the long-term, as an increase in suitable SWFL habitat would be the end result.

Diversions of 1,000–2,000 cfs could result in both beneficial and adverse impacts to occupied SWFL habitat in the Elephant Butte Reservoir pool. Beneficial impacts would occur to a larger area, but adverse impacts could also be wider-spread. Potential scouring and damage to SWFL habitat would likely be on a larger scale, although the duration of flows possible under this alternative would not necessarily be any greater.

Mitigation of these and other adverse effects of no action on SWFL is the subject of a 2003 Section 7 consultation with the Service entitled, "Biological Opinion on the Effects of Water and River Maintenance Operations, Army Corps of Engineers' Flood Control Operations, and Related Non-Federal Action on the Middle Rio Grande, New Mexico."

In addition, the effects of fluctuating reservoir levels at Elephant Butte to SWFLs and their habitat in the floodpool is being addressed separately by Reclamation and the Service. None of the alternatives analyzed in this EIS would result in measurable changes to the Elephant Butte Reservoir pool levels.

LFCC Diversion Effects on SWFL Habitat in the San Acacia Reach

The values shown in **Figure L-3.10** presented modeled floodplain inundation with no LFCC diversions in the San Acacia section. Impacts from variable levels of diversion into the LFCC (as shown in Figure 3.21) would have increasing adverse effects to SWFL territories in the San Acacia Reach, but there would be beneficial effects to territories located at the existing LFCC outfall. With LFCC diversions the average inundation would decrease by about 15% with 500 cfs diversions, 30% with 1,000 cfs diversions; and 57% with 2,000 cfs diversions. LFCC diversions would cause long-term adverse impacts to SWFL-occupied breeding sites and suitable habitat in the San Acacia Sections by reducing the extent of flooding. The magnitude of effects would be directly proportional to the amount of diversions.

Action Alternative B-3

Alternative B-3 would have significant adverse impacts on SWFL averaged over the Rio Chama Section, the Central Section, and the San Acacia Section. The mean annual inundation at occupied territories and nearby suitable habitat would decrease to 29% and 46%, respectively, of No Action, and the 40-year frequency of inundation would decrease to 75% of No Action. The maximum duration of non-inundation periods would increase from 5 to 6 years at occupied sites and from 0 to 1 year at nearby suitable habitat. However, this alternative provides the most inundation to suitable habitat in the Central Section. **Table L-3.27** provides a comparison of the performance of the B-3 Alternative with No Action. Overall, this alternative ranks last among all alternatives, and failure to support the hydrological needs of the SWFL and its habitat would produce a general adverse effect that would be felt in the San Acacia Section and would result in long-term reductions in SWFL population density and failure to meet Recovery Goals for this sub-species.

Alternative B-3 would allow diversions of 1,000–2,000 cfs at the LFCC, resulting in both beneficial and adverse impacts at occupied SWFL habitat in the Elephant Butte delta area. This diversion and other aspects of the alternative produce a reservoir level approximately 10 feet higher than would the No Action Alternative. Beneficial impacts would occur from the additional volume of surface water available to support the large number of occupied territories in this area. Potential scouring and damage to SWFL habitat would likely be on a larger scale, although the duration of flows possible under this alternative would not necessarily be any greater than under other action alternatives. The long-term benefits could outweigh the short-term impacts and would likely occur on a larger scale. These effects would also depend on the reservoir levels, since occupied SWFL territories in this area are occasionally subject to reservoir flooding.

Selection of Alternative B-3 would likely result in significant adverse effects that could require mitigation. The differences between the impacts to SWFL in the San Acacia Section are related to upstream effects as well as the effects of diversion. Due to the potential impacts of this alternative, additional studies are recommended to determine the best timing and duration of upstream storage and release as well as additional modeling to determine the full effects of LFCC diversion if this alternative is selected as the preferred alternative.

Table L-3.27 Performance Measures for Impacts of Alternative B-3 on SWFL

Measure	SWFL Habitat Class	Rio Chama Section	Central Section	San Acacia Section	Overall Impact of Alternative B-3
Mean annual days inundation at occupied sites (days)	Occupied Sites	No territories	37	100	
% Change from No Action with 0 diversions		N/A	289.47%	-78.35%	ADVERSE
Mean annual acre-day inundation (acre-days)	Suitable habitat <10 mi from core areas	72	1010	8789	
% Change from No Action with 0 diversions		554.55%	13.74%	-56.86%	ADVERSE
Mean annual acre-day inundation (acre-days)	Suitable habitat >10 mi from core areas	21	618	584	
% Change from No Action with 0 diversions		0.00%	5.82%	-83.20%	ADVERSE
Mean annual acres inundation (acres)	Suitable habitat <10 mi from core areas	6	57	224	
% Change from No Action with 0 diversions		-57.14%	72.73%	-35.07%	ADVERSE

Measure	SWFL Habitat Class	Rio Chama Section	Central Section	San Acacia Section	Overall Impact of Alternative B-3
Mean annual acre inundation (acres)	Suitable habitat >10 mi from core areas	1	35	29	
% Change from No Action with 0 diversions		-80.00%	59.09%	-72.64%	ADVERSE
40-yr frequency of inundation (%)	Occupied Sites	No territories	25	40	
% Change from No Action with 0 diversions		N/A	47.06%	-24.53%	ADVERSE
40-yr frequency inundation (%)	Suitable habitat >10 mi from core areas	80	48	90	90
% Change from No Action with 0 diversions		-11.11%	-4.00%	-10.00%	ADVERSE
% Years of no inundation	Occupied Sites	N/A	0.7	0.2	0
% Change from No Action with 0 diversions		N/A	0.00%	0.00%	NEUTRAL
Mean duration of non-inundation (years)	Suitable habitat <10 mi from core areas	0.3	0.8	0.2	0
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
Mean duration of non-inundation (years)	Suitable habitat >10 mi from core areas	0.4	0.5	0.1	0
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
40-yr freq inundation (%)	Suitable habitat >10 mi from core areas	85	48	30	85
% Change from No Action with 0 diversions		-5.56%	-4.00%	-43.40%	ADVERSE
Maximum duration of non-inundation (years)	Occupied Sites	No territories	12	6	6
% Change from No Action with 0 diversions		N/A	9.09%	20.00%	ADVERSE
Maximum duration of non-inundation (years)	Suitable habitat <10 mi from core areas	3	5	1	1
% Change from No Action with 0 diversions		200.00%	0.00%	0.00%	NEUTRAL
Maximum duration of non-inundation (years)	Suitable habitat >10 mi from core areas	1	5	11	1
% Change from No Action with 0 diversions		0.00%	0.00%	120.00%	ADVERSE
SUMMARY FINDINGS		**BENEFICIAL**	**NEUTRAL**	**ADVERSE**	**ADVERSE**

Alternative B-3 would result in an overall annual average of 1,657 acres of inundation for the San Acacia Section, which is 2.7% greater than the annual average of 1,615 acres for No Action with the comparable LFCC diversions of 2,000 cfs, as shown in **Figure L-3.32**. Alternative B-3 would result in 56.2% less inundation compared to No Action with zero diversions. Compared with No Action with similar diversions, Alternative B-3 would probably slightly increase inundation to occupied SWFL territories and suitable habitat, resulting in slight long-term benefits, and there could be beneficial effects to territories located at the existing LFCC outfall. However, compared with no action with zero diversions, there could be long-term impacts. The differences between the impacts to SWFL in the San Acacia Section are related to upstream effects as well as the effects of diversion. Due to the potential impacts of this alternative, additional studies are recommended to determine the best timing and duration of upstream storage and release as well as additional modeling to determine the full effects of LFCC diversion if this alternative is selected as the preferred alternative.

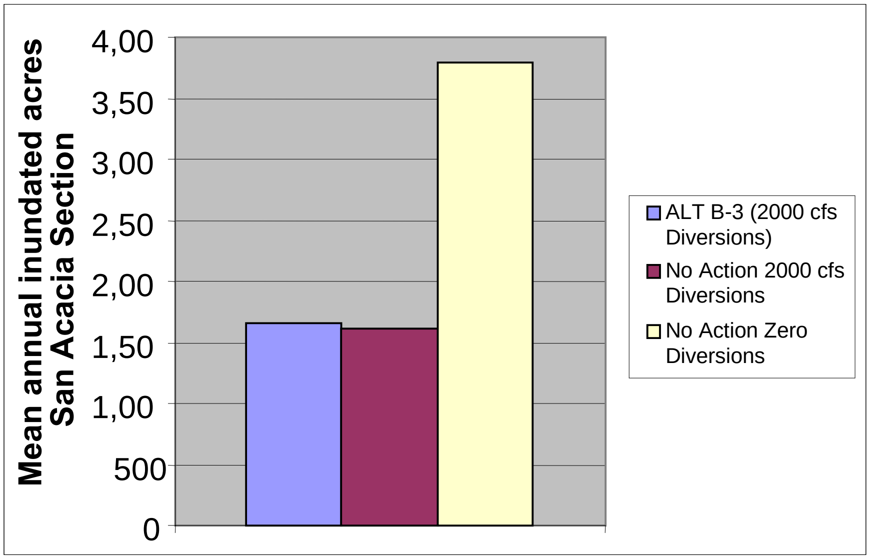


Figure L-3.32 Average Annual Acres of Inundation in San Acacia Section of Alternative B-3 Compared With Variable No Action.

Action Alternative D-3

Alternative D-3 would have significant adverse impacts on SWFL averaged over the three river sections. The mean annual inundation at occupied territories and nearby suitable habitat would decrease overall to 27% and 48%, respectively, from the No Action Alternative. The frequency of inundation would decrease to 80% of No Action frequency. The maximum duration of non-inundation periods would increase from 5 to 6 years at occupied sites and from 0 to 1 year at nearby suitable habitat; however, this alterative does provide the most inundation to suitable habitat in the Rio Chama Section, as frequency of inundation would not change significantly. **Table L-3.28** provides a comparison of the performance of Alternative D-3 with No Action. Failure to support the hydrological needs of the SWFL and its habitat would produce a general adverse effect that would be felt in the San Acacia Section and would result in long-term reductions in SWFL population density and failure to meet Recovery Plan goals for this sub-species; however, this alternative could assist in reaching SWFL Recovery Plan goals for expanding the population by increasing the extent and duration of overbank flooding and establishing and supporting suitable habitat in the Upper Rio Grande Unit, as described in Section 3.6.1.3. However, compared with No Action with zero diversions, there could be long-term impacts. The differences between the impacts to SWFL in the San Acacia Section are related to upstream effects as well as the effects of diversion. Due to the potential impacts of this alternative, additional studies are recommended to determine the best timing and duration of upstream storage and release, as well as additional modeling to determine the full effects of LFCC diversion if this alternative is selected as the preferred alternative.

Table L-3.28 Performance Measures for Impacts of Alternative D-3 on SWFL

Measure	SWFL Habitat Class	Rio Chama Section	Central Section	San Acacia Section	Overall Impact of Alternative D-3
Mean annual days inundation at occupied sites (days)	Occupied sites	No territories	10	116	
% Change from No Action with 0 diversions		N/A	5.26%	-74.89%	ADVERSE
Mean annual acre-day inundation (acre-days)	Suitable habitat <10 mi from core areas	200	903	9177	

Measure	SWFL Habitat Class	Rio Chama Section	Central Section	San Acacia Section	Overall Impact of Alternative D-3
% Change from No Action with 0 diversions		1718.18%	1.69%	-54.96%	NEUTRAL
Mean annual acre-day inundation (acre-days)	Suitable habitat >10 mi from core areas	219	582	648	
% Change from No Action with 0 diversions		942.86%	-0.34%	-81.36%	ADVERSE
Mean annual acres inundation (acres)	Suitable habitat <10 mi from core areas	12	36	221	
% Change from No Action with 0 diversions		-14.29%	9.09%	-35.94%	ADVERSE
Mean annual acre inundation (acres)	Suitable habitat >10 mi from core areas	10	23	25	
% Change from No Action with 0 diversions		100.00%	4.55%	-76.42%	ADVERSE
40-yr freq. Of inundation (%)	Occupied Sites	No territories	20	43	
% Change from No Action with 0 diversions		N/A	17.65%	-18.87%	NEUTRAL
40-yr frequency inundation (%)	Suitable habitat >10 mi from core areas	75	48	90	
% Change from No Action with 0 diversions		-16.67%	-4.00%	-10.00%	NEUTRAL
% Years of no inundation	Occupied Sites	N/A	0.7	0.2	
% Change from No Action with 0 diversions		N/A	0.00%	0.00%	NEUTRAL
Mean duration of non-inundation (years)	Suitable habitat <10 mi from core areas	0.3	0.8	0.2	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
Mean duration of non-inundation (years)	Suitable habitat >10 mi from core areas	0.4	0.5	0.1	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
40-yr frequency inundation (%)	Suitable habitat >10 mi from core areas	85	48	30	
% Change from No Action with 0 diversions		-5.56%	-4.00%	-43.40%	ADVERSE
Maximum duration of non-inundation years	Occupied Sites	No territories	12	6	
% Change from No Action with 0 diversions		N/A	9.09%	20.00%	ADVERSE
Maximum duration of non-inundation (years)	Suitable habitat <10 mi from core areas	4	5	1	
% Change from No Action with 0 diversions		300.00%	0.00%	0.00%	ADVERSE
Maximum duration of non-inundation (years)	Suitable habitat >10 mi from core areas	1	5	11	
% Change from No Action with 0 diversions		0.00%	0.00%	120.00%	ADVERSE
SUMMARY FINDINGS		**NEUTRAL**	**NEUTRAL**	**ADVERSE**	**ADVERSE**

Alternative D-3 would result in an overall annual average of 1,571 acres of inundation for the San Acacia Reach, which is 2.7% less than the annual average of 1,615 acres for No Action with the comparable LFCC diversions of 2,000 cfs (**Figure L-3.33**). Alternative D-3 would result in 58.5% less inundation compared to No Action with zero diversions. Compared with No Action with diversions, Alternative D-3 could slightly decrease inundation to occupied SWFL territories and suitable habitat, resulting in long-term slight adverse impacts, but there could be beneficial effects to territories located at the existing LFCC outfall. However, compared with No Action with zero diversions, there could be long-term impacts. The differences between the impacts to SWFL in the San Acacia Section are related to upstream effects as well as the effects of diversion. Due to the potential impacts of this alternative, additional studies are recommended to determine the best timing and duration of upstream storage and release as well as additional modeling to determine the full effects of LFCC diversion if this alternative is selected as the preferred alternative.

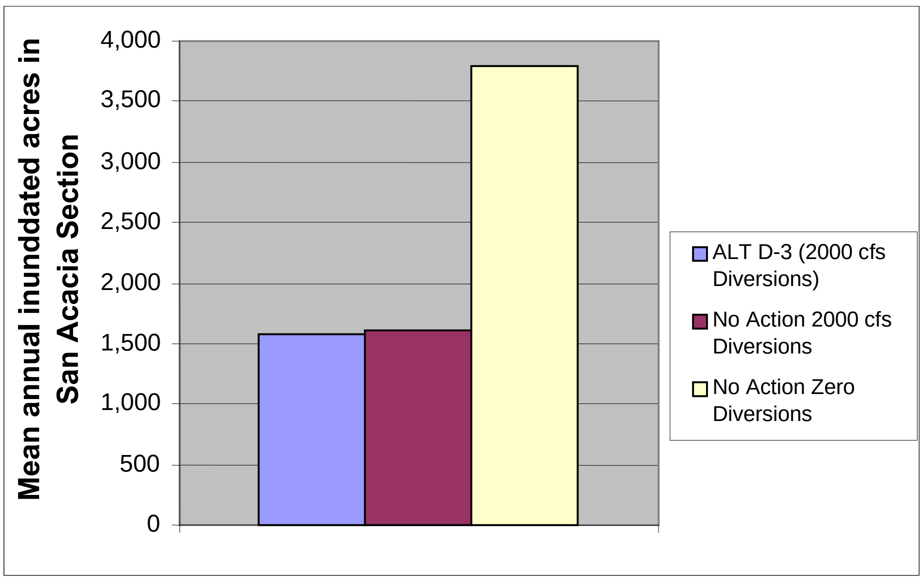


Figure L-3.33 Average Annual Acres of Inundation in San Acacia Section of Alternative D-3 Compared With Variable No Action.

<u>Action Alternative E-3</u>

Alternative E-3 would have significant adverse impacts on SWFL averaged over the three river sections. The mean annual inundation at occupied territories and nearby suitable habitat would decrease overall to 30% and 47% from the No Action Alternative; the 40-year frequency of inundation would decrease to 72% of No Action at occupied territories. The maximum duration of non-inundation periods would increase from 5 to 7 years at occupied sites and from 0 to 1 year at nearby suitable habitat. However, this alternative does provide the most inundation at occupied sites in the Central Sections. **Table L-3.** provides a comparison of the performance of Alternative E-3 with No Action. Failure to support the hydrological needs of the SWFL and its habitat would produce a general adverse effect that would be felt in the San Acacia Section and would result in long-term reductions in SWFL population density and failure to meet Recovery Plan goals for this sub-species. However, this alternative could assist in reaching SWFL Recovery Plan goals for expanding the population by increasing the extent and duration of overbank flooding and establishing and supporting suitable habitat in the Upper Rio Grande Unit, as described in Section 3.6.1.3. Selection of Alternative E-3 would likely result in significant adverse effects that could require mitigation.

Table L-3.29 Performance Measures for Impacts of Alternative E-3 on SWFL

Measure	SWFL Habitat Class	Rio Chama Section	Central Section	San Acacia Section	Overall Impact of Alternative E-3
Mean annual days inundation at occupied sites (days)	Occupied sites	No territories	39	102	
% Change from No Action with 0 diversions		N/A	310.53%	-77.92%	ADVERSE
Mean annual acre-day inundation (acre-days)	Suitable habitat <10 mi from core areas	141	1063	8842	
% Change from No Action with 0 diversions		1181.82%	19.71%	-56.60%	NEUTRAL
Mean annual acre-day inundation (acre-days)	Suitable habitat >10 mi from core areas	109	645	572	
% Change from No Action with 0 diversions		419.05%	10.45%	-83.54%	ADVERSE
Mean annual acres inundation (acres)	Suitable habitat <10 mi from core areas	9	63	224	
% Change from No Action with 0 diversions		-35.71%	90.91%	-35.07%	ADVERSE
Mean annual acre inundation (acres)	Suitable habitat >10 mi from core areas	4	40	27	
% Change from No Action with 0 diversions		-20.00%	81.82%	-74.53%	ADVERSE
40-yr frequency of inundation (%)	Occupied Sites	No territories	23	38	
% Change from No Action with 0 diversions		N/A	35.29%	-28.30%	NEUTRAL
40-yr frequency inundation (%)	Suitable habitat >10 mi from core areas	77	40	90	
% Change from No Action with 0 diversions		-14.44%	-20.00%	-10.00%	ADVERSE
% years of no inundation	Occupied Sites	N/A	0.7	0.2	
% Change from No Action with 0 diversions		N/A	0.00%	0.00%	NEUTRAL
Mean duration of non-inundation (years)	Suitable habitat <10 mi from core areas	0.3	0.8	0.2	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
Mean duration of non-inundation (years)	Suitable habitat >10 mi from core areas	0.4	0.5	0.1	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
40-yr freq inundation (%)	Suitable habitat >10 mi from core areas	88	40	25	
% Change from No Action with 0 diversions		-2.22%	-20.00%	-52.83%	ADVERSE
Maximum duration of non-inundation years	Occupied sites	No territories	7	12	
% Change from No Action with 0 diversions		N/A	-36.36%	140.00%	ADVERSE
Maximum duration of non-inundation (years)	Suitable habitat <10 mi from core areas	1	5	1	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	ADVERSE

Measure	SWFL Habitat Class	Rio Chama Section	Central Section	San Acacia Section	Overall Impact of Alternative E-3
Maximum duration of non-inundation (years)	Suitable habitat >10 mi from core areas	1	6	11	
% Change from No Action with 0 diversions		0.00%	20.00%	120.00%	ADVERSE
SUMMARY FINDINGS		**NEUTRAL**	**NEUTRAL**	**ADVERSE**	**ADVERSE**

Alternative E-3 would result in an overall annual average of 1,863 acres of inundation for the entire Project Area, which is 15.4% greater than the annual average of 1,615 acres for No Action with the comparable LFCC diversions of 2,000 cfs, as shown in Figure L-3.34. This change would potentially provide benefits to SWFL. However, Alternative E-3 would result in 50.8% less inundation compared to No Action with zero diversions. Compared with No Action with diversions, Alternative E-3 could increase inundation to occupied SWFL territories and suitable habitat, resulting in long-term benefits and possible beneficial effects to territories located at the existing LFCC outfall. However, compared with No Action with zero diversions, there could be long-term impacts. These differences in the impacts to SWFL in the San Acacia Section depending on the diversion to the LFCC are related to upstream effects as well as the effects of diversion. If this alternative is selected as the preferred alternative, additional studies are recommended to determine the best timing and duration of upstream storage and release, as well as additional modeling to determine the full effects of LFCC diversion.

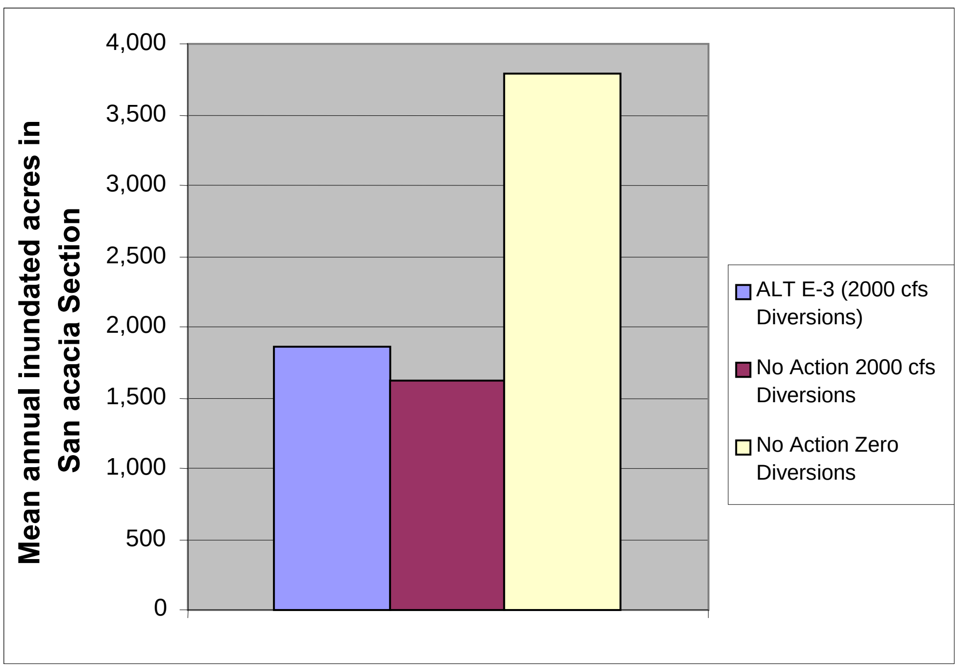


Figure L-3.34 Average Annual Acres of Inundation in San Acacia Section of Alternative E-3 Compared With Variable No Action.

Action Alternative I-1

The I-1 Alternative would have the least adverse impacts on SWFL compared to the other action alternatives in the three river sections. The mean annual inundation at occupied territories and nearby suitable habitat would decrease to 85% and 88%, respectively, of the No Action Alternatives (within the approximate modeling error); the 40-year frequency of inundation would decrease to 95% of No Action frequency at suitable habitat near occupied territories, The maximum duration of non-inundation periods would increase from 5 to 6 years at occupied sites and from zero to 1 year at nearby suitable habitat. **Table L-3.30** provides a comparison of the performance of Alternative I-1 with No Action.

Table L-3.30 Performance Measures for Impacts of Alternative I-1 on SWFL

Measure	SWFL Habitat Class	Rio Chama Section	Central Section	San Acacia Section	Overall Impact of Alternative I-1
Mean annual days inundation at occupied sites (days)	Occupied Sites	No territories	11	391	
% Change from No Action with 0 diversions		N/A	15.79%	-15.37%	NEUTRAL
Mean annual acre-day inundation (acre-days)	Suitable habitat <10 mi from core areas	238	950	17615	
% Change from No Action with 0 diversions		2063.64%	6.98%	-13.54%	BENEFICIAL
Mean annual acre-day inundation (acre-days)	Suitable habitat >10 mi from core areas	174	625	2861	
% Change from No Action with 0 diversions		728.57%	7.02%	-17.69%	BENEFICIAL
Mean annual acres inundation (acres)	Suitable habitat <10 mi from core areas	14	37	332	
% Change from No Action with 0 diversions		0.00%	12.12%	-3.77%	NEUTRAL
Mean annual acre inundation (acres)	Suitable habitat >10 mi from core areas	5	25	99	
% Change from No Action with 0 diversions		0.00%	13.64%	-6.60%	NEUTRAL
40-yr frequency of inundation (%)	Occupied Sites	No territories	20	53	
% Change from No Action with 0 diversions		N/A	17.65%	0.00%	NEUTRAL
40-yr frequency of inundation (%)	Suitable habitat >10 mi from core areas	90	53	95	
% Change from No Action with 0 diversions		0.00%	6.00%	-5.00%	NEUTRAL
% years of no inundation	Occupied Sites	N/A	0.7	0.2	
% Change from No Action with 500 cfs diversions		N/A	0.00%	0.00%	NEUTRAL
Mean duration of non-inundation (years)	Suitable habitat <10 mi from core areas	0.3	0.8	0.2	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
Mean duration of non-inundation (years)	Suitable habitat >10 mi from core areas	0.4	0.5	0.1	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
40-yr frequency inundation (%)	Suitable habitat >10 mi from core areas	93	53	53	
% Change from No Action with 0 diversions		3.33%	6.00%	0.00%	NEUTRAL

Measure	SWFL Habitat Class	Rio Chama Section	Central Section	San Acacia Section	Overall Impact of Alternative I-1
Maximum duration of non-inundation years	Occupied Sites	No territories	12	6	
% Change from No Action with 0 diversions		N/A	9.09%	20.00%	ADVERSE
Maximum duration of non-inundation (years)	Suitable habitat <10 mi from core areas	1	5	1	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
Maximum duration of non-inundation (years)	Suitable habitat >10 mi from core areas	1	5	5	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
SUMMARY FINDINGS		**BENEFICIAL**	**BENEFICIAL**	**NEUTRAL**	**NEUTRAL**

The overall average performance of Alternative I-1 is beneficial to the species, given the large areas of habitat supported in the San Acacia Section. It would provide flows necessary to maintain and expand the population in the Middle Rio Grande SWFL recovery unit in an area with the highest population levels and most extensive suitable habitat adjacent to the possibly vulnerable occupied sites in the pool of Elephant Butte Reservoir. In addition, this alternative could assist in reaching SWFL Recovery Plan goals for expanding the population by increasing the extent and duration of overbank flooding and establishing and supporting suitable habitat in the Upper Rio Grande Unit, as described in Section 3.6.1.3.

Alternative I-1 allows diversion into the LFCC up to 500 cfs. Annual mean drainage flows in the LFCC from 1985 to 2001 ranged from 231 to 450 cfs; thus, additional flows into the LFCC, up to 500 cfs above current drainage flows, would likely improve currently existing SWFL habitat. Although not quantifiable, these additional flows would also likely contribute to the expansion of suitable SWFL habitat when more surface area is flooded. These benefits would be direct and measurable.

LFCC Diversion Effects on SWFL Habitat in the San Acacia Reach

Alternative I-1 would result in an overall annual average of 3,758 acres of inundation for the San Acacia Reach, which is 16.1% greater than the annual average of 3,236 acres for No Action with the comparable LFCC diversions of 500 cfs (**Figure L-3.35**). Alternative I-1 would result in 0.8% less inundation compared to No Action with zero diversions. Compared with No Action with diversions, Alternative I-1 could increase inundation to occupied SWFL territories and suitable habitat, resulting in long-term benefits, and there would be beneficial effects on territories located at the existing LFCC outfall. However, compared with No Action with zero diversions, there could be very slight or negligible long-term impacts.

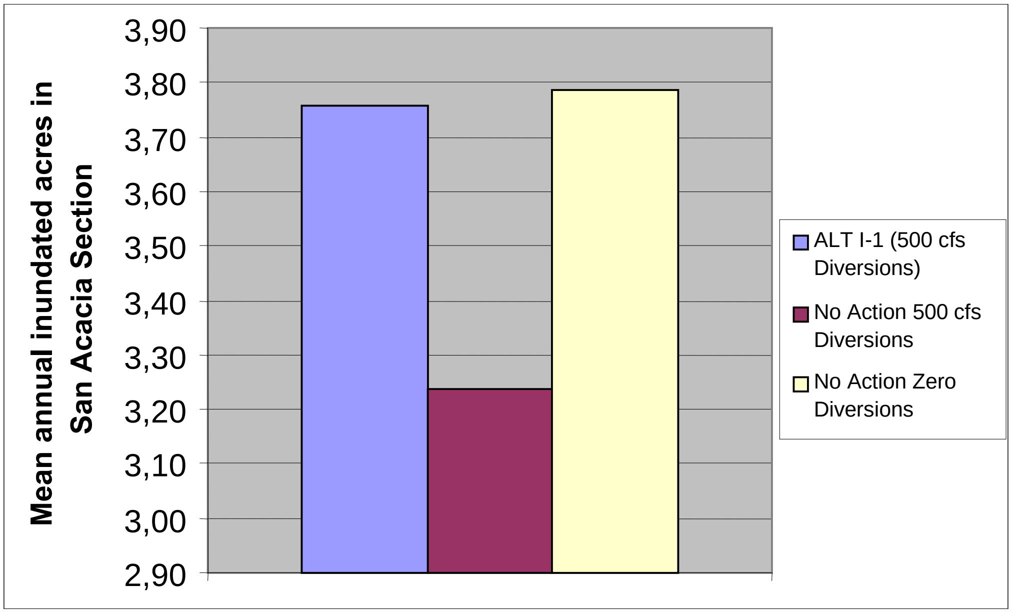


Figure L-3.35 Average Annual Acres of Inundation in San Acacia Section of Alternative I-1 Compared With Variable No Action.

Action Alternative I-2

Alternative I-2 would have adverse impacts on SWFL in the San Acacia Section. The mean annual inundation at occupied territories and nearby suitable habitat would decrease overall to 83% and 69%, respectively, of the No Action Alternative, and the frequency of inundation at occupied sites would decrease to 96% of No Action frequency. The maximum duration of non-inundation periods would increase from 5 to 6 years at occupied sites and from 0 to 1 year at nearby suitable habitat. The frequency of inundation would not show significant change. **Table L-3.** provides a comparison of the performance of Alternative I-2 with No Action. Failure to support the hydrological needs of SWFL and its habitat would produce a general adverse effect that would be felt in the San Acacia Section and would result in long-term reductions in SWFL population density and failure to meet Recovery Plan goals for this sub-species; however, this alternative could assist in reaching SWFL Recovery Plan goals for expanding the population by increasing the extent and duration of overbank flooding and establishing and supporting suitable habitat in the Upper Rio Grande Unit, as described in Section 3.5.1.3.

Alternative I-2 allows diversions into the LFCC up to 1,000 cfs. Diversions between 500 and 1,000 cfs would likely provide both positive and potentially negative impacts to the occupied SWFL habitat. Beneficial impacts would be similar to those under Alternative I-1, in that additional surface area would be inundated, thereby providing a potential increase in suitable SWFL habitat in the delta area. Potentially negative impacts could occur if flows were sufficiently high enough to cause scouring or damage to existing occupied habitat. The timing and duration of high flows would dictate the extent of adverse effect to SWFL habitat. If existing occupied habitat were flooded for extensive periods of time, then adverse impacts to the riparian vegetation could be observed. If this were to occur, it would be over a period of time (years) and indirect. Goodding's willow is tolerant of longer-term inundation and so this potential adverse affect would be gradual and would also be dependent on other factors such as reservoir pool levels. It is quite possible that the benefits would outweigh the adverse impacts in the long term, as an increase in suitable SWFL habitat would be the end result.

Table L-3.31 Performance Measures for Impacts of Alternative I-2 on Southwestern Willow Flycatcher

Measure	SWFL Habitat Class	Rio Chama Section	Central Section	San Acacia Section	Overall Impact of Alternative I-2
Mean annual days inundation at occupied sites (days)	Occupied sites	No territories	10	383	
% Change from No Action with 0 diversions		N/A	5.26%	-17.10%	NEUTRAL
Mean annual acre-day inundation (acre-days)	Suitable habitat <10 mi from core areas	179	872	13552	
% Change from No Action with 0 diversions		1527.27%	-1.80%	-33.48%	NEUTRAL
Mean annual acre-day inundation (acre-days)	Suitable habitat >10 mi from core areas	138	564	2,654	
% Change from No Action with 0 diversions		557.14%	-3.42%	-23.65%	NEUTRAL
Mean annual acres inundation (acres)	Suitable habitat <10 mi from core areas	11	34	308	
% Change from No Action with 0 diversions		-21.43%	3.03%	-10.72%	ADVERSE
Mean annual acre inundation (acres)	Suitable habitat >10 mi from core areas	5	23	95	
% Change from No Action with 0 diversions		0.00%	4.55%	-10.38%	NEUTRAL
40-yr frequency of inundation (%)	Occupied sites	No territories	20	50	
% Change from No Action with 0 diversions		N/A	17.65%	-5.66%	NEUTRAL
40-yr frequency inundation (%)	Suitable habitat >10 mi from core areas	85	50	90	
% Change from No Action with 0 diversions		-5.56%	0.00%	-10.00%	NEUTRAL
% years of no inundation	Occupied Sites	N/A	0.7	0.2	
% Change from No Action with 0 diversions		N/A	0.00%	0.00%	NEUTRAL
Mean duration of non-inundation (years)	Suitable habitat <10 mi from core areas	0.3	0.8	0.2	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
Mean duration of non-inundation (years)	Suitable habitat >10 mi from core areas	0.4	0.5	0.1	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
40-yr freq inundation (%)	Suitable habitat >10 mi from core areas	90	50	50	
% Change from No Action with 0 diversions		-5.56%	0.00%	-5.66%	NEUTRAL
Maximum duration of non-inundation years	Occupied sites	No territories	12	6	
% Change from No Action with 0 diversions		N/A	9.09%	20.00%	**BENEFICIAL**
Maximum duration of non-inundation (years)	Suitable habitat <10 mi from core areas	1	5	1	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
Maximum duration of non-inundation (years)	Suitable habitat >10 mi from core areas	1	5	5	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
SUMMARY FINDINGS		**BENE-FICIAL**	**NEUTRAL**	**NEUTRAL**	**NEUTRAL**

LFCC Diversion Effects on SWFL Habitat in the San Acacia Reach

Alternative I-2 would result in an overall annual average of 3,312 acres of inundation for the San Acacia Reach, which is 23.6% greater than the annual average of 2,680 acres for No Action with the comparable LFCC diversions of 1,000 cfs (Figure L-3.36). Alternative I-2 would result in 12.6% less inundation compared to No Action with zero diversions. Compared with No Action with diversions, Alternative I-2 could increase inundation to occupied SWFL territories and suitable habitat, resulting in long-term benefits, and there would be beneficial effects to territories located at the existing LFCC outfall. However, compared with No Action with zero diversions, there could be long-term impacts.

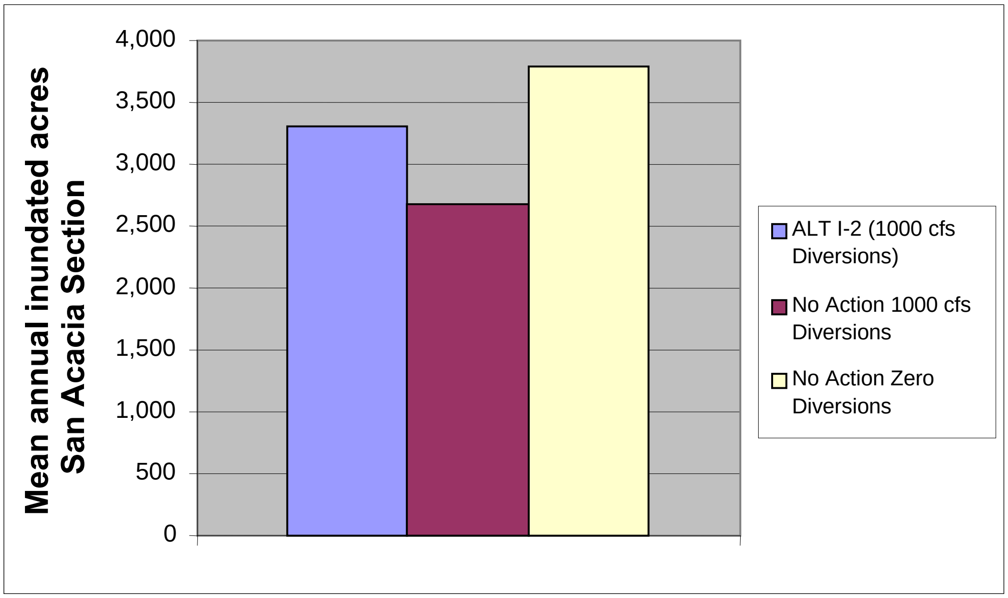


Figure L-3.36 Average Annual Acres of Inundation in San Acacia Section of Alternative I-2 Compared With Variable No Action.

Action Alternative I-3

Alternative I-3 would have significant adverse impacts on SWFL averaged over the three river sections. The mean annual inundation at occupied territories and nearby suitable habitat would decrease overall to 44% and 49%, respectively, of the No Action Alternative. The frequency of inundation at occupied sites would decrease to 91% of No Action frequency. The maximum duration of non-inundation periods would not increase at occupied sites near suitable habitat. **Table L-3.32** provides a comparison of the performance of Alternative I-3with No Action. Alternative I-3 would have a neutral effect on SWFL habitat.

Alternative I-3 would allow diversions of 1,000–2000 cfs. As in Alternative I-2, both beneficial and adverse impacts would occur to occupied SWFL habitat in the Elephant Butte delta area. The extent of inundation would be larger than in Alternative I-2. Beneficial impacts would occur to a larger area, but adverse impacts could also be wider-spread. Potential scouring and damage to SWFL habitat would likely be on a larger scale, although the duration of flows possible under this alternative would not necessarily be any greater. Impacts to SWFL habitat would likely occur in a shorter period of time than under Alternative I-2, especially if flows from the LFCC were in the higher flow range and for longer duration. As in Alternative I-2, the long-term benefits could outweigh the short-term impacts and would likely occur on a larger scale. These effects would also depend on the reservoir levels. Selection of Alternative I-3 would likely result in significant adverse effects that could require mitigation.

Table L-3.32 Performance Measures for Impacts of Alternative I-3 on Southwestern Willow Flycatcher

Measure	WIFL Habitat Class	Rio Chama Section	Central Section	San Acacia Section	Overall Impact of Alternative I-3
Mean annual days inundation at occupied sites (days)	Occupied sites	No territories	9	200	
% Change from No Action with 0 diversions		N/A	-5.26%	-56.71%	ADVERSE
Mean annual acre-day inundation (acre-days)	Suitable habitat <10 mi from core areas	140	817	9,621	
% Change from No Action with 0 diversions		1172.73%	-8.00%	-52.78%	NEUTRAL
Mean annual acre-day inundation (acre-days)	Suitable habitat >10 mi from core areas	108	527	1,392	
% Change from No Action with 0 diversions		414.29%	-9.76%	-59.95%	NEUTRAL
Mean annual acres inundation (acres)	Suitable habitat <10 mi from core areas	9	30	237	
% Change from No Action with 0 diversions		-35.71%	-9.09%	-31.30%	ADVERSE
Mean annual acre inundation (acres)	Suitable habitat >10 mi from core areas	4	20	50	
% Change from No Action with 0 diversions		-20.00%	-9.09%	-52.83%	ADVERSE
40-yr freq. Of inundation (%)	Occupied sites	No territories	18	48	
% Change from No Action with 0 diversions		N/A	5.88%	-9.43%	NEUTRAL
40-yr freq inundation (%)	Suitable habitat >10 mi from core areas	75	48	90	
% Change from No Action with 0 diversions		-16.67%	-4.00%	-10.00%	ADVERSE
% years of no inundation	Occupied Sites	N/A	0.7	0.2	
% Change from No Action with 0 diversions		N/A	0.00%	0.00%	NEUTRAL
Mean duration of non-inundation (years)	Suitable habitat <10 mi from core areas	0.3	0.8	0.2	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
Mean duration of non-inundation (years)	Suitable habitat >10 mi from core areas	0.4	0.5	0.1	
% Change from No Action with 0 diversions		0.00%	0.00%	0.00%	NEUTRAL
40-yr freq inundation (%)	Suitable habitat >10 mi from core areas	88	48	35	
% Change from No Action with 0 diversions		-2.22%	-4.00%	-33.96%	ADVERSE
Maximum duration of non-inundation years	Occupied Sites	No Territories	11	5	
% Change from No Action with 0 diversions		NA	0.00%	0.00%	NEUTRAL
Maximum duration of non-inundation (years)	Suitable habitat <10 mi from core areas	4	5	1	
% Change from No Action with 0 diversions		300.00%	0.00%	0.00%	NEUTRAL
Maximum duration of non-inundation (years)	Suitable habitat >10 mi from core areas	1	5	11	
% Change from No Action with 0 diversions		0.00%	0.00%	120.00%	ADVERSE
SUMMARY FINDINGS		**NEUTRAL**	**NEUTRAL**	**ADVERSE**	**ADVERSE**

LFCC Diversion Effects on SWFL Habitat in the San Acacia Reach

Alternative I-3 would result in an overall annual average of 2,193 acres of inundation for the San Acacia reach, 35.8% greater than the annual average of 1,615 acres for No Action with the comparable LFCC diversions of 2,000 cfs (**Figure L-3.37**). Alternative I-3 would result in 42.1% less inundation compared to No Action with zero diversions. Compared with No Action with diversions, Alternative I-3 could increase inundation to occupied SWFL territories and suitable habitat, resulting in long-term benefits, and there would be beneficial effects to territories located at the existing LFCC outfall. However, compared with No Action with zero diversions, there could be long-term impacts.

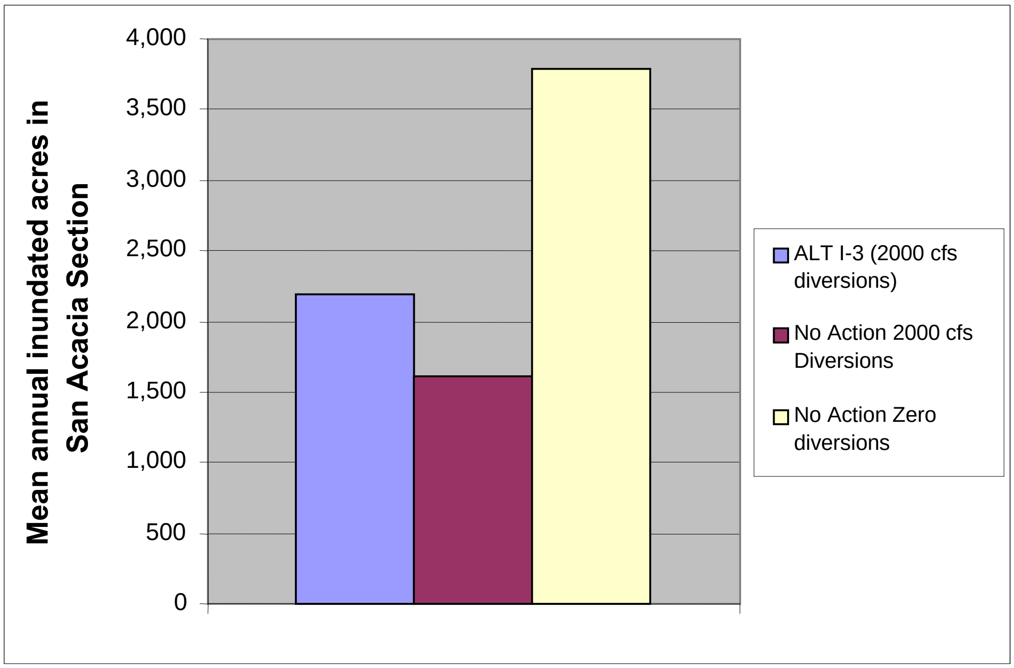


Figure L-3.37 Average Annual Acres of Inundation in San Acacia Section of Alternative 1-3 Compared With Variable No Action.

3.6.1.5 Bald Eagle Impact Assessment Methods

Nesting bald eagles are documented in only a few locations in all of New Mexico, none of which are in the Project Area; these birds occur only as winter residents within the Project Area. Bald eagle concentrations within the Project Area are most closely associated with reservoirs along the Rio Chama and the Middle Rio Grande. Therefore, impacts to the bald eagle were derived by qualitatively considering the potential effects to perch/roost structures and foraging habitat near known bald eagle concentration areas; for example, distance between open water and perch/roost structures or foraging areas was assessed. A quantitative assessment was not attempted because of lack of performance measures that could be specifically tied to impacts that may affect bald eagles under the various project alternatives.

3.6.1.6 Impact Analysis on Bald Eagle

No Action

Impacts to bald eagle habitat can occur from decreasing the available roost sites (tall snags) near open-water habitats (foraging areas), reducing the aquatic habitat supporting the eagle's prey base, or increasing the distance from suitable roosting habitat to open-water feeding areas. Bald eagles currently occur in many places along the Rio Grande, but primarily at Abiquiu and Elephant Butte Reservoirs. This Project does not include operations changes at Elephant Butte Reservoir. The modeled No Action average annual reservoir elevation of Elephant Butte and Abiquiu over the 40-year period would not drastically change relative to available roosting sites. Although difficult to quantify, no change is anticipated under No Action.

Action Alternative B-3

None of the action alternatives propose water operations changes at Elephant Butte or Cochiti Reservoirs. Changes to reservoir levels at Abiquiu under Alternative B-3 would not result in significant alterations to available food supply or perching structures; therefore, Alternative B-3 is not expected to result in adverse effects on bald eagles at the key reservoirs. While it would be difficult to detect and measure impacts to bald eagle habitat parameters in the planning area for any of the alternatives, any potential impacts to roost sites or prey base in the planning area as a result of this alternative are expected to be insignificant.

Action Alternative D-3

None of the action alternatives propose water operations changes at Elephant Butte or Cochiti Reservoirs. Changes to reservoir levels at Abiquiu under Alternative D-3 would not result in significant alterations to available food supply or perching structures. Therefore, Alternative D-3 is not expected to result in adverse effects to bald eagles at the key reservoirs. While it would be difficult to detect and measure impacts to bald eagle habitat parameters in the planning area for any of the alternatives, any potential impacts to roost sites or prey base in the planning area as a result of this alternative are expected to be insignificant.

Action Alternative E-3

None of the action alternatives propose water operations changes at Elephant Butte or Cochiti Reservoirs. Changes to reservoir levels at Abiquiu under Alternative E-3 would not result in significant alterations to available food supply or perching structures; therefore, Alternative E-3 is not expected to result in adverse effects on bald eagles at the key reservoirs. While it would be difficult to detect and measure impacts to bald eagle habitat parameters in the planning area for any of the alternatives, any potential impacts to roost sites or prey base in the planning area as a result of this alternative are expected to be insignificant.

Action Alternative I-1

None of the action alternatives propose water operations changes at Elephant Butte or Cochiti Reservoirs. Changes to reservoir levels at Abiquiu under Alternative I-1 would not result in significant alterations to available food supply or perching structures; therefore, Alternative I-1 is not expected to result in adverse effects on bald eagles at the key reservoirs. While it would be difficult to detect and measure impacts to bald eagle habitat parameters in the planning area for any of the alternatives, any potential impacts to roost sites or prey base in the planning area as a result of this alternative are expected to be insignificant.

Action Alternative I-2

None of the action alternatives propose water operations changes at Elephant Butte or Cochiti Reservoirs. Changes to reservoir levels at Abiquiu under Alternative I-2 would not result in significant alterations to available food supply or perching structures. Therefore, Alternative I-2 is not expected to result in adverse effects on bald eagles at the key reservoirs. While it would be difficult to detect and measure impacts to bald eagle habitat parameters in the planning area for any of the alternatives, any potential impacts to roost sites or prey base in the planning area as a result of this alternative are expected to be insignificant.

Action Alternative I-3

None of the action alternatives propose water operations changes at Elephant Butte or Cochiti Reservoirs. Changes to reservoir levels at Abiquiu under Alternative I-3 would not result in significant alterations to available food supply or perching structures; therefore, Alternative I-3 is not expected to result in adverse effects on bald eagles at the key reservoirs. While it would be difficult to detect and measure impacts to bald eagle habitat parameters in the planning area for any of the alternatives, any potential impacts to roost sites or prey base in the planning area as a result of this alternative are expected to be insignificant.

3.6.1.7 New Mexico Meadow Jumping Mouse Impact Assessment Methods

As a state-listed species (New Mexico Threatened), the New Mexico meadow jumping mouse (meadow jumping mouse) is not protected under the ESA. The mouse is, however, extremely representative of species using marsh and wet meadow habitats. In the same manner that impacts to riparian vegetation types were used as a surrogate for assessing impacts to riparian fauna, impacts to mapped acres of marsh and salt grass/wet meadow are used as a surrogate for effects on the meadow jumping mouse. A quantitative analysis was performed to determine potential impacts to the habitat potentially used by the meadow jumping mouse, as described below.

Average Annual Acre-days of Flooding in Marsh and Wet Meadow Vegetation Types

This parameter measures the hydrological support, in extent and duration, for pertinent vegetation types. These data were obtained by GIS overlay analysis of current vegetation mapping data with the data from FLO 2-D. Specifically, annual acre-days of inundation of marsh and wet meadow habitat potentially used by meadow jumping mouse populations were used as a measure to describe differences between the No Action Alternative and the action alternatives. It was assumed that the baseline condition was at least maintaining extant meadow jumping mouse habitat. The impact discussion therefore discusses each action alternative in terms of percent change from No Action.

3.6.1.8 Impact Analysis on New Mexico Meadow Jumping Mouse

No Action Alternative

Impacts to meadow jumping mouse populations would be limited to available wet meadow habitat. GIS overlay analysis indicates that the No Action Alternative would support wet meadow habitats at a higher level than any of the action alternatives, but only by summing total acre-days throughout the Project Area. On a river section–by–river section basis, No Action provides the greatest support in the San Acacia Section, is fourth for Central Section, and provides the least support of all alternatives in the Rio Chama Section (**Table L-3.**).

Table L-3.33 Average Annual Acre-days Inundation of Potential Meadow Jumping Mouse Habitat by River Section and Alternative

Criterion	Alternative	Acre-Days Inundation			Sum	Average
		Rio Chama	Central	San Acacia		
Supports NM meadow jumping mouse habitat (marsh & wet meadow)	**No Action**	5	146	9,107	9,258	3,086
	B-3	11	152	2,320	3,539	1,180
	D-3	101	141	2,573	2,815	938
	E-3	69	153	2,070	2,292	764
	I-1	114	159	7,679	7,952	2,651
	I-2	89	138	6,993	7,220	2,407
	I-3	69	127	4,190	4,386	1,462

Action Alternative B-3

Under Alternative B-3, there would be 62% less average annual acre-days of inundation of marsh and wet meadow habitat potentially used by meadow jumping mouse populations. However, this Alternative performs over twice as well as No Action in the Rio Chama Section, representing an important increase of support for the jumping mouse because the area has limited marsh/meadow habitat. Alternative B-3 provides a slight increase in the Central Section, but approximately 75% less support for the San Acacia Section than No Action (**Table L-3.**).

Action Alternative D-3
Under this alternative, there would be 70% less average annual acres days of inundation of marsh and wet meadow habitat potentially used by meadow jumping mouse populations. There is over a 200% increase for the Rio Chama Section , slightly less for the Central Section, and 72% less in the San Acacia Section (**Table L-3.**).

Action Alternative E-3
Under this alternative, there would be 75% less average annual acres days of inundation of marsh and wet meadow habitat potentially used by meadow jumping mouse populations. Alternative E-3 performs about the same as B-3, but has the poorest showing for support of meadow jumping mouse habitat in the San Acacia Section, an area where recent surveys report the species is found in all known suitable habitats (**Table L-3.).**

Action Alternative I-1
In terms of species support, Alternative I-1 offers the best overall performance throughout the system of all alternatives. Under this alternative, there would be only 14% less average annual acres days of inundation of marsh and wet meadow habitat potentially used by meadow jumping mouse populations. This alternative provides the highest support for meadow jumping mouse habitat in the Rio Chama Section; a 226% increase over No Action. There is a slight increase (9%) in the Central Section, the best support offered mouse habitat by any alternative. There is a 16% decrease over No Action in the San Acacia Section, the second best performance of all alternatives (**Table L-3.**).

Action Alternative I-2
Under this alternative, there would be 22% less average annual acres days of inundation of marsh and wet meadow habitat potentially used by meadow jumping mouse populations. This alternative is in second place amongst all action alternatives. Compared to No Action, it provides about 220% greater support in the Rio Chama Section, slightly less (9%) in the Central Section, and about 75% in the San Acacia Section (**Table L-3.**).

Action Alternative I-3
The performance of this alternative is essentially identical to that of Alternative I-2, though in proportionately smaller support for jumping mouse habitat in each river section. There would be 52% less average annual acres days of inundation of marsh and wet meadow habitat potentially used by meadow jumping mouse populations. Alternative I-3 shows the poorest support in the Central Section, where surveys show the jumping mouse has begun habitation of ditches and irrigation waterways adjacent to agricultural lands, perhaps because of dwindling acreage of preferred habitat. This alternative may contribute to the downward trend of suitable habitat in the Central Section (**Table L-3.**).

To summarize impacts to New Mexico meadow jumping mouse habitat, while No Action provides the greatest hydrological support to meadow jumping mouse habitat in the San Acacia Section, it would have serious adverse impacts on required habitat types in the Rio Chama Section, providing only 5 average annual acre-days of inundation. This is only 4% of the support offered by the best action alternative and less than half the support of the worst action alternative for that river section. Alternative I-1 performs best of all the action llternatives, offering a fairly well balanced support throughout the Project Area. All other action alternatives show a negative percent change from No Action that ranges from –22% to –75%.

3.6.1.9 Impacts to Hydrological Variability and Adaptive Flexibility

Methods
Proposed new operations would change the flexibility of the system but do not offer a set of operating rules by which those flexibilities would by used. In order to measure the potential variability of new proposed operations, the spring peak flow of the 40-year model was investigated for differences among the action alternatives and the No Action Alternative. Only one representative gage in each section was used: the Chamita gage for the Rio Chama Section, the Central gage for the Central Section, and the San

Acacia gage for the San Acacia Section. Data were not available for different diversions to the LFCC in the San Acacia Section.

Impact Analysis for Peak-Flow Variability and Operational Flexibility
The coefficient of variation was calculated for each alternative and river section (**Table L-3.**). The coefficient of variation expresses sample variability relative to the mean of the sample.

Table L-3.34 Coefficient of Variation of Peak-Flow Magnitude, by Section and Alternative

Mean Peak Flow Magnitude		Rio Chama Section	Central Section	San Acacia Section
Measure	***Gage***	***Chamita***	***Central***	***San Acacia***
Sample Size	ALL	40	40	40
Mean	B-3	1818	3880	1956
	D-3	2047	3771	1879
	E-3	1965	4041	2108
	I-1	2076	3882	2799
	I-2	2076	3882	2778
	I-3	1973	3732	1793
	No Action	2228	3989	3906
Standard Deviation	B-3	495	2187	1825
	D-3	649	1919	1574
	E-3	580	2351	1988
	I-1	575	1891	1806
	I-2	575	1891	1798
	I-3	595	1894	1581
	No Action	521	1868	1781
Coefficient of Variation	B-3	27	56	93
	D-3	32	51	84
	E-3	30	58	94
	I-1	28	49	65
	I-2	28	49	65
	I-3	30	51	88
	No Action	23	47	46

Variation of the peak flow is consistently lowest for the No Action Alternative. The effect of low variability would be to entrench and narrow the river channel and allow vegetation to encroach into the floodway. Rivers with low variability generally develop reduced riparian diversity over time (Kozlowski 2002). Alternative D-3 provides the highest variability in the Rio Chama Section, significantly higher than the No Action Alternative. Alternative E-3 provides the highest peak flow variation for both the Central and San Acacia Sections at statistically significant levels compared to the No Action Alternative.

Flexibility would be provided by operations with high coefficient of variability coupled with high available storage options at Abiquiu in order to augment downstream flows for conservation purposes. This is demonstrated in the comparison of alternatives for low-flow augmentation (**Figure L-3.7**) and maximum peak-flow magnitude variability (**Table L-3.**). Alternative B-3 performs highest for total available upstream storage under low-flow conditions, but is less flexible for downstream delivery during years with highest peak flow volume. Alternatives D-3, E-3, and I-3 provide the greatest flexibility.

3.6.1.10 Summary of Impacts to Biological Resources

Although the goal of developing river operations that would more effectively support all biological resources in the Upper Rio Grande is a good one, many of the biological goals of a dynamic river system are seemingly at odds with one another. High levels of hydrological variability and high magnitude and duration of peak flows can also lead to vegetation disturbance, periodic intermittency and low-flow years, and other adverse effects.

Furthermore, it would be desirable to have river operations aid in the correction of long-term trends such as increase of non-native species and river aggradation/degradation, but the degree of water resource allocation to accomplish these goals must be weighed against the biological benefits of stability and seasonal predictability in a water-limited system.

The relative weights assigned to the various resource categories (**Table L-3.1**) assisted the Biological Team in compiling the results of the numerous tests and impact evaluation methods into a single matrix of biological impacts of the action alternatives, in **Table L-3.**.

The overwhelming result of the biological studies of relative impacts is that the current river operations, as represented in the No Action Alternative without diversions to the LFCC, performed favorably for most measures of biological importance in all river sections. This result is surprising in light of the many publications and studies that implicate the effects of river operations as the primary factor affecting ecosystem function, such as the observed declines in native vegetation and native fish and wildlife and the presence of endangered species.

The worst-performing aspect of the No Action Alternative is the possible future diversion of water to the LFCC without the possibility of increasing channel capacity or upstream storage to mitigate low-flow years or enhance flow variability to offset adverse impacts in the San Acacia Section. Also, the No Action Alternative would continue to have adverse effects on riparian vegetation in the Rio Chama Section.

Based on the relative weights assigned to each resource indicator in this study, Alternative I-2 demonstrates the best overall biological performance among all the action alternatives. This alternative provides upstream storage at intermediate levels, increases channel capacity, and provides intermediate levels of diversion to the LFCC. The effect of these changes would provide significant improvements to riparian vegetation in the Rio Chama Section, while providing similar levels of support for native-dominated floodplain vegetation, faunal diversity, wetlands, and SWFL habitats in the Central and San Acacia Sections.

Adverse effects in the San Acacia Section would occur with Alternative I-2 from diverting 1,000 cfs to the LFCC. Effects would be felt compared to the current operations, as described by the No Action Alternative without diversions to the LFCC. These would consist of reduced area of RGSM habitat, decreased inundation in native vegetation types, decreased inundation in SWFL-occupied and nearby suitable habitats, and reduced wetland support in the Rio Chama Section. However, this alternative performed at a similar level to No Action with equal diversions for most biological measures, including endangered species habitat support and wetland support, and has the flexibility to use upstream stored water to buffer biological systems from the effects of multi-year drought.

Table L-3.35 Selection Matrix for Best Biological Action Alternative by Section and Resource Category

Biological Resource	Guiding Objective	Best Performing Action Alternative by Section and Resource			Best Action Alternative and Relative Impacts (Overall Best Biological Alternative by Resource Category)
		Rio Chama Section	Central Section	San Acacia Section	
Riverine habitats	Supports river channel habitats	I-1	I-1	I-2	I-2 — Potential impacts include significant loss of some types of aquatic habitat in all sections, reduced magnitude, and duration of peak flow compared to no action.
River sport fish	Supports river sport fish populations	I-1	I-1	I-1	I-1 — Potential impacts include reduced channel catfish habitat compared to no action.
Reservoir sport fish	Supports reservoir sport fish populations	I-1	I-1	I-1	I-1 — Potential impacts include decreased reservoir productivity in Abiquiu Reservoir compared to no action.
Riparian habitats	Provides vegetation structural and compositional diversity	I-2	I-1	I-2	I-2 — Potential impacts include decrease in overbank flooding in some arecompared to no action.
Wetlands	Maintains or improves wetlands function at existing sites	I-1	I-1	I-2	I-2 — Potential impacts include decreased flows at 75th percentile and lower groundwater at some wetland sites compared to no action.
Threatened & endangered species	Maintains or improves T&E species habitat	I-1	I-2	I-2	I-2 — Potential impacts include no inundation in currently occupied and suitable habitats for SWFL and decreased available habitat for RGSM in all river sections.
Aquatic and riparian fauna	Supports fish and wildlife diversity	I-1	I-1	I-2	I-2 — Potential impacts include decreased longnose dace habitats and decreased inundation to riparian habitats compared to no action in the San Acacia Section.
Natural management areas	Supports goals of designated natural management areas	I-1	I-1	I-2	I-1 — Potential impacts include increased low-flow days in Central and San Acacia Sections.
Adaptive flexibility	Conservation storage and other flexibilities	B-3	B-3	B-3	B-3 — Potential reduction of available habitat for longnose dace and other aquatic species. Adverse effects to riparian habitats in all sections.
Instream and overbank hydrologic variability	Flow variability	D-3	E-3	E-3	E-3 — Potential impacts include the greatest flexibility by operations with high coefficient of variability coupled with high available storage options at Abiquiu in order to augment downstream flows for conservation purposes.

4.0 RECOMMENDATIONS AND MITIGATION MEASURES

4.1 *Recommendations and Best Management Practices for Biological Resources*

Operational flexibility exists within all action alternatives examined under the Upper Rio Grand Water Operations EIS in the timing and quantity of release of native water stored at Abiquiu Reservoir and in the timing and actualized maximum diversion of water into the Low Flow Conveyance Channel at San Marcial. All possible operations at these facilities could not be completely modeled for effects, but recommendations can be provided that will help guide possible future actions to minimize effects to aquatic resources, including the endangered Rio Grande silvery minnow.

The timing and duration of release of stored native water proposed in the Project are not specified by the alternatives. The specific management plan would have very important consequences for biological resources. Reservoirs can be managed in a manner that provides additional support during crucial annual events such as the spring growing season. Increased flow would augment establishment and regeneration of native riparian vegetation. Note that such flows must be regulated based on both channel and levee capacity. Specific recommendations and best management practices for the release of stored water include:

- Releasing stored native water during low-flow periods to assist in maintaining target flows at levels specified in the Biological Opinion of 2003, or other Biological Opinions then in effect
- Releasing conservation storage to minimize the number of days <100 cfs at San Marcial gage when BO targets cannot be achieved
- Releasing stored native water during May and June to augment peak flow to >5,000 cfs at Albuquerque gage to achieve improved nursery habitat for RGSM and recruitment of native vegetation through overbank flooding
- Releasing stored native water during May and June to increase the duration of peak flows >3,000 cfs at Albuquerque gage to provide important biological signals for fish spawn
- Avoiding releasing stored native water from November to March in order to maximize potential available storage for conservation releases during Spring runoff
- Allowing passage of “flow spikes” to maximize flow variability

The timing of diversions to the LFCC could reduce or eliminate some potentially adverse effects from action alternatives. Diversion of water to the LFCC does not produce effects during low-flow years, since a constant flow of 250 cfs must be in the channel before any additional water is diverted. It may, however, produce adverse effects on biological resources by reducing the peak discharge during Spring runoff. This reduces the amount of overbank flooding needed for native vegetation regeneration and available nursery habitat for aquatic species in the flooded overbank areas on the mainstem of the Rio Grande. It also reduces variability in flow spikes used as biological signals by aquatic species. The amount of impact depends on the duration and quantity of spring runoff. Best management practice for biological resources in this area would avoid operation of the LFCC during the months of May and June during any year in which such diversions would reduce the maximum area of overbank flooding in the San Acacia Section by more than 10% of the amount that would be expected without diversion.

Fish and Wildlife Coordination Act Report for the Upper Rio Grande Water Operations Review and Environmental Impact Statement Colorado, New Mexico, and Texas

Submitted to:
U.S. Army Corps of Engineers
Albuquerque, New Mexico
U.S. Bureau of Reclamation,
Albuquerque, New Mexico
New Mexico Interstate Stream Commission
Albuquerque, New Mexico

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ii

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

This is a Fish and Wildlife Coordination Act Report (CAR) for the Upper Rio Grande Water Operations Review (URGWOPs) and Environmental Impact Statement (EIS) prepared by the U.S. Fish and Wildlife Service (Service) under the authority of and in accordance with the requirements of Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 USC 661-667e). This report addresses the URGWOPs alternatives developed by the U.S. Army Corps of Engineers (Corps), U.S. Bureau of Reclamation (Reclamation), and the New Mexico Interstate Stream Commission (NMISC). This report describes existing fish and wildlife resources in the project area, potential project impacts to fish and wildlife resources, and recommendations to avoid, minimize, and/or mitigate the potential adverse effects to fish and wildlife resources.

The Corps, Reclamation, and NMISC are conducting a review of their joint water storage and delivery operations of Federal dams, reservoirs, and other Federal facilities in the upper Rio Grande. The project area is divided into 5 sections (including 17 reaches) of river from the headwaters in Colorado to Fort Quitman, Texas (Figure 1). The Northern Section of the project area includes: Reach 1 - Alamosa to the New Mexico state line (Lobatos Guage); Reach 2 - Platoro Dam to the Rio Grande (Conejos River); Reach 3 - New Mexico state line to Velarde; and Reach 4 - Velarde to the Rio Chama confluence. The Rio Chama Section of the project area includes: Reach 5 - Heron Dam to El Vado Dam (Rio Chama); Reach 6 - El Vado Dam to Abiquiu Dam (Rio Chama); Reach 7 - Abiquiu Dam to the Rio Grande confluence; Reach 8 - Rio Grande/Chama confluence to Otowi Guage; and Reach 9 - Otowi Guage to Cochiti Dam. The Central Section of the project area includes: Reach 10 - Cochiti Dam to Bernalillo; Reach 11 - Jemez Dam to Rio Grande confluence; Reach 12 - Bernalillo to Isleta Diversion Dam; and Reach 13 - Isleta diversion to Rio Puerco confluence. The San Acacia Section includes Reach 14 - Rio Puerco confluence to Elephant Butte Reservoir. The Southern Section of the project area includes: Reach 15 - Elephant Butte Reservoir to Caballo Dam; Reach 16 - Caballo Dam to El Paso; and Reach 17 - El Paso to Fort Quitman, Texas.

The purpose of the URGWOPs EIS is to: 1) identify the operational flexibility of Federal reservoirs and facilities in the upper Rio Grande basin that are within the existing authorities of the Corps, Reclamation, and the NMISC; 2) develop a better understanding of how these facilities could be operated more efficiently and effectively as an integrated system; 3) formulate a plan for future water operations at these facilities that is within the existing authorities of the Corps, Reclamation, and NMISC; 4) comply with State, Federal, and other processes for making decisions about water operations through better interagency communications and coordination, and facilitation of public review and input; and 5) support Corps, Reclamation, and NMISC compliance with applicable law and regulations, including but not limited to, the National Environmental Policy Act (NEPA) of 1969, and the Endangered Species Act (Act) of 1973, as amended.

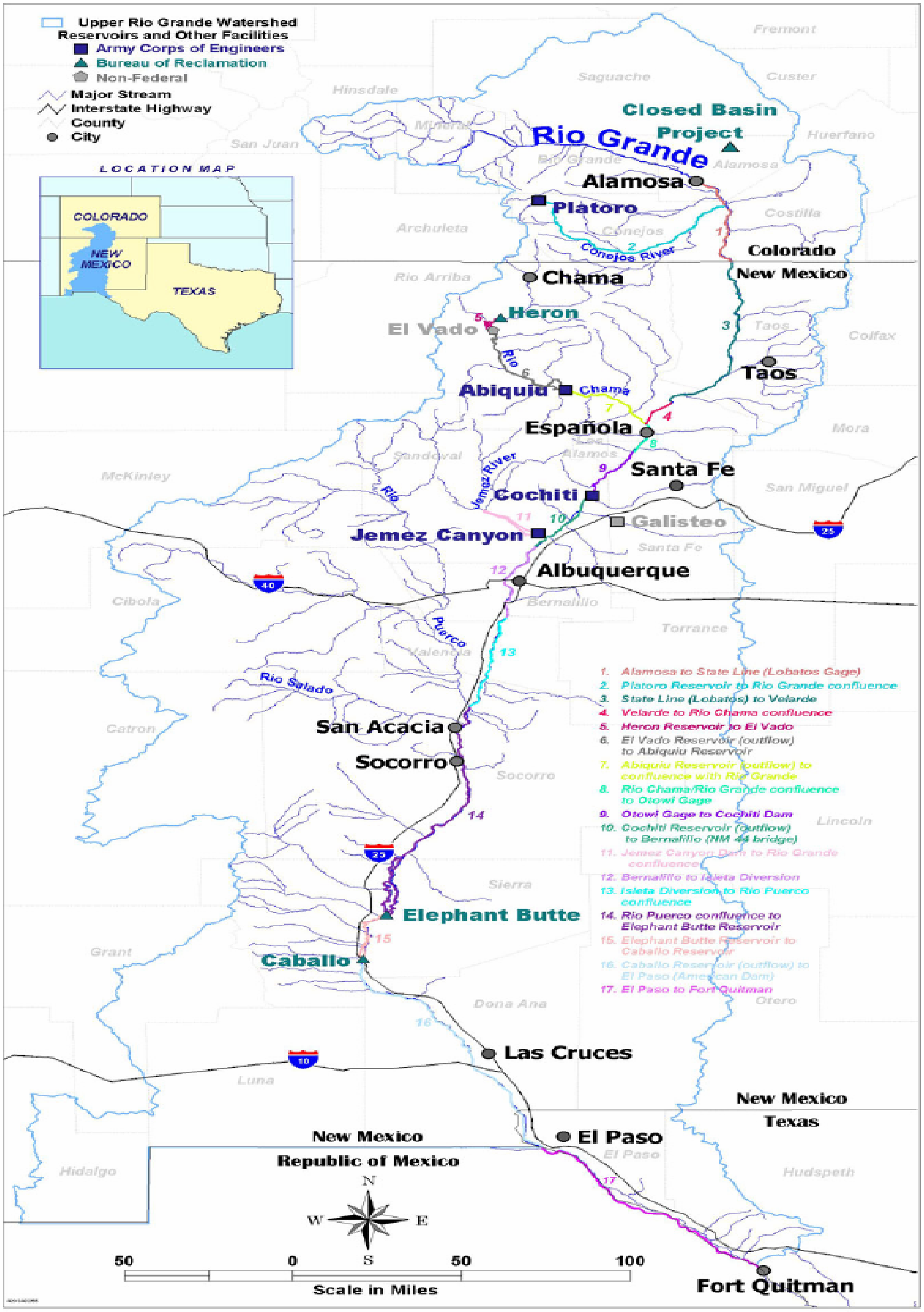

Figure 1. URGWOPs Study Srea (from URGWOPs TeamLink website, July 2004)

DESCRIPTION OF PROJECT AREA

The Rio Grande is the fifth longest river in North America and one of the most ecologically degraded (Fullerton and Batts 2003). It originates in the San Juan Mountains of southern Colorado and flows south through New Mexico, then southeast along the border of Texas before emptying into the Gulf of Mexico at Boca Chica (Texas Natural Resource Conservation Commission 2002). In northern New Mexico, the river descends through the Rio Grande Gorge into the Española Valley, where it is joined from the northwest by the Rio Chama, its largest tributary in the project area. Flows from the Rio Chama originate from runoff in the Rio Chama watershed and from water imported from the San Juan River Basin (i.e., San Juan-Chama Project) in northwestern New Mexico. Further downstream, the river enters Cochiti Lake, which marks the northern boundary of the Middle Rio Grande Valley. From Cochiti Lake downstream to Fort Quitman, Texas, the river flows through a predominantly wide, low gradient valley.

The ancestral Middle Rio Grande developed into a single river system about 5 million years ago (Crawford et al. 1993). Incision of the Middle Rio Grande Valley has been cyclic, and has produced gravel, sand, and silt terraces 9 to 53 meters (m) (30 to 175 feet (ft)) above the current floodplain. The Rio Grande is thought to have reached maximum entrenchment between 10,000 and 20,000 years ago, at a depth 18 to 40 m (60 to 130 ft) below the current valley floor. Since that time, sediment influx from tributaries has resulted in a gradual aggradation of the river bed. Historically, this process led to frequent avulsions of the river channel. The historic river channel was braided and sinuous with a shifting sand substrate that freely migrated across the floodplain, limited only by valley terraces and bedrock outcroppings (Crawford et al. 1993).

It is believed that prior to human settlement and development the Middle Rio Grande generally supported perennial flows, although riverbed drying may have occurred in downstream areas during periods of prolonged drought (Crawford et al. 1993). Hydrographic patterns of the unregulated river would have mirrored the seasonal events of spring snowmelt and late-summer precipitation. Inputs from two tributaries in this region, the Rio Puerco and Rio Salado, were probably not perennial, but were likely more consistent than those provided by the predominantly dry riverbeds of today.

The Middle Rio Grande is the oldest continually inhabited area of the United States and the river valley has been continuously used by agricultural societies for the past 700 years. Prior to the arrival of Europeans, Pueblo farmers practiced floodwater agriculture relying on overbank flows, surface run-off, and to a limited extent, diversions from the river channel (Wozniak 1998). When Coronado's expedition reached the Middle Rio Grande in 1540, it is estimated that 1,012 hectares (25,000 acres) of land were under cultivation. Ditch irrigation based on a network of canals and acequias became widespread with the establishment of Spanish settlements in the sixteenth and seventeenth centuries. More land in the floodplain was cleared for farming, and cottonwood forests were removed to provide timber for building material, fenceposts, and firewood. By 1850, most valley communities were established in their present locations, and by 1880 the area of irrigated land between Cochiti and San Marcial reached a maximum of about 125,000 acres (Crawford et al. 1993).

In the following decade, irrigated land use in the Middle Rio Grande dropped below 20,234 hectares (50,000 acres), until the 1930s. A combination of ecological and hydrological factors contributed to this decline. Overgrazing and deforestation of surrounding lands increased sediment loads and riverbed aggradation. This resulted in increased flooding, a higher water table, and saturation of riparian and cultivated lands. At the same time, increasing water demand upstream, particularly in the San Luis Valley of southern Colorado, decreased the supply of water for irrigation in the Middle Rio Grande. This increased the frequency of river drying in the southern reaches of the river, and supply shortages in the El Paso/Juarez area in the late 1880s and 1890s. The problems of uneven water distribution and saturation of valley lands persisted through the early stages of modern river management (Crawford et al. 1993, Middle Rio Grande Conservancy District (MRGCD) 1993).

Several small-scale water management facilities were constructed on the Middle Rio Grande prior to 1900. These structures were often unable to withstand the periodic flooding that occurred, and had to be continually repaired or replaced. The era of large-scale, federally-funded river management began shortly after the passage of the Reclamation Act in 1902. One of Reclamation's first projects after the passage of this act was constructing a dam and reservoir at Elephant Butte to serve the water needs of southern New Mexico and west Texas. Further north, the MRGCD was formed in 1925, to provide the Middle Rio Grande Valley an irrigation, drainage, and flood control system. Over the past century the various Reclamation, Corps, and MRGCD water projects transformed the Rio Grande in New Mexico into a fully managed and regulated river system. These projects and others continue to influence the hydrology, geomorphology, and fish and wildlife resources of the Rio Grande.

Major Water Management Facilities in the Project area

Several major water management facilities occur in the URGWOPs project area. These facilities include: the Closed-Basin wells; Platoro Dam; Heron Dam; El Vado Dam; Abiquiu Dam; Cochiti Dam; Jemez Canyon Dam; the Low Flow Conveyance Channel (LFCC); Elephant Butte Dam; and Caballo Dam. Although these facilities occur within the URGWOPs project area, not all of them fall within the authority of the URGWOPs EIS review.

Closed-Basin Wells

The Closed Basin [wells] Project (Project) was authorized by Congress in 1972 through PL 92-514, and later amended through PL 96-375 in 1980, PL 98-570 in 1984, and PL 100-516 in 1988. The Project is owned and operated by Reclamation. Management oversight is provided by a three member Operating Committee consisting of one representative from the Colorado Water Conservation Board, one from the Rio Grande Water Conservation District, and a member appointed by the Secretary of Interior. The Project's objectives include: 1) assisting Colorado in meeting annual deliveries under the Rio Grande Compact; 2) maintaining the Alamosa National Wildlife Refuge and the Blanca Wildlife Habitat Area, and stabilizing San Luis Lake; 3) allowing Colorado to apply for the reduction and elimination of any accumulated deficit in the deliveries as determined by the Rio Grande Compact Commission; and 4) providing irrigation supply and other beneficial uses in Colorado. The Project is authorized for groundwater production up to 600,000 acre-feet (ac-ft) in any consecutive ten-year period specifically to assist

Colorado in meeting annual Rio Grande Compact deliveries. Up to 5,300 ac-ft of water per year can be used for wildlife mitigation. Average annual water production is currently limited to 25,000 ac-ft due to well degradation. Although the Project is within the scope of the URGWOPs review and EIS, no operational flexibilities have been identified.

Platoro Dam and Reservoir

Platoro Dam was authorized under the Flood Control Act of 1944. The dam is owned by Reclamation, and managed by the Conejos Water Conservancy District (CWCD). The reservoir is operated for flood control and irrigation storage. The Corps monitors the flood and conservation space in a joint-use pool. If flood space is needed, then water in the conservation space is released to make room for flood inflows. Maximum releases are within the channel capacities in the Conejos River downstream (2,500 cubic feet per second (cfs)) at the Mogote gage and 1,600 cfs at the La Sauces gage). During normal operation, the CWCD maintains a 7 cfs release from October through April, and a bypass flow of 40 cfs or natural inflow whichever is less from May through September. Flood control is the only authority under review in the URGWOPs EIS for this facility.

Heron Dam and Reservoir

Heron Dam was authorized by Congress in 1962 through PL 87-483 (San Juan-Chama Transmountain Diversion Project). The reservoir is owned and operated by Reclamation to store and deliver water for irrigation, municipal, domestic, and industrial uses, and to benefit recreation and fish and wildlife resources. Up to 400,000 ac-ft (reservoir capacity) of San Juan-Chama water is stored in Heron Reservoir to provide a reliable water supply for downstream contractors. Carry-over storage of unused individual contractor water is not permitted except by the use of "waivers". A waiver allows a contractor to postpone the date in which they must take delivery of a current year's water allocation. Without the use of waivers, contractors must take delivery of their water by December 31 of each year. By using waivers, contractors can delay taking delivery of their water until April 30 of the following year. By agreement with San Juan-Chama water contractors, releases from Heron Reservoir are timed to maintain minimum winter flows below El Vado Reservoir. Winter releases follow Bureau of Land Management Rio Chama Instream Flow Assessment recommendations, and comply with the Wild and Scenic Rivers Act. The agreement also includes higher weekend releases in the summer over a six- to eight-week period to benefit whitewater rafting.

El Vado Dam and Reservoir

El Vado Dam and Reservoir were constructed by the MRGCD for flood control and irrigation (Reclamation 1983). In 1955, Reclamation rehabilitated the dam, and in 1966, constructed new outlet works to facilitate passage of additional water entering the reservoir from the San Juan-Chama Project (Reclamation 1983). El Vado Reservoir is owned by the MRGCD and operated by Reclamation under contract with the MRGCD. The reservoir's main function is irrigation storage, but the reservoir also provides incidental recreation, flood protection, sediment control, and power generation. El Vado Dam and Reservoir are not within the authority of the URGWOPs EIS review.

Abiquiu Dam and Reservoir

Abiquiu Dam was authorized for construction by the Flood Control Act of 1948, (PL 80-858) and the Flood Control Act of 1950 (PL 81-516). Construction of the dam was initiated in 1956, and the project was completed and placed into operation in 1963. The reservoir is owned and operated by the Corps primarily for flood and sediment control, but also for San Juan-Chama water supply storage, incidental recreation, and run of the river power generation. During flood control operations up to 1,800 cfs (i.e., channel capacity) is released downstream. However, releases are managed so that downstream flows do not exceed 3,000 cfs at Chamita and 10,000 cfs at the Otowi gage. Under normal operations, native water is bypassed at a rate below the downstream channel capacity. San Juan-Chama water, for Albuquerque and other contractors, is stored up to a reservoir elevation of 6,220 ft and released upon request. Voluntary water release exchanges occur between the MRGCD (at El Vado Reservoir) and Albuquerque (at Abiquiu Reservoir) to support irrigation, municipal, and industrial uses. Under normal operations efforts are made to maintain flows of 70 cfs from November through March for the trout fishery downstream of Abiquiu Reservoir. Carry-over floodwater in Abiquiu Reservoir or Cochiti Lake is held after July 1. Water is released between November 1 and March 31 when natural flow at the Otowi gage falls below 1,500 cfs.

Cochiti Dam and Lake

Cochiti Dam was authorized for construction by the Flood Control Act of 1960 (PL 86-645). The dam is owned and operated by the Corps for flood and sediment control, recreation, conservation, and development of fish and wildlife resources. During flood control operations, inflows are released as quickly possible without causing downstream flooding. During normal (non-flood control) operations, the dam passes native inflow. Carry-over floodwater in Cochiti Lake can be held after July 1, but cannot encroach upon the 212,000 acre-foot summer flood space.

Jemez Canyon Reservoir

Jemez Canyon Dam was authorized for construction by the Flood Control Act of 1948 (PL 80-858) and is owned and operated by the Corps for flood and sediment control. During flood control operations, water is released quickly without causing downstream flooding. Under current operations, the reservoir is dry and the project is operated as a run of the river facility.

Low Flow Conveyance Channel (LFCC)

The LFCC was constructed by Reclamation in the 1950s. The purpose of the LFCC is to convey Rio Grande flows downstream, improve drainage, supplement irrigation water supply, and assist New Mexico in making its downstream Rio Grande Compact deliveries. Up to 2,000 cfs can be diverted into the LFCC at San Acacia when outfall conditions allow (i.e., when the LFCC is physically capable of passing 2,000 cfs downstream into Elephant Butte Reservoir). However, diversions into the LFCC at San Acacia have not occurred since 1985 because of channel and outfall disrepair. Drainage flows in the LFCC supply the majority of the water needs at the Bosque del Apache National Wildlife Refuge, and supply the MRGCD with irrigation water. Between 2000 and 2003, drainage flows downstream of San Acacia were pumped to the river during low flows to support Rio Grande silvery minnow (*Hybognathus amarus*) (silvery minnow).

Elephant Butte Dam and Reservoir

Construction of Elephant Butte Dam was authorized in 1905 under provisions of the Newlands Act of 1902. The dam is owned and operated by Reclamation for irrigation water supply, municipal and industrial use, flood control, and recreation. It is secondarily operated for hydroelectric power generation and incidental sediment control. Elephant Butte Reservoir retains all inflows in excess of downstream irrigation demand. Releases from the dam during the irrigation season are to satisfy irrigation demand downstream of Caballo Dam and to maintain Caballo Reservoir pool levels. A 50,000 acre-foot flood control space is maintained in the reservoir from April 1 to September 30, and a 25,000 acre-foot space is maintained from October 1 to March 31. Flood control releases are required when the reservoir level is within the 50,000 acre-foot flood control space. Flood control releases are coordinated between Caballo Reservoir, upstream Corps projects, and the United States Section, International Boundary and Water Commission (IBWC). During flood control operations, maximum releases up to 5,000 cfs (downstream channel capacity) can occur. Flood control is the only authority under review in the URGWOPs EIS for Elephant Butte Dam and Reservoir.

Caballo Dam and Reservoir

Construction of Caballo Dam was authorized under the Rio Grande Rectification Treaty of 1933. Caballo Dam is owned and operated by Reclamation, however, flood control operations are directed by IBWC. The reservoir stores irrigation, municipal and industrial water, and provides flood control and incidental sediment control. During normal operations, the IBWC requires the 100,000 acre-foot flood pool to be evacuated as quickly as possible from June 1 to October 31.

The reservoir retains all inflows in excess of downstream irrigation demands and the 5,000 cfs downstream channel capacity. Because of existing flood capacity, downstream target flows are 2,500 to 3,500 cfs. Reclamation and IBWC coordinate the operation of the flood control pool to ensure that flows at the American Diversion Dam downstream are maintained below 11,000 cfs. The reservoir is currently operated to maintain a storage level below 50,000 ac-ft from October 1 to January 31 to leave enough space for winter accretions. From February 1 to September 30, the reservoir is maintained within a 50,000 to 80,000 acre-foot storage level. Flood control is the only authority under review in the URGWOPs EIS for Caballo Dam and Reservoir.

PROJECT DESCRIPTION

Six action alternatives and a no action alternative are analyzed in the EIS (Table 1). The action alternatives consist of management scenarios that include: 1) adjusting waiver dates for the carry-over of stored, unused, non-permitted contract water in Heron Reservoir; 2) conserving storage of native Rio Grande water at Abiquiu Reservoir instead of releasing it downstream; and 3) Low Flow Conveyance Channel (LFCC) water diversions. The action alternatives also include modifications to the river channel capacity[1] (i.e., maximum releases during normal operations) below Abiquiu Reservoir and Cochiti Lake.

[1] The channel capacity is the normal (non-emergency) operations maximum flow in the river channel. This flow is usually set by analysis and policy and may not represent the transport capacity of the existing river channel.

Table 1. URGWOPs EIS Alternatives

Alternative	Operations
I-3	• Heron Waivers: No change-April 30 • Abiquiu conservation storage: up to 180,000 ac-ft • Abiquiu channel capacity: No change-1,800 cfs • Cochiti channel capacity: No change-7,000 cfs • LFCC water diversion: 0 to 2,000 cfs
I-2	• Heron Waivers: No change-April 30 • Abiquiu conservation storage: up to 75,000 ac-ft • Abiquiu channel capacity: No change-1,800 cfs • Cochiti channel capacity: No change-7,000 cfs • LFCC water diversion: 0 to 1,000 cfs
I-1	• Heron Waivers: No change-April 30 • Abiquiu conservation storage: up to 20,000 ac-ft • Abiquiu channel capacity: No change-1,800 cfs • Cochiti channel capacity: No change-7,000 cfs • LFCC water diversion: 0 to 500 cfs
E-3	• Heron Waivers: September 30 • Abiquiu conservation storage: up to 180,000 ac-ft • Abiquiu channel capacity: No change-1,800 cfs • Cochiti channel capacity: 10,000 cfs • LFCC water diversion: 0 to 2,000 cfs
D-3	• Heron Waivers: August 31 • Abiquiu conservation storage: up to 180,000 ac-ft • Abiquiu channel capacity: 2,000 cfs • Cochiti channel capacity: No change-7,000 cfs • LFCC water diversion: 0 to 2,000 cfs
B-3	• Heron Waivers: September 30 • Abiquiu conservation storage: up to 180,000 ac-ft • Abiquiu channel capacity: 1,500 cfs • Cochiti channel capacity: 8,500 cfs • LFCC water diversion: 0 to 2,000 cfs
No Action	• No operational changes • Heron Waivers: No change-April 30 • LFCC water diversion: 0 to 2,000 cfs

Alternative I-3

Under Alternative I-3, the existing April 30 waiver date at Heron Reservoir and the existing channel capacities below Abiquiu Reservoir and Cochiti Lake would not change. However, Alternative I-3 would include conservation storage up to 180,000 ac-ft of native Rio Grande water at Abiquiu Reservoir. According to the joint lead agencies, the release of this water would be managed to benefit fish and wildlife resources, while assisting NMISC in meeting their downstream Rio Grande Compact delivery obligations. In addition to conservation storage, Alternative I-3 would include water diversions between 0 and 2,000 cfs into the LFCC.

Alternative I-2

Under Alternative I-2, the existing April 30 waiver date at Heron Reservoir and the existing channel capacities below Abiquiu Reservoir and Cochiti Lake would not change. However, Alternative I-2 would include conservation storage up to 75,000 ac-ft of native Rio Grande water at Abiquiu Reservoir. Like Alternative I-3, the release of this water would be managed to benefit fish and wildlife resources while assisting NMISC in meeting their downstream Rio Grande Compact delivery obligations. Alternative I-2 would also include diversions into the LFCC between 0 and 1,000 cfs.

Alternative I-1

Under Alternative I-1, the existing April 30 waiver date at Heron Reservoir and the existing channel capacities below Abiquiu Reservoir and Cochiti Lake would not change. However, Alternative I-1 would include conservation storage up to 20,000 ac-ft of native Rio Grande water at Abiquiu Reservoir. Like the other action alternatives, the release of this water would be managed to benefit fish and wildlife resources while assisting NMISC in meeting their downstream Rio Grande Compact delivery obligations. Alternative I-1 would include diversions into the LFCC between 0 and 500 cfs.

Alternative E-3

Under Alternative E-3, the existing waiver date for carry-over water storage at Heron Reservoir would be changed from April 30 to September 30. Conservation storage up to 180,000 ac-ft of native Rio Grande water would be held at Abiquiu Reservoir and later released to benefit fish and wildlife resources while assisting NMISC in meeting their downstream Rio Grande Compact delivery obligations. The channel capacity below Abiquiu Reservoir would remain unchanged, however, the channel capacity below Cochiti Reservoir would increase from 7,000 to 10,000 cfs. Alternative E would also include diversions into the LFCC between 0 and 2,000 cfs.

Alternative D-3

Under Alternative D-3 the waiver date for carry-over water storage at Heron Reservoir would be changed from April 30 to August 31. Conservation storage up to 180,000 ac-ft of native Rio Grande water would be held at Abiquiu Reservoir and later released to benefit fish and wildlife resources while assisting NMISC in meeting their downstream Rio Grande Compact delivery obligations. The channel capacity below Abiquiu Reservoir would be increased from 1,800 to 2,000 cfs while the channel capacity below Cochiti Lake would remain unchanged. Alternative D-3 would also include diversions into the LFCC between 0 and 2,000 cfs.

Alternative B-3

Under Alternative B-3, the waiver date for carry-over water storage at Heron Reservoir would be changed from April 30 to September 30. Conservation storage of up to 180,000 ac-ft of native Rio Grande water would be held at Abiquiu Reservoir and later released to benefit fish and wildlife resources while assisting NMISC in meeting their downstream Rio Grande Compact delivery obligations. The channel capacity of the Rio Chama below Abiquiu Reservoir would be reduced from 1,800 cfs to 1,500 cfs. Below Cochiti Lake the channel capacity would be increased from 7,000 cfs to 8,500 cfs. Alternative B-3 would also include diversions into the LFCC of between 0 and 2,000 cfs.

No Action

The No Action Alternative would include no operational changes upstream of the LFCC, however, it would include diversions between 0 and 2,000 cfs into the LFCC at the San Acacia Diversion Dam.

EVALUATION METHODOLOGY

Since project planning began in 1998, the Service has been actively involved in the URGWOPs planning process, participating on numerous interdisciplinary teams and providing extensive verbal and written planning input to the joint lead agencies. In addition to this CAR, the Service has provided the lead agencies three Fish and Wildlife Coordination Act Planning Aid Letters (PALs). The first PAL was provided to the lead agencies on September 27, 2001, and contained a bibliography of pertinent literature related to fish and wildlife resources in the project area. The second PAL provided to the lead agencies on July 10, 2002, contained information on fish and wildlife resources in the project area, recommendations to minimize or avoid project impacts to fish and wildlife resources, and recommendations to enhance these resources. The third and final PAL, provided to the lead agencies on March 28, 2005, contained updated information on federally listed species, additional recommendations to minimize or avoid project impacts to fish and wildlife resources, and additional recommendations to enhance fish and wildlife resources in the project area.

The majority of the technical information used by the Service to evaluate project impacts to fish and wildlife resources was provided by the lead agencies. Much of this information was in the form of modeling output from the Upper Rio Grande Water Operations Model (URGWOM), Flow-2D, and Aquatic Habitat Models. Given the uncertainty of future climactic and hydrologic conditions, modeling information is the best available estimator of future change with or without the project. The modeling output provided by the lead agencies was useful not only in comparing the future with and without the project, but in predicting how baseline conditions would change over time. In addition to the technical information provided by the lead agencies, the Service also reviewed relevant project area literature.

FISH AND WILDLIFE RESOURCES WITHOUT THE PROJECT

Historic evidence of large fish species indicates that the Rio Grande was a clearer, larger, and more stable river than has been observed over the past century (Scurlock 1998). Prior to the development of Colorado's San Luis Valley in the 1870s, there were only two records of intermittent flows in the Middle Rio Grande, during prolonged and severe droughts in 1752 and 1861 (Service 2001). Over the past century, however, the Rio Grande has been consistently dewatered in the Angostura, Isleta, and San Acacia reaches, as irrigation diversions and drains have significantly reduced the overall volume of water in the river. Reaches particularly susceptible to drying in recent years include: 1) the area immediately downstream of Isleta Diversion Dam; 2) an 8-km (5-mi) reach near Tome; 3) an 8-km (5-mi) reach near the U.S. Highway 60 bridge; and 4) an extended 58-km (36-mi) reach from Brown Arroyo, downstream of Socorro, to Elephant Butte Reservoir (Service 2001).

A primary purpose of the various flood and sediment control facilities authorized under the 1948 Flood Control Act was to reverse the continuing aggradation of the river. This has largely been achieved by trapping sediment in the reservoirs, and using sediment-free reservoir releases as scouring flows to degrade (lower) the riverbed. These actions have incised the channel, increased channel capacity, reduced flood risk, and restored function to many MRGCD drains whose outfalls were formerly below the aggraded riverbed. At the same time, levees and channel modifications have constrained the river to an artificially small floodplain, reduced meandering, and produced a narrower, swifter river.

An important cumulative effect of water management activities in the project area has been to reduce the magnitude of peak spring run-off and summer thunderstorm flow events. While seasonal extremes in the river's annual flow remain present to some degree, the historic flow regime that provided a high spring peak flow leading to overbank flooding has largely been eliminated as a regular hydrological pattern (Crawford et al.1993). The current flow regime as dictated by irrigation, municipal uses, flood control, and water delivery obligations has substantially reduced the volume of peak flows and also altered their timing.

Impacts associated with the altered flow regime have been exacerbated by the use of artificial structures such as Kelner jetty jacks to control lateral migration of the river channel and artificially constrict the floodplain. A dampening of peak discharges, and subsequent decrease in sediment movement, have resulted in channel narrowing. Levee construction and channel

straightening have allowed increased human development and use of the floodplain, while greatly restricting the width available to the active river channel. Between Cochiti and Elephant Butte Reservoirs, river channel surface area was reduced by roughly 50 percent between 1935 and 1989 (Crawford et al. 1993). Floodway capacity for sustained spring flows ranges from around 20,000 cfs in the Albuquerque area to around 7,500 cfs in adjacent river reaches. The channel capacity of the Rio Grande within the floodway is currently maintained by Reclamation at around 7,000 cfs (Crawford et al. 1993).

The active river channel continues to be modified, especially by the invasion of non-native plant species. Salt cedar and Russian olive have been replacing native vegetation in the Middle Rio Grande for decades. These exotic species are highly erosion-resistant, and river flows often scour the streambed rather than remove these plants. Erosion-resistant vegetation thus produces a narrower, deeper, and swifter river channel that may not provide suitable habitats for native aquatic biota. As a result of these changes, aquatic habitat characterized by sandy substrate, shallow water, and consistent low-velocity flows has diminished.

Aquatic Resources

Aquatic habitat in the Rio Grande has been altered by levees, dams, and reservoirs that store sediment and control water releases for agricultural use, flood control, recreation, and protection of development within the floodplain. Kellner jetty jack fields have straightened and channelized the river for more effective water transport. Reservoir operations have reduced peak flows and provided lower flows for a longer duration (Crawford et al. 1993). Downstream of Cochiti Dam, the altered sediment and flow regimes have resulted in the transformation from a wide, braided, sand bed system to a narrower and deeper channel with no active floodplain (Reclamation 1999). Therefore, wetlands and slack water areas are scarce (Crawford et al. 1993). The cold, clear-water releases from Cochiti Dam and the entrenched channel, armored with a gravel bed, have created an aquatic system that favors cool-water fishes and invertebrates, and limits warm water fisheries below the dam downstream to Albuquerque. Consequently, the existing aquatic resources in the project area differ from those that occurred historically due to human activities (Crawford et al. 1993).

The loss of native fish species in the project area illustrates that the hydrologic and morphological changes in the channel have had a major impact on fishery resources. The historic or pre-development ichthyofauna of the Middle Rio Grande in New Mexico is thought to have included at least 16 species (Hatch 1985, Smith and Miller 1986, and Propst et al. 1987), four of which were endemic to the region. The Phantom shiner (Notropis orca) and Rio Grande bluntnose shiner (Notropis simus) are extinct. The Rio Grande shiner (Notropis jemezanus) and Rio Grande speckled chub (Extrarius aestivalis) are extirpated from the New Mexico portion of the Rio Grande. The silvery minnow is the only native pelagic, broadcast spawning minnow surviving in the Middle Rio Grande (Bestgen and Platania 1991). A considerable number of non-native fishes have been introduced into the Rio Grande, either accidentally or as gamefish. Today, the project area contains at least 27 fish species, of which 12 are native and 15 are non-native.

Fish surveys have been conducted monthly in the project area by the Service's New Mexico Fishery Resources Office since October 1999. These surveys target the silvery minnow, but provide information on other species as well. Silvery minnows are caught consistently, but in very low numbers. Other species in the project area include brown trout, western mosquitofish, white sucker, flathead chub, fathead minnow, red shiner, gizzard shad, longnose dace, Rio Grande chub, channel catfish, small-mouth bass, white bass, common carp, and river carpsucker.

A listing of common and scientific names of fish that may occur in the Rio Grande within the project area is provided in Appendix A.

Terrestrial Resources

Vegetation

The Middle Rio Grande corridor extends through a matrix of Plains–Mesa Sand Scrub and Desert Grassland vegetation in the north, and Chihuahuan Desert Scrub in the south (Dick-Peddie 1993). Within the river floodplain, however, vegetation differs markedly from adjacent upland areas. The majority of riparian communities along the middle valley are dominated by Rio Grande cottonwood, which forms a sparse to dense canopy in the river floodplain. In areas of relatively intact native vegetation, cottonwoods sometimes share dominance with one of several native willows, particularly Gooding willow and peachleaf willow. These species may also be a major component of the understory. Other common native species in understory layers include coyote willow, New Mexico olive, skunkbush, rabbitbrush, and sandbar willow.

For cottonwoods and some willows, seed dispersal, germination, and seedling development typically take place only when the river overflows its banks and spills into the floodplain. High flows scour existing vegetation and deposit bare sediments required for the successful establishment of these species. Overbank flooding also helps facilitate vegetative reproduction of cottonwoods (Dick-Peddie 1993).

The riparian forest, or bosque, has been heavily impacted by human activities. Historically, cottonwoods were extensively harvested as fuel and building material. However, even greater impacts have resulted from twentieth-century flood control activities. Prior to human intervention, conditions necessary for cottonwood reproduction were available in most areas. Since the establishment of the levee system and flood control facilities, these conditions have become rare or non-existent. For example, the majority of cottonwoods in the Middle Rio Grande bosque today are roughly the same age, and were likely established during the last significant overbank flooding in 1941 (Crawford et al. 1993). Lack of flooding not only inhibits reproduction of cottonwoods and other native species; it also disrupts natural processes of decomposition, soil formation, and nutrient cycling. Lower river flows in general have also reduced the growth rate of established riparian vegetation. As a result, many of the Middle Rio Grande's cottonwood gallery forests are retreating, with a population of aging trees not being replaced by new growth. If these declines continue, non-native salt cedar and Russian olive will become the predominant plant species in the Rio Grande bosque (Crawford et al. 1993, Molles et al. 1998, Ellis et al. 1999).

In addition to riparian forests, other types of plant communities occur in limited areas. Sandbar communities consisting of grasses, forbs, and seedlings of cottonwood and willow exist in some locations, but are often scoured by high flows. Wetland habitats are limited in extent but present in some areas, particularly between the San Marcial railroad bridge and the delta of Elephant Butte Reservoir. Wetlands may include cattail marshes with cattail and bulrush, and wet meadows dominated by saltgrass, sedges, and young willows.

The failure of the cottonwood bosque to re-establish itself has coincided with an invasion of non-native species over the past 80 years. In many portions of the project area, cottonwood associations are being replaced by stands dominated by one or both of two fast-growing exotics: salt cedar and Russian olive. These invaders colonize the same kinds of open areas necessary for cottonwood and willow recruitment. Where not dominant, these species often form a major component of the shrubby understory. Particularly where there is no shady canopy to block sunlight, salt cedar form large, uniform stands in the floodplain. Salt cedar is most prevalent in the southern end of the Middle Rio Grande Valley, particularly in the San Acacia Reach, but extensive stands may be found throughout other portions of the project area.

Areas with dense growths of salt cedar can have major impacts on river and floodplain hydrology. Salt cedar thickets consume large amounts of water, and may locally deplete the water table. Because salt cedar is highly erosion resistant, thick stands growing alongside the river may armor river banks and contribute to river channelization. Salt cedar eradication projects have been undertaken at Bosque del Apache National Wildlife Refuge, Rio Grande Valley State Park in Albuquerque, and other locations.

Russian olive is the major exotic species in many locations in the northern part of the valley and along the Rio Chama. This species sometimes occurs in uniform stands, with few other species present, and often forms a dense understory in association with cottonwood. Other introduced species such as Siberian elm, tree-of-heaven, china-berry tree, mulberry, and black locust are found in the bosque, particularly along levee roads and in other disturbed areas. In the Corrales Bosque north of Albuquerque, Siberian elm may be poised to become the main overstory tree species as cottonwoods die off over the coming decades (Crawford et al. 1999). Suitability of non-native vegetation as habitat for native wildlife has been the subject of debate.

A listing of common and scientific names of plants that may occur in the Rio Grande floodplain within the project area is provided in Appendix B.

Mammals

Existing mammal populations are also a result of the water operations and land uses in the project area. Hink and Ohmart (1984) performed systematic floral and faunal surveys throughout the Middle Rio Grande. Residential development, agricultural conversion and subsequent irrigation systems, and construction of bridges/roads resulted in the permanent loss of habitats. Development has also caused a disruption of animal movement and dispersal patterns, and has caused continual disturbance to animal communities in the adjacent, fragmented portions of the bosque (Crawford et al. 1993). One of the largest mammals likely to occur in the project area is the coyote. Other mammals such as raccoon, beaver, muskrat, long-tailed weasel, and striped skunk may occur in the general project area. Desert cottontail rabbit, black-tailed jackrabbit, rock squirrel, pocket gopher, deer mouse, western harvest mouse, and American porcupine are also likely to occur. The most common small mammals in the Middle Rio Grande bosque are the white-footed mouse and house mouse (Stuart and Bogan 1996). 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.

A listing of common and scientific names of mammals that may occur in the Rio Grande floodplain within the project area is provided in Appendix C.

Birds

Hink and Ohmart (1984), found that riparian areas are used heavily by most bird species in New Mexico. Cottonwood-dominated community types are highly used and are preferred habitat for many species, especially during the nesting season. Marshes, drains, and areas of open water contribute to the bird diversity of the riparian ecosystem as a whole because of the strong attraction by water-loving birds. At various times of the year, such as during migration, riparian areas support the highest bird densities and species richness in the project area. Since wetlands are scarce, reservoirs and the river in and near the project area provide habitat on a seasonal basis for a variety of waterfowl including Canada geese, mallard, gadwall, green-winged teal, American widgeon, northern pintail, northern shoveler, ruddy duck, and common merganser.

Shorebirds such as the spotted sandpiper and killdeer are likely to occur in the project area. Raptors that may occur in the project area include the bald eagle, turkey vulture, northern harrier, sharp-shinned hawk, Cooper's hawk, red-tailed hawk, American kestrel, common barn owl, and great-horned owl. Birds from a variety of habitats that may be in the project area at any given time include the common nighthawk, belted kingfisher, great blue heron, northern flicker, downy woodpecker, hairy woodpecker, violet-green swallow, northern rough-winged swallow, cliff swallow, barn swallow, black-billed magpie, common raven, plain titmouse, white-breasted nuthatch, canyon wren, western bluebird, mountain bluebird, American robin, northern mockingbird, American pipit, American dipper, European starling, yellow warbler, spotted towhee, white-crowned sparrow, red-winged blackbird, Brewer's blackbird, northern oriole and evening grosbeak (Udvardy 1977). Game species include the mourning dove, Merriam's turkey, and scaled quail.

A listing of common and scientific names of birds that may occur in the Rio Grande floodplain within the project area is provided in Appendix D.

Reptiles and Amphibians

Hink and Ohmart (1984) documented 3 turtle species, 17 species of lizards, and 18 snake species in the Middle Rio Grande Valley. According to Degenhardt et al. (1996), up to 57 species of reptiles may occur in the Middle Rio Grande Region of New Mexico. Reptiles typically found within the project area include the western collared lizard, southern prairie lizard, Great Plains skink, regal ringneck snake, desert striped whipsnake, smooth green snake, and western garter snake. The most common reptiles observed during studies in 1982 and 1983 were the plateau striped whiptail lizard and New Mexico whiptail. Thirteen amphibian species may be found in the Middle Rio Grande Valley (Degendardt et al. 1996). Amphibians associated with the riparian areas such as wet meadows and marshes include chorus frogs, leopard frogs, and bullfrogs (Crawford et al. 1993). Amphibians common to all the habitat types (wetland, riparian, and upland) include the tiger salamander, Woodhouse's toad, red-spotted toad, and northern leopard frog. The most often captured or perhaps the most abundant amphibians along the Rio Grande were the bullfrog and Woodhouse’s toad (Hink and Ohmart 1984). Other species documented along the Rio Grande include Couch’s spadefoot toad, New Mexico spadefoot, red-spotted toad, and northern leopard frog (Hink and Ohmart 1984). Applegarth (1983) suggests the northern leopard frog and painted turtle were more abundant when wetlands were more numerous.

A listing of common and scientific names of reptiles and amphibians that may occur in the Rio Grande floodplain within the project area is provided in Appendix E.

Threatened and Endangered Species

Federally endangered southwestern willow flycatcher (Empidonax traillii extimus) (flycatcher), silvery minnow, and designated critical habitat for the silvery minnow occur in the project area. Other federally listed and candidate species occurring in the project area include the threatened bald eagle (Haliaeetus leucocephalus) and the candidate yellow-billed cuckoo (Coccyzus americanus) (cuckoo).

Southwestern Willow Flycatcher

The Service listed the flycatcher as endangered on February 27, 1995 (60 FR: 10693-10715). The flycatcher is also classified as endangered by the State of New Mexico (New Mexico Department of Game and Fish 1987). The current range of the flycatcher includes southern California, southern portions of Nevada and Utah, Arizona, New Mexico, western Texas, and southwestern Colorado (Unitt 1987, Browning 1993). In New Mexico, the species has been observed in the Rio Grande, Rio Chama, Zuni, San Francisco, San Juan, and Gila River drainages. Available habitat and overall numbers have declined statewide (62 FR: 39129- 39147). A final recovery plan for the flycatcher was developed in 2003 (68 FR: 10485), and a final rule designating critical habitat was published on October 19, 2005 (FR 60886-61009).

Loss and modification of nesting habitat is the primary threat to this species (Phillips et al. 1964, Unitt 1987). Loss of migratory stopover habitat also threatens the flycatcher's survival. Large scale losses of southwestern wetlands have occurred, particularly the cottonwood-willow riparian habitats that are used by the flycatcher (Phillips et al. 1964, Carothers 1977, Rea 1983, Johnson and Haight 1984, Howe and Knopf 1991). The flycatcher is a riparian obligate and nests in riparian thickets associated with streams and other wetlands where dense growths of willow, buttonbush, boxelder, Russian olive, salt cedar or other plants are present. Nests are often associated with an overstory of scattered cottonwood. Throughout the flycatcher's range, these riparian habitats are now rare, widely separated by vast expanses of arid lands, and are reduced in size. Flycatchers begin arriving in New Mexico in late April and May to begin nesting and the young fledge in early summer. Flycatchers nest in thickets of trees and shrubs approximately 2 to 7 m (6.5 to 23 ft) in height or taller, with a densely vegetated understory from ground or water surface level to 4 m (13 ft) or more in height. Surface water or saturated soil is usually present beneath or next to occupied thickets (Phillips et al. 1964, Muiznieks et al. 1994). At some nest sites, surface water may be present early in the nesting 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.

Rio Grande Silvery Minnow

The silvery minnow was formerly one of the most widespread and abundant fish species in the Rio Grande Basin occurring from Española, New Mexico, to the Gulf of Mexico (Bestgen and Platania 1991). This species is a moderately sized, stout minnow, approximately 9 centimeters (3.5 inches (in)) in length that spawns in the late spring and early summer, coinciding with high spring flows (Sublette et al. 1990). Natural 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. Stream reaches dominated by straight, narrow, incised channels with rapid flows are not typically occupied by silvery minnows (Sublette et al. 1990, Bestgen and Platania 1991).

Currently, the silvery minnow is restricted to the Middle Rio Grande in New Mexico, occurring only from Cochiti Dam downstream to the headwaters of Elephant Butte Reservoir (Platania 1991). The species was federally listed as endangered in July 1994 (59 FR: 36988-37001) and is also listed as endangered by the State of New Mexico. The Service (58 FR: 11821-11828) cited the de-watering of portions of the Rio Grande below Cochiti Dam through water regulation activities, the construction of main-stream dams, the introduction of non-native competitor/predator species, and the degradation of water quality as factors responsible for declines in the silvery minnow population. On February 19, 2003, the Service published a final rule establishing critical habitat for the silvery minnow within the last remaining portion of their historical range in the Middle Rio Grande, from Cochiti Dam to the utility line crossing the Rio Grande, a permanent identified landmark in Socorro County (68 FR: 8088-8135). The width of critical habitat along the Rio Grande is defined as those areas bound by existing levees or, in areas without levees, 91 m (300 ft) of the riparian zone adjacent to the bankfull stage of the river.

The Service determined the primary constituent elements of critical habitat for the silvery minnow based on studies of their habitat and population biology (68 FR 8088). The primary constituent elements of silvery minnow critical habitat include:

1. A hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining diverse aquatic habitats (e.g., backwaters, side channels, pools, eddies, and runs). This hydrologic regime should, to the extent possible, mimic a natural hydrograph. Flows in the early spring to early summer (March through June) should create aquatic habitat complexity and trigger spawning; flows in the summer and fall (June through October) should be sufficient to maintain aquatic habitat and prevent river drying; and flows in the winter (November through February) should be relatively constant.

2. Unimpounded stretches (i.e., river miles) of river that contain a variety of habitat types (i.e., pools, backwaters, etc.) and year-round flow.

3. Silt and sand dominated substrates.

4. Suitable water quality; that is, water flowing through critical habitat should be well oxygenated (year-round) and remain in the temperature range of 1 oC (35 oF) to 30 oC (85 oF).

The primary constituent elements identified above facilitate the physiological, behavioral, and ecological requirements of the silvery minnow. The first primary constituent element provides sufficient flows to minimize the formation of isolated pools. This element is essential to the conservation of the silvery minnow because the species cannot withstand river drying. Water is a necessary component of all silvery minnow life history stages. The second primary constituent element facilitates silvery minnow reproduction and recruitment. Low-velocity habitats provide food, shelter, and nursery habitat, which are essential for the survival and recruitment of the species (68 FR 8008). The third primary constituent element, silt and sand substrates (Dudley and Platania 1997), characterize habitats that are used by the silvery minnow for foraging and shelter. The final primary constituent element provides suitable water quality necessary for silvery minnow survival.

Bald Eagle

The project area is also within the known and historic range of the bald eagle. The Service reclassified the bald eagle from endangered to threatened on July 12, 1995 (60 FR: 36000-36010). Adult bald eagles are easily recognized by their white heads and dark bodies. Wintering bald eagles frequent all major river systems in New Mexico from November through March, including the Rio Grande. This species prefers to roost and perch in large trees near water, typically cottonwoods in the project area. Prey includes fish, waterfowl, and small mammals.

Major present and foreseeable threats to the bald eagle include habitat degradation and destruction, and environmental contamination (e.g., prey base contamination). The main threats to New Mexico's wintering bald eagle population include impacts to their prey base and the availability of suitable roost sites. Between 1988 and 1996, the Corps conducted annual winter bald eagle surveys along the Rio Grande from Albuquerque, upstream to El Vado Dam. The mean annual number of bald eagle sightings during the surveys is 64, with the largest number sighted occurring in 1993 (88). Survey data show that wintering bald eagles use the habitat in the vicinity of the project for feeding, perching, and roosting (Reclamation 1999).

Yellow-billed cuckoo

The western population of the yellow-billed cuckoo has experienced a severe decline in distribution and abundance throughout the western United States. This is primarily attributed to loss, degradation, and fragmentation of riparian woodland habitats, overgrazing, and river management, including altered flow and sediment regimes, and flood control practices, such as channelization and bank protection (Laymon and Halterman 1989). On July 25, 2001, the Service published a 12-month finding on a petition to federally list the cuckoo in the western United States under the Act. The Service found that the petitioned action was warranted, but precluded by higher priority listing actions, making the western population a candidate species. In New Mexico, the cuckoo is a candidate species in the western portion of the State, to and including the Rio Grande corridor.

The cuckoo prefers riparian habitat with dense willow, cottonwood, salt cedar and/or mesquite (Hamilton and Hamilton 1965, Gaines 1974, Walters 1983, Howe 1986, Lehman and Walker 2001). Food sources include large insects, caterpillars, katydids, cicadas, grasshoppers, crickets, frogs, lizards, bird eggs and young, fruit and seeds (Hughes 1999). Suitable breeding habitat consists of large stands of dense willow and cottonwood, but exotics like salt cedar are also used. South of Caballo Dam, nesting cuckoos were detected in Seldon Canyon along the Rio Grande (Tafanelli and Meyer 1999). These territories were located in either narrow salt cedar habitat, tall and dense salt cedar habitat, or mixed salt cedar/willow habitat. Therefore, habitat preferences of western cuckoos may be more varied than previously thought (Lehman and Walker 2001).

In New Mexico, the cuckoo was historically rare statewide, but common in riparian areas along the Rio Grande between Albuquerque and Elephant Butte Reservoir, and locally common along other New Mexico rivers. A review on the status of the species in New Mexico concluded that the species would likely experience future declines in the State due to loss of riparian woodlands (Howe 1986). Along the Rio Grande, water and flood control projects have altered flow regimes and river dynamics, inhibiting regeneration of cottonwood-willow riparian habitats. Future degradation and loss of such riparian vegetation would limit the amount of available habitat for the cuckoo (W. Howe, Service, pers., comm., 1999). Cuckoos have also been observed downstream of the San Marcial railroad bridge (Reclamation 2000).

Future Conditions Without the Project

The future conditions without the project include the affected environment with trends through the implementation period. Baseline biological conditions were projected through time to develop expected trends and future conditions.

Under the No Action Alternative, no operational changes are proposed in the Northern, Rio Chama, Central or Southern Sections of the project area. Therefore, fish and wildlife resources in these sections are expected to remain at or near their existing conditions without the project. In the Central Section, fish and wildlife resources may improve over time as a result of ongoing and proposed bosque and aquatic habitat improvement projects. In addition, the management of Jemez Canyon Reservoir as a flow-through facility should benefit fish and wildlife resources in the Central Section by increasing sediment inputs to the Rio Grande and reducing riverbed incision between the confluence of the Rio Grande and Bernalillo.

The No Action Alternative includes operational changes in the San Acacia Section that would impact fish and wildlife. According to the joint lead agencies, the future without the project would include diversions between 0 and 2,000 cfs into the LFCC at the San Acacia Diversion Dam. These diversions would significantly impact fish and wildlife resources in and adjacent to the river in the San Acacia Section, particularly between the San Acacia Diversion Dam and the San Marcial railroad bridge. Impacts to fish and wildlife resources would include entrainment of fish and other aquatic biota into the LFCC, habitat degradation downstream of the San Acacia Diversion Dam. Diversion related impacts to fish and wildlife resources would be directly proportional to the the magnitude of flow diverted from the river. Diversions into the LFCC would further regulate or reduce the hydrograph in the San Acacia Section, increasing intermittency and diminishing natural hydrologic processes (e.g., overbank flooding, scouring, and deposition) that create and maintain diverse aquatic and riparian habitats. For example, under the No Action Alternative, flows downstream of the San Acacia Diversion Dam would be less than or equal to 250 cfs 87.5 percent of the time over the 40-year modeling period, compared to only 27.1 percent of the time without diversions. Mean flows would also decline. With diversions, mean flows downstream of the San Acacia Diversion Dam would be approximately 392.1 cfs over the 40-year modeling period, compared to 1,004.4 cfs without diversions. As a result of these hydrologic changes, aquatic and riparian habitats in the San Acacia Section would increasingly uniform and degraded. In riparian areas, highly water-consumptive, non-native vegetation such as salt cedar would have a competitive advantage over native vegetation and increasingly dominate the riparian vegetative community. As non-native vegetation proliferates, evapotranspiration rates could increase. This could result in a lowering of the water table and increase the frequency and duration of river drying, particularly in areas where monotypic salt cedar stands develop or expand.

Threatened and Endangered Species

Issues with federally listed species will be addressed in detail during section 7 consultation under the Act.

FISH AND WILDLIFE RESOURCES WITH THE PROJECT

No operational changes are proposed in the Northern or Southern Sections of the project area. Therefore, fish and wildlife resources in these sections are expected to remain at or near their existing conditions with the project. Operational changes are, however, proposed in the Rio Chama, Central, and San Acacia Sections that would impact fish and wildlife resources. The largest impacts to fish and wildlife resources would occur in the San Acacia Section, and occur as a direct result of diversions into the LFCC. Impacts associated with diversions would be similar to those described above for the No Action Alternative. Project-related impacts to fish and wildlife resources described below for the Rio Chama and Central Sections, are based on URGWOPs modeling information and include the full range of impacts anticipated. The same is true for the riparian impacts described for the San Acacia Section. Due to modeling limitations and the wide range of variability in potential diversions under each alternative (i.e., 0 to 2,000 cfs under Alternatives B-3, D-3, E-3, and I-3), the aquatic impacts described for the San Acacia Section include only those that would occur when flows in the river are sufficient to divert the maximum allowable under each alternative (i.e., up to 2,000 cfs). They do not include the impacts of the higher frequency, lower level diversions (e.g., less than 2,000 cfs) that would occur under each alternative. Thus, the impacts to aquatic resources described for the San Acacia Section are only a portion of the total impacts expected with the project.

Alternative I-3

Under Alternative I-3, the mean annual maximum acres of overbank flooding would decline by approximately 27 percent (39 acres) in the Rio Chama Section, 7 percent (19 acres) in the Central Section, and 40 percent (1,104 acres) in the San Acacia Section. In the three sections combined, the mean annual maximum acres of overbank flooding would decline by approximately 37 percent (1,162 acres).

Although the maximum extent of overbank flooding in the Rio Chama Section would be lower, the extent and duration of spring overbank flooding over the 40-year modeling period would be higher, increasing approximately 82 percent (936 acre-days). In the Central and San Acacia Sections, the extent and duration of spring overbank flooding would decline by approximately 10 percent (760 acre-days) and 54 percent (71,071 acre-days), respectively. For the three sections combined, the extent and duration of spring overbank flooding would decline by approximately 50 percent (70,895 acre-days).

Under Alternative I-3, longnose dace habitat in the Rio Chama, Central, and San Acacia Sections combined would decline by approximately 12.3 percent (102,405 square feet (ft2)) on average, with the largest habitat losses (57.8 percent (87,333 ft2)) occurring in the San Acacia Section. Channel catfish habitat would decline by approximately 8.1 percent (219,268 ft2) for the three river sections impacted, with the largest habitat losses (39.9 percent, (198,403 ft2)) occurring in the San Acacia Section. Flathead chub and river carpsucker habitat would decline by approximately 8.0 percent (91,459 ft2)), with the largest habitat losses (40.7 percent (96,970 ft2)) again occurring in the San Acacia Section.

Alternative I-2

Under Alternative I-2, the mean annual maximum acres of overbank flooding in the Rio Chama and San Acacia Sections would decline by approximately 15 percent (22 acres) and 10 percent (285 acres) respectively, and increase in the Central Section by approximately 3 percent (8 acres). In the three sections combined, the mean annual maximum acres of overbank flooding would decline by approximately 9 percent (299 acres).

Although the maximum extent of overbank flooding in the Rio Chama Section would be lower under Alternative I-2, the extent and duration of spring overbank flooding over the 40-year modeling period would be substantially higher, increasing by approximately 115 percent (1,313 acre-days). In the Central and San Acacia Sections, the extent and duration of spring overbank flooding would decline by approximately 3 percent (222 acre-days) and 31 percent (40,292 acre-days), respectively. For the three sections combined, the extent and duration of spring overbank flooding would decline by approximately 28 percent (39,201 acre-days).

Under Alternative I-2, longnose dace habitat in the Rio Chama, Central, and San Acacia Sections combined would decline by approximately 9.7 percent (80,483 ft2) on average, with the largest habitat losses (45.1 percent (68,143 ft2)) occurring in the San Acacia Section. Channel catfish habitat would decline by approximately 6.6 percent (179,149 ft2), with the largest habitat losses (31 percent (154,122 ft2)) occurring in the San Acacia Section. Flathead chub and river carpsucker habitat would decline by 6.8 percent (77,179 ft2) with the largest habitat losses (32.3 percent (76,856 ft2)) again occurring in the San Acacia Section.

Alternative I-1

Under Alternative I-1, the mean annual maximum acres of overbank flooding in the Rio Chama section would remain unchanged. However, in the Central and San Acacia Sections, it would increase by approximately 17 percent (43 acres) and 5 percent (148 acres), respectively. In the three sections combined, the mean annual maximum acres of overbank flooding would decline by approximately 3 percent (105 acres).

Although the maximum extent of overbank flooding in the Rio Chama Section would not change under Alternative I-1, the extent and duration of spring overbank flooding over the 40-year modeling period would be substantially higher, increasing by approximately 164 percent (1,867 acre-days). In the Central Section, the extent and duration of spring overbank flooding would increase by approximately 8 percent (609 acre-days). In the San Acacia Section, the extent and duration of spring overbank flooding would decline by approximately 15 percent (20,164 acre-days). For the three sections combined, the extent and duration of spring overbank flooding would decline by approximately 13 percent (17,688 acre-days).

Under Alternative I-1, longnose dace habitat in the Rio Chama, Central, and San Acacia Sections combined would decline by approximately 5 percent (41,737 ft2) on average, with the largest habitat losses (27 percent (40,802 ft2)) occurring in the San Acacia Section. Channel catfish habitat would decline by approximately 3.7 percent (100,632 ft2), with the largest habitat losses (18.7 percent (92,966 ft2)) occurring in the San Acacia Section. Flathead chub and river carpsucker habitat would decline by 3.9 percent (44,898 ft2), with the largest habitat losses (19.7 percent (44,898 ft2)) again occurring in the San Acacia Section.

Alternative E-3

Under Alternative E-3, the mean annual maximum acres of overbank flooding would decline by approximately 27 percent (39 acres) and 53 percent (1,464 acres) in the Rio Chama and San Acacia Sections, respectively, and increase by approximately 91 percent (236 acres) in the Central Section. Channel capacity in the Central Section would also increase from 7,000 to 10,000 cfs. In the three sections combined, the mean annual maximum acres of overbank flooding would decline by approximately 40 percent (1,267 acres).

Although the maximum extent of overbank flooding in the Rio Chama Section would decline under Alternative E-3, the extent and duration of spring overbank flooding over the 40-year modeling period would be substantially higher, increasing by 76 percent (869 acre-days). In the Central Section, the extent and duration of spring overbank flooding would increase by approximately 14 percent (1,087 acre-days). In the San Acacia Section, the extent and duration of spring overbank flooding would decline by approximately 65 percent (85,206 acre-days). For the three sections combined, the extent and duration of spring overbank flooding would decline by approximately 59 percent (83,250 acre-days).

Under Alternative E-3, longnose dace habitat in the Rio Chama, Central, and San Acacia Sections combined would decline by approximately 12.2 percent (101,506 ft2) on average, with the largest habitat losses (57.8 percent (87,226 ft2)) occurring in the San Acacia Section. Channel catfish habitat would decline by a total of approximately 8 percent (215,816 ft2), with the largest habitat losses (39.7 percent (197,695 ft2)) occurring in the San Acacia Section. Flathead chub and river carpsucker habitat would decline by 7.9 percent (90,087 ft2), with the largest habitat losses 40.6 percent (96,667 ft2)) again occurring in the San Acacia Section.

Alternative D-3

Under Alternative D-3, the mean annual maximum acres of overbank flooding in the Rio Chama and San Acacia Sections would decline by approximately 9 percent (13 acres) and 55 percent (1,516 acres), respectively, and increase in the Central Section by approximately 8 percent (20 acres). In the three sections combined, the mean annual maximum acres of overbank flooding would decline by approximately 48 percent (1,509 acres).

Although the maximum extent of overbank flooding in the Rio Chama Section would decline under Alternative D-3, the extent and duration of spring overbank flooding over the 40-year modeling period would be substantially higher, increasing by 132 percent (1,506 acre-days). This increase is due, in part, to the proposed increase in channel capacity from 1,800 to 2,000 cfs downstream of Abiquiu Reservoir. In the Central and San Acacia Sections, the extent and duration of overbank flooding would decrease by approximately 1 percent (40 acre-days) and 63 percent (83,309 acre-days), respectively. For the three sections combined, the mean duration of overbank flooding would decline by approximately 58 percent (81,843 acre-days).

Under Alternative D-3, longnose dace habitat in the Rio Chama, Central, and San Acacia Sections combined would decline by approximately 12 percent (100,206 ft2) on average, with the largest habitat losses (57.8 percent (87,235 ft2)) occurring in the San Acacia Section. Channel catfish habitat would decline by approximately 8 percent (215,060 ft2), with the largest habitat losses (39.8 percent (198,089 ft2)) occurring in the San Acacia Section. Flathead chub and river carpsucker habitat would decline 7.9 percent (90,148 ft2), with the largest habitat losses (40.7 percent (96,929 ft2)) again occurring in the San Acacia Section.

Alternative B-3

Under Alternative B-3, the mean annual maximum acres of overbank flooding would decline by approximately 53 percent (78 acres) in the Rio Chama Section and 53 percent (1,455 acres) in the San Acacia Section, and increase by approximately 78 percent (203 acres) in the Central Section. The decline in the mean annual maximum acres of overbank flooding in the Rio Chama Section is partly attributed to the proposed decrease in channel capacity downstream of Abiquiu Reservoir from 1,800 to 1,500 cfs. Likewise, the increase in the mean annual maximum acres of overbank flooding in the Central Section is due, in part, to the proposed increase in channel capacity from 7,000 to 8,500 cfs downstream of Cochiti Lake. In the three sections combined, the mean annual maximum acres of overbank flooding would decline by approximately 42 percent (1,330 acres).

In the Rio Chama and San Acacia Sections, the extent and duration of spring overbank flooding over the 40-year modeling period would decrease by 6 percent (67 acre-days) and 64 percent (85,009 ac-ft), respectively. In the Central Section, the extent and duration of overbank flooding would increase by approximately 10 percent (783 ac-ft). For the three sections combined, the mean duration of overbank flooding would decline by approximately 60 percent (84,293 acre-days).

Under Alternative B-3, longnose dace habitat in the Rio Chama, Central, and San Acacia Sections combined would decline by approximately 12.7 percent (105,999 ft2) on average, with the largest habitat losses (58.5 percent 88,240 ft2)) occurring in the San Acacia Section. Channel catfish habitat would decline by approximately 8.2 percent (220,763 ft2), with the largest habitat losses (40.2 percent (199,925 ft2)) occurring in the San Acacia Section. Flathead chub and river carpsucker habitat would decline by 8.0 percent (91,348 ft2), with the largest habitat losses (41.1 percent (97,736 ft2)) again occurring in the San Acacia Section.

Threatened and Endangered Species

Issues with federally listed species will be addressed in detail during section 7 consultation under the Act.

DISCUSSION

The Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667e) directs the Federal action agency to consult with the Service for purposes of "preventing a net loss of and damage to wildlife resources." It further directs the action agency to give wildlife conservation measures equal consideration to features of water resource development. Consideration is to be given to all wildlife, not simply those that are legally protected under the Endangered Species Act or those with high economic and recreational value. Further, the recommendations of the Service are to be given full consideration by the action agency. All aspects of the proposed project should be managed to avoid and minimize impacts to wildlife resources.

Water development projects that result in adverse impacts to fish and wildlife require the development of mitigation plans. These plans consider the value of fish and wildlife habitat affected. The Service has established a mitigation policy used as guidance in recommending mitigation (Service 1981). The policy states that the degree of mitigation should correspond to the value and scarcity of the fish and wildlife habitat at risk. Four resource categories in decreasing order of importance are identified:

Resource Category No. 1 Habitats of high value for the species being evaluated that are unique and irreplaceable on a national basis or in the ecoregion section. No loss of existing habitat value should occur.

Resource Category No. 2 Habitats of high value that are relatively scarce or becoming scarce on a national basis or in the ecoregion section. No net loss of in-kind habitat value should occur.

Resource Category No. 3 Habitats of high to medium value that are relatively abundant on a national basis. No net loss of habitat value should occur and loss of in-kind habitat should be minimized.

Resource Category No. 4 Habitats of medium to low value. Loss of habitat value should be minimized.

The habitats in the immediate project area are classified as follows: Resource Category No. 2 - riparian vegetation (includes trees and shrubs such as willows) and aquatic habitat.

Riparian habitats are classified in category 2 because they are scarce and are rapidly disappearing. About 90 percent of the historic wetland and riparian habitat in the Southwest has been eliminated (Johnson and Jones 1977). The mitigation goal for riparian areas (trees and shrubs) in the project area is no net loss in wildlife value as a result of the proposed project. To ensure that mitigation is successful for impacts to riparian habitats, we recommend that a long-term monitoring and mitigation plan be developed.

Aquatic habitats are classified in category 2 because they are relatively scarce in the Southwest and provide high wildlife value for several native fish species (e.g., longnose dace, flathead chub, river carpsucker, etc.). The mitigation goal for aquatic habitat (e.g., backwaters, riffles, and runs) in the project area is to have no net loss of habitat value as a result of the proposed project. To ensure that mitigation is successful for impacts to aquatic habitats, we recommend that a long-term monitoring and mitigation plan be developed.

The Service has ranked the Project alternatives based on the overall amount of habitat potentially impacted and thus, the resulting impacts to aquatic and terrestrial resources throughout the project area, from least to most:

- Alternative I-1
- Alternative I-2
- Alternative I-3
- Alternative D-3
- Alternative E-3
- Alternative B-3
- No Action

The proposed project would include actions that could have both positive and negative impacts on fish and wildlife resources in the project area. Actions that could potentially benefit fish and wildlife resources include conservation storage of native Rio Grande flood carry-over water at Abiquiu Reservoir, and increasing the capacity of the river channel downstream of Abiquiu Reservoir and Cochiti Lake. Conservation storage could be used to augment peak flows during low flow years, minimize intermittency, trigger spawning, and meet other life history requirements of fish and wildlife downstream. Increasing the channel capacity downstream of Abiquiu Reservoir and Cochiti Lake could facilitate higher magnitude releases and promote overbank flooding, scouring, deposition, and other natural hydrologic processes that create and maintain diverse aquatic and riparian habitats.

Although conservation storage could benefit fish and wildlife resources, it could also negatively impact these resources as well. Increased storage at Abiquiu Reservoir could further regulate the hydrograph and diminish naturally occurring high flow events that create and maintain fish and wildlife habitats. It could also reduce flows necessary for spawning, rearing, and other fish and wildlife life history requirements. Furthermore, the release of conservation storage in November and December as modeled in URGWOPs, would provide little if any benefit to fish and wildlife resources. The Service strongly recommends that the joint lead agencies seek to obtain the authority and flexibility to manage conservation storage in a manner that maximizes benefits to fish and wildlife resources while also assisting the NMISC in meeting their downstream delivery obligations. This authority should include the ability to carry-over conservation storage from year-to-year and release it in a manner and at times (i.e., spring and summer) most beneficial to fish and wildlife resources.

Of the operational changes proposed, diversions into the LFCC would cause the most impacts to fish and wildlife resources. Because of the wide range of potential diversions (e.g., 0 to 2,000 cfs), implementation of each alternative as proposed could have major impacts to fish and wildlife resources in the San Acacia Section that would be difficult to mitigate, if not impossible. This is because under all of the alternatives as proposed, diversions could occur whenever flows at the San Acacia Diversion Dam exceed 250 cfs. For example, under Alternative B-3, up to 89 percent of the river flow could be diverted into the LFCC when flows at San Acacia are 2,250 cfs. Although these diversions may benefit wetlands west of the LFCC, they could reduce available instream habitat by 89 percent or more, significantly impacting fish and wildlife resources. Even under Alternative I-1 where diversions are capped at 500 cfs, up to 67 percent of the river flow could be diverted into the LFCC. If rates of entrainment correspond to the proportion of river flow diverted, then up to 89 percent and 67 percent of the eggs and larve in the drift at San Acacia could be entrained into the LFCC under Alternatives B-3 and I-1, respectively.

Diversion related impacts to fish and wildlife could be reduced to a mitigable level by limiting the magnitude of flow diverted from the river and diverting only what is necessary to improve downstream deliveries. The joint lead agencies should continue to study the surface and groundwater hydrology of the river and LFCC in the San Acacia Section to determine the level of diversions required to improve downstream deliveries. Only those levels shown to improve deliveries should be considered for diversion, and only when they comprise a small proportion of the flow in the river. However, to the extent possible, diversions should be avoided to ensure the protection of fish and wildlife resources in the San Acacia Section.

To further reduce diversion related impacts to fish and wildlife resources, the joint lead agencies should redesign the diversion structure at San Acacia to minimize or avoid entraining fish, eggs, and larvae into the LFCC. To avoid entrainment related impacts, the joint lead agencies should investigate the feasibility of infiltration galleries rather than a surface diversion. If infiltration galleries are found to be infeasible, then the diversion structure should be screened and include design features to reduce approach velocities. Reducing the approach velocities would help to minimize entrainment and impingement of fish, larvae, and other aquatic biota on the intake screens.

To further minimize diversion related impacts to fish and wildlife resources, the joint lead agencies should consider increasing the channel capacity below Abiquiu Reservoir and Cochiti Lake, and avoid decreasing channel capacity and further limiting management flexibility. Channel capacity increases could facilitate higher magnitude releases from Abiquiu Reservoir and Cochiti Lake that could benefit fish and wildlife resources in the Rio Chama and Central

Sections while minimizing diversion related impacts in the San Acacia Section. Higher magnitude spring releases from Cochiti Lake could be timed to increase spring peak flows in the Central Section above levels typically considered safe for the San Marcial railroad bridge downstream. This “extra” water could then be diverted from the river into the LFCC ensuring flows at the San Marcial railroad bridge remain at a safe level. Thus, fish and wildlife resources in the Central Section could benefit from larger spring peak flows, diversion related flow reductions downstream of the San Acacia Diversion Dam could be minimized or avoided, and flows below the San Marcial railroad bridge could remain within safe levels.

Without diversions into the LFCC the proposed project would result in a net benefit to fish and wildlife resources. Conservation storage could be used to increase peak flows necessary for habitat creation and maintenance as well as provide spawning cues necessary for other life history requirements. It could also be used to reduce intermittency downstream and help to maintain habitat during critical low-flow periods. Increasing the channel capacities below Abiquiu Reservoir and Cochiti Lake could facilitate higher spring releases and channel forming and maintaining flows. Large diversions into the LFCC would be difficult if not impossible to mitigate, particularly with the wide variability of diversions proposed in each alternative.

RECOMMENDATIONS

To avoid or minimize project related impacts to fish and wildlife resources, we recommend that the joint lead agencies:

1. Develop a long-term monitoring and mitigation plan to identify and offset project related impacts to aquatic and riparian habitats.

2. Obtain the authority to carry-over conservation storage from year-to-year and release it in a manner and at times (i.e., spring and summer) most beneficial to fish and wildlife resources.

3. Continue studying the surface and groundwater hydrology of the river and LFCC in the San Acacia Section to determine the level of diversions necessary to improve downstream deliveries.

4. To the extent possible, minimize, diverting into the LFCC. Divert only the amount necessary to improve downstream deliveries, and only when diversions would comprise a small proportion of the flow in the river.

5. Investigate the use of infiltration galleries instead of a surface diversion at San Acacia.

6. Redesign the LFCC intake to include screens and minimize approach velocities.

7. Increase the channel capacity below Abiquiu Reservoir and Cochiti Lake.

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Common Name Scientific Name

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Gizzard shad (N) *Dorosoma cepedianum*
Rainbow trout (I) *Oncorhynchus mykiss*
Brown trout (I) *Salmo trutta*
Northern pike (I) *Esox lucius*
Red shiner (N) *Cyprinella lutrensis*
Common carp (I) *Cyprinus carpio*
Rio Grande chub (N) *Gila pandora*
Rio Grande silvery minnow (N) *Hybognathus amarus*
Fathead minnow (N) *Pimephales promelas*
Flathead chub (N) *Platygobio gracilis*
Longnose dace (N) *Rhinichthys cataractae*
River carpsucker (N) *Carpiodes carpio*
Flathead catfish (N) *Pylodictis olivaris*
White sucker (I) *Catostomus commersoni*
Rio Grande sucker (N) *Catostomus plebeius*
Smallmouth buffalo (N) *Ictiobus bubalus*
Black bullhead (I) *Ictalurus melas*
Yellow bullhead (I) *Ictalurus natalis*
Channel catfish (I) *Ictalurus punctatus*
Western mosquitofish (N) *Gambusia affinis*
White bass (I) *Morone chrysops*
Green sunfish (I) *Lepomis cyanellus*
Bluegill (N) *Lepomis macrochirus*
Longear sunfish (I) *Lepomis megalotis*
Largemouth bass (I) *Micropterus salmoides*
White crappie (I) *Pomoxis annularis*
Black crappie (I) *Pomoxis nigromaculatus*
Yellow perch (I) *Perca flavescens*
(N=native, I=introduced or non-native)

Appendix B. Common and Scientific Names of Plants That May Occur in the URGWOPs Project Area.

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Common Name Scientific Name

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Baccharis (N) *Baccharis spp.*
Seepwillow (N) *Baccharis glutinosa*
Coyote willow (N) *Salix exigua*
Peachleaf willow (N) *Salix amygdaloides*
Goodding's willow (N) *Salix gooddingii*
Buttonbush (N) *Cephalanthus spp.*
False indigo bush (N) *Amorpha fruticosa*
New Mexico olive (N) *Forestiera neomexicana*
Black locust (N) *Robinia pseudo-acacia*
Boxelder (N) *Acer negundo*
Chinaberry (I) *Melia azedarach*
Rio Grande cottonwood (N) *Populus fremonti*
White mulberry (I) *Morus alba*

Russian olive (I) *Elaeagnus angustifolia*
Salt cedar (I) *Tamarix spp.*
Siberian elm (I) *Ulmus pumila*
Tree-of-heaven (I) *Ailanthus altissima*
Apache plume (N) *Fallugia paradoxa*
Wolfberry (N) *Lycium andersonii*
Fourwing saltbush (N) *Atriplex canescens*
Virginia creeper (I) *Parthenocissus inserta*
Phragmites (N) *Phragmites communis*
Sago pondweed (N) *Potamogeton pectinatus*
Sedge (N) *Carex spp.*
Saltgrass (N) *Distichlis stricta*
Spikerush(N) *Eleocharis spp.*
Horsetail (N) *Equisetum spp.*
Rush (N) *Juncus spp.*
Bulrush (N) *Scirpus spp.*
Sacaton (N) *Sporobolus spp.*
Cattail (N) *Typha latifolia*
Smartweed (N) *Polygonum lapathifolium*
American milfoil (N) *Myriophyllum exalbescens*
Yerba manza (N) *Anemopsis californica*
Primrose (N) *Oenothera spp.*
Fendler globemallow (N) *Sphaeralcea fendleri*
Pricklypear (N) *Opuntia spp.*
Buffalo gourd (N) *Cucurbita foetidissima*
Spiny aster (I) *Aster spinosus*
Golden currant (N) *Ribes aureum*
Watercress (N) *Nasturtium officionale*
(N=native, I=introduced or non-native)

Appendix C. Common and Scientific Names of Mammals That May Occur in the URGWOPs Project Area.
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Common Name Scientific Name
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Opossum *Didelphis virginiana*
Desert shrew *Notiosorex crawfordi*
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*
Desert cottontail *Sylvilagus auduboni*
Black-tailed jackrabbit *Lepus californicus*
Beaver *Castor canadensis*
Gunnison’s prairie dog *Cynomys gunnisoni*

Colorado chipmunk *Eutamias quadrivittatus*
Spotted ground squirrel *Spermophilus spilosoma*
Rock squirrel *Spermophilus variegatus*
Red squirrel *Tamiasciurus hudsonicus*
Northern grasshopper mouse *Onychomys leucogaster*
Deer mouse *Peromyscus maniculatus*
White-footed mouse *Peromyscus leucopus*
Piñon mouse *Peromyscus truei*
Western harvest mouse *Reithrodontomys megalotis*
Hispid cotton rat *Sigmodon hispidus*
Norway rat *Rattus norvegicus*
Muskrat *Ondatra zibethicus*
New Mexican jumping mouse *Zapus hudsonius luteus*
Ord kangaroo rat *Dipodomys ordii*
Merriam kangaroo rat *Dipodomys merriami*
Silky pocket mouse *Perognathus flavus*
Plains pocket mouse *Perognathus flavescens*
Yellow-faced pocket gopher *Pappogeomys castanops*
Botta pocket gopher *Thomomys bottae*
American porcupine *Erethizon dorsatum*
Coyote *Canis latrans*
Gray fox *Urocyon cinereoargenteus scottii*
Raccoon *Procyon lotor*
Striped skunk *Mephitis mephitis*
Long-tailed weasel *Mustela frenata*
Mink *Mustela vison*
Badger *Taxidea taxus*
Bobcat *Lynx rufus*
Mountain lion *Felis concolor*
Mule deer *Odocoileus hemionus*
Appendix D. Common and Scientific Names of Birds That May Occur in the URGWOPs Project Area.
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Common Name Scientific Name
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Pied-billed grebe *Podilymbus podiceps*
Common loon *Gavia immer*
American white pelican *Pelecanus erythrorhynchos*
Double-crested cormorant *Phalacrocorax auritus*
Olivaceous cormorant *Phalacrocorax olivaceus*
American bittern *Botaurus lentiginosus*
Least Bittern *Ixobrychus exilis*
Great blue heron *Ardea herodias*
Great egret *Ardea alba*
Snowy egret *Egretta thula*
Little blue heron *Egretta caerulea*
Cattle egret *Bubulcus ibis*
Green-backed heron *Butorides striatus*
Black-crowned night heron *Nycticorax nycticorax*
White-faced ibis *Plegadis chihi*
Snow goose *Chen caerulescens*

Canada goose *Branta canadensis*
Wood duck *Aix sponsa*
Green-winged teal *Anas crecca*
Mallard *Anas platyrhynchos*
Northern pintail *Anas acuta*
Cinnamon teal *Anas cyanoptera*
Northern shoveler *Anas clypeata*
Gadwall *Anas strepera*
Hooded merganser *Mergus cuculatus*
Red-breasted merganser *Mergus serrator*
Ruddy duck *Oxyura jamaicensis*
Virginia rail *Rallus limicola*
Sora *Porzana carolina*
Common moorhen *Gallinula chloropus*
American coot *Fulica americana*
Sandhill crane *Grus canadensis*
Whooping crane *Grus americana*
Killdeer *Charadrius vociferus*
Black-necked stilt *Himantopus mexicanus*
American avocet *Recurvirostra americana*
Solitary sandpiper *Tringa solitaria*
Spotted sandpiper *Actitis macularia*
Long-billed curlew *Numenius americanus*
Forster's tern *Sterna forsteri*
Black tern *Chlidonias niger*
Turkey vulture *Cathartes aura*
Osprey *Pandion haliaetus*
Black-shouldered kite *Elanus caeruleus*
Mississippi kite *Ictinia mississippiensis*
Bald eagle *Haliaeetus leucocephalus*
Northern Harrier *Circus cyaneus*
Cooper's hawk *Accipiter cooperii*
Common black-hawk *Buteogallus anthracinus*
Swainson's hawk *Buteo swainsoni*
Red-tailed hawk *Buteo jamaicensis*
American kestrel *Falco sparverius*
American peregrine falcon *Falco peregrinus anatum*
Ring-necked pheasant *Phasianus colchicus*
Northern bobwhite *Colinus virginianus*
Scaled quail *Callipepla squamata*
Gambel's quail *Callipepla gambelii*
Rock dove *Columba livia*
White-winged dove *Zenaida asiatica*
Morning dove *Zenaida macroura*
Common ground-dove *Columbina passerina*
Yellow-billed cuckoo *Coccyzus erythropthalmus*
Greater roadrunner *Geococcyx californianus*
Common barn-owl *Tyto alba*
Great horned owl *Bubo virginianus*
Burrowing owl *Athene cunicularia*
Lesser nighthawk *Chordeiles acutipennis*

Common nighthawk *Chordeiles minor*
White-throated swift *Aeronautes saxatalis*
Black-chinned hummingbird *Archilochus alexandri*
Rufous hummingbird *Selasphorus rufus*
Belted kingfisher *Ceryle alcyon*
Northern flicker *Colaptes auratus*
Olive-sided flycatcher *Contopus borealis*
Western wood-pewee *Contopus sordidulus*
Southwestern willow flycatcher *Empidonax traillii extimus*
Black phoebe *Sayornis nigricans*
Say's phoebe *Sayornis saya*
Ash-throated flycatcher *Myiarchus cinerascens*
Cassin's kingbird *Tyrannus vociferans*
Western kingbird *Tyrannus verticalis*
Eastern kingbird *Tyrannus tyrannus*
Violet-green swallow *Tachycineta thalassina*
Bank swallow *Riparian riparia*
Cliff swallow *Hirundo pyrrhonota*
Barn swallow *Hirundo rustica*
Northern rough-winged swallow *Stelgidopteryx serripennis*
Black-billed magpie *Pica pica*
American crow *Corvus caurinus*
Chihuahuan raven *Corvus cryptoleucus*
Black-capped chickadee *Parus atricapillus*
Verdin *Auriparus flaviceps*
White-breasted nuthatch *Sitta carolinensis*
Cactus wren *Campylorhynchus brunneicapillus*
Black-tailed gnatcatcher *Polioptila melanura*
Eastern bluebird *Sialia sialis*
Western bluebird *Sialia mexicana*
Hermit thrush *Catharus guttatus*
American robin *Turdus migratorius*
Gray catbird *Dumetella carolinensis*
Northern mockingbird *Mimus polyglottos*
Curved-billed thrasher *Toxostoma curvirostre*
Crissal thrasher *Toxostoma dorsale*
European starling *Sturnus vulgaris*
Bell's vireo *Vireo bellii*
Warbling vireo *Vireo gilvus*
Orange-crowned warbler *Vermivora celata*
Virginia's warbler *Vermivora virginiae*
Lucy's warbler *Vermivora luciae*
Yellow warbler *Dendroica petechia*
Yellow-rumped warbler *Dendroica coronata*
Common yellowthroat *Geothlypis trichas*
Wilson's warbler *Wilsonia pusilla*
Yellow-breasted chat *Icteria virens*
Summer tanager *Piranga rubra*
Western tanager *Piranga ludoviciana*
Northern cardinal *Cardinalis cardinalis*
Pyrrhuloxia *Cardinalis sinuatus*

Rose-breasted grosbeak *Pheucticus ludovicianus*
Black-headed grosbeak *Pheucticus melanocephalus*
Blue grosbeak *Guiraca caerulea*
Lazuli bunting *Passerina amoena*
Indigo bunting *Passerina cyanea*
Painted bunting *Passerina ciris*
Spotted towhee *Pipilo maculatus*
Brown towhee *Pipilo fuscus*
Dark-eyed junco *Junco hyemalis*
Rufous-crowned sparrow *Aimophila ruficeps*
American tree sparrow *Spizella arborea*
Chipping sparrow *Spizella passerina*
Lark sparrow *Chondestes grammacus*
Black-throated sparrow *Amphispiza bilineata*
Lark bunting *Calamospiza melanocorys*
Lincoln's sparrow *Melospiza lincolnii*
White-crowned sparrow *Zonotrichia leucophrys*
Red-wing blackbird *Agelaius phoeniceus*
Western meadowlark *Sturnella neglecta*
Yellow-headed blackbird *Xanthocephalus xanthocephalus*
Brewer's blackbird *Euphagus cyanocephalus*
Great-tailed grackle *Quiscalus mexicanus*
Bronzed cowbird *Molothrus aeneus*
Brown-headed cowbird *Molothrus ater*
Orchard oriole *Icterus spurius*
Northern oriole *Icterus galbula bullockii*
House finch *Carpodacus mexicanus*

Appendix E. Common and Scientific Names of Reptiles and Amphibians That May Occur in the URGWOPs Project Area.

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Common Name Scientific Name

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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*

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