U.S. Fish & Wildlife Service

Rio Grande Silvery Minnow

(Hybognathus amarus)

Draft Revised Recovery Plan

January 2007

DRAFT

REVISED

RIO GRANDE SILVERY MINNOW

(*Hybognathus amarus*)

RECOVERY PLAN

Southwest Region
U.S. Fish and Wildlife Service
Albuquerque, New Mexico

Approved: _____

Regional Director, Southwest Region, U.S. Fish and Wildlife Service

Date: _____

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EXECUTIVE SUMMARY

Current Status of the Species
Rio Grande silvery minnow historically occupied approximately 3,862 river km (2,400 mi) in New Mexico and Texas. It was found in the Rio Grande from Española, New Mexico, down through Texas to the Gulf of Mexico (Bestgen and Platania 1991). It was also found in the Pecos River, a major tributary of the Rio Grande, from Santa Rosa, New Mexico, downstream to its confluence with the Rio Grande in Texas.

Currently, the Rio Grande silvery minnow is believed to occur only in one reach of the Rio Grande in New Mexico, a 280 km (174 mi) stretch of river that runs from Cochiti Dam to the headwaters of Elephant Butte Reservoir. Its current habitat is limited to about 7 percent of its former range. The species was listed as federally endangered in 1994 (59 FR 36988 36995).

Habitat Requirements and Threats
The Rio Grande silvery minnow uses only a small portion of the available aquatic habitat. In general, the species most often uses silt substrates in areas of low or moderate water velocity (e.g., eddies formed by debris piles, pools, and backwaters). The Rio Grande silvery minnow is rarely found in habitats with high water velocities, such as main channel runs, which are often deep and swift. The species is most commonly found in depths of less than 20 centimeters (cm) (7.9 inches [in]) in the summer and 31-40 cm (12.2-15.75 in) in the winter. Few use areas with depths greater than 50 cm (19.7 in).

Throughout much of its historic range, the decline of the Rio Grande silvery minnow may be attributed in part to destruction and modification of its habitat due to dewatering and diversion of water, water impoundment, and modification of the river (channelization). Competition and predation by introduced non-native species, water quality degradation, and other factors may also have contributed to its decline.

Recovery Strategy
Three goals have been established for the recovery of the Rio Grande silvery minnow:

1. Prevent the extinction of the Rio Grande silvery minnow in the middle Rio Grande of New Mexico.

2. Recover the Rio Grande silvery minnow to an extent sufficient to change its status on the List of Endangered and Threatened Wildlife from endangered to threatened (downlisting).

3. Recover the Rio Grande silvery minnow to an extent sufficient to remove it from the List of Endangered and Threatened Wildlife (delisting).

Downlisting (Goal 2) for the Rio Grande silvery minnow may be considered when three

populations (including at least two that are self-sustaining) have been established within the historical range of the species and have been maintained for at least five years.

Delisting (Goal 3) of the species may be considered when three self-sustaining populations have been established within the historical range of the species and have been maintained for at least ten years.

Actions Needed

Recovery actions in the Plan are grouped into five areas:

1. Develop a thorough knowledge of the Rio Grande silvery minnow's life history, ecology, and behavior, and the current status of its habitat.
2. Restore, protect, and alter habitats as necessary to alleviate threats to the Rio Grande silvery minnow.
3. Ensure the survival of the Rio Grande silvery minnow in its current habitat and reestablish the species in suitable habitats within its historical range.
4. Implement and maintain an adaptive management program so that appropriate research and management activities are implemented in a timely manner to achieve recovery of the Rio Grande silvery minnow.
5. Design and implement a public awareness and education program.

Estimated Cost of Recovery

Costs associated with recovery are estimated for each of the five categories listed above, based on the years in which specific actions are scheduled to occur. These costs are furthered detailed in the Implementation Schedule. Total cost to recover the Rio Grande silvery minnow is estimated at $114,125,000.

Date of Recovery

Reclassification to threatened could be initiated in 25 years. Delisting could be accomplished within 5 years of reclassification.

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1.0 BACKGROUND

1.1 Introduction

The Endangered Species Act of 1973 as amended (16 U.S.C. 1531 et seq.) (ESA) establishes policies and procedures for identifying, listing, and protecting species of wildlife that are endangered or threatened with extinction. The ESA defines an "endangered species" as "any species which is in danger of extinction throughout all or a significant portion of its range." A "threatened species" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The decision to list a species is based on a consideration of the five factors listed in section 4(a)(1) of the ESA:

- Listing Factor A. The present or threatened destruction, modification, or curtailment of its habitat or range.
- Listing Factor B. Overutilization for commercial, recreational, scientific, or educational purposes.
- Listing Factor C. Disease or predation.
- Listing Factor D. The inadequacy of existing regulatory mechanisms.
- Listing Factor E. Other natural or manmade factors affecting its continued existence.

The Rio Grande silvery minnow, *Hybognathus amarus*, was declared an endangered species in 1994 (U.S. Fish and Wildlife Service 1994) and added to the List of Endangered and Threatened Wildlife. The U.S. Secretary of the Interior is responsible for administering the ESA's provisions as they apply to this species. Day-to-day management authority has been delegated to the U.S. Fish and Wildlife Service (Service), an agency within the Department of the Interior.

To help identify and guide species' recovery needs, section 4(f) of the ESA directs the Secretary of the Interior to develop and implement recovery plans for listed species or populations. Such plans are to include: 1) a description of management actions necessary to conserve the species or population; 2) objective, measurable criteria that, when met, will allow the species or population to be removed from the List of Endangered and Threatened Wildlife; and 3) estimates of the time and funding needed to achieve the plan's goals and intermediate steps. Recovery plans are advisory documents. Recovery recommendations contained in such plans are aimed at lessening or alleviating the threats to the species and ensuring self-sustaining populations in the wild.

Procedures for reclassifying and delisting species are set forth in the ESA (section 4) and

in the regulations (50 CFR Part 424) promulgated to implement its listing provisions. A species can be delisted if the Secretary of the Interior determines that it no longer meets the endangered or threatened status, based on a consideration of the five listing factors.

Further, a species may be delisted, according to 50 CFR Part 424.11(d), if the best scientific and commercial data available substantiate that the species or population is neither endangered or threatened, due to 1) extinction; 2) recovery; or 3) a finding that the original data for classification of the species were in error.

A recovery plan for Rio Grande silvery minnow was first developed in 1999 (U.S. Fish and Wildlife Service 1999). This plan is a revision of the 1999 document. It includes new information based on recent research and an updated Recovery Program. Additionally, the plan now includes objective, measurable criteria for downlisting (to threatened) and delisting. The plan was written by the Rio Grande Silvery Minnow Recovery Team (see Acknowledgments).

This section of the Rio Grande Silvery Minnow Recovery Plan (1.0) provides background information on the species, including its taxonomy, life history, and current distribution and population status. It also details the reasons (per the five listing factors) the species was listed as endangered, and describes the critical habitat that has been designated for the species and conservation efforts to date. Also included in 1.0 is a detailed report on endangered species recovery actions from the tribal perspective, with recommendations on how Indian tribes and the Federal Government can better cooperate on recovery issues; the report was prepared by the Recovery Team's tribal subgroup. Section 2.0 provides the overall recovery strategy for the Rio Grande silvery minnow. Section 3.0 describes the goals of the plan (prevention of extinction, downlisting, and eventual delisting), as well as the specific objectives that must be achieved to meet those goals and the criteria by which it will be determined if the objectives have been met. Section 4.0 outlines the management actions that will lead to the goals, objectives, and criteria being met, and recovery of the species. Section 5.0 details how the various components of the recovery plan (the criteria and the actions) address the threats that led to the species' endangered status. Section 6.0 outlines the implementation schedule for management actions, responsible parties and potential partners, and estimated costs. Additional information on historical Rio Grande silvery minnow population numbers and extirpations, as well as various documents that structure the Government's relationship with Indian tribes, are included as appendices.

1.2 Status of the Species

The Rio Grande silvery minnow is one of seven species in the genus *Hybognathus* found in the United States (Pflieger 1980). Rio Grande silvery minnow is believed to occur only in one reach of the Rio Grande in New Mexico, a 280 km (174 mi) stretch of river that runs from Cochiti Dam to the headwaters of Elephant Butte Reservoir. (Bestgen and Platania 1991, Dudley et al. 2005). Its current habitat is limited to about 7 percent of its former range, and is split by three river-wide dams into four discrete reaches (Figure 1).

The area currently occupied by the Rio Grande silvery minnow is roughly equivalent to the portion of the Rio Grande that is commonly known as the "middle Rio Grande." For the purposes of this document, the middle Rio Grande is defined as the stretch of river between Cochiti Dam and Elephant Butte Reservoir.

Throughout much of its historic range, the decline of the Rio Grande silvery minnow may be attributed in part to destruction and modification of its habitat due to dewatering and diversion of water, water impoundment, and modification of the river (channelization). Competition and predation by introduced non-native species, water quality degradation, and other factors may also have contributed to its decline.

In addition to being federally listed under the ESA in 1994, the Rio Grande silvery minnow was listed as endangered by New Mexico (19 NMAC 33.1), Texas (sections 65.171 - 65.184 of Title 31 T.A.C.), and the Republic of Mexico (SDS 1994).

While some of the threats mentioned above have been reduced since the Rio Grande silvery minnow was listed as endangered, none have been eliminated. The status of the species continued to decline through 2003. In 2004 and 2005 abundance of Rio Grande silvery minnow in the remaining population (in the middle Rio Grande) increased. Nonetheless, this population has become fragmented and isolated and is vulnerable to natural and human-caused factors that could further reduce population size.

Critical habitat for the species was designated by the Service in 2003. The critical habitat encompasses 252 km (157 mi) of the middle Rio Grande, from the Cochiti Dam downstream to the utility line at River Mile 62.1, just north of Elephant Butte Reservoir. The width of the critical habitat is defined as the area bound by existing levees, or, where no levees are present, as 91.4 meters (300 ft) of riparian zone adjacent to each side of the bankfull stage of the middle Rio Grande. The Pueblo lands of Santo Domingo, Santa Ana (including lands within the Jemez watershed), Sandia, and Isleta found within this area are excluded from this designation because specific management plans for the minnow were developed for these Pueblos prior to critical habitat designation (U.S. Fish and Wildlife Service 2003b).

Each listed species receives a recovery priority number. The species recovery priority number for the Rio Grande silvery minnow is 2c, which is given for species with a high degree of threat, a high-to-moderate potential for recovery, and a number of existing conflicts between the species' recovery and economic development.

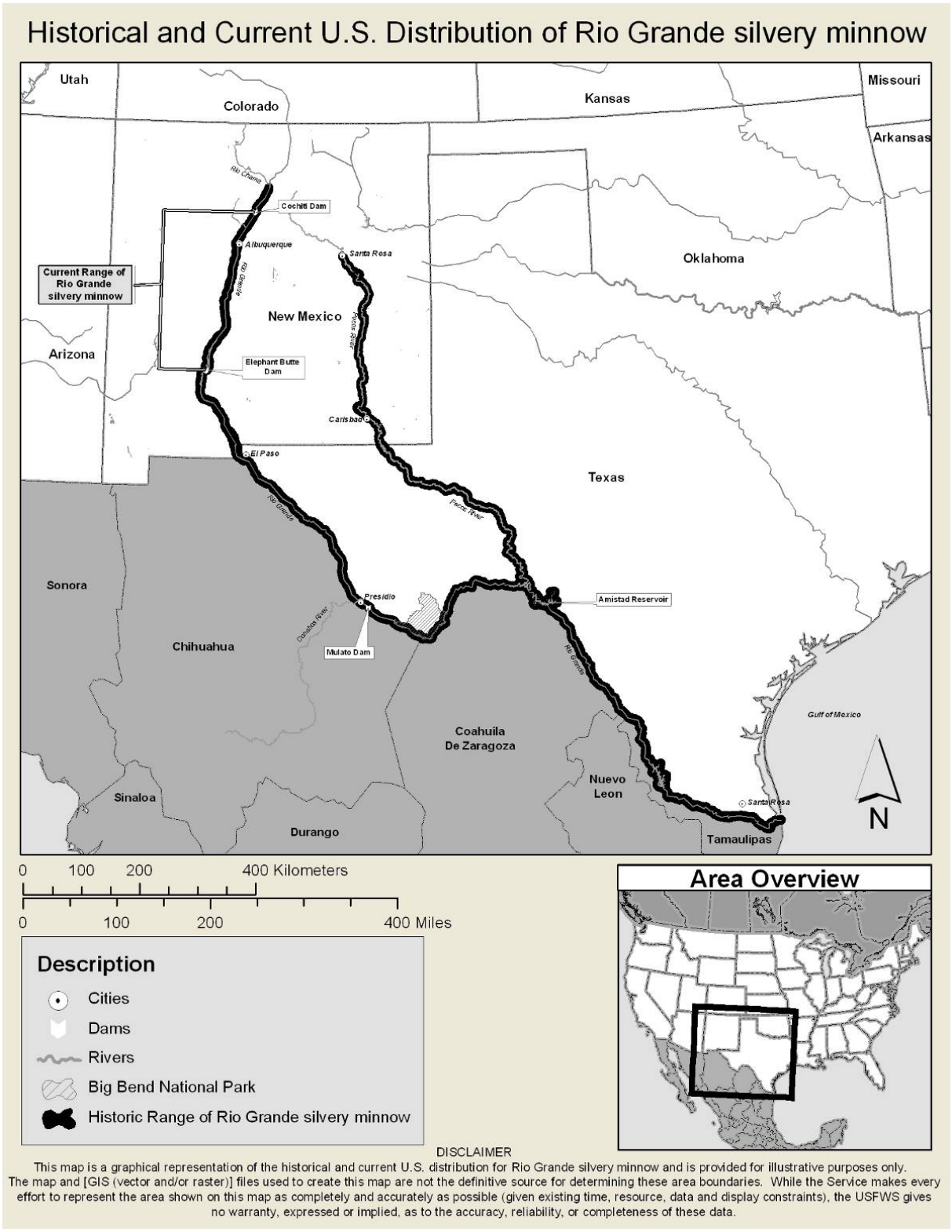

Figure 1. Historical and Current Distribution of Rio Grande Silvery Minnow.

1.3 Description and Taxonomy

1.3.1 Description

The Rio Grande silvery minnow is a small, relatively heavy-bodied minnow, round to ovate in cross-section, with moderately small eyes and a small, slightly oblique mouth (Pfleiger 1980). Adults may reach 3.5 inches (87 mm) in standard length (standard length, or SL, is measured from the tip of the snout to the base of the tail). Live specimens are light greenish-yellow dorsally and light cream to white ventrally. Fins are moderate in length and variable in shape; dorsal and pectoral fins are rounded at tips. Scales above the lateral line are sometimes outlined by melanophores, suggesting a diamond grid pattern. The head and snout are moderately pigmented dorsally by melanophores. The body is fully scaled, with breast scales slightly embedded and smaller. The subterminal mouth extends horizontally to almost the anterior margin of the orbit. The snout is rounded and overhangs the upper lip when viewed ventrally. The eye is small and orbit diameter is much less than gape width or snout length (Bestgen and Propst 1996)(Figure 2.)

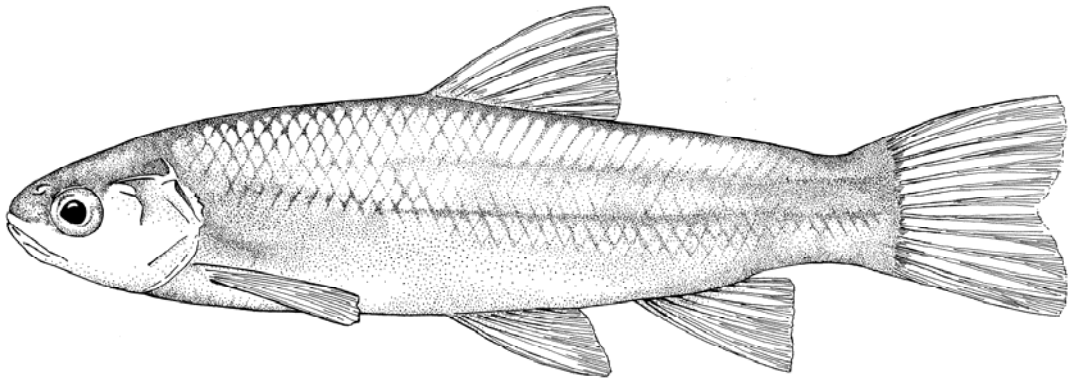

Figure 2. Rio Grande Silvery Minnow (Fish and Wildlife Service).

The species expresses little sexual dimorphism. The pectoral fins of males flare broadly from their base to a triangular fan shape; those of females are shorter, narrower, and oval-shaped. The pectoral rays of breeding males are thickened, while those of females are slender. Pectoral fin length is significantly greater for males.

1.3.2 Taxonomy

The Rio Grande silvery minnow is a member of the broadly distributed genus *Hybognathus* (family *Cyprinidae*). Members of this genus are morphologically similar, which contributed to a confusing taxonomic history (Bestgen and Propst 1996). The species was originally described as *Algoma amara* by Girard (1856), based on specimens obtained from the Rio Grande near Brownsville, Texas. Over the next 120 years, it was variously synonymized with several other members of the genus. However, a detailed morphomeristic study (Bestgen and Propst 1996) of *Hybognathus* demonstrated the distinctiveness of *H. amarus.* Additional details on the species' description and taxonomy

can be found in the original listing package (59 FR 36988).

1.4 Life History / Ecology

1.4.1 Introduction

Until fairly recently, little was known of the life history and ecology of the Rio Grande silvery minnow (Sublette et al. 1990). Much of the following information is derived from studies undertaken since the mid-1990s.

1.4.2 Reproduction and Early Life History

The Rio Grande silvery minnow is a pelagic spawner (Platania 1995b) that produces thousands of semibuoyant, non-adhesive eggs that passively drift downstream while developing (Platania and Altenbach 1998). This reproductive behavior and egg physiology is relatively common among fish species inhabiting the Rio Grande and the Pecos River, including four taxa that have been eliminated from the middle Rio Grande (Platania and Altenbach 1998).

Each female may produce 3 to 18 clutches of eggs in a 12-hour period. Mean clutch size is about 270 eggs. Eggs are about 1.6 mm (0.06 in) in diameter upon fertilization, but quickly swell to 3.0 mm (0.12 in). Following fertilization, the eggs drift with the current for up to 50 hours, remaining suspended in the water column during development (Platania 1995b). Egg hatching time is temperature dependent but rapid, and generally occurs in 24-48 hours (Platania 2000). More rapid development and hatching of eggs is observed in higher water temperatures.

Recently hatched larval fish attempt to remain a part of the drift by swimming vertically in the water column. About three days after hatching, the gas bladder of the larval fish develops, the yolk-sac is almost completely absorbed, and the fish begin feeding. They then end their passive drifting, move horizontally, and appear to actively seek low-velocity habitats (Platania 1998). Larvae are about 3.7 mm (0.15 in) total length (total length, or TL, is measured from the tip of the snout to the end of the tail) upon hatching. In low-velocity habitats, growth is rapid and lengths of 39-41 mm (1.53-1.61 in) are attained by late autumn.

Spawning by Rio Grande silvery minnow is associated with high-flow events such as spring runoff or summer rainstorms, and typically occurs over a relatively brief period (1 month) in May or June, although spawning can occur later in the season. Spawning takes place in the water column when water temperature is 20-24^0 C (68-75^0 F).

From 1999 to 2004, peak spawning was observed to occur each year soon after the initiation of spring snowmelt runoff or the release of artificial flow-spikes from Cochiti Reservoir. While spawning appeared to be strongly associated with changes in flow and water temperature, each year the peak spawning period occurred over a very short time, typically a three-day period (Platania and Dudley 2002, 2003b; Middle Rio Grande Endangered Species Act Collaborative Program 2004).

Spawning results in high mortality of Rio Grande silvery minnow. In general, six months after spawning (by December of any given year), more than 98 percent of surviving Rio Grande silvery minnow are Age-0 fish – those that hatched the previous summer. (After their nominal birth date of January 1 they become Age-1 fish). This ratio remains relatively stable over the year.

Most growth occurs between June (post-spawning) and October. Age-1 fish are 45-49 mm (1.77-1.89 in) by the start of the spawning season. Maximum size attained by Rio Grande silvery minnow is about 89 mm SL (3.5 in). Maximum documented longevity in the wild is about 25 months but very few survive more than 13 months. Conversely, it is not uncommon for Rio Grande silvery minnow in captivity to live beyond two years.

1.4.3 Habitat Preferences

The middle Rio Grande valley, where the Rio Grande silvery minnow is currently found, has an arid to semi-arid climate typical of the southwestern United States. The area is characterized by abundant sunshine, low relative humidity, little precipitation, and wide diurnal temperature fluctuations. The Rio Grande itself, prior to widespread human influence, was a wide, perennially flowing, aggrading river with a shifting sand substrate. The river freely migrated across a wide floodplain and was limited only by valley terraces and bedrock outcroppings. Detailed descriptions of the geography and climate of the Rio Grande and the Pecos River can be found in Appendices A and B of the 1999 Rio Grande Silvery Minnow Recovery Plan (U.S. Fish and Wildlife Service 1999).

Studies in the Rio Grande have shown that Rio Grande silvery minnow uses only a small portion of the available aquatic habitat (Platania 1993). In general, the species is most often found in areas of low or moderate water velocity (e.g., eddies formed by debris piles, pools, and backwaters) and is rarely found in habitats with high water velocities, such as main channel runs, which are often deep and swift (Dudley and Platania 1997, Watts et al. 2002).

Habitat preferences include (Dudley and Platania 1997):

- Water velocity: Rio Grande silvery minnow are most abundant (86.5 percent) in areas with little or no water velocity (<10 cm/sec), seen occasionally (11.0 percent) in areas of moderate velocity (11-30 cm/sec), and seen rarely (0.8 percent) in habitats with water velocities greater than 40 cm/sec.
- Water depth: The species is most commonly caught in depths of less than 20 cm (7.9 in) or 31-40 cm (12.2-15.75 in). Few use areas with depths greater than 50 cm (19.7 in).
- Substrate: The species is most commonly (91.3 percent) caught over silt. Sand is the second most common substrate (8.1 percent), while gravel and cobble account for less than 1 percent of the substrate frequented.
- Mesohabitat: The most frequently used habitats are eddies formed by debris piles (40.5 percent), pools (35.9 percent), and backwaters (13.8 percent), reflecting a preference for low-velocity areas. Main channel runs (the most abundant

mesohabitat) are avoided; only 1.3 percent of Rio Grande silvery minnows utilize them.

1.4.4 Habitat Preference by Life Stage

During the larval stage, Rio Grande silvery minnow almost without exception use relatively shallow areas with low or no water velocity and a fine particulate substrate (silt or silt/sand mixture) (Pease et al. 2006, Dudley and Platania 1997). Such conditions are most frequently encountered in habitats not directly associated with the main river channel (e.g., backwaters and secondary channel pools).

As they grow larger, Rio Grande silvery minnow demonstrate an overall shift in velocity, depth, and substrate use that is reflective of habitat use shifts from low- to moderate-velocity areas. Small size-classes are generally found in backwaters, pools, and along shoreline habitats, while larger individuals use a broader spectrum of habitats, including main and side channel runs. However, the majority of all size-classes still predominantly occupy low-velocity habitats.

1.4.5 Seasonal Habitat Preferences

Habitat use differs from summer (April-September) to winter (October-March). Summer habitats include pools and backwaters. In winter, preferred habitat is found near instream debris piles; at that time, more than 70 percent of specimens are found in or adjacent to debris piles (Dudley and Platania 1996). Diminished water velocity appears to be a major factor influencing winter habitat selection.

The species also shifts to deeper waters in winter. Median depth shifted from 11-20 cm (4.33-7.87 in) in summer to 31-40 cm (12.2-15.75 in) in winter. Deeper areas generally have lower water velocities.

Individuals are found almost exclusively over silt and sand substrata in both summer and winter. However, all substrate classes, except boulders, are utilized to some degree.

1.4.6 Diet

The Rio Grande silvery minnow has an elongated and coiled gastrointestinal tract, which is typical of an herbivorous fish. The presence of sand and silt in the gut of wild-captured specimens suggests that epipsammatic algae (algae growing on the surface of sand) is an important food. Laboratory-reared Rio Grande silvery minnow have been observed grazing on algae in the aquaria (Platania 1995b).

1.4.7 Movement

A 2001-2002 mark-recapture study of hatchery-reared, wild-produced Rio Grande silvery minnow examined dispersal of hatchery-reared Rio Grande silvery minnows (Platania et al. 2003). Collectively, 77 percent of marked fish released in January 2002 were collected within 48 hours either at or downstream of the release site. The distance traveled by recaptured fish ranged from 1.1 km (0.68 mi) to more than 25 km (15.5 mi). Of the 11 Rio Grande silvery minnow recaptured during or after April 2002, 10 had moved upstream.

1.5 Distribution and Population

1.5.1 Overview

The Rio Grande silvery minnow was once one of the most widespread and abundant species in the Rio Grande basin of New Mexico, Texas, and Mexico (Bestgen and Platania 1991), occupying about 3,862 river km (2,400 mi). It was found in the Rio Grande from Española, New Mexico, down through New Mexico and Texas to the Gulf of Mexico (Bestgen and Platania 1991), and in the Pecos River from Santa Rosa, New Mexico, downstream to its confluence with the Rio Grande in Texas (Pflieger 1980). It was also found in the lower Rio Chama and the lower Jemez River, tributaries of the Rio Grande in New Mexico (Figure 1). It has never been found in any Mexican tributaries to the Rio Grande, despite extensive collection efforts (Edwards et al. 2003).

Today, the Rio Grande silvery minnow is no longer found in the vast majority of its historic range (Figure 1). It has been declining in distribution and abundance for more than 50 years, and has been extirpated from the Rio Chama and the Pecos River, as well as from most of its historic range in the mainstem Rio Grande.

The Rio Grande silvery minnow is part of a reproductive guild of five cyprinids (all spawn eggs that drift downstream) that historically occupied the Rio Grande in New Mexico. The four other species in the guild have been extirpated from the Rio Grande in New Mexico; two of them are now extinct. The Rio Grande silvery minnow is the only remaining member of the reproductive guild in New Mexico.

The currently occupied habitat of the Rio Grande silvery minnow is equivalent to only about 7 percent of its former range, and is fragmented by dams (Cochiti, Angostura, Isleta, and San Acacia) into four discrete reaches: Cochiti Reach (35.9 km/22.3 mi), Angostura Reach (65 km/40.4 mi), Isleta Reach (85.5 km/53.1 mi), and San Acacia Reach (93.7 km/58.2 mi) (Figure 3). Sampling studies have documented the species in the three lower reaches (Angostura, Isleta, and San Acacia), but due to access restrictions, it has not been documented in the Cochiti Reach since 1995 (Platania and Dudley 2003a). The currently occupied portion of the Rio Grande in New Mexico flows through several large municipalities, including the City of Albuquerque and several large Native American Pueblos. The species (26 specimens) was also recently found in the Lower Jemez River, between the Jemez Canyon Dam and its confluence with the Rio Grande (about 2.8 mi) (Dudley et al. 2005). A major portion (252 km/157 mi) of the species' current range was designated as critical habitat in 2003 (Figure 3).

The remnant population of Rio Grande silvery minnow has continued to steadily decline in abundance, despite its listing as an endangered species in 1994 (U.S. Fish and Wildlife Service 1994). Rio Grande silvery minnow catch rates declined two to three orders of magnitude between 1993 and 2004. Additionally, the relative abundance of the species declined from approximately 50 percent of the total fish community in 1995 to about 5 percent in 2004. However, the October density of silvery minnows was significantly higher ($p<0.05$) in 2004 than in 2003 and autumnal catch rates increased by more than an

order of magnitude between those years. Silvery minnow catch rates in 2004 were comparable to those in 2001. Despite seasonal fluctuations in the abundance of the species, recent samples indicate an increase over the last two years with gains occurring in all three reaches where it is known to exist. Although population levels in 2004 only approached the lows observed following extensive river drying in 1996, it is noteworthy that the percent increase between 2003 and 2004 was the single largest (i.e., over an order of magnitude) observed since the onset of systematic sampling (1993). Similar trends were also evident from a comparison of annual catch rates (Platania and Dudley 2005). October 2005 catch data are not yet available; however, summer sampling indicates that the abundance of silvery minnows increased substantially.

The following section describes ongoing population studies that were initiated in the early 1990s. These studies provide the best information on recent population trends and the current status of the Rio Grande silvery minnow.

Information on the historical distribution of the species can be found in Appendix C of the 1999 Recovery Plan (U.S. Fish and Wildlife Service 1999).

1.5.2 Recent Population Studies and Trends

Since the early 1990s, the U.S. Bureau of Reclamation (BOR), the Service, the New Mexico Department of Game and Fish (NMDGF), and the U.S. Army Corps of Engineers (COE) have cooperated to fund fish studies in the middle Rio Grande. Long-term monitoring (started in 1993) of the general trends in abundance, distribution, and composition of the middle Rio Grande fish community is included in these studies.

1.5.2.1 Study Area and Methods

The Rio Grande shows considerable variety in hydrological and biological characteristics. At higher elevations upstream, it is a narrow coldwater river with large substrata and a salmonid-dominated fish community. Downstream areas are wide and sand-bottomed, and support a warm water fish community. Water flow is regulated by five mainstem reservoirs on the Rio Chama and Rio Grande and by numerous smaller irrigation diversion dams. The complex system of ditches, drains, and conveyance channels provide irrigation water for agriculture in the Rio Grande Valley.

The study area of the population survey is the middle Rio Grande from Cochiti Dam to Elephant Butte Reservoir. Most sampling occurred in the area from Angostura Diversion Dam to just above Elephant Butte Reservoir (Figure 4). The sampling methods are described in detail in Appendix E.

The Cochiti Reach (35.9 km/22.3 mi), the uppermost portion of the study area, begins at Cochiti Dam. Here the river passes through the Pueblos of Cochiti, Santo Domingo, and San Felipe. Access has been restricted in the reach, precluding fish sampling. The last comprehensive ichthyofaunal surveys of the Cochiti Reach documented the presence, at

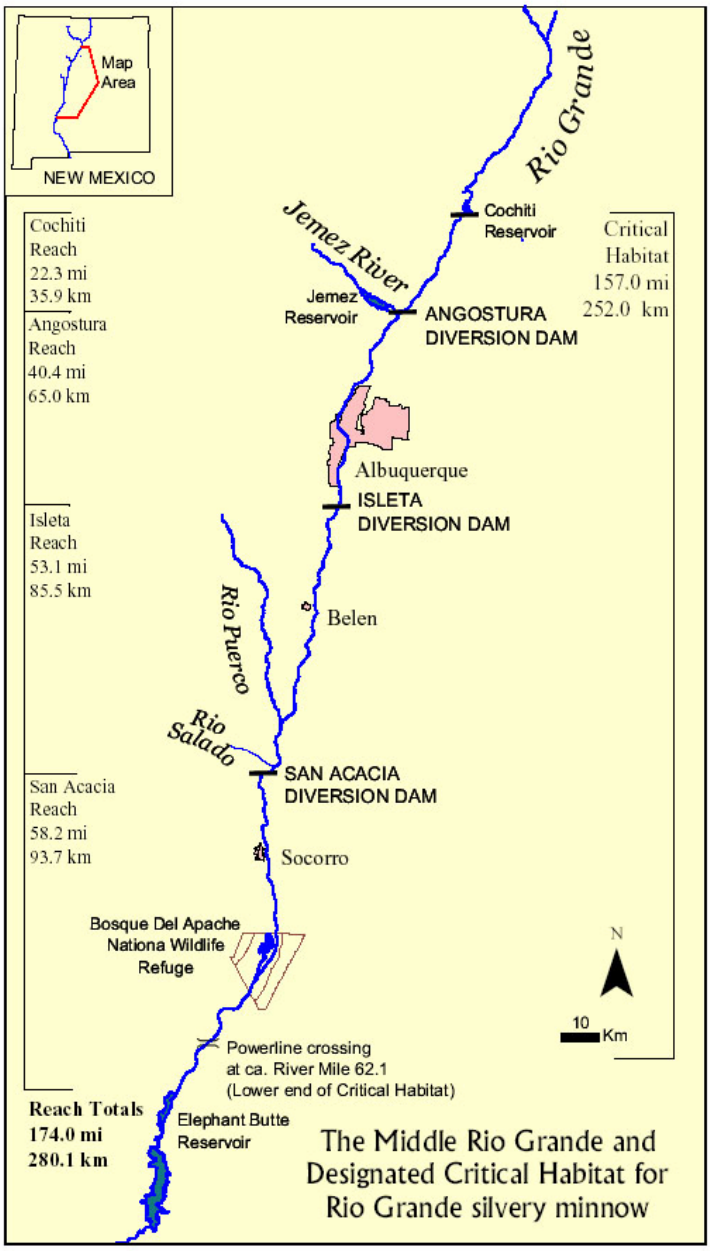

Figure 3. Rio Grande Silvery Minnow Current Habitat and Designated Critical Habitat.

low abundance, of Rio Grande silvery minnow on the Pueblos of Santo Domingo and San Felipe (Platania 1995a).

Cochiti Reservoir, located 76 km (47.22 mi) upstream of Albuquerque and operational since 1973, is the primary flood control reservoir in the area and regulates flow to some degree in the mainstem middle Rio Grande. Hypolimnetic water released from the reservoir is cold and clear, creating a distinctly different riverine environment from the one that existed here historically. The river is highly incised in the Cochiti Reach because

of flow regulation and the lack of an upstream sediment supply (upstream sediment settles out in Cochiti Reservoir). The substrates in this reach are primarily cobble and gravel and there are few backwater or side channel habitats.

The Angostura Reach (65 km/40.4 mi) is downstream of the Cochiti Reach, starts at the Angostura Diversion Dam. It includes the portion of the river that passes through Albuquerque. The Isleta Reach (85.5 km/52.9 mi) begins a few miles south of Albuquerque, at the Isleta Diversion Dam. The San Acacia Reach, the farthest downstream reach in the study area, includes 93.7 km (58.2 mi) of the river, from the San Acacia Diversion Dam to Elephant Butte Reservoir.

The river changes considerably throughout the study area. The portion of the river between Angostura Diversion Dam to Bernalillo is a transition zone. The river channel becomes more braided, the floodplain widens, and the substrate is primarily gravel and sand. From Bernalillo downstream to Albuquerque, the channel often exceeds 100 meters (328 ft) in width, lower velocity habitats are more common, and sand and silt substrates become more dominant. Backwaters and side channel habitats are more abundant in this area than they are further north in the Cochiti Reach. Below Albuquerque, the Rio Grande is wide and braided with a predominantly sand substrate, high suspended silt load, and a wide variety of mesohabitats. The mainstem channel is generally wide (100-200 meters/328-656 ft) and less than 1 meter (3.28 ft) deep, with a velocity of less than 1 m/s. Further south, from about the middle of Bosque del Apache National Wildlife Refuge to the inflow of Elephant Butte Reservoir, the river channel is generally less than 50 meters (164 ft) wide.

The populations of Rio Grande silvery minnow and other fish species are monitored at selected sites. Most recently, sampling has been conducted at 20 sites during each month of the year (five in the Angostura Reach, six in the Isleta Reach, and nine in the San Acacia Reach). No sampling has been done recently in the Cochiti Reach, as it is under the jurisdiction of Native American Pueblos and is not accessible. The same sampling sites have been used consistently since 1993, although several sites have been added over time to increase the spatial extent of sampling.

Analyses were made of moving averages (one-, two-, and five-year, using mean quarterly Rio Grande silvery minnow catch rates over time (1993-1997, 1999-2004)); population trends over time (comparing mean annual and autumnal Rio Grande silvery minnow catch rates over 1993-1997 and 1999-2004); and relationships between catch rates for ten focal species and hydraulic variables (e.g., peak discharge, days above or below a threshold discharge value). Highlights of the study results are presented here. More information can be found in Dudley et al. 2005.

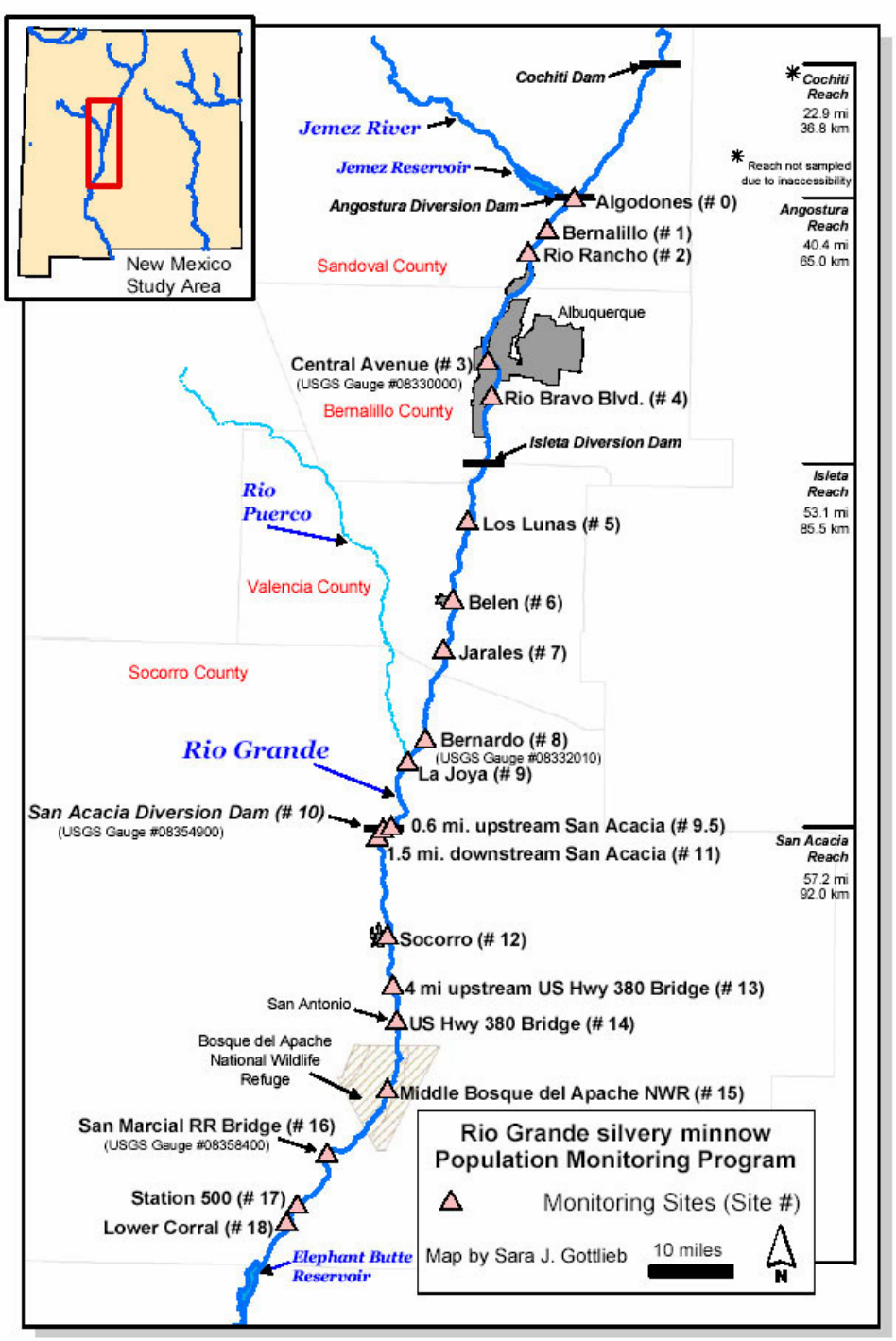

Figure 4. Rio Grande Silvery Minnow Population Study Sampling Locations.

1.5.2.2 Current Population Status

In 2004 (the most recent annual data available), catch rates were highest in the Angostura Reach (2,226 specimens) and approximately equal in the Isleta (442) and San Acacia (371) reaches. This pattern was primarily due to higher catch rates of young-of-year following spawning, and to some extent, the addition of hatchery fish to the Angostura Reach. Improved spring spawning and recruitment conditions occurred throughout the middle Rio Grande study area (Dudley and Platania 2005).

From May to December, Age-0 individuals comprised nearly the entire catch; they were most abundant from May to July. Higher catch rates were observed during the months of November and December as water temperatures cooled and fish congregated in small mesohabitats (e.g., backwaters and debris piles). December 2004 catch rates were more than an order of magnitude higher than the January 2004 catch rates.

Within each reach, the highest catch rates were generally recorded at or near upstream sampling localities. In the Angostura Reach, the highest catch rate was associated with augmentation sites.

1.5.2.3 Population Trends: 1993 to 2004

The Rio Grande silvery minnow catch rate, plotted as quarterly collections, has declined since systematic sampling began in 1993. In the last decade, the catch rate has declined two to three orders of magnitude, with the largest declines occurring from 1999 to 2003. October population monitoring samples (Figure 5) also illustrate that the magnitude of decline (as measured logarithmically) has been substantial.

However, catch rates in 2004 were noticeably higher than those of 2002 and 2003. Catch rates in 2004 were comparable to those seen in 2001. Although the 2004 population levels were still relatively low – they were below the lows seen after extensive river drying in 1996 – it is noteworthy that the percent increase between 2003 and 2004 was the single largest (i.e., over an order of magnitude) seen during this project (since 1993).

Analyses of Rio Grande silvery minnow October catch rates from 1993 to 2004 revealed significant relationships with hydraulic variables. At the Albuquerque gage, catch rates increased significantly with maximum discharge and all combinations of number of days with discharge exceeding a threshold value. The factor that explained the most variation (93 percent) in mean catch rate was number of days with discharge greater than 3,000 cubic feet per second (cfs). At the San Marcial gage, the mean October catch rate increased significantly with maximum discharge and several of the combinations of number of days with discharge exceeding a threshold value. The factor that explained the most variation (93 percent) in the mean catch rate was number of days of discharge greater than 2,000 cfs. Additionally, in the San Acacia Reach, there was a strong negative relationship between the mean October catch rate and the number of low-flow days (number of days <200 cfs or <100 cfs).

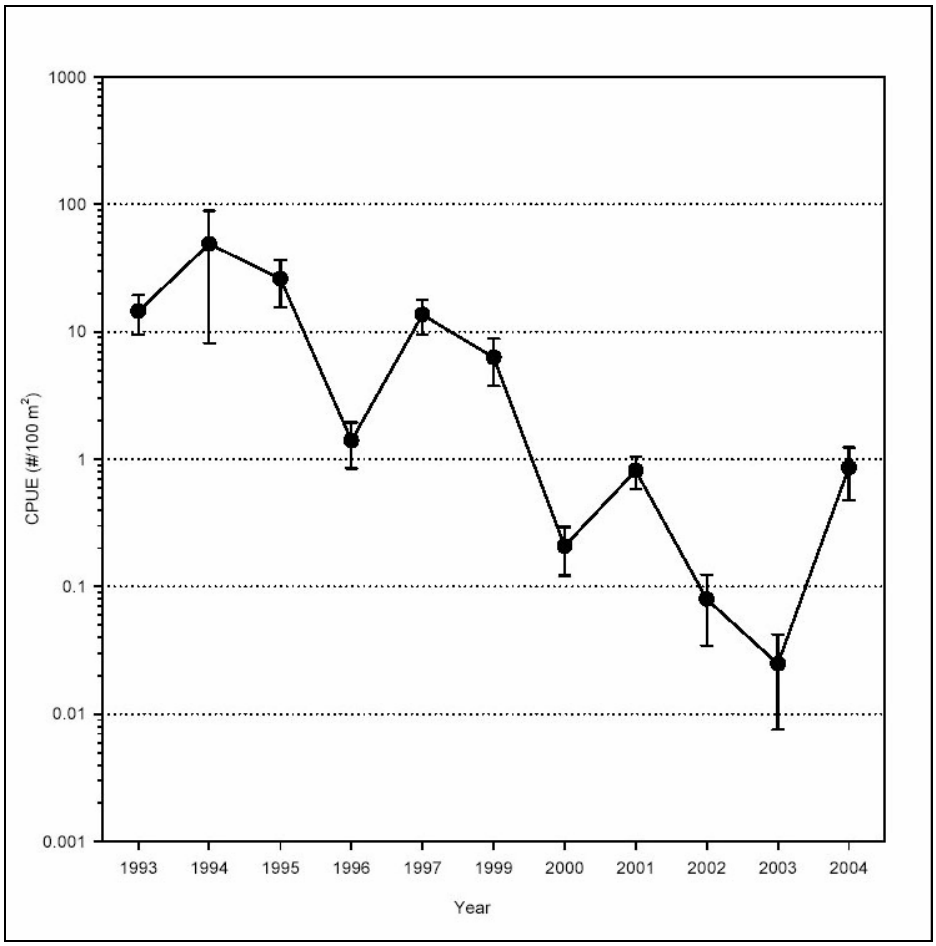

Figure 5. Rio Grande Silvery Minnow Population Trends.

These relationships indicate that extended periods of low flow reduce habitat availability and may create unfavorable environmental conditions (e.g., high water temperatures, poor water quality) when flows approach very low levels in certain portions of the reach. In addition to high water temperatures and possibly poor water quality, the likelihood of intra- and inter-specific interactions (e.g., predator-prey or competition) would be expected to increase during low flows as available aquatic habitat decreases. Low flows also raise the likelihood of drying in portions of the reach, leading to loss of aquatic life.

In contrast, elevated and extended flows during 2004 likely resulted in more favorable conditions for the growth and survivorship of newly hatched Rio Grande silvery minnow larvae. It is possible that even low numbers of eggs and larvae could have resulted in greatly increased recruitment success because of the inundation of shoreline habitats, abandoned side channels, and backwaters. Low velocity and shallow areas provide the warm and productive habitats required by larval fishes to successfully complete their early life history.

Spring runoff in 2005 was also above average, leading to a peak of over 6,000 cfs at Albuquerque and sustained high flows (> 3,000 cfs) for more than two months.

Monitoring in 2005 show increased numbers over 2004 (Dudley and Platania *pers. comm*. 2005).

1.5.2.4 Rio Grande Silvery Minnow and the Total Fish Community

The 2004 fish community in the study area was numerically dominated by cyprinids. The native fish consisted of seven species. Red shiner (*Cyprinella lutrensis*) was the most abundant native species collected (32,523 specimens), followed by fathead minnow (*Pimephales vigilax*) (5,572), Rio Grande silvery minnow (3,039), river carpsucker (*Carpiodes carpio*) (1,843), flathead chub (*Platygobio gracilis*) (1,596), longnose dace (*Rhinichthys cataractae*) (328), and smallmouth buffalo (*Ictiobus bubalus*) (2). The most abundant introduced species were western mosquitofish (*Gambusia affinis*) (9,510), white sucker (*Catostomus commersonii*) (1,715), channel catfish (*Ictalurus punctatus*) (881), common carp (*Cyprinus carpio*) (419), yellow bullhead (*Ameiurus natalis*) (27), and yellow perch (*Perca flavescens*) (26). Nine other non-native fish species were present at much lower numbers (fewer than 15). Rio Grande silvery minnow was the fourth most abundant of the ten focal taxa (the most common native and non-native species).

In 2004, Rio Grande silvery minnow comprised a higher fraction of the total fish community than it has since 1999. This percentage had dropped precipitously over the past decade, but it improved markedly between 2003 and 2004. However, the relative abundance of Rio Grande silvery minnow is still very low: the species comprised less than 6 percent of the fish community since 2000, and its relative abundance in 2003 was lower (0.4 percent) than had ever been previously recorded (Dudley and Platania 2005).

The magnitude of change in catch rates of Rio Grande silvery minnow over time is particularly striking when compared to the overall fish catch rates (all species) of the past decade. For most fish species in the middle Rio Grande, rank abundance remained relatively constant over the past decade. Rio Grande silvery minnow, in contrast, declined from being one of the most abundant species in the early to mid-1990s to being one of the least abundant species and the least regularly collected native taxa in 2003. However, the rank abundance of Rio Grande silvery minnow did increase more from 2003 to 2004 than did that of any other fish species in the Rio Grande during that time period (Dudley and Platania 2005).

1.5.2.5 Mesohabitat Associations

The overall distribution of mesohabitats sampled did not differ notably between reaches, although there were some exceptions. Backwaters and isolated pools were more commonly sampled in the Isleta and San Acacia reaches, while riffles were more commonly sampled in the Angostura Reach. The habitats occupied by Rio Grande silvery minnow were diverse and included all of the habitats sampled. Those that were occupied most frequently by Rio Grande silvery minnow included shoreline runs or pools and backwaters. A wide variety of habitats were sampled to provide a balanced monitoring program of the fish community and all life stages of Rio Grande silvery minnow.

1.5.2.6 Current Population Trends

The annual reproductive effort of the Rio Grande silvery minnow normally occurs in spring; it results in the production of a relatively large number of eggs being released into the water column and dispersed downstream.

Historically, a spring runoff from high-mountain snowmelt, combined with increasing water temperatures, was likely the stimulus for reproductive activity. In years of sufficient snow pack, water flow in the middle Rio Grande peaked in late spring and resulted in several months of sustained flooded habitats. Today, however, dams and reservoirs moderate the magnitude, amplitude, and duration of spring discharge. Water diversions for agriculture often substantially reduce the total volume of water flow. Compounding the situation, flow can be severely compromised in years of drought, when agricultural diversions remove a proportionally larger amount of the available water, further reducing the peak flows that stimulate spawning and leading to drying of sections of the river downstream. These factors all are believed to have contributed to the decline of the Rio Grande silvery minnow seen in recent years.

In 2004 and 2005, however, the Rio Grande experienced an increased stream discharge, compared to the extended low-flow conditions seen in 2002 and 2003.

A large natural runoff flow occurred in May 2004, triggering spawning. The peak mean daily discharge of 3,340 cfs was nearly three times the volume that occurred during May 2003 (1,420 cfs). The runoff also lasted for several weeks, in contrast to the artificial spike in 2003, which lasted only about four days. These elevated and extended flows likely resulted in more favorable conditions for the growth and survivorship of newly hatched larvae of Rio Grande silvery minnow in 2004 (Porter and Massong 2003, 2004). (It is possible that even low numbers of eggs and larvae could have resulted in greatly increased recruitment success because of the inundation of shoreline habitats, abandoned side channels, and backwaters.) The flow spike resulted in the recruitment of substantially more individuals into the year-class than was seen in 2002 or 2003. There was also evidence, based on the presence of multiple size-classes, that the species spawned again in June 2004.

However, portions of the river still dried sporadically in 2004. The areas that most frequently dried were isolated sections of the river from Isleta Diversion Dam downstream to La Joya, New Mexico, and from near Escondida, New Mexico, downstream to the southern terminus of Bosque del Apache National Wildlife Refuge. In September 2004, extremely low flow conditions throughout the Isleta and San Acacia reaches resulted in extensive river drying and loss of aquatic life.

Overall, the cumulative effects of several consecutive years of river drying, downstream displacement, and habitat degradation continue to contribute to the decline of Rio Grande silvery minnow. The marked and alarming decline in abundance of Rio Grande silvery minnow recorded in 2003 provides the strongest evidence yet that the problems that led to the precipitous decline of this species have not been remedied. The increased

abundance of Rio Grande silvery minnow in 2004 and 2005 is a positive sign, but it does not mean that the threats that endanger this species have been eliminated.

1.6 Genetics

The ability of a species to persist over the long term is determined in part by the amount of genetic variation that is retained by a species. As a population declines, genetic variation is lost and this is manifested by the loss of allelic diversity and heterozygosity. Loss of genetic variation can lead to reduced viability and fecundity (inbreeding depression) (Falconer 1981; Ralls & Ballou 1983), affect a species' ability to adapt and respond to environmental changes, and ultimately heighten the risk of extinction (Frankham 1995; Higgins and Lynch 2001).

Genetic data have been collected for the Rio Grande silvery minnow. The data set includes information from eight generations: one generation that preceded the precipitous decline that occurred in the last decade (1987), three generations that preceded the augmentation program (1999, 2000, 2001; Alò & Turner, 2005), and four generations that were supplemented with captively spawned and/or captively reared stocks (2002-2005; Turner et al. 2005). The following information was derived from studies of this data set.

Overall, mitochondrial (mt) DNA gene diversity declined nearly 18 percent between 1987 and 2005. In addition, researchers have identified other changes:

- There have been two sharp declines in mitochondrial haplotype diversity in the "wild" Rio Grande silvery minnow population. The first occurred in 1999, the second in 2001. Each loss of diversity followed a sharp decline in abundance of Rio Grande silvery minnow: between 1995 and 1997, and again between 1999 and 2000, catch rates declined by an order of magnitude (Dudley et al. 2004). These declines in diversity coincided with extensive river drying in the San Acacia Reach of the Rio Grande.
- Microsatellite allelic diversity was less in 1999, but detected diversity was greater from 1999 to 2002. Although numerical abundance of the wild population continued to decline drastically after 2001, reaching extremely low levels in 2003, there was no substantial loss of allelic diversity over that time period.
- Declines in heterozygosity were recorded for the Rio Grande silvery minnow from 1987 to 1999 and between 2000 and 2002. However, heterozygosity increased between 2002 and 2005. Supplemental stocking with captively-reared wild caught-eggs between 2001 and 2003 may have temporarily alleviated loss of alleles and heterozygosity in the wild (Turner et al. 2004).

Turner et al. (2004) predicted higher levels of diversity at the southerly (downstream) end of the species' current distribution: eggs are able to drift past diversion structures, but upstream movement of adult fish is prevented by diversion dams, so diversity will gradually be eroded in upstream reaches and enhanced in the downstream reaches. (The reaches examined, from upstream to downstream, are Angostura, Isleta, and San Acacia.) This prediction held true in 2001 and 2002, with higher diversity seen in the San Acacia Reach when compared to Isleta in 2001, and to Angostura in 2002. In those years, the

San Acacia Reach also held the highest densities of Rio Grande silvery minnow (Dudley et al. 2004). The downstream diversity trend was less apparent in 2003. The San Acacia Reach had slightly higher levels of diversity at microsatellite loci, but the Angostura Reach had higher mitochondrial gene diversity. In 2005, the Angostura Reach showed higher diversity at both microsatellite and mitochondrial loci. The 2005 upstream shift in diversity presumably reflects 1) the injection of variation into the Angostura Reach by augmentation with captively reared fish, and 2) reduced abundance (and hence genetic diversity) in the Isleta and San Acacia reaches due to extensive drying in those reaches in 2003 and 2004.

Stocks reared from wild-caught eggs consistently show higher levels of allelic diversity than do stocks produced by captive spawning (Osborne et al. 2006). In particular, these stocks are more likely to contain rare alleles that are present at low frequencies in the wild population. In 2004 and 2005, captive spawning was initiated with a particular focus on maximizing genetic diversity of captive stocks. These stocks were produced using paired matings and although fewer fish were used, higher levels of allelic diversity were seen and inbreeding co-efficients were considerably lower when compared to previous captive spawning events.

Genetic studies also have demonstrated that the effective population size for the Rio Grande silvery minnow is a fraction of the census size (Alò & Turner 2002) and have suggested a mechanism that drives the effective size to very low levels (Osborne et al. 2005). Estimates of effective size ranged from 1378 (1987-2000) (95 percent confidence limits of 615 and 9632.7) to a low of 50 between 2004 and 2005 (95 percent confidence limits of 32.9 and 61.6). Estimates of the effective population size for stocks that were reared from wild-caught eggs were consistently lower than for wild counterparts. This indicates that samples collected and reared in captivity do not accurately reflect the allele frequencies or allelic diversity seen in the wild population. Failure to address these causal mechanisms, namely the interaction of life-history and river fragmentation, will cause genetic diversity to decline rapidly despite augmentation efforts.

Reintroduction of Rio Grande silvery minnow into areas it once occupied will be an important component of recovery of the species. Genetic monitoring should be conducted on reintroduced populations to ensure that genetically diverse individuals are restocked, and to track the fate of genetic diversity in the reintroduced populations over time. The results of such a study will provide important genetic guidelines to future restocking efforts.

1.7 Reasons for Listing / Threats Assessment

1.7.1 Historical Perspective

Historically, the Rio Grande silvery minnow occurred in the Rio Grande from near Española, New Mexico, to near the Gulf of Mexico, and in the Pecos River from near Santa Rosa, New Mexico, to its confluence with the Rio Grande.

Prior to the large-scale influence of humans on the watershed, the ecosystem that

supported the species was a highly dynamic fluvial system with channel dimension, planform and profile reflective of the natural basin hydrology, sediment regime, and site-specific geological and local controls. It is believed that a significant portion of the river was a wide, braided, sand-bedded system with an extensive active floodplain composed of numerous secondary channels, floodplain lakes and marshes, and woody debris.

The Rio Grande has undergone considerable change in the last 150 years, and is no longer the highly dynamic system it once was. Several large dams and irrigation diversions have been built on the river, and the entire system is now operated to reduce flood threats and to supply water for irrigation and municipal and industrial uses. In many areas, channel incision has reduced overbank flow onto the floodplain. Channels have been straightened and deepened, and aquatic plants and snags have been removed to lessen hydrologic resistance and reduce the retention time of water and organic matter. These changes have reduced the surface area and physical complexity of the habitat, reduced refugial habitats, prevented upstream movement of fish, and altered species interactions. The quantity and type of sediment entering the river has also changed, due to changes in watershed conditions and retention behind dams. Alterations in the magnitude and variability of flow, plus extractions of water for consumptive uses, have resulted in river drying and have reduced the magnitude, frequency, and duration of peak-flow events, and have increased the magnitude, frequency, and duration of low-flow events.

The Pecos River has also been constrained and altered due to the construction of dams and water management measures, with similar effects on the ecosystem (U.S. Fish and Wildlife Service 1999).

1.7.2 Extirpations

Due to these and other factors, the Rio Grande silvery minnow has already been extirpated from several portions of its historic habitat.

- In the Rio Grande downstream of Elephant Butte Reservoir, New Mexico, extirpation is believed to be due to the effects of large dams and other diversions, as described above.
- Hubbs et al. (1977) documented the “inexplicable” absence of Rio Grande silvery minnow from a reach of the Rio Grande between El Paso, Texas, and its confluence with the Pecos River, where Hubbs (1958) had earlier documented the species to occur. However, Chernoff et al. (1982) noted that the Rio Grande between El Paso and the mouth of the Rio Conchos is at times virtually dry. Sublette et al. (1990) documented the former occurrence of the Rio Grande silvery minnow in the Rio Grande between Caballo Reservoir, New Mexico, and El Paso, Texas, where the river channel is often dry.
- In the Rio Grande downstream of its confluence with the Pecos River, Treviño-Robinson (1959) documented the early 1950s “cosmopolitan” occurrence of Rio Grande silvery minnow, and also noted that for “the first time in recorded history” a portion of this reach (near the mouth) went dry in 1953. Although Treviño-Robinson could not document any “apparent undesirable or severe after effects” from the drought, Rio Grande silvery minnow have not been documented in this portion of the Rio Grande since the mid-1950s (in part, U.S. Fish and Wildlife

Service 1999). In the most downstream stretch of the Rio Grande, Edwards and Contreras-Balderas (1991) documented the absence of the silvery minnow from the Rio Grande below Falcon Dam, citing declining stream flows and deteriorating water quality as the environmental stressors suspected to be responsible.

- In the Pecos River, hybridization and/or competition with non-native congener species operated to displace the species. It was displaced in the Pecos River of New Mexico by its congener *H. placitus* (plains minnow), which was apparently introduced in 1968, probably from the Canadian Drainage (Cowley 1979). Displacement was complete in less than one decade.

For a reach-by-reach analysis of the last known collections of Rio Grande silvery minnow, see Appendix F.

1.7.3 Current Status

Today, the Rio Grande silvery minnow is believed to occur only in one part of the middle Rio Grande of New Mexico, a 280 km (174 mi) stretch of river that runs from Cochiti Dam to Elephant Butte Reservoir. Its currently occupied habitat is equivalent to about 7 percent of its historic range.

The Rio Grande silvery minnow has, at times during the last 20 years, been very abundant in selected reaches of the middle Rio Grande, indicating that environmental and habitat conditions were at times conducive to its survival. This is a species with high reproductive potential that appears able to survive the modified general flow pattern of the Rio Grande in most years.

However, four species that shared similar ecological attributes with Rio Grande silvery minnow – speckled chub (*Macrhybopsis aestivalis*), Rio Grande shiner (*Notropis jemezanus*), phantom shiner (*Notropis orca*), and bluntnose shiner (*Notropis simus*) – have already been extirpated from the middle Rio Grande. All were short-lived cyprinids with a common reproductive strategy and egg type.

When the Rio Grande silvery minnow was designated as endangered in 1994 (U.S. Fish and Wildlife Service 1994), the Service concluded that it should be listed because of the extremely limited habitat it currently occupies and its declining abundance, and because it can be expected to become extinct in the foreseeable future because of the remaining threats to the species and its habitat. Today, the viability of the species remains threatened. The current suite of conditions in some reaches of the middle Rio Grande, if allowed to continue, may lead to the extirpation of the Rio Grande silvery minnow, the last surviving endemic mainstem cyprinid.

1.7.4 The Five Listing Factors

The 1994 listing package (U.S. Fish and Wildlife Service 1994) described numerous threats to the Rio Grande silvery minnow, categorized in terms of the standard five listing factors; additional threats have since been identified. The five listing factors, along with all the identified threats to the species related to each factor, are listed below. Not all of

the threats are equally significant, and some may have been addressed or have been deemed insignificant since they were first identified.

All of these issues are discussed in more detail in the following sections.

Listing Factor A. The present or threatened destruction, modification, or curtailment of its habitat or range.

Dewatering and Diversion

- Annual dewatering of a large percentage of the species' habitat
- Risk of two consecutive below-average flow years, which can affect short-lived species
- Increase in non-native and exotic fish species
- Increase in contamination concentrations during low flows, which may exacerbate other stresses
- Entrainment of eggs and young-of-year in diversion structures
- Fragmented habitat

Water Impoundment

- Altered flow regimes
- Prevention of overbank flooding
- Trapped nutrients
- Altered sediment transport regimes
- Prolonged summer base flows
- Reduced food supply
- Altered preferred habitat
- Prevention of species' dispersal
- Creation of reservoirs and altered flow regimes that favor non-native fish species that may compete with or prey upon the species
- Stored spring runoff and summer inflow, which would normally cause flooding
- Reduced flows, which may limit the amount of preferred habitat and limit dispersal of the species
- Lack of suitable habitat for young-of-year
- Fragmented habitat

River Modification

- Confined flood flows
- Trapped sediment
- Establishment of stabilizing vegetation
- Elimination of meanders, oxbows, and other components of historic aquatic habitat
- Replacement of preferred sand and silt substrate with gravel and cobble
- Reduction of floodplain areas where young can develop
- Geomorphological changes to the river channel

Water Pollutants

- Poor water quality caused by agriculture and urbanization in the Rio Grande basin, especially during low flows and storm events

Listing Factor B. Overutilization for commercial, recreational, scientific, or educational purposes.

- Possible over-utilization through scientific collecting
- Licensed commercial bait dealers possibly selling bait minnows
- Incidental utilization of species during legal collection of bait minnows for personal use

Listing Factor C. Disease or predation.

Disease

- Risk of stress and disease when Rio Grande silvery minnow are confined to pools during periods of low flow
- Increased risk of stress-induced disease outbreaks possibly exacerbated when high levels of pollutants or other stresses are present

Predation

- Predation by non-native fishes, as well as by birds and mammals
- Competition for space and food with non-native fish during low flows

Listing Factor D. The inadequacy of existing regulatory mechanisms.

- No protection of habitat under State law
- Inability to acquire instream water rights for the benefit of fish and wildlife
- Inadequate regulations to restrict the use of bait fish, illegal use of bait fish, introduction of non-natives via bait bucket, and introduction of disease or parasites by importation of bait fish

Listing Factor E. Other natural or manmade factors affecting its continued existence.

- Reduced population numbers and potential loss of genetic diversity
- Introduction and subsequent competition from non-native fish

1.7.5 Listing Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

Loss of habitat can occur with channel drying (as a result of meteorological drought conditions, extraction of water for consumptive uses, including from groundwater sources, and reservoir storage of water); water impoundment (such as that caused by large dams); channel straightening and other geomorphic channel alterations (which, for example, reduces surface area and physical complexity of the habitat, and reduces retention time of water and organic matter); and pollution. All of these factors are currently affecting the habitat of the Rio Grande silvery minnow and threatening the survival of the existing population.

1.7.5.1 Dewatering and Diversion

Dewatering (channel drying) is caused primarily by the diversion of water for agricultural and other uses and by climatic drought. This can affect the Rio Grande silvery minnow in several ways, including causing a loss of habitat and a fragmented habitat, and posing a particular risk of extirpation when there are two consecutive below-average flow years.

During the more than 100 years for which flow records have been maintained, it has not been unusual for portions of the middle Rio Grande between Angostura Diversion Dam and Elephant Butte Reservoir to experience periods of no flow. Even before the construction of mainstem dams, the middle Rio Grande often had periods of no flow. During such periods, it is suspected that Rio Grande silvery minnow survived in areas where irrigation return flows re-entered the river, in the pools formed by water leaking through the gates of the diversion dams, in the irrigation ditches and drains, and in the reaches of stream above the diversions (from which offspring could repopulate downstream reaches when conditions permitted). It is not known why these same factors do not provide sufficient habitat to support Rio Grande silvery minnow under current conditions. It is possible that other factors, such as an increase in non-native fish species, or contamination, are exacerbating the stresses placed upon the species during low-flow periods.

The impacts of water diversion may not be severe in years when an average or above-average amount of water is available. In years of below-average water availability, however, diversions can contribute to the river channel drying from Isleta Diversion Dam downstream about 179 km (111 mi) to the headwaters of Elephant Butte Reservoir for two months or more. When two below-average years occur consecutively, a short-lived species such as Rio Grande silvery minnow can be severely affected, if not completely eliminated from reaches of the river.

In 1989 and 1990, for example, as is typical in years of below-average water supply, extensive portions of the Rio Grande downstream of San Acacia Diversion Dam were completely dewatered. It took at least two years for those populations to return to pre-1989 levels. In 1996, extensive reaches of the river in the San Acacia Reach were again dewatered, resulting in the loss of thousands of Rio Grande silvery minnow and other fish species. Significant declines in population were also seen in 2002 and 2003, again due to dewatering.

In 2004 and 2005, large stretches of the middle Rio Grande below the Isleta and San Acacia diversion dams again dried. In 2004, 109.44 km (68 mi) of river between the Isleta Diversion Dam and the southern boundary of Bosque del Apache National Wildlife Refuge were dewatered. In 2005, 38 miles were dewatered in the same area. Service staff rescued approximately 12,587 (2004) and 626,444 (2005) Rio Grande silvery minnows from isolated pools of water. Most (92.5 percent) were transported alive and released upstream, in the more consistently wet Albuquerque reach. Observations by field biologists at the time suggest that during periods of such extreme water scarcity, the species seeks out habitats that are cooler and deeper, such as pools and habitats that are associated with overhead cover, irrigation drain return flows, and shallow groundwater.

Currently, the Rio Grande from approximately 8.04 km (5 mi) downstream of N.M. Highway 49 at Los Lunas to the vicinity of Fort Craig (approximately 144.8 km/90 mi) may be classified as an influent system – one that shows a net loss of water as it flows downstream. About half of this reach (69.2 km/43 mi) is very vulnerable to channel drying. Reaches most vulnerable include:

- Approximately 8.04 km (5 mi) downstream of N.M. Highway 49 at Los Lunas to the Jarales Bridge, downstream of Belen (29 km/18 mi total)
- Approximately 9.65 km (6 mi) downstream of the Escondida Bridge to the southern boundary of Bosque del Apache National Wildlife Refuge (33.8 km/21 mi total)
- From San Marcial to the vicinity of Fort Craig (6.44 km/4 mi total).

The entrainment of Rio Grande silvery minnow (primarily eggs and larvae) in the infrastructure of irrigation systems is also suspected to contribute to the decline of the species (e.g., U.S. Fish and Wildlife Service 1999). The Service has studied the effects of Low Flow Conveyance Channel (LFCC) experimental operations on the fish community upstream of San Acacia Diversion Dam. The study determined that Rio Grande silvery minnow eggs were entrained and that catch rates at LFCC and Rio Grande monitoring sites were not significantly different. Monthly fish monitoring in the LFCC has also indirectly documented the entrainment of young-of-year and adult Rio Grande silvery minnow, since the number of fish always significantly increased immediately after operation. Egg entrainment in irrigation canals has also been documented in low-flow years (U.S. Bureau of Reclamation 2003). Beyond these studies, there is a dearth of information on how irrigation practices and the infrastructure that accommodates such practices impinge directly on recruitment and indirectly on other components essential to the viability of the species. Prominent information deficits pertain to:

- The inverse relationship of floodplain nursery habitat and egg drift at higher spring flows
- A statistically reliable estimate of the number of Rio Grande silvery minnow eggs and larvae that become and remain entrained in irrigation canals
- The impact of different river discharge flow rates and volumes of irrigation diversion on the incidence of egg and larvae entrainment and the rate of egg and larvae transport (the incidence of egg and larvae entrainment correlated to variation in flow, the timing and volume of irrigation diversion, and irrigation head gate design, including any mediating provisions)
- The biological significance of the foregoing issues in terms of Rio Grande silvery minnow prospects of long-term survival (e.g., how extinction probability varies with the rate of irrigation system entrainment of eggs and larvae).

1.7.5.2 Water Impoundment

Impoundment of water in the Rio Grande by mainstem dams has affected the flow regime of the river, fragmented habitat, and resulted in geomorphological changes to the channel.

Since the completion of Elephant Butte Dam in 1916, one additional dam has been constructed in New Mexico on the mainstem of the Rio Grande (upstream of Elephant Butte) and five have been constructed on major tributaries. In addition, three river wide diversion structures have been built on the middle Rio Grande, replacing pre-existing individual rock and brush diversion structures. These structures and their associated reservoirs were built for various purposes, including 1) to allow for irrigation diversion from the river (Angostura, Isleta, and San Acacia diversion dams), 2) flood control (El Vado, Cochiti, Jemez Canyon, Gallisteo, and Abiquiu reservoirs), 3) storage of Rio

Grande water (El Vado Reservoir), and 4) storage of San Juan Chama Project water (Heron, El Vado, and Abiquiu reservoirs) (Figure 3). The construction and operation of these structures and their associated reservoirs have modified the natural flow of the river. The flood control reservoirs store a portion of the spring runoff that, if not stored, could result in levee breaches and/or significant flooding of homes, businesses, and irrigated lands. Most of the stored flood water is released shortly after the peak snowmelt runoff. In isolated cases, after July 1 of a high runoff year, any flood water remaining in storage is held over until the end of the irrigation season and then released. Additionally, native Rio Grande water can be stored in El Vado Reservoir during the snowmelt runoff for later release to meet irrigation diversion demand. Finally, San Juan Chama Project water (water diverted into the Rio Grande from the San Juan basin) is stored in several reservoirs and released on call to meet various downstream demands. The ultimate effect of the reservoir operations is to reduce the size of the flood peaks, extend or decrease the duration of the snowmelt runoff (depending on the size of the runoff), and increase the volume of water entering the Middle Rio Grande valley during normal natural low flow periods.

Such altered flow regimes depart significantly from natural conditions, and can significantly alter the habitat by preventing overbank flooding, trapping nutrients, altering sediment transport regimes, prolonging summer base flows, and creating reservoirs that favor non-native fish species. These changes may affect the Rio Grande silvery minnow by reducing its food supply, altering its preferred habitat, preventing dispersal, and providing a continual supply of non-native fish that may compete with or prey upon the species. Altered flow regimes may also result in improved conditions for other native fish species that occupy the same habitat, causing those populations to expand at the expense of the Rio Grande silvery minnow.

Fragmentation of the habitat by the dam structures is also suspected to be a factor in the decline of the Rio Grande silvery minnow. Diversion dams do not preclude downstream passage of fish or their propagules (drifting eggs and larvae), but they do prevent upstream movement of fish. Upstream movement of individual fish in dam-free (>25 km/15.5 mi) has been seen in studies of marked hatchery-reared individuals (Platania et al. 2003), validating the negative impact these structures have on Rio Grande silvery minnow populations.

Habitat fragmentation and degradation have also contributed to a sequential decline and loss of fish from upstream to downstream (Platania and Altenbach 1998, Porter and Massong 2004). Population monitoring data showed that between 1994 and 2002, Rio Grande silvery minnow were disproportionately distributed in the middle Rio Grande: the majority of individuals were in the San Acacia Reach and the rest were in the Angostura and Isleta reaches. This distribution was predicted given the reproductive strategy of the species, which results in large quantities of semibuoyant eggs being released into the water column and dispersing downstream. This pattern did change somewhat after the massive drying that occurred in the Isleta and San Acacia reaches in 2002, 2003 (and some in 2004), and the extensive augmentation that occurred in the Angostura Reach.

The dams also make it possible during a low-flow year to completely divert all of the flow from the river channel into irrigation ditches. The species does not persist in the irrigation ditches or the LFCC. Platania (1993b) collected fish samples from 11 locations along the LFCC between 1987-1989 and failed to locate any Rio Grande silvery minnows. Recent work by New Mexico State University has found Rio Grande silvery minnow using drain outfalls (Finkbeiner *pers. comm.* 2005).

1.7.5.3 River Modification

Channelization of the middle Rio Grande has resulted primarily from the placement of Kellner jetty fields, or jacks, along the river. They are designed to protect levees by retarding flood flows, trapping sediment, and promoting vegetation. Since 1951, BOR and COE have installed more than 100,000 jacks, occupying more than 2,000 hectares (5,000 ac) (Bullard and Wells 1992).

The effects of such actions can be seen downstream. From Elephant Butte Dam downstream about 325 km (202 mi) to the Rio Grande's confluence with the Rio Conchos, the river is fully controlled by reservoir releases and irrigation return flows. Meanders, oxbows, and other components of the historic habitat have been eliminated in order to pass water as efficiently as possible for agricultural irrigation and downstream deliveries. The sandy substrate that the Rio Grande silvery minnow prefers has been replaced by gravel and cobble, and no backwater areas exist where the young can develop. Winter flows released from Caballo Dam often equal .06 cubic meters per second (2 cubic ft per second), which is not enough flow to maintain habitat for fish.

The loss of low-velocity habitat – the generally preferred habitat of the Rio Grande silvery minnow – is of particular concern. The species is collected from only a small portion of the available aquatic habitats (Dudley and Platania 1997), so the loss of an already limited amount of suitable habitat is especially problematic. Such losses may most severely affect the smaller size-classes of Rio Grande silvery minnow and other cyprinids, as low-velocity nursery habitats are essential for the survival of larval and juvenile Rio Grande silvery minnow. The habitats used almost without exception by most young-of-year fishes, and especially the Rio Grande silvery minnow, are the relatively shallow areas of low or no water velocity over fine substrate. These conditions are most often encountered in backwaters and secondary channels pools, not the main channel.

The species also seeks out such habitat in the winter, in particular instream debris piles. This is a critical survival factor, as in winter fish are relatively inactive and rarely feed, and lower velocity areas provide a place where the energy costs of maintaining position in the water column are greatly reduced. Elevated winter water releases can result in a decrease in low-velocity habitats and often make areas with debris one of the few available and suitable habitats. Elevated winter releases can also mobilize instream debris and reduce its availability to fish.

1.7.5.4 Water Pollution

The growth of cities and agricultural operations along the Rio Grande in New Mexico over the last century may have adversely affected the river's water quality. During low-

flow periods, a large percentage of the river's flow consists of municipal and agricultural discharge and less water is available to dilute pollutants. This degradation of water quality may affect Rio Grande silvery minnow survival. Poor water quality in the Rio Grande near Albuquerque, especially during low flows, may be a particular problem, as low numbers of the species and an overall reduced fish community are typically found there (Bestgen and Platania 1991).

Water quality may also be a concern in the Rio Grande near Big Bend (Texas), a possible reintroduction location. The "Binational Study Regarding the Presence of Toxic Substances in the Rio Grand/Rio Bravo and its Tributaries Along the Boundary Portion Between the United States and Mexico" was initiated in 1992 by the International Boundary and Water Commission. In Phase 1, 19 mainstem and 26 tributary sites from El Paso to Brownsville, Texas, were assessed (chemical analysis of water, sediment, and fish tissue; toxicity tests on water and sediment; and benthic community indices) (International Boundary and Water Commission (IBWC) 1994, Texas Natural Resources Conservation Commission (TNRCC) 1994). The TNRCC found high-level water quality impairment due to pesticides and toxic chemicals in the Rio Grande below International Dam and near its confluence with the Río Conchos, as well as in the Río Conchos. Elevated levels of bacteria, dissolved salts, and nutrients have also been found (IBWC 2003).

1.7.6 Listing Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

There is no evidence that the species is being overutilized for commercial, recreational, scientific, or educational purposes.

The Service and NMDGF manage scientific collection of the species through a permit process. Generally, the only authorized scientific collections of Rio Grande silvery minnow are for scientific investigations; collections for the sole purpose of obtaining museum specimens are rarely considered. Although the numbers of Rio Grande silvery minnows observed in the Middle Rio Grande have been relatively low since 1996, the inefficiency of present collection methods makes it unlikely that scientific collections have aggravated the existing condition.

Licensed commercial bait dealers may sell bait minnows only within the drainage where they have been collected. They are also restricted from selling any State-listed fish species. However, it has been demonstrated on the Pecos River in New Mexico that the dealers and retailers often cannot identify listed fish species. Use of the species for recreational purposes could occur should an individual unknowingly collect the species while gathering bait minnows for personal use.

There is no evidence to suggest overutilization of the Rio Grande silvery minnow for any of these purposes poses a threat to the species.

1.7.7 Listing Factor C. Disease or Predation

1.7.7.1 Disease

During periods of low flow, fish confined to pools may experience stress that can result in outbreaks of parasitic disease. Most notable is parasitism by the protozoan *Ichthyophthirius multifilis.* External parasites, such as the copepod *Lernaea*, also are more common among fish in confined conditions. In addition, stress-induced outbreaks may be exacerbated when high levels of pollutants or other stresses are present. No studies on the impact of disease and parasites upon Rio Grande silvery minnow have been conducted, however, so the significance of these threats is not known.

1.7.7.2 Predation

Although it is unlikely that predation is a major factor in the decline of the Rio Grande silvery minnow, it has probably played a minor role, with increasing importance as populations have come under greater stress from other factors.

Predation occurs when non-native species – including northern pike (*Esox lucius*), walleye (*Stizostedion vitreum*), white crappie (*Pomoxis annularis*), white bass (*Morone chrysops*), black and brown bullheads (*Ameiurus melas, A. nebulosus*), smallmouth bass (*Micropterus dolomieui*), and largemouth bass (*M. salmoides*) – are confined, during low flow or no flow, in limited habitat with Rio Grande silvery minnow and other native species.

These non-native species were introduced primarily by State and Federal fish and wildlife management agencies in efforts to develop sport fisheries in the reservoirs created by mainstem dams. The introduced species have not remained confined to the reservoirs and have become established in the river both upstream and downstream, where it is suspected they may compete with Rio Grande silvery minnow for space and food, in addition to preying upon them.

Native predatory fish species, including the Rio Grande chub (*Gila pandora*) and bluegill (*Lepomis macrochirus*), may also prey upon subadult Rio Grande silvery minnow under circumstances of limited habitat. Avian predation by herons and bitterns, for example (Family Ardeidae), may also increase when Rio Grande silvery minnow become confined in small clear-water pools.

The effects of such stressors on populations of Rio Grande silvery minnow are unquantified.

1.7.8 Listing Factor D. The Inadequacy of Existing Regulatory Mechanisms

1.7.8.1 No Protection of Rio Grande Silvery Minnow Habitat Under State Law

The State of New Mexico lists the Rio Grande silvery minnow as an endangered species, Group 2 (New Mexico Department of Game and Fish 1988), which includes those

species "whose prospects of survival or recruitment within the State are likely to be in jeopardy within the foreseeable future." This listing provides the protection of the New Mexico Wildlife Conservation Act (section 17-2-37 through 17-2-46 NMSA 1978) and prohibits taking of such species except under the issuance of a scientific collecting permit. However, the protection afforded to the species by the State does not extend to the habitat upon which the species depends.

1.7.8.2 Instream Water Rights for Fish and Wildlife

At the time the Rio Grande silvery minnow was listed as endangered, the interpretation in New Mexico was that State water law did not provide for "instream flow," (i.e., the acquisition and use of water rights for the instream protection of fish and wildlife and their habitats). However, since the listing, the New Mexico State Engineer and the New Mexico Attorney General have separately opined that no provision of State water law prohibits the State Engineer from issuing a permit for the use of water for instream flow purposes. State law does require that such a permit only be issued pursuant to an application for such a permit by a person or public entity (as defined in State law). While no such application has been received specifically for instream flow, a permit application was received and approved by the State Engineer in 2001 to provide for the storage and release of water to maintain flow between two points on the river for fish and wildlife purposes. That permit was used in 2001 and 2002. No additional permit applications have been received since that time (Schmidt Peterson *pers. comm.* 2005).

1.7.8.3 Inadequate Regulations to Restrict the Use of Bait Fish

State game and fish regulations in New Mexico once allowed the use of live minnows, including those brought into the State from other drainages, for sport fishing. While this is no longer allowed, the practice encouraged the spread of non-native species, one of which, the plains minnow, completely replaced and/or hybridized with Rio Grande silvery minnow in the Pecos River.

Cowley (1979) discovered the introduction of plains minnow (*H. placitus*) into the Pecos River drainage, New Mexico, from collections made as early as 1968, and also recognized the disappearance there of Rio Grande silvery minnow. The last known collections of Rio Grande silvery minnow from the Pecos River took place in 1968 near Roswell, New Mexico. These same collections verified the first specimens of *H. placitus* from the river. It is suspected, because of the widespread use of *H. placitus* as a commercial bait species, that its introduction was a result of the release of bait fish by anglers.

The use of live minnows from other drainages may also have introduced diseases and parasites harmful to Rio Grande silvery minnow.

It is possible that the illegal use of non-native bait fish continues, and may introduce additional non-native species that may compete with or prey upon Rio Grande silvery minnow or introduce diseases or parasites harmful to the species.

1.7.9 Listing Factor E. Other Natural or Manmade Factors Affecting its Continued Existence

1.7.9.1 Reduced Population Numbers and Potential Loss of Genetic Diversity

The current population of Rio Grande silvery minnow has been severely reduced from its historic size, making the species particularly vulnerable to problems that are intrinsic to small populations, including extinction due to population fluctuations, loss of genetic diversity, and threats from congener competition and hybridization.

Reductions in numbers and populations of Rio Grande silvery minnow increase the risk of decreased genetic diversity and the potential for inbreeding depression. This could lead to a reduced ability of the species to cope with environmental variability and to further reductions in overall population size and in recruitment and reproductive potential (Gilpin & Soulé 1986).

Reduced populations always risk decreased genetic viability. Genetic viability describes the pool of genetic diversity adequate to allow a population of animals to survive environmental pressures that may exceed the limits of plasticity. Genetic variability consists of within-population genetic diversity and genetic variation found among linked populations or stocks.

One way to assess genetic risk is through consideration of "genetic effective population size" (N_e), which is roughly the number of individuals contributing genes to the next generation. Effective population size can be used to gauge the number of individuals needed in a population to maintain genetic variation and to determine the degree of genetic risk to wild populations. N_e likely differs by species and specific genetic analyses are needed to determine the N_e for the Rio Grande silvery minnow. Studies (Alò & Turner 2005, Turner et al. 2003, Turner et al. 2004) to date indicate that the N_e for the remaining population of Rio Grande silvery minnow is around 100 individuals, despite recent population supplementation from hatchery reared and captively bred fish. Small populations in the wild risk inbreeding (interbreeding of closely related individuals) which results in reduced fitness and ability to cope with random environmental fluctuations (stochasticity).

1.7.9.2 Competition with Non-Native Fish

As mentioned above, New Mexico State regulations once allowed the use of live minnows, including those brought into the State from other drainages, for sport fishing. This practice encouraged the spread of non-native species, including the plains minnow, which replaced and/or hybridized with Rio Grande silvery minnow in the Pecos River. Such competition and/or hybridization with non-native species in the future could potentially affect the remaining populations of Rio Grande silvery minnow.

1.8 Biological Constraints and Needs

A number of biological constraints and needs have been identified that should be considered in planning and management. Each of these parameters needs to be maintained over a large enough area on an annual basis to sustain the populations of Rio Grande silvery minnow.

1. *Natural flow regimes.* The historic hydrograph includes extended periods of desiccation that may have had a substantial negative impact on the species, although available evidence (Wesche et al. 2005) shows that periods of river desiccation have declined since the 1930s.

2. *Periodic flood events during spring and summer to initiate breeding.* Successful reproduction of the Rio Grande silvery minnow may be tied to flood events within the basin, although there is contradictory evidence to suggest multiple reproductive events in both wild and captive populations of Rio Grande silvery minnow. Periodic floods need to be maintained in order for the species to successfully reproduce in the natural environment.

3. *Appropriate habitat for early life-history stages, including floodplain and other shallow, quiet water environments.* These habitats have been identified as important to survival of larvae and juveniles. There is a further need to maintain connections with the river proper to allow the young and juveniles back into fluvial habitats for later life stages.

4. *Suitable water quality*. Suitable water quality should be maintained to sustain the Rio Grande silvery minnow and its food supply. No description of "suitable" water quality currently exists, however. One limited study (Buhl 2004) found no chronic or acute toxicological effects on Rio Grande silvery minnows from wastewater treatment plant discharges or drain-water discharges in the middle Rio Grande.

5. *Unimpeded flows to allow for movement of various life stages.* Dams, diversions, and river impediments can have negative impacts on the downstream movement of eggs and larvae and on the ability of subadult and adult fish to move upstream. There is no evidence to date to suggest optimal timing, periodicity, or geographic extent of upstream movement.

1.9 Critical Habitat

1.9.1 Critical Habitat Description

Critical habitat for the Rio Grande silvery minnow was designated in 2003, under section 4(a)(3)(A) of the Endangered Species Act (68 FR 8088).

Critical habitat was designated for the species in New Mexico, only in the middle Rio

Grande. Critical habitat extends from Cochiti Dam, in Sandoval County, downstream to the utility line that crosses the river (a permanent landmark) in Socorro County (approximately 252 km (157 mi)). Excluded from this designation were the Pueblo lands of Santo Domingo, Santa Ana, Sandia, and Isleta. Because each of these Pueblos submitted management plans that provide for special management considerations or protections for the silvery minnow these lands were not included in the final critical habitat designation. The Service determined that the benefits of exclusion outweigh those of including the Pueblos of Santa Domingo, Santa Ana, Sandia, and Isleta as part of the critical habitat designation. A major factor in this determination was that, even if excluded, these river reaches owned and managed by the Pueblos will nonetheless receive special management and protection through the Pueblos' management plans. Under these management plans, the silvery minnow will benefit from monitoring, restoration, enhancement, and survey efforts. The critical habitat designation also includes a portion of the Jemez River, a tributary of the Rio Grande north of Albuquerque. Critical habitat includes the Jemez River from the Jemez Canyon Dam to the upstream boundary of the Santa Ana Pueblo (it does not include Jemez watershed lands within the Pueblo).

The width of the critical habitat designation, in areas of the river that are bound by existing levees, is defined as extending to those levees. The designation of critical habitat will not result in the removal of existing levees. While areas outside of the existing levees may be important for the overall health of the Rio Grande ecosystem, these areas have almost no potential for containing the primary constituent elements (see below) because they are separated from the river by the levees and are rarely inundated with water. Therefore, they were not considered essential to the conservation of the species. (Nevertheless, these and other areas outside of the critical habitat designation will continue to be subject to conservation actions that may be implemented under section 7(a)(1) of the ESA, the regulatory protections afforded by the jeopardy standard in section 7(a)(2) of the ESA, and take prohibitions in section 9 of the ESA.)

In areas without levees, the width of the critical habitat designation is defined as the area of bankfull width plus 91.4 meters (300 ft) of riparian zone on each side of the banks. The bankfull width is the width of the river at bankfull stage (the flow at which the river begins to leave the channel and move into the floodplain). Bankfull stage, while a function of the size of the stream, is a fairly consistent feature related to the formation, maintenance, and dimensions of the stream channel. The 91.4-meter-width defines the lateral extent of the areas believed to be essential to the conservation of the species. Although the Rio Grande silvery minnow cannot be found in these areas when they are dry, they likely provided backwater habitat and were sometimes flooded in the past. Therefore, they may provide habitat during high-water periods.

The 91.4 meter width was selected for several reasons:

1. The biological integrity and natural dynamics of the river system are maintained within this area. The floodplain and its riparian vegetation: provide space for natural flooding patterns and latitude for necessary natural channel adjustments to maintain appropriate channel morphology and geometry; store

water for slow release to maintain base flows; provide side channels and other protected areas for larval and juvenile fish; allow the river to meander within its main channel in response to large flow events; and recreate the mosaic of habitats necessary for the conservation of the species.

2. Conservation of the adjacent riparian zone helps provide essential nutrient recharge and protection from sediment and pollutants, which contributes to successful spawning and recruitment of Rio Grande silvery minnow.

3. Vegetated lateral zones are widely recognized as providing a variety of aquatic habitat functions and values (e.g., aquatic habitat for fish and other aquatic organisms, moderation of water temperature changes, and detritus for aquatic food webs) and help improve or maintain local water quality.

The critical habitat designation takes into account the naturally dynamic nature of riverine systems and recognizes that floodplains (including riparian areas) are an integral part of the stream ecosystem.

Although it was determined that other areas also are essential to the conservation of the Rio Grande silvery minnow, these areas were not designated as critical habitat because of the Service's analysis under section 4(b)(2) of the ESA. That analysis found that the benefits of excluding these areas from critical habitat designation outweighed the benefits of including them. They include the middle Pecos River from immediately downstream of Sumner Dam to Brantley Dam, New Mexico, and the Rio Grande from the upstream boundary of Big Bend National Park to the Terrell/Val Verde county line, Texas. A discussion of the benefits of excluding or including these areas can be found in the 2003 critical habitat designation (68 FR 8088).

1.9.2 Primary Constituent Elements

The area of the middle Rio Grande designated as critical habitat contains all of the primary constituent elements that are essential to the conservation of the species during some or all of the year, and can provide for the physiological, behavioral, and ecological requirements of the Rio Grande silvery minnow.

The primary constituent elements of critical habitat for the Rio Grande silvery minnow were determined based on several studies of its habitat and population biology (see 68 FR 8088 for a listing of the studies).

The primary constituent elements are as follows:

1. A hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining a diversity of aquatic habitats such as, but not limited to, the following: backwaters (a body of water connected to the main channel, but with no appreciable flow), shallow side channels, pools (the portion of the river that is deep with relatively little velocity compared to the rest of the channel), eddies (a pool with water moving opposite to that in the river channel), and runs (flowing water in the river channel without

obstructions) of varying depth and velocity. All of these are necessary for particular Rio Grande silvery minnow life-history stages in appropriate seasons. The Rio Grande silvery minnow requires habitat with sufficient flows from early spring (March) to early summer (June) to trigger spawning, flows in the summer (June) and fall (October) that do not increase prolonged periods of low or no flow, and a relatively constant winter flow (November through February).

2. The presence of low-velocity habitat (including eddies created by debris piles, pools, backwaters, or other refuge habitat) within unimpounded stretches of flowing water of sufficient length (i.e., river miles) to provide a variety of habitats with a wide range of depth and velocities.

3. Substrates of predominantly sand or silt.

4. Water of sufficient quality to maintain natural, daily and seasonally variable water temperatures in the approximate range of greater than 1^{o} C (35^{o} F) and less than 30^{o} C (85^{o} F), and to reduce degraded water quality conditions (decreased dissolved oxygen).

These primary constituent elements of critical habitat provide for the physiological, behavioral, and ecological requirements of the Rio Grande silvery minnow. The first element provides water of sufficient flows to reduce the formation of isolated pools. This element is essential to the conservation of the species because it cannot withstand permanent drying (loss of surface flow) of long stretches of river. Water is a necessary component for all life stages and provides for hydrologic connectivity to facilitate fish movement.

The second element provides habitat necessary for development and hatching of eggs and the survival of the species from larvae to adult. Low-velocity habitat provides food, shelter, and sites for reproduction, which are essential for the survival and reproduction of Rio Grande silvery minnow.

The third element provides appropriate silt and sand substrates, which are important in creating and maintaining appropriate habitat and life requisites such as food and cover.

The fourth element provides protection from degraded water quality conditions. When water quality conditions degrade (e.g. water temperatures are too high or dissolved oxygen concentrations are too low), Rio Grande silvery minnow are likely to be injured or die.

1.9.3 Effects of Critical Habitat Designation

Section 7(a)(2) of the Endangered Species Act requires all Federal agencies to ensure that actions they fund, authorize, or carry out do not destroy or adversely modify critical habitat to the extent that the action appreciably diminishes the value of the critical habitat for the survival and recovery of the species. Individuals, organizations, States, Indian pueblos and tribes, local governments, and other non-Federal entities are affected by the

designation of critical habitat only if their actions occur on Federal lands, require a Federal permit, license, or other authorization, or involve Federal funding.

Activities on Federal lands that may affect the species or its critical habitat require section 7 consultation. Actions on private, State, or Indian Pueblo and tribal lands receiving funding or requiring a permit from a Federal agency also will be subject to the section 7 consultation process if the action may affect critical habitat. Federal actions not affecting the species or its critical habitat, as well as actions on non-Federal land that are not federally funded or permitted, will not require section 7 consultation.

1.10 Conservation Efforts

1.10.1 Introduction

Since 1991, NMDGF, the Service, the Bureau of Reclamation, the COE, the University of New Mexico, and the Pueblos of Santo Domingo, Santa Ana, Sandia, and Isleta have cooperated to conduct research and monitor the status of the Rio Grande silvery minnow and the associated fish community and habitat in the middle Rio Grande valley. Studies on the distribution, abundance, life history, and habitat use of the species have revealed much about the biology of the species and its habitat. The results of these studies – essential first steps in conserving the species – are described elsewhere in this document.

These organizations, as well as others, have also initiated programs to stabilize and enhance the species. Pueblos such as Sandia, Isleta, and Santa Ana have cooperated in silvery minnow research and monitoring. The Pueblo of Sandia has cooperated with the Service and BOR in tagged fish and egg monitoring studies for almost four years and participated in augmentation for the last three. Santa Ana recently signed a Safe Harbor Agreement with the Service for silvery minnow, southwestern willow flycatcher (*Empidonax traillii extimus*), and bald eagle (*Haliaeetus leucocephalus*) and has undertaken habitat restoration efforts to benefit all three species. The Pueblos of Santo Domingo, Sandia, and Isleta have also initiated habitat restoration programs on their lands.

The following sections further describe ongoing conservation actions to benefit the Rio Grande silvery minnow. Several of these efforts were funded or coordinated under the auspices of the Middle Rio Grande Endangered Species Act Collaborative Program. This program focuses on the protection and recovery of both the Rio Grande silvery minnow and the Southwestern willow flycatcher. Signatories include State and Federal agencies, environmental and business groups, pueblos and tribes, and universities.

1.10.2 Propagation and Augmentation

The Service and other organizations have cooperated in captive propagation and augmentation. These programs aim to establish refugial populations to prevent the extinction of the species, produce genetically viable captive-bred fish, and augment the wild population, as well as learn more about propagation and augmentation methods (Remshardt 2001).

1.10.2.1 Egg Collection

Wild-caught Rio Grande silvery minnow eggs were collected from the middle Rio Grande from 2000 to 2003 for use in propagation and augmentation programs. Eggs were collected just after the spawn in a variety of locations. Most were collected in the southernmost part of the species' current range, just above Elephant Butte Reservoir; this location allowed for the collection of eggs that had drifted downstream from throughout the current range of the species, thus including a wide range of genetic material. To date, more than 1.1 million eggs have been collected. Albuquerque Biological Park (BioPark) distributes the eggs to State and Federal cooperators after collection and processing (removal of organic debris and estimates of numbers), for future propagation and augmentation efforts. A portion of the eggs are also maintained at the BioPark for grow-out into production fish and broodstock for captive propagation.

In 2005, egg catch rates were low, so an estimated 10,000 young-of-year fish were collected from the river for use as broodstock.

1.10.2.2 Propagation Facilities

Currently, Rio Grande silvery minnow are held at the four locations described below. Maintaining specimens at several facilities helps to protect them from extirpation due to unforeseen events.

1.10.2.2.1 Service, Dexter National Fish Hatchery and Technology Center

Dexter National Fish Hatchery and Technology Center (Dexter NFHTC) in Dexter, New Mexico, serves as the lead Federal facility for propagation. Activities include the establishment of an ad hoc propagation work group, development of a captive propagation plan, refinement of captive propagation and rearing techniques, maintenance and expansion of refugial populations, and research on life history, feed formulation, feeding trials, fish marking, and tag retention. Dexter NFHTC uses modified warm-water fish culture techniques to rear the fish and has well-water and water-reuse capabilities. The propagation program utilizes 11 ponds (two acres total), two 2000-gallon recirculation systems with temperature control and independent bio-filtration, 10 3-foot-diameter circular tanks, two 10-foot-rectangular flow-through tanks, and 12 40-gallon aquaria. The facility annually produces more than 150,000 subadult (> 35mm) Rio Grande silvery minnow for augmenting populations in the middle Rio Grande. Dexter NFHTC began working on the propagation program in 2001. Since then, significant advancements have been made in developing appropriate and consistent propagation and culture methods for maintaining large numbers of Rio Grande silvery minnow for propagation and augmentation.

1.10.2.2.2 City of Albuquerque, BioPark, Rio Grande Silvery Minnow Rearing and Breeding Facility

The BioPark began experimental propagation of Rio Grande silvery minnow in 2000, in cooperation with the U.S. Fish and Wildlife Service. In 2003, the BioPark added new state-of-the-art facilities, including an indoor breeding and

hatching system, 12 20,000-gallon outdoor rearing and holding tanks, and an outdoor naturalized refugium stream, which is used for holding a captive population, spawning, rearing, and research. The facility can annually produce 75,000 fish for augmentation and can hold 30,000 fish as a captive population. It can also process wild-caught eggs and produce eggs and larvae for distribution to other facilities. The naturalized refugium is intended to produce fish that are better able to adapt to river conditions upon release, compared to those raised in conditions with minimal habitat and flow.

1.10.2.2.3 New Mexico Fishery Resources Office

The New Mexico Fishery Resources Office in Albuquerque oversees management activities associated with propagation and augmentation, including development of propagation and augmentation plans, monitoring activities, collection of broodstock for propagation facilities, and transfer between propagation facilities. A 1,000-gallon recirculating system at the facility is used to seasonally hold juvenile and adult Rio Grande silvery minnow for a variety of purposes, including broodstock maintenance, salvage, and propagation.

1.10.2.2.4 U.S. Geological Survey, Biological Resources, New Mexico Cooperative Fish and Wildlife Research Unit, New Mexico State University Rio Grande Silvery Minnow Propagation and Research Facility Geothermal Native Fish Culture Facility (A-Mountain)

In 2001, captive breeding, rearing, and research activities began at the A-Mountain facility in Las Cruces, New Mexico. The primary objective of this faculty is to provide space for additional captive breeding and broodstock maintenance, as well as space for research on feed and stress responses. Another research lab on the campus contains an 870-gallon recirculating system; several Rio Grande silvery minnow studies have been completed there.

Several other facilities, including Mora National Fish Hatchery and Technology Center, the Rock Lake State Fish Hatchery, and the Museum of Southwestern Biology have also assisted with propagation efforts.

1.10.2.3 Propagation Activities

The Dexter NFHTC is the main Federal facility for propagation. Since the program began, survival rates of specimens reared there have increased steadily, rising from 15 percent in 2001 to 86 percent in 2004.

Dexter NFHTC currently maintains a captive refugia/broodstock of 16,000 adult (wild-collected) fish from the 2002 and 2003 year classes. As a rule of thumb, 10 percent of all wild-collected eggs are maintained as a genetic reserve population. Individuals from the 2002 year class were provided to the BioPark and A-Mountain facilities for captive spawning activities. In 2005, Dexter staff spawned 222 pairs of 2002 broodstock, resulting in 200,000 larvae produced for grow-out. These fish were stocked into 8 ponds equaling 1.5 total surface acres. An additional 3 ponds (0.50 total surface acres) are used to maintain the captive broodstock.

The Dexter NFHTC program relies in part on receiving eggs collected from the annual egg salvage operations on the Rio Grande. When enough eggs are not available through this salvage effort, the staff spawns wild-collected captive broodstock to meet augmentation numbers; this was necessary in 2003, 2004, and 2005.

The A-Mountain facility maintains multiple years of captive broodstock and spawns adult fish in support of the captive propagation program. The eggs/larvae produced are transferred to Dexter NFHTC or the BioPark for hatching and rearing in ponds.

The BioPark began experimental propagation of Rio Grande silvery minnow in 2000, in cooperation with the Service. Experimental propagation concentrated on providing grow-out facilities for wild-caught eggs, inducing broodstock to spawn through injections of carp pituitary extract (CPE), and studies concerning captive propagation. Studies included experiments on alternative methods of artificial inducement to spawning and the use of environmental manipulations (without CPE) to induce natural spawning. Studies have also looked at egg and larval developmental rates, and swimming speeds (to provide data for the design and construction of fish passages in the river). In 2001, the level of effort in collection of wild eggs and captive spawning increased, allowing propagation efforts to change from experimental to production (fish were subsequently used to augment the wild population).

In June 2003, the BioPark's naturalized refugium was brought online. This outdoor system is an oval-shaped channel with a volume of 50,000 gallons. It has habitat features including sand substrate, plunge pools, backwaters, runs, and debris piles. Current is generated using a large circulating pump. Flow can be raised to 1.5 feet/second. Spawning in the refugium has occurred on several occasions as a result of an increase in flow and turbidity. The refugium is used primarily for grow-out of fish for augmentation and for holding broodstock.

1.10.2.4 Augmentation Activities

Augmentation efforts began in May and June 2000, with the release of an estimated 204,000 larval and 414 adult Rio Grande silvery minnow in the middle Rio Grande, near the NM Highway 6 Bridge in Los Lunas and the NM Highway 44 Bridge in Bernalillo, by staff from the UNM Museum of Southwestern Biology. The larval fish were the result of captive spawning of wild adults from the San Acacia Reach (surviving adults were returned to the river after spawning).

To date, augmentation efforts have resulted in the release of more than 600,000 Rio Grande silvery minnow; 400,000 were tagged for future identification. While the primary goal is to produce Rio Grande silvery minnow raised from wild-caught eggs, releases have included minnows that were raised from salvaged eggs as well as minnows from eggs produced by artificial spawning in captivity.

1.10.2.5 Tagging Studies

Currently, all Rio Grande silvery minnows are tagged before release. Several tagging

methods have been tested, and all specimens now carry Visible Implant Elastomer (VIE) tags (Remshardt and Davenport 2003). Information from recapture of tagged individuals is being used to determine the effects of different release protocols on survival. Laboratory studies indicate that VIE tag retention rates are generally high, ranging from 98-100 percent for up to one month and 77-82 percent for three to six months.

1.10.2.6 Research

Several of the facilities involved in the propagation and augmentation program have also conducted research studies.

The BioPark has researched methods of artificial inducement to spawn as well as the use of environmental manipulations to induce natural spawning. In 2004, natural spawns at the facility resulted in the production of 200,000 eggs. In 2005, studies produced data on the influence of flow and turbidity on the spawning of Rio Grande silvery minnow. Preliminary results indicate that the species will spawn following a change in either flow or turbidity.

Feed studies to improve survival and performance of captive specimens were initiated at A-Mountain through a cooperative effort with Dexter NFHTC and Bozeman Fish Technology Center. Test diets were formulated by the Bozeman center, while A-Mountain and Dexter NFHTC served as test sites. Growth was best in juveniles provided with an experimental flake feed (Caldwell et al. 2005). Swimming stamina challenge tests indicated that fish in captive propagation facilities can be conditioned prior to release into the wild, improving chances for survival.

The U.S. Geological Survey, Yankton Ecotoxicology Research Center, Yankton, South Dakota, has also conducted research with the species. Studies began in 1998, comparing relative sensitivity and acute toxicity of Rio Grande silvery minnow and a surrogate species (fathead minnow) to a variety of waterborne inorganic contaminants. The center is currently conducting toxicity testing with larval fish obtained from the BioPark.

1.10.3 Habitat Restoration

1.10.3.1 Habitat Restoration Plan

A framework habitat restoration plan for the middle Rio Grande has been developed under the auspices of the MRGESACP (Tetra Tech EM Inc. 2004).

The restoration plan, released in September 2004, does not outline or require specific habitat restoration projects; rather it serves as a guide for implementing such activities in the future by providing a framework for soliciting and evaluating restoration proposals. Areas of focus are the riverine and riparian zones along the Rio Chama below Abiquiu Dam and the mainstem of the Rio Grande from Velarde to Elephant Butte Reservoir.

The plan notes that a lack of egg and larval retention habitat and fragmentation of the river by diversion dams are significant impediments to the survival of the Rio Grande silvery minnow, and that such habitats must be significantly increased to prevent the

extinction of the species. It also notes that populations must be established in more than one reach, and that augmentation will be necessary until the population stabilizes. Within these broad habitat guidelines, the plan outlines a "suite of actions" that will be needed in order for habitat restoration efforts to meet the goal of egg and larval retention and young-of-year rearing habitat:

- Sustained flows in key reaches to promote sufficient populations of wild fish
- Spring flow peak in mid- to late-May to stimulate spawning
- Establishment of channel conditions that retard downstream displacement of eggs and larvae
- Establishment of a sustainable population of Rio Grande silvery minnow in the Angostura reach
- Establishment of suitable feeding and cover habitat for juveniles and adults
- Remediation of longitudinal discontinuity associated with irrigation diversion structures

The plan also discusses some of the specific restoration techniques that will be considered for future Rio Grande silvery minnow habitat restoration projects, and notes that later documents will outline the specific activities to be undertaken in each reach. The restoration techniques discussed include:

- passive restoration
- terrace and bank lowering
- high-flow, ephemeral side channels
- high-flow, bank-line embayments
- arroyo connectivity
- main channel widening
- removal of lateral confinements
- river bar and island enhancement
- destabilization of islands and bars
- gradient-control structures
- woody debris
- sediment management
- fish passages

Four habitat restoration projects were funded for implementation in FY 2004:

- installation of snag structures in the Albuquerque reach
- creation of habitat using bar and channel modifications and debris snags
- development of nursery habitats and low-flow habitats in mid-channel islands
- reestablishment of a hydrological connection between the river and bosque at the Rio Grande Nature Center

1.10.3.2 Completed Habitat Restoration Projects

Several habitat restoration projects have already been completed.

- The Los Lunas Habitat Restoration Project involved removing jetty jacks along 6,000 feet of river bank, lowering 50 acres of river bank, contouring to integrate floodplain functions, and construction of side channels, wetlands, and other features.

- Two woody debris installation projects have been conducted in the Albuquerque Reach to encourage the development of pools and wintering habitat. Cottonwood snags and woody debris of various sizes have been used and are being monitored.
- Inlets were added to the River Widening Project at Bosque del Apache National Wildlife Refuge for minnow habitat.
- The Pueblo of Santa Ana is creating over 100-acres of riparian wetland habitat along the active floodplain, 40 of which are complete. More than 725 acres of cottonwood bosque have been restored through the clearing of salt cedar and Russian olive (a total of 1300 acres are slated for restoration). The Pueblo has also worked to restore the geomorphology of 6-river miles traversing the Pueblo including the installation of three gradient restoration facilities, each of which provides a 500-foot-long fish passage apron.
- A river bar modification project just south of I-40 Bridge involved the construction of side and backwater channels on an existing bar as well as modification of the top surface of the bar to create habitat over a range of flows.

1.10.3.3 Habitat Restoration Research

The BOR is evaluating Rio Grande silvery minnow nursery habitat requirements and how trends in fluvial geomorphology affect the species' habitat. Monitoring at Los Lunas suggests that inlets provide suitable habitat for larvae as well as winter habitat for adults. Results from electrofishing surveys indicate that Rio Grande silvery minnows prefer vertical structures without overhanging vegetation, and areas with reduced water velocities, such as secondary channels. Creating this type of habitat in areas with channel incision should increase nursery habitat availability. More areas with suitable nursery habitat should increase populations, via increased recruitment.

1.10.4 Water Management

Water management activities in the middle Rio Grande valley have advanced significantly over the past five years with the recognition that the available surface water supply is insufficient in many years to meet all demands upon it. Given the drought, litigation, research on historical flows and climate, and daily observation and management of river flows and reservoir releases over the past few irrigation seasons, water managers now have a better understanding of the variability of the natural system and how to manage releases of stored water to better maintain flows at specific points along the river.

1.10.4.1 Background

In the late 1990s, and perhaps until experiencing the dry year of 2000, the implicit assumption regarding the surface water supply of the middle Rio Grande basin was that the available supply was sufficient on a year-to-year basis to meet all existing demands. In fact, as described below, the surface water supply to the middle Rio Grande valley is not sufficient to do so, especially during drought periods (S.S. Papadopulos & Associates, 2001, 2002).

From the late 1970s through the mid-1990s, surface water supply was approximately 20 percent higher than it had been in the preceding two to three decades. The surface water

supply in that period has been reported to be among the wettest in the last 1,000 years (based on tree-ring data). From the available record, the basin appears to experience wet and dry periods on a 50-70-year cycle. The wet periods (such as the late 1970s through mid-1990s) can be 15-30 percent wetter than the long-term average, while the dry (below average) periods can be 15-30 percent drier (S.S. Papadopulos & Associates, 2001, 2002). During the last significant drought period (1950s), the available gage record indicates that the Rio Grande dried south of Albuquerque in multiple years and on as many as 100 days in one year. The drying experienced during those periods in the Isleta and San Acacia reaches significantly exceeded that of the Albuquerque reach (USGS 2001).

Natural surface water supplies in the middle Rio Grande are highly variable from year to year. Annual flow volumes of native Rio Grande water as measured at the Otowi gage have measured as low as 250,000 acre-feet to over 2,000,000 acre-feet (USGS 2001). The distribution of flows is skewed, with a few high years significantly affecting the mean. The last five years have seen annual native flow volumes at Otowi of less than 750,000 acre-feet each year as well as one of the lowest annual native flows on record (250,000 acre-feet in 2002). The vast majority of the native flow at Otowi during a water year (October 1 through September 30) occurs March through June and accounts for about 60 percent of the annual total flow. About 20 percent of the annual native flow occurs from November through February, the rest from July through October.

1.10.4.2 Water Management Actions to Meet Biological Opinion Flow Targets and Requirements

Specific water management actions have been used to meet middle Rio Grande valley river flow targets, manage river recession, and generate the spawning spikes specified in the Service Biological Opinion for water operations and flood control (U.S. Fish and Wildlife Service 2003a), including:

- interagency coordination of daily river and reservoir operations
- improvements to irrigation metering and management
- indirect use of native Rio Grande water (both stored and direct flow)
- release of stored San Juan-Chama Project water and use by exchange
- direct use of stored native Rio Grande water made available by the State of New Mexico
- pumping from the Low Flow Conveyance Channel to the river

1.10.4.3 Summary

The water management agencies responsible for the middle Rio Grande have been successful in recent years in implementing a number of innovative and flexible operations and programs to assist with meeting the needs of water users, including the Rio Grande silvery minnow. Those operations and programs have been successful primarily due to two sources of water that most likely will not be available in coming years: San Juan-Chama Project water and New Mexico accrued credit water.

With the exception of 2,990 acre-feet of San Juan-Chama Project water reserved for use in Indian water rights settlements, the entire firm yield (96,200 acre-feet) of the project is

under contract. A substantial amount of that water has been surplus to the needs of the various contractors until recently, and many are now implementing plans to fully use their allocations. The State of New Mexico in recent years has enjoyed a substantial surplus of accrued credits under the Rio Grande Compact and has made that source of water available to the United States through the Conservation Water Agreement and the Emergency Drought Water Agreement, to assist with meeting the flow targets and water management operations required by Biological Opinions. The Conservation Water Agreement and Emergency Drought Water Agreement are unique in the history of State-Federal relationships during implementation of the requirements of the ESA.

1.10.5 Salvage

Over the last several years, dry conditions on the middle Rio Grande have led to several periods of river "intermittency," or discontinuous flow. When such conditions occurred, it was necessary to conduct emergency salvage operations to move Rio Grande silvery minnow from isolated pools in drying areas to stretches of the river that were still flowing, in order to reduce mortality. Typically, the fish were relocated from a drying downstream region of the middle Rio Grande to wetter upstream areas. River intermittency usually occurs between July and October.

In 1996, 1998, and 1999, informal salvage operations relocated an estimated total of 11,000 individuals (adults and juveniles) from isolated pools in the San Acacia Reach upstream to several locations within the Isleta and Angostura reaches. Since 2001, Rio Grande silvery minnows have been rescued under a formal program administered by the Service as required by the 2003 Biological Opinion (U.S. Fish and Wildlife Service 2003a). In 2001, 240 were salvaged; in 2002, 3,662; and in 2003, 713. In 2004, 12,865 Rio Grande silvery minnow were salvaged (U.S. Fish and Wildlife Service 2005). A total of 626,444 Rio Grande silvery minnow were salvaged in both main channel and floodplain areas of the middle Rio Grande in 2005.

1.10.6 Summary

Although various conservation efforts have been undertaken in the past and others are currently being carried out in the middle Rio Grande, and abundance in recent years is increasing, the threat of extinction of the Rio Grande silvery minnow continues because of the high probability of continued drought, the fragmented and isolated nature of currently occupied habitat, and the absence of silvery minnows in other parts of the historic range. Additional work needs to be done to conserve this species and the ecosystems upon which it depends.

The following perspective paper was prepared by the Tribal Subgroup of the Rio Grande Silvery Minnow Recovery Team to reflect the unique concerns, roles, and responsibilities of sovereign governments in participating in the recovery of the Rio Grande silvery minnow.

1.11 Tribal Perspective on Rio Grande Silvery Minnow Management and the Endangered Species Act

The following section was prepared by the Tribal Subgroup of the Rio Grande Silvery Minnow Recovery Team. It is important to note that while most, if not all, of the Indian sovereigns within New Mexico have interests in and will be affected by the ongoing efforts to protect and recover the species, each Indian sovereign will choose its level of partnership and participation in those efforts, and that nothing in this recovery plan creates duties, obligations, or commitments enforceable upon any of those Indian sovereigns.

1.11.1 Introduction

To speak with one voice for all the Indian tribes in the Southwest Region that have a stake in Rio Grande silvery minnow management and the recovery of endangered species is not possible (Figure 6). There are probably as many approaches to this issue as there are tribes. It is possible that many tribes, beyond disagreeing with the notion of acceptance of and cooperation with the ESA, would be hesitant to even participate in this dialogue. Therefore, this paper in no way intends to speak for every tribe in the United States or even in the Southwest Region. Instead, the ideas presented here represent a consensus among some tribes that believe there is room for dialogue with the Service on ways to improve the Federal/tribal relationship as it relates to endangered species management. Many of the problems surrounding this issue remain extremely sensitive and contentious. Therefore, there is a need for the Federal Government, including the Service to establish more effective relationships with the tribes, based on mutual respect for each other's needs and the desire to move beyond an adversarial relationship to a problem-solving approach.

1.11.2 Background

Before tribal involvement in the Rio Grande silvery minnow recovery is discussed, it is important to provide some background on the ESA as it relates to tribal interests. Before this is possible, however, some history of the Federal/tribal relationship is necessary. This relationship is built on the U.S. Constitution, multiple U.S. Supreme Court decisions, Federal statutes, and executive orders and policies of several Presidential administrations. By far, the most important and pervasive of these concepts are Tribal Sovereignty and Trust Responsibility.

1.11.2.1 Tribal Sovereignty

The inherent sovereignty of Indian tribes and nations has long been recognized by the United States Constitution, the Federal Government and Federal courts. See, Cherokee Nation v. Georgia (1831); United States v. Winans (1905) (Indian nations reserve all

governmental powers and individual rights not specifically abrogated by Congress, or granted away by the tribes in their treaties or agreements with the United States). As a result of that Constitutionally established government-to-government relationship, the Federal Government has a responsibility to protect Indian trust resources (Indian trust resources generally include land, water, air, minerals, and wildlife, reserved or otherwise owned or held in benefit for Indian pueblos, nations and tribes). That legal principle has been reiterated extensively in recent years within the context of natural resource management, Parravano v. Babbitt (1995) (Federal Indian trust responsibility extends not just to the Interior Department but attaches to the Federal Government as a whole), Covelho Indian Community v. FERC (1990) (As a Federal agency, FERC is subject to the Federal Indian trust responsibility . . . that responsibility is to be executed to the highest standards of fiduciary conduct).

As sovereign nations, tribes and tribal lands are not subject to the same public laws that govern other lands within the United States, either public or private. It has been legally established that inherent in the establishment of a reservation is the right of Indians to hunt and fish on reservation lands free from State regulation. Cases such as Menominee Tribe v. the United States (1968), Washington v. Passenger Vessel Association (1979), New Mexico v. Mescalero Apache Tribe (1983), Arapahoe Tribe v. Hodel (1990), and Minnesota v. Mille Lacs Band of Chippewa Indians (1999) have cemented this precept. Some of these rights are based on treaty rights, but many follow from the mere establishment of a reservation and the self -governance powers inherent therein. Congress may, limit the powers of Indian self-governance, including the denial of treaty established hunting or fishing rights, as it did when it prohibited Indians from hunting eagles under the Eagle Protection Act. But to do so the Congressional act abrogating those powers must be clear and explicit. See, Lone Wolf v. Hitchcock (1903). Absent clear Congressional intent, however, tribal self-governance and their retained rights and powers are not extinguished and may be upheld even if they affect off-reservation lands (including both public and private land) where a tribe has a treaty-established or other federally recognized interest. Winters v. United States (1908); United States v. Winans (1905). In general, however, Congress has not abrogated tribal interests and utilization of Indian trust resources and the matter has been, for the most part, left to tribal regulation.

Although Congress does have authority to restrict some tribal wildlife practices, it is unclear whether the Service and the U.S. National Marine Fisheries Service (the two agencies responsible for enforcing the Act) have authority to enforce the ESA on tribal land; the issue has never been decided by the courts. At the heart of the matter is the question of what Congress' intent was when it established the ESA. The ESA does not specifically mention tribes, and other court cases have upheld the concept that, unless tribal treaty and other rights are specifically abnegated by an act of Congress or a particular piece of legislation, they remain in force. In the one court case that came the closest to testing this question, United States v. Dion, a tribal member was convicted of taking a bald eagle for commercial use. The statute, under which the case was prosecuted, however, was not the ESA but the Eagle Protection Act. The ESA question was left unanswered.

Given this ambiguity (not to mention the potential for costly and lengthy litigation), many tribal leaders and natural resource managers would prefer to work out these conflicts with cooperative agreements with Federal and State officials, rather than through the courts.

All of the above is not to imply that all Indian tribes are unwilling to work with the ESA or even see it as a burden. In fact, some tribes have used the ESA to benefit them, especially in regards to the protection of dwindling fish stocks in the Pacific Northwest and the Great Lakes region. For example, the Pyramid Lake Paiute Tribe in Nevada and other entities used the ESA to achieve listing of the Cui-ui sucker in Pyramid Lake, and to protect water resources and reduce diversions from the Truckee River. In the Pacific Northwest, off-reservation treaty fishing rights are often protected by mandatory conservation measures, which are backed with the strong arm of the ESA.

All this legal maneuvering does little to help endangered species. Consequently, a dialogue has arisen between some tribes and the Service about whether it is possible to set aside differences over interpretation of the ESA and other laws and instead concentrate on cooperative policies that can be adopted to help endangered species and their habitat.

1.11.2.2 Trust Responsibility

As shown by the preceding section, it is well-established that Indian tribes in the United States are sovereign entities, and that the U.S. is legally required to protect Indian trust resources for the benefit of the respective Indian pueblos, nations, and tribes. Those legal duties ultimately are intended to ensure that Indian lands remain capable and sufficient of serving as viable homelands for the respective tribes. In managing trust lands or assisting tribes in doing so, the government must act for the exclusive benefit of the tribes, and ensure that Indian lands and resources are protected and maintained for the physical, economic, social, and spiritual well-being of tribes. Tribal lands are not Federal lands and are not set aside or designated for a primary purpose of wildlife refuge, critical habitat for endangered species, or for the protection of other flora or fauna except as it may directly benefit the tribe. As a practical matter, tribal lands comprise some of the most wild and most scenic places on the continent and tribal lands in many cases support a far greater biological diversity than the surrounding public or private lands. Nevertheless, tribal lands are first and foremost homelands to Indian people, established to provide for their traditional, cultural, social, and economic benefit.

The interaction of tribal sovereignty and trust responsibility is complex as tribes and the government struggle to protect Indian trust resources while at the same time respecting the tribes' powers to manage their own affairs. As a result, several Executive Branch administrative directives and orders bear directly on the relationship of the Service and other Interior Department agencies to tribes. The following are examples of these directives and orders (the full text of some of these directives can be found in the appendices):

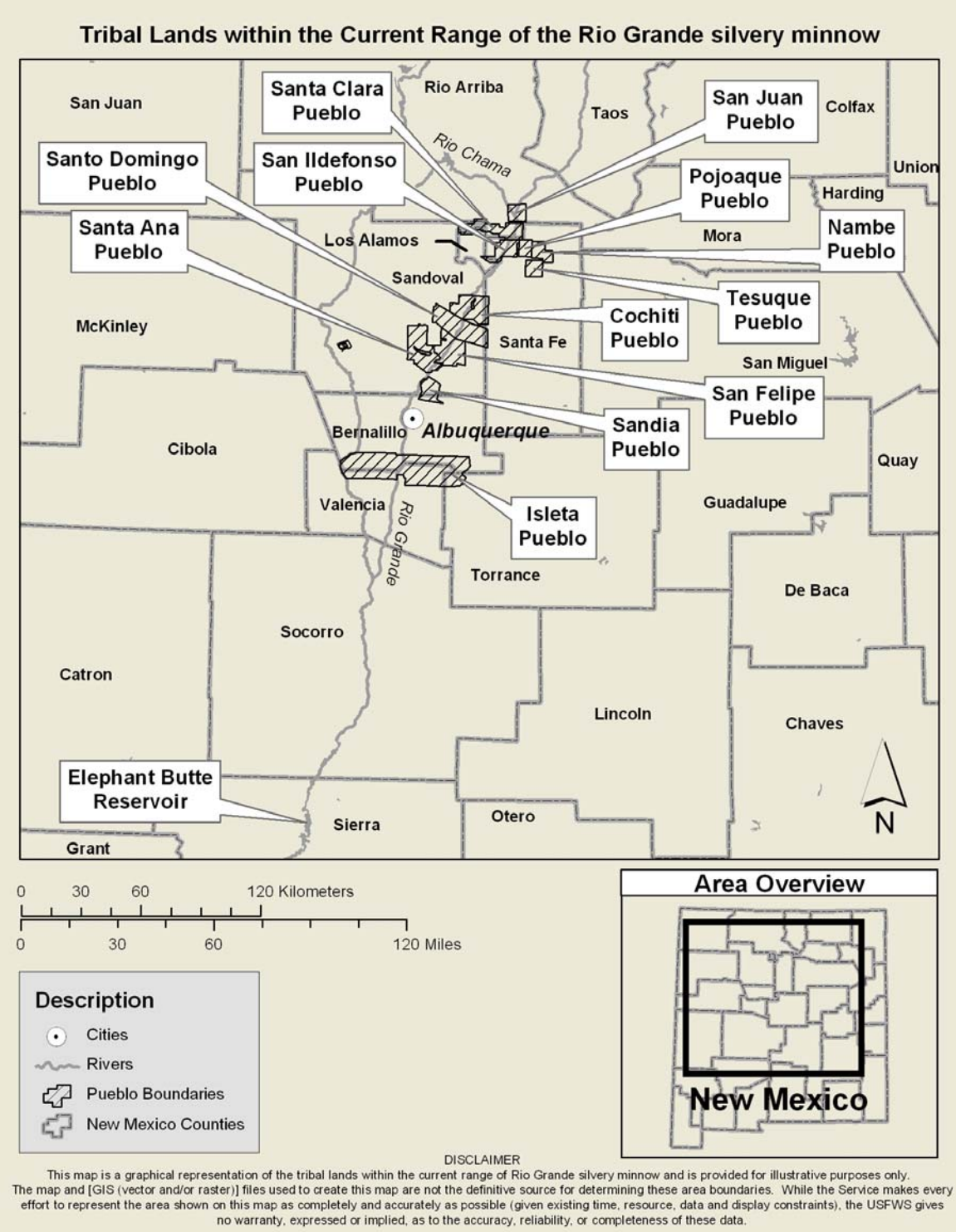

Figure 6. Tribal lands within the Current Range of the Rio Grande Silvery Minnow.

1.11.2.2.1 Secretarial Order 3175 (November 8, 1993) and Interior Department Manual 512 DM2 These documents require all Interior Department agencies to identify potential effects from their activities on Indian trust resources and to havemeaningful consultation with tribes where Department activities affect tribal resources, either directly or indirectly. This Order also directs Interior agencies to remove procedural impediments to working effectively with tribal governments, to consult with tribes on a government-to-government basis where trust resources are affected, and to identify potential effects on Indian trust resources of Department plans, projects, programs, and activities.

1.11.2.2.2 Presidential Memorandum of April 29, 1994 This document reasserts the Federal Indian trust responsibility and requires that all Executive Branch departments and agencies implement their activities in accordance with the government-to-government relationship between Indian tribes and the United States. It requires these departments to consult with tribal governments to the greatest extent practicable prior to taking actions that affect tribal governments; to assess the impact of Federal activities on tribal trust resources, and to ensure that tribal rights and concerns are taken into account during plan development and program implementation (see Appendix A).

1.11.2.2.3 The Native American Policy of the U.S. Fish and Wildlife Service, June 28, 1994 This policy reiterates the government-to-government relationship and establishes a framework for joint projects and formal agreements. It also directs the Service to assist tribes in identifying Federal and non-Federal funding sources for wildlife management activities, and provides a framework for the Service to give technical assistance to tribes, where requested. While the Service has been helpful to tribes from a technical standpoint, many tribes feel that funding for tribally-related wildlife protection activities has been limited and difficult to acquire. The Partners for Fish and Wildlife program has provided some funds, but these are often for small-scale projects.

1.11.2.2.4 Joint Secretarial Order 3206, June 5, 1997 This is perhaps the most far-reaching of the Executive Branch directives and has been very well received by most tribes (see Appendix B). It also has potentially the greatest impact on how tribes and the Federal government manage endangered species. The Order recognizes the value of cooperation between Federal and tribal governments. It also recognizes the jurisdictional tensions inherent in Indian trust resources management. In order to strike a workable balance, the Secretarial Order specifically states that it "shall not be construed to grant, expand, create, or diminish any legally enforceable rights, benefits, or trust responsibilities . . . under existing law", while making clear that it "does not preempt or modify the [U.S. Fish and Wildlife Service's] statutory authorities." It reaffirms the trust and treaty responsibilities of the U.S. government and instructs Federal agencies to "be

sensitive to Indian culture, religion, and spirituality," the basis of which often relies on the use of natural resources. It also reminds Interior departments that Indian lands are not subject to the same controls as Federal lands; instructs them to recognize that tribes are the appropriate governmental entities to manage their lands and resources; and instructs them to support tribal measures that preclude the need for conservation restrictions. At the same time, the Order strives to harmonize tribal concerns and interest about the ESA with Federal mandates to enforce it; and it allows for the tribes to develop their own conservation plans for listed species that are more responsive to tribal needs.

The Order states: The departments shall work directly with Indian tribes on a government-to-government basis to promote healthy ecosystems…Accordingly, the departments shall seek to establish effective government-to-government working relationships with tribes to achieve the common goal of promoting and protecting the health of these ecosystems. Whenever the agencies, bureaus, and offices of the departments are aware that their actions planned under the Act [ESA] may impact tribal trust resources, the exercise of tribal rights, or Indian lands, they shall consult with, and seek the participation of, the affected Indian tribes to the maximum extent practicable. This shall include providing affected tribes adequate opportunities to participate in data collection, consensus seeking, and associated processes.

> …Accordingly, the Departments will carry out their responsibilities under the Act [ESA] in a manner that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the Departments, and that strives to ensure that Indian tribes do not bear a disproportionate burden for the conservation of listed species, so as to avoid or minimize the potential for conflict and confrontation [emphasis added].

1.11.2.2.5 Executive Order No. 13084, May 14, 1998 This Presidential Order instructs all executive branch agencies to establish a process whereby elected officials and other representatives of Indian tribal governments may provide meaningful and timely input into the development of regulatory policies and matters that significantly or uniquely affect their communities. Interestingly, it also instructs agencies, to the extent practicable and permitted by law, to consider any application by a tribal government for a waiver of statutory or regulatory requirements with a general view toward increasing opportunities for flexible approaches to governmental policies. This opportunity for administrative flexibility has the potential to play a key role in how the Service implements endangered species recovery.

1.11.3 Tribal Concerns about the Endangered Species Act

Indian tribes often work closely with the Federal government to meet many natural resource management needs; therefore a wide array of activities on Indian lands can trigger Federal regulation, including ESA section 7 consultations. Consequently, nearly

every type of federally funded or federally approved activity requires consultation measures of one sort or another. While the intent of these regulations is to protect federally listed threatened and endangered species, the regulatory processes can occasionally create a bureaucratic quagmire that can impede projects and conflict with tribal economic development, which has often lagged behind that of non-Indian communities.

In recent years many tribes in the United States have become wary of the intent of the ESA and the manner in which it is applied on tribal lands. Many tribes feel that they have been far better land stewards than the vast majority of private landowners and even some Federal land management agencies, and consequently have a higher proportion of endangered species on their land. In addition, most tribal lands are far less developed (i.e., have a higher proportion of rangelands, forests, or de facto wilderness) than surrounding private or public land. This means that tribal lands have the potential to act as a safe haven for some endangered or rare species, which are driven off surrounding private land as it is developed. Tribes feel that they have been penalized for this good stewardship by having restrictions placed on development activities, and being told what they can and cannot do on their own land, which is viewed as a direct affront to tribal sovereignty. While tribes want to keep vast areas of resource use on their lands, they do not want to be penalized for not having "urbanized" yet.

A more far-reaching concern of tribes is the use of certain federally protected species for religious, cultural, or ceremonial purposes. As an example, considerable conflict has arisen in the past about Indian use of eagle feathers. Some cases have been decided in Federal courts including the U.S. Supreme Court. Nearly all Indian tribes in the United States revere bald and golden eagles and use the birds' feathers or other parts in ceremonies or dances. Bald eagles are federally listed leading to additional restrictions on its take, beyond the Migratory Bird Treaty Act and Bald Eagle Protection Act. Currently, individual tribal members must apply to the Service through the National Eagle Repository to obtain eagle carcasses and feathers, a process that can take as long as 3 to 4 years. While many tribal members understand the need for this process, others view it as a direct affront to religious freedom and feel frustrated by the delays entailed in applying for an eagle. In the past, some latitude has been given to tribes to take such species, although any take may be considered a violation of the ESA, The Migratory Bird Treaty Act, The Lacey Act, or other Federal or State wildlife laws. Again, court cases have led to conflicting interpretations about the circumstances under which a tribe or individual tribal member can "take" a species for cultural or religious purposes, and the type of permit needed. Some tribes are working cooperatively with the Service to allow some of these activities.

Within the context of the ESA, many previous endangered species recovery plans have done an inadequate job of integrating tribal concerns. While some tribes were included at the level of "stakeholders" or "interested parties," their participation, comments, or suggestions carried little, if any weight, in the development of recovery plans. For example, the Tulalip Tribes of the Pacific Northwest have charged that they were largely ignored in the section 7 consultation process during the development of a major habitat

conservation plan. Several tribes in the Southwest were upset to find that critical habitat for the Mexican spotted owl had been proposed on tribal land without prior consultation. Critical habitat for Rio Grande silvery minnow was also proposed on pueblo lands in New Mexico despite the objections of tribal leaders, and the Service set forth on a path for Rio Grande silvery minnow augmentation plans affecting pueblo lands without any prior consultation with the affected pueblos. Many other examples exist where tribes were inappropriately brought into the endangered species recovery process due to a lack of meaningful consultation and inadequate time for the review of proposed actions. Instances such as these may have been more appropriately handled simply through better communication. Many tribes are striving to alleviate some of these communication problems through increased cooperation.

1.11.3.1 Endangered Species and Tribal Water

Tribes continue to closely monitor the potential ramifications of Rio Grande silvery minnow recovery on water rights, water availability, and water use. Like all governments, and many private landowners, tribes make active use of the region's limited water supplies for economic development, municipal requirements, farming, ranching, and recreation. Most importantly, the pueblos/tribes continue to have a unique and spiritual relationship with the Rio Grande, which emphasizes their strong traditional and cultural ties to the river. In a region where water is limited, yet vital to the needs of many, battles over who controls how much water are inevitable. Tribes along the Rio Grande continue to be involved in issues surrounding other endangered species, like the Southwestern willow flycatcher, and while they are generally supportive of the conservation of ecosystems upon which endangered species depend, they are nevertheless wary of being forced to shoulder a disproportionate share of the burden for their recovery.

For tribes, the issues surrounding the recovery of the Rio Grande silvery minnow including the requirements of ensuring sufficient water to sustain the species are inextricably linked to water rights. In all but a few instances in the Southwest, Indian water rights are senior to those of all other users. Specifically, water rights for Indian pueblos in New Mexico include congressionally established, historic use, federally reserved (Winters Doctrine) and, in some instances, contractual water rights, most of which are vested, recognized, and protected under Federal law.

The lack of funding, as well as the complicated and cumbersome process of water rights negotiations, means that significant water rights claims within many basins and river systems are largely unadjudicated. Despite this, water development and management have continued to rapidly expand through the construction of dams and reservoirs, diversion structures, irrigation systems, and municipal water use facilities. When and if water rights within the Rio Grande basin are adjudicated, it is clearly the intent of the tribes to advocate for and secure their rights to sufficient quantities of water required to sustain their reservations as permanent homelands for their current tribal members and for future generations.

Indian water rights are not subject to forfeiture due to non-use, and thus may be exercised at any time in the future, while still retaining their senior priority. The use of water in the Rio Grande by Indian tribes has not contributed to the decline of species. As tribes continue to use their vested federally reserved and aboriginal water rights, they are sometimes criticized for exercising these rights. According to some endangered species proponents, tribal/pueblo use of water could negatively affect listed species. It is inevitable that as pueblos/tribes continue to embark on new economic development on their lands, there will be growing demands on limited water resources in the Rio Grande basin. It is also likely that as tribes secure their rights to the water within the Rio Grande they will become a significant factor in sustaining river flows and as a result may directly and indirectly contribute beneficially to the ecological integrity of the Rio Grande.

1.11.3.2 Federal/Tribal Cooperation on Endangered Species

The diversity of opinion about Federal/tribal relations has led to a contentious history of differing interpretations over Federal/tribal resource jurisdiction. Nevertheless, the Service and many tribes have expressed a willingness to work together on endangered species issues. Within the last few years, many tribes have gained considerable natural resource management expertise and the Service and other Federal agencies are now recognizing and acknowledging this expertise. Tribes have benefited substantially by having more opportunities to directly participate on a broader level in various work groups and collaborative efforts administered by Federal agencies such as BOR, the Service, and the U.S. Environmental Protection Agency (EPA). Many Federal agencies have established Native American Liaison positions and now offer entire tribal programs. The overall intent of recently issued Federal directives is to establish policies whereby input from tribes can become a regular and critical part of resource planning initiatives, and to encourage more tribal participation. Tribes welcome these changes, utilizing them when it is in their best interest.

Some tribes have moved forward in an effort to establish new parameters in the way Indian nations and the Service interacts regarding issues of mutual concern. The Pueblo of Santa Ana has executed a Safe Harbors Agreement with the Service, the first in the United States between the Service and an Indian tribe. The White Mountain Apache Tribe, San Carlos Apache Tribe, Tohono O'odham Nation, and Pueblo of Zuni have established Statement of Relationships (SORs) with the Service. All these activities have served as models for other Pueblos/Tribes/Indian Nations. These documents establish a framework by which the Service and the tribes will recognize differences of opinion and interpretation, and will work through problems toward a common goal of promoting biodiversity and healthy ecosystems. The Pueblo of Santa Ana's Safe Harbors Agreement recognizes the Pueblo's intensive efforts in restoring its ecosystem, its partnership with the Service in significantly increasing and improving endangered species habitat, and the Pueblo's primacy in managing its resources for ecosystem enhancement and sustainability. The SOR reaffirms tribal sovereignty, while recognizing the Service's technical expertise and willingness to assist tribes with complex management issues. These initiatives have become possible in part because tribes have invested in and increased technical capabilities and infrastructure, and as a result a new framework for open dialogue has been developed. Tribes are now encouraged that many of the issues

that they have been advocating are now being taken seriously. Central to this approach is the Service's use of some of its administrative flexibility to work with tribes and establish mutually satisfactory solutions to controversial resource management issues. One example of this approach is the Pueblo of Zuni's construction of the first Native American-owned eagle aviary to alleviate the wait for eagle feathers for tribal members. Through the cooperation and assistance of the Service, permits were obtained within a reasonable time frame. Another example is the Service acknowledging the White Mountain Apache Tribe's inherent right to manage its natural resources, including endangered species. This acknowledgement has supported the tribe's pro-active approach to addressing endangered species on tribal lands, which includes the development of management plans and integration of the ESA in their overall natural resource goals and objectives. Because these proactive approaches strengthen tribal self-sufficiency and sovereignty, other tribes throughout the southwest are considering adopting these approaches to help resolve ESA issues on tribal land. These are good examples of how the Service can utilize its administrative flexibility to assist tribes in adopting a unique and innovative solution to a unique problem.

Tribes are now striving to have a greater voice in endangered species recovery. When the initial steps were taken toward a recovery plan for the Southwestern willow flycatcher, tribes expressed dismay at the lack of direct tribal involvement. Tribes believed that their voices were being unduly diluted; given the potential effect recovery efforts for the flycatcher could have on tribal land. This issue was later rectified by the formation of a tribal subgroup. Learning from that experience, the Service created a tribal subgroup as part of the Rio Grande silvery minnow recovery team, with the responsibility to interject tribal perspectives into the Rio Grande silvery minnow recovery plan. Under Secretarial Order 3206, tribes have considerable authority to manage endangered species on Indian lands. Under the auspices of tribal sovereignty, individual tribes have more authority to manage endangered species than the individual states. If a tribe is not satisfied with the process, it can choose not to participate and instead develop its own plan.

Given the tentative nature with which tribal leaders and land mangers have approached endangered species issues, there are several reasons why the Rio Grande silvery minnow recovery plan gives us cause for optimism. The goal of the recovery process is not only higher populations of this fish but also restored riverine habitat. For many tribes in the Southwest, rivers and streams that cross their land provide critical areas for traditional plant and animal collection, recreation, and cultural and religious use. Tribes see riparian and riverine protection as an excellent long-term goal. In only a few generations, tribes have seen these areas severely degraded, mainly from human-induced changes. Some of these changes have unquestionably provided benefits to tribes, although the tribes had no say in the activities. To restore riparian and wetland habitat and to improve this critical ecosystem may be a goal that all tribes in the region can support if the Service is respectful of tribal sovereignty throughout the recovery process for the Rio Grande silvery minnow.

Tribal leaders, as well as tribal resource managers, have been tentative in their approach to endangered species issues. Concerns that tribes have with endangered species

conservation include infringement on their status as self-sufficient, sovereign nations by being forced, either directly or indirectly to protect, conserve, and manage their resources for the benefit of Federally listed species. As a result of tribes complying with the ESA, the management of tribal natural resources for the expressed benefit of its tribal members could be potentially compromised.

The goal of the recovery process, of course, is not only to restore endangered species populations, but also to improve their habitats. In situations where water is a key element to species recovery, such as is the case for the Rio Grande silvery minnow and the Southwestern willow flycatcher, tribal involvement in the conservation of these species may be vital to their continued existence.

1.11.4 Future Needs and Directions

The current climate presents opportunities for significant improvement over what has been a contentious history. The Service and other Interior agencies have considerable administrative flexibility to work cooperatively with tribes and more actively seek their input and guidance when dealing with endangered species and other region-wide initiatives. Some of the Executive Orders and Directives instruct agencies to use this flexibility. It should be remembered that even if a project or consultation may not appear to affect a tribe's resources, there may be aspects of the situation that are not immediately apparent. These include recognition of all tribal water rights, including but not limited to Prior and Paramount and aboriginal water rights, water quality standards, water management, and traditional and cultural resources that may give a tribe a stake in the management of these resources outside of trust lands.

The Service has taken great strides to achieve concrete results. Tribes applaud the appointment of several tribal members to serve as Native American Liaisons within the Service, and the creation of Interior Department directives, which are favorable to a more cooperative relationship.

1.11.4.1 Recommendations for Enhancing Meaningful Tribal Participation in Relation to the Endangered Species Act

> 1. Ensure Effective Communication. Many of the past problems outlined in this paper could be avoided with early, open, and honest communication. As stated in Secretarial Orders 3206 and 3175, tribes must be kept involved and informed at all levels and treated as equal partners. To accomplish this, tribes must be involved at the earliest stages of planning; contact with tribes should be frequent; any and all related information must be provided to the tribes for their review; appropriate contacts at all levels must be maintained; and finally, tribes must have sufficient time to review, discuss, and have the opportunity to engage in formal government-to-government consultation. Agencies are reminded that Indian tribes and tribal leaders shall not be viewed as part of the general public, but rather must be dealt with on a government-to-government basis. Agency personnel who are required to communicate and maintain working relationships with tribes must have appropriate training and knowledge in tribal communication

protocols; and because all tribes are unique, it is important that individuals be aware of each tribe's culture and customs. The Service should err on the side of consulting and communicating with tribes prior to taking action, rather than assuming an action will not affect a tribe.

2. Promote Incentives for Endangered Species Act Conservation. Tribes generally have the perception that they are unjustly penalized for not engaging in large scale land and resource development on their lands and as a result, tribal lands often maintain pristine habitats that support a variety of endangered species. Consequently, tribes are often faced with designation of critical habitat on tribal land, and are required to prepare ESA management plans or otherwise justify exclusion from critical habitat designation. Therefore, the presence of endangered species on tribal lands is often considered as a liability, a view also commonly held by non-Indian governments as well as private landowners. Tribes reject the notion that management of their lands should be dictated by and revolve around Federal directives for endangered species management, instead of fulfilling tribal needs and desires. Short of exempting tribes from the ESA, incentives and alternatives need to be provided to tribes that will allow them to continue managing tribal lands and resources in accordance with their own goals and objectives. An example of this would be the development of an Ecosystem Management Plan that addresses a holistic approach rather than a species-specific approach.

3. Protect Tribal Water Rights. The protection of endangered species should not diminish the importance of water to pueblos/tribes in maintaining their traditional and cultural values and their economic livelihood for future generations. Where a species is affected by a Federal water project, the courts have held that the projects must be operated consistent with the protection of senior Indian water rights. Any discussion of water resources and any development of recovery plans that dictate or even imply a change in water use should be conducted on a government-to-government basis with each affected pueblo/tribe, taking into full account vested tribal water rights and water resources. Specifically, when developing an environmental baseline by which to gauge the status or trends in a species' population, tribal water rights must be factored in regardless of whether those already vested water rights have been fully exercised. Before Indian water rights are affected, junior users should bear the brunt of restrictions. However, given the lengthy and complicated nature of water rights negotiations or adjudication, parties should not let unresolved water rights issues hold up conservation measures.

4. Seek Other Conservation Options in Lieu of Critical Habitat Designation on Tribal Lands. There is a consensus among most Indian tribes that opposes critical habitat designation on their lands. The arguments against designation include infringement of Federal government policies and regulations on tribal sovereignty, disregard of tribal authority to manage their natural resources in accordance with their goals and objectives, disregard of the potential economic

impacts that are placed on tribes, direct conflict between ESA and tribal resource management goals, the lack of Federal funding to conserve endangered species, and finally, the question of whether or not the ESA applies to tribal lands.

Developing cooperative or conservation agreements between tribal governments and the Service that specifically address endangered species conservation on tribal lands could serve as a mechanism to establish partnerships that would enhance the survival of listed species, while providing tribes the flexibility and option to determine the extent of their involvement in ESA conservation. These agreements could detail commitments tribes are willing to make to protect and manage listed species and could also detail commitments the Service would make to assist tribes in addressing the ESA on tribal lands. Formal agreements may not be necessary when tribal actions already meet mutually beneficial goals. The Service should, whenever possible, defer to existing natural resource conservation management underway by tribes.

Prior to considering any lands for critical habitat, the Service should inform tribal governments of their intent to designate and should initiate the process in a manner that will ensure that tribes have all necessary information to provide meaningful input. Tribal input should include formal government-to-government consultation with tribal leadership, as well as meetings with their technical representatives. Discussions should include alternatives tribes can consider to avoid designation, and also ways that the Service can directly or indirectly assist in fulfilling tribal desires.

5. Establish Funding Sources. Developing and maintaining endangered species conservation programs require not only a long-term commitment on the part of the management agency, but also a considerable commitment of resources. Lack of adequate funding is frequently a major reason why tribes are reluctant to engage in endangered species conservation. A considerable burden is often placed on tribal resources because of the need to comply with ESA issues that either directly or indirectly affect them. Tribal resources are expended when tribes are forced to seek exemptions from critical habitat designation, are required to conduct endangered species surveys in order to perform projects, or must participate in ESA-related meetings, programs, and initiatives. Indian tribes have limited funding sources or funding opportunities for endangered species. Although the recovery and conservation of endangered species is a Federal responsibility and mandate, the burden of implementing conservation measures is all too often placed on Indian tribes.

Funding sources to assist tribes in addressing ESA conservation efforts on tribal lands should be established, such as expansion of the Service's Partners for Fish and Wildlife Program or the Middle Rio Grande Endangered Species Act Collaborative Program to specifically address ESA conservation on tribal lands. The Interior Department should consider the identification of ESA funds to be transferred to the Bureau of Indian Affairs for tribes/pueblos to be utilized

through the PL 93-638 process. Any proposed amendments to the ESA should include provisions for the use of Federal funds for recovery or species management by tribes/pueblos under section 6 of the ESA.

6. Implement Secretarial Order 3206. This directive has been extremely positive and defines the tribal/Federal relationship over endangered and sensitive species, and should be upheld and utilized as a mechanism for open dialogue between Federal agencies and tribal governments. This directive also recognizes that Indian tribes are the appropriate governmental entities to manage their lands and tribal trust resources.

Specifically, in regards to recovery, Secretarial Order 3206 directs Interior Departments to:

a. Solicit and utilize the expertise of affected Indian tribes by having tribal representation, as appropriate, on Recovery Teams when the species occurs on Indian lands (including tribally-owned fee lands), affects tribal trust resources, or affects the exercise of tribal rights.
b. In recognition of tribal rights, cooperate with affected tribes to develop and implement Recovery Plans in a manner that minimizes the social, cultural and economic impacts on tribal communities, consistent with the timely recovery of listed species. The Services shall be cognizant of tribal desires to attain population levels and conditions that are sufficient to support the meaningful exercise of reserved rights and the protection of tribal management or development prerogatives for Indian resources.
c. Invite affected Indian tribes, or their designated representatives, to participate in the Recovery Plan implementation process through the development of a participation plan and through tribally designated membership on recovery teams. The Services shall work cooperatively with affected Indian tribes to identify and implement the most effective measures to speed the recovery process.
d. Solicit and utilize the expertise of affected Indian tribes in the design of monitoring programs for listed species and for species that have been removed from the lists of endangered and threatened wildlife and plants occurring on Indian lands or affecting the exercise of tribal rights or tribal trust resources.

7. Respect Cultural Values. Many tribal religious, social, and cultural beliefs are based on the concept of reverence for the earth and all its creatures. In addition, all Native American cultures utilize wildlife and wildlife parts in practicing their traditional and cultural ways. Because certain wildlife species are federally protected, issues can potentially arise that are extremely sensitive. In order to promote and maintain effective communications and working relations with the tribes, Federal and State agencies must be continually sensitive to these values. Care and tact must be used in discussing issues that relate to cultural and traditional practices.

8. Promote Multiple-Use Land Management. Caring for and protecting the environment is paramount to tribal land managers. In promoting this philosophy, tribes generally desire to control the use of their own land, while practicing multiple-use resource management. Woven into the culture are activities such as hunting, fishing, ranching, and farming, which are just as much a part of the value system and way of life as is environmental protection. As stated earlier, many tribes feel that they are affected disproportionately by laws such as the ESA, especially when extensive development on non-Indian lands occurs, leaving tribal lands as refuges for endangered species and consequently preventing tribes from engaging in economic developments on their homelands.

9. Ensure Confidentiality of Tribal Information. All tribes have serious concerns regarding endangered species information that is gathered on tribal land and has consequently inhibited effective cooperative relations with other management agencies. Tribes need to be assured that information collected on tribal lands during the course of research, inventories, and other management activities will not be subject to disclosure to the general public. The tribe must hold discretion over who has access to tribal data and other relevant information. This is especially the case when information has cultural and traditional significance. The confidentiality of information is an important cornerstone of tribal sovereignty, self-governance, and spiritual and religious power. Unfortunately, recent court decisions have undermined the tribe's ability and desire to maintain sensitivity over certain information collected through cooperative efforts, especially when tribes utilize Federal funding to collect information.

1.11.4.2 Specific Recommendations for Implementing Rio Grande Silvery Minnow Recovery on Tribal Lands

While the above recommendations address the implementation of the ESA on tribal lands in general, several specific recommendations for implementing Rio Grande silvery minnow recovery are provided below.

1. A tribal liaison should be a voting member of the Rio Grande silvery minnow technical team. While the technical team currently represents some of the most knowledgeable fisheries biologists in the field, tribal resource managers can provide a perspective that could assist in the recovery efforts. Because tribal lands are strategically located within areas potentially occupied by Rio Grande silvery minnows, habitat conditions on tribal land could provide potential benefits to the minnow. Tribal resource managers can therefore provide invaluable technical insight based on practical knowledge that could have positive implications to other areas of the minnow's range. Having a tribal representative who is able to articulate tribal interests can alleviate some of the concerns and discomfort tribes have in dealing with the Service. Establishing tribal sub-teams as part of recovery efforts can also serve as a mechanism to encourage more meaningful tribal participation and input.

2. Opportunities should be made available to tribal resource managers, through State, Federal, and private entities, to obtain technical training to collect biological information on tribal lands. Training should include, but not be limited to, the use of appropriate sampling techniques and inventory protocols. In situations where tribal programs may not have adequate technical staff, agencies or other entities engaged in data collection activities should be encouraged to provide assistance to tribes to gather scientific data specific to the Rio Grande silvery minnow for management purposes. Many tribal resource management programs generally lack proper equipment to conduct field data collections. To assist tribes in accomplishing information gathering, functional surplus equipment should be made available to tribes, and/or opportunities provided to tribal resource programs to have access to agency equipment by means of loans or the purchase of equipment specifically for tribal use.

3. Because of the sensitivity of tribal data, information collected on tribal lands should remain in the possession of tribes. Divulging or sharing of tribal information must be at their discretion. Tribes will determine the nature of information and the accessibility restrictions on tribal sensitive data. It is vital that agencies or individuals who are permitted to access tribal data have a clear understanding that regardless of whether the information is general or specific, it must be considered confidential and distributed or shared appropriately only upon written permission from the tribe. Tribes who engage in Rio Grande silvery minnow habitat or population data collection are encouraged to be proactive in managing their resources; in accomplishing this, it could be beneficial for tribes to share some information with other management agencies. One way of sharing data could be through the establishment of technical work groups, consisting of tribal and agency biologists. Such a workgroup could, at the request of the tribes, assist in data collection as well as other Rio Grande silvery minnow conservation activities. The extent of cooperation could be defined by means of written agreements, which must also contain information confidentiality protocols.

4. If a tribe has a Rio Grande silvery minnow recovery plan or is thinking about developing one, it should strongly consider implementing a tribal resource management plan reviewed by the Service in compliance with section 7 of the ESA.

5. Funding sources must be made available to tribes to assist them in conducting habitat and population assessments on tribal land. If tribes have the technical capability, they should be encouraged to carry out all assessments on tribal lands. If a tribe does not have the in-house technical expertise necessary to conduct the fieldwork, funding should be made available to the tribes to develop technical capacity or to have the option to hire appropriate expertise.

6. Several pueblos in the middle Rio Grande have developed Rio Grande silvery minnow Management Plans. These plans identify activities the tribes will engage in to assist in the conservation and management of minnows and minnow habitat.

These management plans, which have been reviewed and accepted by the Service, were developed to promote a proactive approach to the ESA and to preclude the need for designation of critical habitat on tribal lands. Because each pueblo is unique, each management plan is likewise unique in its approach to Rio Grande silvery minnow management. Tribes have demonstrated that they are fully capable of managing their own natural resources. Tribes therefore have a vested interest and desire to contribute to Rio Grande silvery minnow recovery, while also promoting tribal self-sufficiency and maintaining their sovereign status. How effective these plans are in the conservation of the Rio Grande silvery minnow depends on the availability of funding for implementation.

7. Recovery efforts for the Rio Grande silvery minnow may include population augmentation and possibly the establishment of experimental populations. Consequently, it is highly likely that pueblos that have lands along the mainstem of the Rio Grande will be directly affected by these recovery actions. It is imperative that each tribe be consulted on a government-to-government basis (i.e., Secretarial Order 3206 and Presidential Memorandum of April 29, 1994). Each affected tribe may, at its discretion, allow access to tribal lands followed by Rio Grande silvery minnow releases. Although it is the prerogative of each tribe to either participate or not participate in Rio Grande silvery minnow augmentation or establishment of experimental populations, it is of paramount importance that the Service clearly explain and discuss with all tribes the processes involved as well as the potential implications that could result from these actions, prior to the Service making any decisions or taking any action that might possibly impact tribal rights and resources.

8. Suggestions for region-wide water conservation should be included in the recovery plan. Protection of endangered species does not always automatically mean a total abandonment of all forms of development or severe impacts to tribal and non-tribal water rights. If species can be protected through conservation measures, this is always preferable to other alternatives and there may be relatively little change in the way sustainable development is carried out. In the case of the Rio Grande silvery minnow, water conservation may play a significant role in assuring that tribes continue to use water to their advantage while still offering a means of protection to listed species. The Service should always strive to ensure that implementation of any Rio Grande silvery minnow conservation measures not result in an adverse impact to a tribe's exercise of it aboriginal, Prior and Paramount, or federally reserved water rights.

9. It is the prerogative of each individual tribe to participate in the recovery process. Any tribe involved in the recovery process has the option of sharing information related to the Rio Grande silvery minnow recovery process.

It is believed the recommendations provided above will help to alleviate some tribal concerns, and will allow tribes to more effectively participate and contribute positively to the conservation and preservation of ecosystems. Considering the

positive atmosphere that is presently emerging within the Service and the desire among many tribal leaders and resource managers to be proactive in the management of tribal resources, it is important that this opportunity be cultivated into a cooperative partnership that will continue fostering sound natural resources conservation and a healthy environment, while strengthening the sovereignty and self-sufficiency of tribal governments.

2.0 RECOVERY STRATEGY

As described in the previous section, the Rio Grande silvery minnow's range and abundance have become severely limited due to a number of factors. Primary among these are habitat degradation (extensive channel drying, disruption of the natural hydrograph by water control structures, and changes in stream morphology) and habitat fragmentation (division of the habitat into discrete sections by water control structures).

This section and those that follow it (Sections 2.0, 3.0, 4.0, and 5.0) describe the recovery plan for the Rio Grande silvery minnow, as developed by the Rio Grande Silvery Minnow Recovery Team. Included are:

- an overall strategy (below);
- the goals of the plan (prevention of extinction, downlisting, and eventual delisting), the objectives that must be achieved to meet those goals, and the criteria by which the objectives will be measured (Section 3.0);
- the management actions that will lead to recovery of the species (Section 4.0);
- an explicit description of how the recovery plan addresses the threats to the species (Section 5.0); and
- an implementation schedule, including time estimates, responsible parties, and estimated costs (Section 6.0).

The Rio Grande silvery minnow recovery plan takes a three-pronged approach: 1) implement immediate steps (actions) that are needed to prevent the extinction of the species; 2) implement steps that will allow downlisting of the species from endangered to threatened; and 3) implement steps that will allow the eventual removal of the species from the List of Endangered and Threatened Wildlife (delisting). The steps within these approaches are not necessarily distinct from one another. In most cases, for example, actions taken immediately will contribute to the conditions that will eventually allow for delisting.

All of the actions outlined in Section 4.0 are necessary for the recovery of the Rio Grande silvery minnow. The most important and overarching actions are below.

1. Develop additional, detailed knowledge of the biology of the species and the habitat upon which it depends. This information is crucial to implementing other actions in the program.

2. Restore and protect the habitats used by the species, and protect and expand the existing populations, by means of the following:
    - strategic habitat modifications to provide proper habitat at low flows;
    - new strategies to provide water needed by the species;

- habitat restoration activities and a comprehensive program of propagation and augmentation (including establishing at least two new populations);

3. Follow an adaptive management approach throughout the recovery process, to ensure that research and management actions are implemented in a timely manner and adjusted as necessary.

4. Implement monitoring efforts throughout the recovery process, to track progress toward recovery and through delisting and post-delisting.

5. Implement public awareness and education programs to ensure that all interested parties are informed of the need for and rationale for recovery actions, to enlist their support for the program. This will include a standardized, publicly accessible database for information concerning the Rio Grande silvery minnow.

In addition to the strategy outlined above, the Rio Grande Silvery Minnow Recovery Team recognizes the need for long-term management of the habitat and the species once delisting is accomplished, and calls for the eventual development of a monitoring and management plan for water and habitat.

3.0 RECOVERY GOALS, OBJECTIVES, AND CRITERIA

The Rio Grande Silvery Minnow Recovery Team has developed a set of detailed recovery goals, objectives, and criteria for the Rio Grande silvery minnow. The *recovery goals* reflect the desired outcome of this plan – prevention of extinction, downlisting the species, and delisting the species. The *recovery objectives* describe the conditions that are necessary to achieve those goals. The *recovery criteria* describe the desired values for those conditions, and have been established for each recovery objective.

This section of the recovery plan describes the recovery goals, objectives, and criteria in detail. (These elements are also presented in graphical form in Table 1.) Section 4.0, Recovery Program, describes the actions that must be taken over the next several years to reach these goals, objectives, and criteria.

3.1 Recovery Goals

Three goals have been established for the recovery of the Rio Grande silvery minnow:

- **Recovery Goal 1.** Prevent the extinction of the Rio Grande silvery minnow in the middle Rio Grande of New Mexico.

- **Recovery Goal 2.** Recover the Rio Grande silvery minnow to an extent sufficient to change its status on the List of Endangered and Threatened Wildlife from endangered to threatened (downlisting).

- **Recovery Goal 3.** Recover the Rio Grande silvery minnow to an extent sufficient to remove it from the List of Endangered and Threatened Wildlife (delisting).

3.2 Recovery Objectives and Criteria

Recovery Goal 1: Prevent the extinction of the Rio Grande silvery minnow in the middle Rio Grande of New Mexico.

Recovery Objective 1-A. A middle Rio Grande population at a level sufficient to prevent extinction, as defined by criteria related to population distribution, population size, and annual reproduction.

Recovery Criteria 1-A-1
Using the standard annual sampling protocol (Appendix H), and sampling at a minimum of 20 representative sites:

- Document the presence of Rio Grande silvery minnow (all unmarked fish) at ¾ of all sites sampled in the middle Rio Grande of New Mexico during October;
  or
- Document sub-populations of an estimated minimum 500,000 unmarked fish each (with an assumed effective population size of 500) in the Angostura and Isleta reaches of the middle Rio Grande during October, and an estimated minimum sub-population of 100,000 in the San Acacia Reach; these may also be defined as sub-populations in which the lower boundary of a 95 percent confidence interval of October catch per unit effort (CPUE) data from all sites within each reach is > 1 fish/100 m^2.

Recovery Criteria 1-A-2
Annual reproduction in the middle Rio Grande below Cochiti Reservoir, as indicated by the presence of young-of-year.

Recovery Objective 1-B. A captive population sufficient to prevent extinction.

Recovery Criteria 1-B-1
A captive population of 50,000 to 100,000 fish.

Recovery Goal 2: Recover the Rio Grande silvery minnow to an extent sufficient to change its status on the List of Endangered and Threatened Wildlife from endangered to threatened (downlisting).

Recovery Objective 2-A. Three populations (including at least two that are self-sustaining) in the Rio Grande silvery minnow's historical range, as defined by criteria related to population distribution, population size, and annual reproduction.

Recovery Criteria 2-A-1
1. Using the standard annual sampling protocol (Appendix H), and sampling at a minimum of 20 representative sites:

- Document the presence of Rio Grande silvery minnow (all unmarked fish) at ¾ of all sites sampled in the middle Rio Grande of New Mexico in October, for five consecutive years (based on minnow population dynamics);
  or
- Document sub-populations of an estimated minimum 500,000 unmarked fish (with an assumed effective population size of 500) in each of three reaches of the middle Rio Grande (Angostura, Isleta, San Acacia) in October, for five consecutive years; these may also be defined as populations in which the October CPUE data from all

monitoring sites within each reach is >5 fish/100 m^2, for five consecutive years.

2. Two additional populations of Rio Grande silvery minnow, in the historical range of the species, but outside of the middle Rio Grande of New Mexico, each composed of a minimum of 500,000 unmarked fish (each with an assumed effective population size of 500), for five consecutive years.

Recovery Criteria 2-A-2
Annual reproduction in all three populations, as indicated by the presence of young-of-year, for five consecutive years.

Recovery Objective 2-B. Habitat sufficient to support three such populations, as defined by criteria related to river base flow and hydrographs.

Recovery Criteria 2-B-1
River management that provides flows in each of the populated reaches sufficient to maintain the populations (self-sustaining or managed), for five consecutive years.

Recovery Criteria 2-B-2
Hydrographs and floodplain inundation sufficient to support spawning and recruitment as specified in Criteria 2-A-1 and 2-A-2, for five consecutive years.

Recovery Objective 2-C. A captive population sufficient to support augmentation needs.

Recovery Criteria 2-C-1
A captive population of 50,000 to 100,000 fish.

Recovery Objective 2-D. Water quality that is sufficient to support three such populations, as defined by criteria related to State and Federal water quality standards.

Recovery Criteria 2-D-1
Achieve water quality criteria pursuant to the Federal Water Pollution Control Act, as amended, in addition to State and tribal water quality standards, in currently occupied and potential Rio Grande silvery minnow habitat.

Recovery Goal 3: Recover the Rio Grande silvery minnow to an extent sufficient to remove it from the List of Endangered and Threatened Wildlife (delisting).

Recovery Objective 3-A. Three self-sustaining populations within the Rio Grande silvery minnow's historical range, as defined by criteria related to population distribution, population size, and annual reproduction.

Recovery Criteria 3-A-1

1. Using the standard annual sampling protocol (see Appendix H), and sampling at a minimum of 20 representative sites:

- Document the presence of Rio Grande silvery minnow (all unmarked fish) at ¾ of all sites sampled in the middle Rio Grande of New Mexico in October, for ten consecutive years;
  or
- Document sub-populations of an estimated minimum of 500,000 unmarked fish (with an assumed effective population size of 500) in each of three reaches of the middle Rio Grande (Angostura, Isleta, San Acacia) in October, for ten consecutive years; these may also be defined as populations in which the October CPUE data from all monitoring sites within each reach is >5 fish/100 m^2, for ten consecutive years.

2. Two additional populations of Rio Grande silvery minnow, in the historical range of the species, but outside of the middle Rio Grande of New Mexico, each composed of a minimum of 500,000 unmarked fish (each with an assumed effective population size of 500), for ten consecutive years.

Recovery Criteria 3-A-2

Annual reproduction in all three populations, as indicated by the presence of young-of-year, for ten consecutive years.

Recovery Objective 3-B. Habitat sufficient to support three such populations, as defined by criteria related to river base flow and hydrographs.

Recovery Criteria 3-B-1

River management that provides flows in each of the populated reaches sufficient to maintain the population, for ten consecutive years.

Recovery Criteria 3-B-2

Hydrographs and floodplain inundation sufficient to support spawning and recruitment as specified in Criteria 3-A-1 and 3-A-2, for ten consecutive years.

Recovery Objective 3-C. Water quality that is sufficient to support three such populations, as defined by criteria related to State and Federal water quality standards.

Recovery Criteria 3-C-1
Achieve water quality criteria pursuant to the Federal Water Pollution Control Act, as amended, in addition to State and tribal water quality standards, in currently occupied and potential Rio Grande silvery minnow habitat.

For the purposes of this document, a *self-sustaining population* is defined as one that can sustain a specified population level without augmentation with captive-bred fish. A *managed population* is one that requires some augmentation to sustain specified population numbers.

Table 1. Summary of Rio Grande Silvery Minnow Recovery Goals, Objectives, and Criteria (for exact language of objectives and criteria, see the previous section).

RECOVERY GOALS	**RECOVERY OBJECTIVES**	**RECOVERY CRITERIA**
1. Prevent extinction of Rio Grande silvery minnow in the middle Rio Grande of New Mexico.	**1-A.** A middle Rio Grande population at a size sufficient to prevent extinction.	**1-A-1.** presence of fish (all unmarked) at ¾ of sampling sites in middle Rio Grande (NM) in October; *or* minimum sub-populations of 500,000 unmarked fish in Angostura and Isleta reaches and 100,000 in San Acacia Reach in October (may be expressed as sub-populations in which the lower boundary of 95 percent confidence interval of October CPUE data from all sites within each reach >1 fish/100 m^2). **1-A-2.** Annual reproduction below Cochiti Reservoir, as indicated by presence of young-of-year.
	1-B. A captive population sufficient to prevent extinction.	**1-B-1.** A captive population of 50,000 to 100,000 fish.
2. Recover the Rio Grande silvery minnow to an extent sufficient to change its status on the List of Endangered and Threatened Wildlife from endangered to threatened (downlisting).	**2-A.** Three populations (including at least two that are self-sustaining) in the species' historical range.	**2-A-1.** 1. presence of fish (all unmarked) at ¾ of all sites sampled in the middle Rio Grande (NM) in October, for five consecutive years; *or* minimum sub-populations of 500,000 unmarked fish in Angostura, Isleta, and San Acacia reaches in October, for five consecutive years (may be defined as populations in which the October CPUE data from all monitoring sites within each reach is >5 fish/100 m^2, for five consecutive years. 2. Two additional populations in the historical range of the species, but outside of the middle Rio Grande of New Mexico, each composed of a minimum of 500,000 unmarked fish, for five consecutive years.

RECOVERY GOALS	RECOVERY OBJECTIVES	RECOVERY CRITERIA
		2-A-2. Annual reproduction in all three populations, as indicated by the presence of young-of-year, for five consecutive years.
	2-B. Habitat sufficient to support three such populations.	**2-B-1.** River management that provides flows in each of the populated reaches sufficient to maintain the population (self-sustaining or managed), for five consecutive years. **2-B-2.** Hydrographs and floodplain inundation sufficient to support spawning and recruitment as specified in the population criteria, for five consecutive years.
	2-C. A captive population sufficient to support augmentation needs.	**2-C-1.** A captive population of 50,000 to 100,000 fish.
	2-D. Water quality sufficient to support three such populations.	**2-D-1.** Achieve water quality criteria pursuant to the Federal Water Pollution Control Act, as amended, in addition to State and tribal water quality standards, in currently occupied and potential Rio Grande silvery minnow habitat.
3. Recover the Rio Grande silvery minnow to an extent sufficient to remove it from the List of Endangered and Threatened Wildlife (delisting).	**3-A.** Three self-sustaining populations in the species' historical range.	**3-A-1.** 1. Presence of fish (all unmarked) at ¾ of all sites sampled in the middle Rio Grande (NM) in October, for ten consecutive years; *or* minimum sub-populations of 500,000 unmarked fish in Angostura, Isleta, and San Acacia reaches in October, for ten consecutive years (may also be defined as populations in which the October CPUE data from all monitoring sites within each reach is >5 fish/100 m^2, for ten

RECOVERY GOALS	RECOVERY OBJECTIVES	RECOVERY CRITERIA
		consecutive years). 2. Two additional populations in the historical range of the species, but outside of the middle Rio Grande (NM), each composed of a minimum of 500,000 unmarked fish, for ten consecutive years. **3-A-2.** Annual reproduction in all three populations, as indicated by the presence of young-of-year, for ten consecutive years.
	3-B. Habitat sufficient to support three such populations.	**3-B-1.** River management that provides flows in each of the populated reaches sufficient to maintain the population, for ten consecutive years. **3-B-2.** Hydrographs and floodplain inundation sufficient to support spawning and recruitment as specified in the population criteria, for ten consecutive years.
	3-C. Water quality sufficient to support three such populations.	**3-C-1.** Achieve water quality criteria pursuant to the Federal Water Pollution Control Act, as amended, in addition to State and tribal water quality standards, in currently occupied and potential Rio Grande silvery minnow habitat.

4.0 RECOVERY PROGRAM

4.1 Introduction

This section describes the actions that, if implemented, will result in achieving the goals of the Rio Grande Silvery Minnow Recovery Plan. The actions are presented first with narrative descriptions, and then are presented in outline form (Table 2). Some of these efforts are already underway.

This program will be evaluated, and updated if necessary, at the end of each five-year period. The Recovery Team will also review the progress made on these actions at least annually.

Although completion of all the recommended actions would result in recovery of the Rio Grande silvery minnow, recovery is not dependent upon completion of every activity described here.

Of particular importance will be complete and regular coordination with tribes and pueblos throughout the recovery process. Tribal waters comprise a significant portion of the silvery minnow's current habitat and are paramount to ensuring the survival of the species. Tribal participation in the recovery process is voluntary. Technical and financial assistance should be made available to all tribes and pueblos who elect to implement recovery actions on their lands.

The number format used to describe these actions does not indicate the relative priority or chronological sequence of the recovery actions. Each individual recovery action is assigned a priority level, a cost estimate, and responsible party; that information is presented in Section 6.0, Implementation Schedule. A cross-reference chart detailing how the recovery actions relate to the five listing factors, the specific threats to the species, and the recovery objectives and criteria, is provided in Section 5.0, Addressing Threats.

4.2 Recovery Actions and Narrative

1.0 Develop a thorough knowledge of the Rio Grande silvery minnow's life history, ecology, and behavior, and the current status of its habitat.

Perpetuation of the Rio Grande silvery minnow in the wild depends upon a thorough knowledge of the species' life history, ecology, and behavior, and application of that knowledge to restore and protect appropriate habitats.

1.1 Investigate and determine biological factors.

While much has been learned about the Rio Grande silvery minnow's life history from recent research, there are still crucial gaps in our knowledge. The actions

below address some of those gaps.

1.1.1 Determine the environmental factors and flow regimes that cue spawning in the Rio Grande silvery minnow, and spawning periodicity under multiple flow regimes.

More information is needed on what factors trigger spawning (e.g., increases in flow, water temperature, and chemical composition of water). While Rio Grande silvery minnow are known to spawn with increases in streamflow, it is not known how the precise timing or magnitude of spawning is affected by various flow scenarios. These factors should be analyzed individually so that the most important cues can be identified.

1.1.2 Determine distances and rates of dispersal for various life stages of Rio Grande silvery minnow.

Factors that need to be investigated and documented include:

- Rates of travel and magnitude of dispersal of eggs and larvae at various flows.
- Movement of young-of-year and juveniles from inundated floodplain habitat to the main channel at various flow regimes.
- Upstream and downstream movement/dispersal of adults during various flow regimens, including distances moved, quantification of number of fish moving, and seasonality of movement.

1.1.3 Determine spatial and temporal recruitment rates of Rio Grande silvery minnow.

Developmental progression of Rio Grande silvery minnow from larvae to juvenile and juvenile to adult fish (i.e. recruitment) depends on numerous biotic and abiotic conditions. Quantified rates of recruitment between even these broad ontogenetic (developmental) stages (larvae, juvenile, adult) are not currently known for Rio Grande silvery minnow. A thorough understanding of the rates of recruitment between various life stages, which may differ by river reach, would provide valuable information that is necessary to assess population structure and direct recovery efforts.

1.2 Investigate and determine habitat requirements.

The actions below will help to fill in gaps in our knowledge of the habitat needs of the Rio Grande silvery minnow, as well as help to determine areas where the species can be reintroduced in the future.

1.2.1 Determine habitats occupied by early life stages of Rio Grande silvery minnow.

Dudley and Platania (1997) studied habitat use and availability of post-larval (>20 mm SL) Rio Grande silvery minnow. The habitat requirements of earlier life stages ($\leq$20 mm SL) of Rio Grande silvery minnow need to

be better understood in order to effectively manage populations.

1.2.2 Determine the relationship between water discharge (timing, magnitude, amplitude, duration) and Rio Grande silvery minnow distribution and abundance.
Analyze trends in Rio Grande silvery minnow distribution and abundance related to river connectivity and other factors.

1.2.3 Determine stream flows that will provide suitable habitat for all life stages of Rio Grande silvery minnow.
An understanding of the relationship between stream flow and habitat availability will help determine the amount, location, and duration of flows necessary to provide suitable habitat for the various life stages of the Rio Grande silvery minnow.

1.2.4 Based on knowledge of Rio Grande silvery minnow habitat needs and the research above, determine potential habitats available for Rio Grande silvery minnow in the middle Rio Grande and elsewhere in its historical range.

- Determine the extent of the floodplain, using geographic information systems and Digital Elevation models.
- Assess trends of channel degradation and aggradation.

1.3 Conduct genetic studies on Rio Grande silvery minnow populations.
The ability of a species to persist over the long term is determined in part by the amount of genetic variation that is retained by a species. Baseline studies of Rio Grande silvery minnow genetic variation suggest there have been recent sharp declines in mitochondrial haplotype diversity in wild populations. Monitoring of Rio Grande silvery minnow genetic diversity is necessary to determine whether these declines are continuing and to evaluate the effectiveness of measures taken to maintain genetic diversity

1.4 Determine the nature, extent, and role of water quality degradation in the decline of the Rio Grande silvery minnow, as well as the water quality standards necessary for its protection and recovery.
Many land use activities and their resultant discharges (both point and non-point) have the potential to affect the Rio Grande silvery minnow and its habitat. These include discharges from industrial sites, wastewater treatment plants, flood channels, and mining sites, runoff from feedlots and grazing land, return flows from agriculture, and other sources. The impacts of these activities and their discharges are not well understood and should be investigated.

1.4.1 Collect and evaluate existing data on water quality and sediment quality and identify future investigations that are needed. Identify the toxic compounds that are now found in both point and non-point sources.

The Recovery Team has worked to identify areas of the Rio Grande that have impairments in water quality and sediment quality that may correlate to the absence or low abundance of the Rio Grande silvery minnow. No conclusions have been reached and additional work needs to be done. Data collection and monitoring efforts should be coordinated with ongoing studies, including those conducted under MRGESACP (http://www.fws.gov/mrgesacp/pdf/Hydrologic_and_Biologic_Data.pdf), the U.S. Geological Survey's Rio Grande Valley National Water-Quality Assessment Program, and the investigation of Rio Grande water quality by the U.S. and Mexico.

Many types of pollutants have the potential to affect the aquatic ecosystem and the Rio Grande silvery minnow, and should be considered for further evaluation. Recommendations for additional water quality data collection should be formulated, and all data should be included in the adaptive management database.

1.4.2 Design and undertake toxicity tests to assess the effects of contaminants on various life stages of Rio Grande silvery minnow.

Determine if the concentrations of several common inorganic contaminants found in the middle Rio Grande affect the survival of the Rio Grande silvery minnow. Further assess the suitability of the fathead minnow as a surrogate for Rio Grande silvery minnow.

Testing of organic chemicals such as pharmaceuticals may also be warranted. In 2001, sampling in the middle Rio Grande found up to 140 nanograms per liter of estrone in ambient water below a wastewater treatment plant discharge. The potential endocrine-disrupting effects of such chemicals should be assessed.

1.4.3 Design and undertake studies to assess the effects of point and non-point source discharges on Rio Grande silvery minnow food sources.

Pollutants have the potential to affect the Rio Grande silvery minnow in indirect as well as direct ways. An assessment of how various pollutants are affecting other species will help to uncover whether or not such pollutants might indirectly be affecting the Rio Grande silvery minnow.

1.4.4 Design and undertake studies to assess the effects of stormwater pulse-flows (water quality and contaminants) on Rio Grande silvery

minnow and other cyprinids.
There are few industrial effluent discharges to the Rio Grande or to its tributaries in New Mexico; point source discharges are largely from municipal wastewater treatment plants (WWTPs). Effluent discharges from WWTPs have been demonstrated to contain contaminants that may affect the water quality of the river. While most treated WWTP effluents are not expected to adversely affect aquatic life when that effluent quality meets the water quality limits specified by the EPA, accidental violations could cause toxic conditions for Rio Grande silvery minnow near points of discharge. The short- and long-term effects of such events on Rio Grande silvery minnows should be evaluated.

1.4.5 Design and undertake studies to determine the effects of various flow regimes and pollutant loading on water quality in Rio Grande silvery minnow habitat.
There is little information available on the correlation between water quantity and quality of suitable habitat for the species. Water quality issues specifically associated with extreme low flow conditions, such as temperature, dissolved oxygen, and pH variations, can lower the toxicity thresholds of some parameters. It is important to determine this information for effective management of existing populations as well as for determining the feasibility of reestablishment sites.

1.4.6 Determine turbidity and sediment levels that reflect historical ecological conditions suitable for the Rio Grande silvery minnow.
Higher turbidity levels have been associated with spawning of Rio Grande silvery minnows. However, dams and other diversions alter the natural sediments and turbidity levels. Efforts to determine the natural sediments and turbidity levels should be made and various means to obtain these in the Rio Grande should be explored.

1.4.7 Develop technical feasible water quality criteria for protection of the Rio Grande silvery minnow.
The development of water quality criteria for the Rio Grande silvery minnow will allow for the adoption of water quality standards. Such standards can be adopted by both States and pueblos under the Clean Water Act Section 106 program.

1.5 Determine the nature and extent of interaction between other fish species (native and non-native) and Rio Grande silvery minnow, and the role of these species in the decline of Rio Grande silvery minnow.
The introduction and spread of non-native fish species has been identified as a threat to the continued existence of Rio Grande silvery minnow. Non-native

species have been introduced in the past to provide additional angling opportunities (e.g., channel catfish and largemouth bass), as food fishes (e.g., common carp), and as biological controls (western mosquitofish).

Regardless of the reason for introduction, most (perhaps all) non-native fishes in the Rio Grande drainage have at least the potential to interact negatively with Rio Grande silvery minnow. Some may compete for limited resources such as food, nursery habitat, and escape cover, while others may prey upon them or pose a threat through hybridization. The plains minnow, a Rio Grande silvery minnow congener, was found in the Pecos River shortly before the extirpation of the Rio Grande silvery minnow from that river was documented. Low-level introgression between the two species was determined from several specimens (Cook et al. 1992), but it is uncertain if hybridization played a role in the Rio Grande silvery minnow's extirpation.

Occurrence, distribution, and abundance of non-native species within the historical range of the Rio Grande silvery minnow vary geographically. At least 16 non-native fishes occur in the middle Rio Grande of New Mexico (Dudley et al. 2003, Plateau Ecosystems Consulting 2001) and 15 have been documented in the historical New Mexico-Pecos River range of the Rio Grande silvery minnow (Sublette et al. 1990). The extent of interaction (from none to competition for limited resources to predation) varies with the non-native species in question, its life stage, and a wide array of biotic and abiotic environmental influences.

1.5.1 Determine the distribution and extent of non-native fish species.
Extensive sampling of fish assemblages in the Rio Grande and the Pecos River since 1990 has added considerably to the knowledge of non-native fish occurrence and abundance in much of historical range of the Rio Grande silvery minnow. Using the data in these studies, the distribution, abundance, and habitat associations of all regularly occurring non-native fish species in the Rio Grande drainage should be compiled into a single document and assessments of non-native "problems" within each reach made. Also needed are studies to quantify movement of non-native fishes from reservoirs and studies to evaluate mechanical or selective removal of problem non-native fishes.

1.5.2 Determine predation and competition effects on Rio Grande silvery minnow by other Rio Grande fish species.
There have been no studies to determine if non-native piscivores (e.g. channel catfish) prey upon or compete with Rio Grande silvery minnow. In the Rio Grande, most extant non-native species are more likely predators than competitors, but in the Pecos River, several extant non-native cyprinids (e.g. plains minnow and Arkansas River shiner) might compete with Rio Grande silvery minnow if it was repatriated to that

system. Studies to characterize the mesohabitats of the Rio Grande silvery minnow and associated species are ongoing. The results of these studies will provide a measure of the likelihood of negative interactions between individual non-native species and the Rio Grande silvery minnow in the Rio Grande. Based upon this work, more detailed studies may be warranted. Such studies should focus on characterizing specific modes of interaction, quantification of impacts, and identification of means or methods to ameliorate negative interactions. Data obtained from Rio Grande silvery minnow habitat association studies in the Rio Grande will be useful in evaluating the efficacy of restoring Rio Grande silvery minnow to its historical Pecos River range.

1.5.3 Determine effects of different flow regimes (timing, magnitude, amplitude, duration) on non-native fishes.

Ongoing studies, while focused on characterizing habitat use by the Rio Grande silvery minnow under a variety of flows, are also acquiring information that could be used to characterize relationships between flow regimes and individual non-native fish species populations. Rather than considering non-native fishes collectively, studies (using information acquired under aforementioned studies) should focus on those non-native species that have been demonstrated to have negative interactions with Rio Grande silvery minnow. Based upon this work, additional research and experimentation may be warranted.

1.5.4 Review and update existing regulations and policies on stocking of non-native sport fishes and bait fish use.

NMDGF does not stock warmwater sport fishes in the middle Rio Grande. Non-native salmonids, however, are stocked seasonally in major drains and canals of the Middle Rio Grande Conservancy District upstream of Isleta.

Bait fish regulations in the Rio Grande silvery minnow's historical range vary considerably. Texas enacted bait fish regulations for the Pecos River region in 1999: the only bait fish allowed are common carp, fathead minnow, gizzard and threadfin shad, golden shiner, goldfish, Mexican tetra, Rio Grande cichlid, silversides, and sunfish. In the New Mexico portion of the Pecos River, bait fish sale and use is restricted to native fishes (red shiner and fathead minnow). In addition, anglers may not personally obtain bait fish from the Pecos River within the reach designated as critical habitat for Pecos bluntnose shiner. In the New Mexico portion of the Rio Grande, bait fish regulations are less restrictive.

Bait fish regulations should be updated to reflect the following: 1) all

purveyors of bait fish in the Rio Grande watershed within New Mexico and Texas should be licensed and inspected at least annually; 2) only species native to the Rio Grande should be legal bait fish; 3) all bait fish imported into the watershed should be certified disease-free; 4) bait fish should be purchased only from licensed and inspected dealers; and 5) it should be illegal to obtain bait fish, by seining or traps, from the Rio Grande within the reach currently occupied by the Rio Grande silvery minnow.

1.5.5 Develop and implement a long-term monitoring program to identify changes in the populations, status, distribution, and habitat conditions of endangered and other native fish species.
In order to evaluate the effectiveness of recovery actions taken, it is imperative that a long-term study program that will assess changes in the Rio Grande silvery minnow populations and their status be developed and maintained.

1.6 Determine threats to Rio Grande silvery minnow from congener competition and hybridization.
The Pecos River has been identified as a site for reestablishment of Rio Grande silvery minnow. However, a full understanding of the mechanisms responsible for the extirpation of the species must first be achieved. Hybridization between Rio Grande silvery minnow and the plains minnow, a congener is possibly one of the factors responsible for the extirpation of Rio Grande silvery minnow. The ability of plains minnow to invade and become established in the Rio Grande and the Pecos River must be assessed.

1.6.1 Determine the level and rate of hybridization between Rio Grande silvery minnow and plains minnow, *Hybognathus placitus*.
Laboratory investigations of hybridization of Rio Grande silvery minnow with plains minnow have been conducted (Caldwell 2003). In an experimental setting, hybrid offspring viability was low. Although this work suggested that natural hybridization and production of fertile offspring was unlikely, additional research is needed to better define and characterize hybridization as a factor possibly contributing to elimination of Rio Grande silvery minnow from the Pecos River.

1.6.2 Investigate interactions (competition) between congeners at various life stages.
An investigation designed to address competition between Rio Grande silvery minnow and the plains minnow would be useful to predict the outcome of any efforts to reestablish the Rio Grande silvery minnow in the Pecos River.

1.7 Determine the nature and extent of predation on Rio Grande silvery minnow by avian and other predators.

While predation is a natural part of the ecology of the Rio Grande silvery minnow, the importance of this factor is largely unknown. Of special interest is the role that avian and other non-fish predators have on the species, especially during sensitive early periods of its life history and when it inhabits shallow, nearshore habitats.

2.0 Restore, protect, and modify habitats as necessary to alleviate threats to the Rio Grande silvery minnow.

As described earlier in this report, various activities have reduced and altered Rio Grande silvery minnow habitat within the historic range of the species. To ensure survival of the species, it will be necessary to restore and protect habitats, as well as develop and implement water management strategies that maintain suitable habitat.

2.1 Modify existing habitats as needed.

Several techniques for improving aquatic habitats at a mesohabitat scale are discussed in the Habitat Restoration Plan for the Middle Rio Grande (Tetra Tech 2004). These include terrace and bank lowering, high-flow ephemeral channels, high-flow bank-line embayments, main-channel widening, removal of lateral confinements, river bar and island enhancement, and destabilization of islands and bars. The construction of Rio Grande silvery minnow nursery and refugial habitat would provide areas to support recruitment and enhance survival throughout the year.

2.1.1 Develop and implement a strategic habitat restoration program, based on the results of actions in section 1.2, to create essential Rio Grande silvery minnow habitat.

A strategic program will assist agencies in determining where to initiate habitat construction projects essential to preventing population decline or extinction.

In addition, a program of non-native floodplain plant removal and native floodplain plant replacement is needed, with a bi-national approach where appropriate.

2.1.2 Develop and implement conceptual designs for Rio Grande silvery minnow habitat.

Evaluation criteria for such designs should include costs, environmental disturbance, longevity, ease of construction, and habitat suitability over a range of flows. Investigate the potential of habitat construction that, during periods of low flow, will provide suitable habitat for the Rio Grande silvery minnow. Suitable habitat should be constructed in reaches where

there may be limited water availability. There are numerous reports by action agencies and the MRGESACP that can provide guidance for habitat restoration.

2.1.3 Provide main channel fish passage at irrigation diversion structures.

Evaluations of upstream dispersal of Rio Grande silvery minnow and of genetic integrity throughout the population have been recommended elsewhere. Rio Grande silvery minnow eggs and larvae move downstream, potentially stranding fish below barriers (diversion structures). Promoting the ability of Rio Grande silvery minnows to disperse between sub-reaches can increase reproduction among sub-populations, thereby increasing effective population size and maximizing the retention of genetic diversity.

The successful design and implementation of fish passage structures (or other diversion facilities that do not block upstream dispersal) could allow Rio Grande silvery minnow to repopulate areas where they were spawned.

2.1.4 Evaluate the impact of entrainment of Rio Grande silvery minnow in irrigation canals as a function of flow regime and habitat restoration.

Successful recovery of the Rio Grande silvery minnow depends on recruitment of eggs and larvae in the Rio Grande. The life history of the species indicates a high natural mortality of eggs and protolarvae (nearly 99 percent), with a theoretical expected survival to the juvenile stage of less than 1 percent. Current studies are attempting to predict entrainment's impact on recruitment. Entrainment of eggs, larvae, and young-of-year in irrigation canals may reduce recruitment.

2.1.5 Implement management strategies to reduce entrainment of Rio Grande silvery minnow into irrigation canals and the Low Flow Conveyance Channel.

Downstream repopulation of the Rio Grande silvery minnow is enhanced by the free and unimpeded downstream movement of eggs, larvae, and adults within the Rio Grande. Entrainment of Rio Grande silvery minnows into irrigation canals may reduce downstream recruitment. The extent of entrainment should be investigated and quantified under a range of flows and diversion structures modified to minimize entrainment, or provide for an outfall to the river.

2.1.6 Seek review of all proposed instream and floodplain projects by biologists and geologists, in order to enhance the potential for increased habitat value.

River maintenance techniques should be designed and evaluated to minimize impacts to the Rio Grande silvery minnow and its habitat. Ensuring that all such projects undergo review by biologists and geologists will help to ensure that they meet this goal.

2.2 Provide suitable habitat for the Rio Grande silvery minnow using water management strategies for the middle Rio Grande valley.

2.2.1 Identify constraints (climate, depletions and other losses, reservoir operations, diversions) that affect habitat during periods of low flow.

Determine institutional and physical requirements for delivering conservation water to support habitat and other biological functions.

2.2.2 Implement, if appropriate, changes in river and dam operations (and other options) to enhance habitat for Rio Grande silvery minnow in the Rio Grande valley.

Dams should be operated in a manner that enhances habitat for the Rio Grande silvery minnow, e.g., by providing sufficient storage capacity and by providing necessary flow regimes that mimic natural flow conditions (when possible and in accordance with existing operating rules). Any proposed changes that affect or impact tribal trust resources or water rights require the approval or involvement of the tribes/pueblos.

2.2.2.1 Retrofit or modify, if necessary, the operation of dams where sediment retention may be effectively managed for partial restoration of historic geomorphology.

Sediment retention behind dams has resulted in channel incision and degradation of Rio Grande silvery minnow habitat. Partial passage of sediment at selected dams through operations or retrofitting with sediment transport features may be options for managing Rio Grande silvery minnow habitat.

2.2.2.2 Within existing legal authorities, provide storage space for water to augment streamflow.

Acquire institutional instruments and physical space for storage and delivery of conservation water to support habitat and biological functions. Provide conservation water storage capacity in upstream reservoirs of the Rio Grande.

2.2.2.3 Identify how water supply and flood control operations affect riverine habitat development and habitat availability, and seek benefits for Rio Grande silvery minnow.
Determine options for measuring habitat diversity by more closely mimicking the flow regimes found under natural conditions. Habitat conditions may be improved by releasing water to encourage the fluvial processes necessary for a more dynamic river channel, to provide for occasional overbank flooding of the bosque, and to bypass sediment through the reservoirs to feed the sediment–starved reaches.

2.2.2.4 Within existing legal authorities, provide more flexibility in water releases and/or storage for spawning and larval survivorship in the middle Rio Grande.
For below-average water years, spring runoff may be insufficient to provide adequate floodplain habitat for Rio Grande silvery minnow production. Strategies for managing the hydrograph to provide short-term peaks in runoff should be identified and implemented.

2.2.3 Within existing legal authorities, encourage conjunctive use of surface water and groundwater in the Rio Grande.
Develop a management program that would allow water users to use a higher proportion of surface water in wet years for direct use or for groundwater recharge. Direct diversion of groundwater into the river may provide a source of supplemental water in times of drought. If necessary, enact statutes to provide for groundwater recharge and recovery.

2.2.4 Implement measures to increase water use efficiencies, water conservation, and forbearance in the middle Rio Grande valley to maintain river flows.
To alleviate future demands on surface water, water conservation plans must be funded and implemented. Legal and institutional issues associated with "saved" water and the impact of various plans and measures on the hydrology and the environment should be considered.

Consider establishing a voluntary water-use forbearance program, in which participants may leave previously irrigated land fallow or may choose to not irrigate and legally reassign the water to other uses. Participants could opt to forbear for a single season, multiple seasons, or at regular intervals. Water acquired through voluntary forbearance could be stored and subsequently released to benefit the species. Work to remove legal and logistical constraints on storage and delivery options (see Oad and King 2005).

2.2.5 Establish policies that limit floodplain development and educate the public on the need to limit such development.
Floodplain development has a negative influence on Rio Grande silvery minnow habitat and prevents natural processes from occurring. Events such as flooding also have great negative economic impact. Foster public awareness of the multiple uses of the riparian bosque habitats and their importance in conserving the natural plants and animals of the region.

2.3 Within existing legal authorities, develop and implement water management strategies that will provide suitable habitat for the Rio Grande silvery minnow in areas where the species will be reintroduced (outside the middle Rio Grande).
The Recovery Plan calls for the establishment of two additional populations of Rio Grande silvery minnow, outside of its current range of the middle Rio Grande. Doing so will require the development of water management strategies that ensure suitable habitat for the species.

2.3.1 Work with Mexico to provide water delivery to the Rio Grande/Rio Bravo del Norte (Big Bend region).
The Rio Grande in the Big Bend region of Texas serves as the border between the U.S. and Mexico. Actions taken in Mexico could affect efforts to establish a population of Rio Grande silvery minnow in this area. Since international agreements have been reached to provide water from the Río Conchos to Texas, efforts need to be maintained so that water is supplied to the Rio Grande silvery minnow habitat in the Big Bend region, should they be reintroduced there.

2.3.2 Encourage flows within the Big Bend reach that support Rio Grande silvery minnow populations.
Demands on surface water in both countries will likely continue to increase. Cooperative efforts to conserve water must be encouraged, funded and implemented. Legal and institutional issues associated with "saved" water and the impact of various plans and measures on the hydrology and the environment should be evaluated.

Specific actions could be implemented binationally in the Big Bend region, such as the removal of exotic riparian vegetation and replacement of native riparian vegetation. This could locally enhance the flows of the Rio Grande and help with the establishment of an introduced population of Rio Grande silvery minnow in this reach.

2.3.3 Evaluate and implement, if appropriate, changes in river and reservoir operations to enhance habitat for Rio Grande silvery minnow.

River and reservoir operations should be conducted in a manner that enhances habitat for the Rio Grande silvery minnow, such as by providing sufficient storage capacity and by providing necessary flow regimes more like natural flow conditions (when possible and in accordance with existing operating rules). Any proposed changes that affect tribal trust resources or water rights require the approval or involvement of the tribes/pueblos.

2.3.3.1 Within existing legal authorities, provide for storage of water to augment streamflow.

Provide conservation water storage capacity in upstream reservoirs.

2.3.3.2 Within existing legal authorities, identify how reservoir operations for water conveyance affect riverine habitat development and habitat availability.

Determine how habitat diversity could be improved by more closely mimicking the flow regimes found under natural conditions. Habitat conditions may be improved by releasing water to encourage the fluvial processes necessary for a more dynamic river channel, to provide for occasional overbank flooding, and to bypass sediment through the reservoirs to feed the sediment-starved reaches.

2.3.4 Investigate the legal, institutional, and technical feasibility of implementing a program of conjunctive use of surface and groundwater.

Determine feasibility of establishing a management program that would allow water users to use a higher proportion of surface water in wet years for direct use or for groundwater recharge. Direct diversion of groundwater into the river may provide a source of supplemental water in times of drought. Statutes may need to be enacted to provide for groundwater recharge and recovery.

2.3.5 Within existing legal authorities, implement all measures to increase water use efficiencies and conservation.

To alleviate future demands on surface water, water conservation plans must be funded and implemented. Legal and institutional issues associated with “saved” water and the impact of various plans and measures on the hydrology and the environment should be considered.

2.3.6 Implement a comprehensive program of data collection on water supply and use for improvement of water and habitat management.

Water rights in the Middle Rio Grande have not been adjudicated and most water uses are not measured. A program of monitoring surface diversions and return flows, and groundwater use should be implemented. Any system of monitoring or accounting must reflect an agreement that technical information related to tribe/pueblo water supply and use is confidential and proprietary and within the control of tribal/pueblo governments.

2.3.7 Use standard geological and GIS techniques to determine extent of floodplain in all reaches.

Ground surveys and aerial photography can estimate the degree of channel incision and the flow needed to flood terraces for creating Rio Grande silvery minnow habitat. Pointbars and islands may provide some essential floodplain habitat at some flows.

2.3.8 Measure channel degradation and aggradation trends.

River channel aggredation and degradation data define long-term trends for channel incision and floodplain abandonment. These studies can provide insights on riverine and Rio Grande silvery minnow habitat quality.

2.3.9 Retrofit or change the operation of inflow gates at dams where sediment retention is detrimental to the appropriate geomorphology.

Sediment retention behind dams has resulted in channel incision and degradation of Rio Grande silvery minnow habitat. Partial passage of sediment at selected dams through operations or retrofitting with sediment transport features may be options for managing Rio Grande silvery minnow habitat.

2.3.10 Establish policies that limit floodplain development and educate the public on the need to limit such development.

Floodplain development has a negative influence on Rio Grande silvery minnow habitat and prevents natural processes from occurring. Events such as flooding also have a great negative economic impact. The public needs to be aware of the multiple uses of the riparian bosque habitats and their importance in conserving the natural plants and animals of the region.

2.3.10 Investigate the potential of habitat construction that, during periods of low flow, will provide suitable habitat for the Rio Grande

silvery minnow.
Recent studies on Rio Grande silvery minnow ecology indicate the value of floodplain habitat as nursery areas for eggs and larvae. Fluvial geomorphologists have documented the abandonment of the floodplain throughout the Rio Grande. Construction of habitat features that create flooded surfaces during the Rio Grande silvery minnow spawning period should provide essential habitat for rearing young fish and contribute to recruitment.

3.0 Ensure the survival of the Rio Grande silvery minnow in its current habitat and reestablish the species into suitable habitats in its historical range.

3.1 Continue Rio Grande silvery minnow captive propagation activities.

Propagation activities have been underway for several years. These efforts should continue in order to provide Rio Grande silvery minnow for augmentation of the existing population when necessary, and for the reestablishment of two additional populations.

3.1.1 Develop, implement, and annually update a controlled propagation plan for long-term Rio Grande silvery minnow propagation activities.

A plan to guide captive propagation of Rio Grande silvery minnow should be developed and implemented. Such a plan should incorporate methods and protocols that will ensure maximization of remaining genetic diversity. The plan should also provide detail on appropriate methods to enable annual production necessary to meet augmentation and repatriation needs. In addition, the plan should enable production of sufficient numbers of Rio Grande silvery minnow for brood stock and research needs.

3.1.2 Evaluate and annually refine methods of Rio Grande silvery minnow propagation.

Detailed records of propagation efforts should be maintained. This information should be evaluated and considered to improve methods. Where appropriate, specific research efforts may be undertaken to improve propagation/rearing techniques and used to update the controlled propagation plan.

3.1.3 Continue genetic monitoring and study of propagated Rio Grande silvery minnow.

Large changes in Rio Grande silvery minnow abundance may affect genetic diversity. To guide and refine captive propagation protocols, detailed genetic information on both the wild and the captive populations is necessary. Genetic monitoring should follow a detailed protocol designed to provide critical information in a timely manner.

3.1.4 Continue the use of propagated Rio Grande silvery minnow for scientific research.

Propagated Rio Grande silvery minnow maintained in captivity may be used in studies to restore and protect the species. Some examples are described below.

3.1.4.1 Develop a larval fish key to the middle Rio Grande and for stream segments where reintroductions are likely.

A developmental series of Rio Grande silvery minnow was produced from captive spawning of adults collected from the wild. Adults used to produce the series, together with the resultant eggs and larvae, were deposited in the Museum of Southwestern Biology, Division of Fishes. Growth rates and timing of developmental features of Rio Grande silvery minnow are presented in Platania (1995a, 2000). Identification of larval fish would be aided by providing a larval fish key for the middle Rio Grande in New Mexico with morphometric and meristic information on the Rio Grande silvery minnow. A larval fish key should be developed for locations planned for reintroduction.

3.1.4.2 Determine the efficacy of various methods for marking Rio Grande silvery minnow (all life stages).

Many of the studies proposed in this plan require the ability to track and identify specific sub-populations of Rio Grande silvery minnow. While several marking methods have been evaluated for marking juvenile and adult Rio Grande silvery minnow, no method has been formally tested for marking larval individuals. Laboratory studies to examine and test different mechanisms of marking larval Rio Grande silvery minnow are needed.

3.1.4.3 Determine the role of environmental parameters in sex determination of Rio Grande silvery minnow.

Temperature has been demonstrated to be a factor responsible for determining sex during embryonic development of several species. If this is true with Rio Grande silvery minnow, there may be a need to reassess some conservation strategies.

3.1.4.4 Determine the rate of development and hatching success under various environmental conditions for Rio Grande silvery minnow.

Previous studies have demonstrated a positive correlation between decreased hatching time and increased water temperatures.

Additional studies are needed to investigate rates of development and survival of larval fishes under various environmental regimes.

3.2 Continue Rio Grande silvery minnow augmentation activities.
Augmentation of the existing population of the Rio Grande silvery minnow has already taken place. The captive breeding program must be continued in order to provide fish for future augmentation, as necessary.

3.2.1 Develop, follow, and annually update a master plan for Rio Grande silvery minnow augmentation.
The need for augmentation of populations and sub-populations will spatially and temporally vary. A plan that identifies augmentation and repatriation locations and identifies population number goals is needed to achieve goals in a timely manner. The plan should be refined, as new information becomes available and the species moves toward recovery. Such a plan would necessarily require consultation with tribes and pueblos and respect the individual desire of each to participate or not.

3.2.2 Coordinate augmentation needs with propagation activities.
Based upon annual population estimates, determine the number of Rio Grande silvery minnow needed to augment each population (or sub-population) to enable timely achievement of long-term population goals.

Based upon estimates of populations and sub-populations, augmentation plans will be developed for each reach. Annual population estimates should be used to refine each augmentation plan.

3.2.3 Determine the effects of various stocking conditions and release sites on Rio Grande silvery minnow.
An experimental augmentation program (Remshardt and Davenport 2003) has been in place since June 2002. Releases have occurred at several sites and dates (fall and spring) throughout the Angostura Reach. Monitoring of the augmentation efforts has provided information on effective stocking conditions and release sites. Research efforts should continue.

Preliminary results have verified the importance of low-velocity habitat of sufficient depth (> 0.5 m) for release; these habitats provide areas for cover and acclimation to riverine conditions after release.

3.2.4 Determine the effects of hatchery-to-release site transport conditions on stocked Rio Grande silvery minnow.
Effective transport protocols have been developed and are currently in use for all transfers of Rio Grande silvery minnow.

3.2.5 Estimate the minimum viable population size for maintaining healthy populations within each reach and for re-introduction areas.
The Rio Grande silvery minnow is a species with high reproductive potential when suitable spawning conditions exist. A minimum viable population estimate provides a target population value for ensuring genetic diversity and sustainability of the species. Minimum viable population size should be calculated to help define population targets to ensure genetic diversity and sustainability for river reaches and reintroduced populations.

3.3 Reestablish Rio Grande silvery minnow at appropriate locations in its historical range.

3.3.1 Develop a master plan for reestablishment of Rio Grande silvery minnow in new locations within its historical range.
The reestablishment plan should 1) describe the purposes, implementation schedule, and costs for the specific sites selected for reestablishment; 2) identify the source of fish used for reestablishment; and 3) establish target levels of both fish and habitat necessary for recovery. The decision-making process must involve partners such as tribes, landowners, and other interested parties. It may be necessary or appropriate to develop a seperate augmentation plan that addresses tribal lands and tribal interests. Such a plan should recognize that tribal participation in reintroduction efforts would be voluntary.

3.3.2 Develop and implement a plan (for each reintroduction location) that delineates actions necessary for reestablishment of Rio Grande silvery minnow.
Apart from the master plan above, it will be necessary to develop and implement a plan for each reintroduction location. Such plans should include information from the master plan, as well as further details on the local site, expenses, implementation schedule, habitat protection and maintenance, and population monitoring. A sampling program based on the protocol used in the middle Rio Grande (see Appendix H) should be developed and implemented such that information collected may be compared more equitably between populations.

3.3.3 Monitor the reintroduced populations of Rio Grande silvery minnow.
Use the above sampling program to conduct long-term fish monitoring to assess spatial and temporal changes in age class structure and abundance of reintroduced populations of Rio Grande silvery minnow and other fishes.

4.0 Implement and maintain an adaptive management program and ensure that appropriate research and management activities are implemented in a timely manner to achieve recovery of the Rio Grande silvery minnow.

The Rio Grande and its associated aquatic and riparian habitats are complex and dynamic. Currently, there is considerable uncertainty regarding the potential effects of various Rio Grande silvery minnow management actions on the Rio Grande silvery minnow, water users, and the existing infrastructure. As our understanding of these systems increases, it may be necessary to adjust and refine this Recovery Plan. This is the essence of adaptive management, which may be defined as management in the face of uncertainty, with a focus on reduction of uncertainty over time.

To maintain an adaptive management approach to the recovery of the Rio Grande silvery minnow, it will be necessary for the Recovery Team and others to continually analyze new and additional information regarding the biological, physical, and chemical conditions of the Rio Grande basin, as described in the systems below.

4.1 Utilize an independent and autonomous scientific advisory panel to the MRGESACP (and also for any other programs that are formed to guide and implement recovery actions).

An independent scientific advisory panel, with complete autonomy from all agencies, is necessary to provide an independent, unbiased, and credible evaluation of Rio Grande silvery minnow research and monitoring activities.

The panel should convene annually to review ongoing and proposed research and management activities. The panel should be used to assist in evaluation of research and management proposals.

4.2 Continue long-term Rio Grande silvery minnow monitoring programs through downlisting and post delisting.

4.2.1 Use the Middle Rio Grande Long-Term Fish Population Monitoring Program methodology as the model in the development and implementation of a sampling protocol for a long-term fish monitoring program.

Monitoring programs for each of the populations should build on existing data and use statistically valid methods to assess changes in age-class structure and abundance of Rio Grande silvery minnows and other fish. The Middle Rio Grande Long-Term Fish Population Monitoring Program (Appendix H) has established a methodology and provides a historical context.

4.2.2 Develop and implement a sampling methodology of sufficient rigor to generate a statistically reliable population estimate for each population of Rio Grande silvery minnow.

Because recovery objectives are tied to population estimates, a reliable method of determining the number of individuals in a population (or sub-population) should be developed.

4.2.3 Establish and maintain a single, centralized, standardized database for storage and retrieval of hydrologic, biologic, economic, and social data, including both stockings and captures of target species, and collect and maintain specimens in a research museum.
A standardized and centralized database should be developed and maintained to incorporate the accurate compilation and storage of all relevant data, including data on population and land-use activities. The database should be made available to all resource agencies, institutions, and individuals conducting or evaluating research and management activities, as well as to the general public.

4.3 Periodically review, evaluate, and revise research and management activities to ensure progress toward recovery of the Rio Grande silvery minnow.
As projects are completed or relevant findings verified, new information may identify additional or alternative research needs or recovery actions that may be needed. Adaptive management will allow for the development of new research and implementation of management activities. As necessary, recovery actions and goals may be refined or revised to reflect new information and understanding.

5.0 Design and implement a public awareness and education program.
Public awareness of the issues and conditions that led to the Rio Grande silvery minnow's being listed as an endangered species, as well as of the recovery plan itself and related water resource issues, should be encouraged. Such a program should seek to educate people on the issues and the rationale for regulatory and management actions, encourage their compliance with regulations, and solicit their support for the Rio Grande silvery minnow recovery program as well as for water quality and conservation, riverine habitat, and endangered species issues in general. A good way to achieve this is through an information and education program that actively involves all stakeholders and interested parties, and makes use of several means to reach and educate people. Such a program will be implemented using the efforts of local and national staff and resources.

5.1 Issue notices regarding status of Rio Grande silvery minnow recovery effort.
The Recovery Team will work with the New Mexico Ecological Services Office communications office to fulfill legal requirements to disseminate information about the availability of the Rio Grande Silvery Minnow Recovery Plan. This will include posting appropriate notices in the Federal Register.

5.2 Develop and implement an outreach and communications plan that will help all interested parties better understand the Rio Grande silvery minnow and its habitat, as well as related conservation and water management issues and how they affect the human community.

A comprehensive outreach and communications plan will be developed jointly by members of the Recovery Team and the External Affairs staff of the Service. Some basic considerations and ideas for such a plan are outlined below.

5.2.1 Identify key audiences.

A variety of stakeholders are interested in the Rio Grande silvery minnow recovery plan, and communication and education efforts must be tailored to each group. A first step to communicating is identifying these key audiences and their individual information needs. Audiences may include Federal, State and local governments, legislators, tribes, water users, local businesses, landowners, media (newspapers, magazines, editorial boards, conservation publications, radio, television), conservation groups, recreationists, schoolchildren, the general public, and other decision makers and opinion leaders.

5.2.2 Identify key messages.

The outreach plan should identify the key messages that need to be transmitted to all of these audiences in order to educate people on the various issues, encourage positive behavior (e.g. encourage water conservation), and/or solicit support for the recovery plan. The key messages should be tailored for the various audiences, but used consistently throughout outreach materials.

5.2.3 Develop targeted outreach programs and materials.

A wide variety of outreach programs are needed to reach the key audiences identified above. While the details of such programs will be determined as part of the outreach plan to be developed by the communications departments of the Service, the Recovery Team suggests the following actions.

- Develop a plan to regularly meet with various stakeholder groups, to keep them apprised of recovery plan progress, assess their concerns and how they view the recovery process, enlist their ongoing assistance in recovery efforts, and consider revisions in the plan as necessary. Such a plan should include a strategy for working with Mexican states and tribal interests in both the U.S. and Mexico.
- Work with local and national media (including environment and agriculture reporters, editorial boards, conservation magazines, and radio and television stations) to encourage interest and accuracy in reporting.

- Develop and maintain a website focused on Rio Grande silvery minnow recovery. This may be included in (or a prominent part of) the Rio Grande Endangered Species Act Collaborative Program website. The website should provide access to all official reports and databases, as well as information written specifically for the general public (adults and children). It should also feature one or more email lists where interested parties can sign up to receive notice of meetings, events, new publications, comment periods, and other timely information. It might also include a weblog, where timely news and events can be posted and easily disseminated to interested parties who visit the weblog directly or subscribe to automatic updates through a feed reader (for an example, see the enviroblogs page at http://groups.blogdigger.com). It should make use of existing educational materials, by providing prominent links to "outside" materials such as the Service's FAQ page on endangered species.
- Develop educational programs for schoolchildren. This might include programs such as Habitat Trunks, field trips to river restoration areas, and classroom materials. The Rio Grande silvery minnow website should also provide a children's section, providing easy access to endangered species education materials prepared by the Service (e.g. www.fws.gov/endangered/kids) and others.
- Enlist the assistance and expertise of outside groups in developing educational programs for adults and children, such as the National Audubon Society (children's publications), the National Wildlife Federation (www.nwf.org/wildlifeuniversity), the BioPark, and others. At a minimum, the educational programs on endangered species prepared by these groups should be easily accessible from the Rio Grande silvery minnow website.
- Establish and/or maintain opportunities where people can see captive Rio Grande silvery minnow. An informative aquarium display of live specimens can be a positive educational experience. The BioPark currently maintains one example of this. Others should be established at appropriate facilities, such as National Wildlife Refuges, within the area of current and historic distribution of this species.
- Develop outreach materials that educate various groups and reinforce the key messages, including public service announcements, op-eds, targeted newsletters (such as the newsletter being prepared by the MRGESACP for irrigators, or brochures targeted for bait shops or wildlife refuge visitors), instructional videos, brochures, fact sheets, slide shows, t-shirts,

bumper stickers, and posters. The website address should be prominently displayed on all materials.

- Develop materials in English and Spanish. Make many of the materials available through the Service web site, where they can be translated into Spanish.

4.3 Recovery Action Outline

1.0 Develop a thorough knowledge of the Rio Grande silvery minnow's life history, ecology, and behavior, and the current status of its habitat.

1.1 Investigate and determine biological factors.
While much has been learned about the Rio Grande silvery minnow's life history from recent research, there are still crucial gaps in our knowledge. The actions below address some of those gaps.

1.1.1 Determine the environmental factors and flow regimes that cue spawning in the Rio Grande silvery minnow, and spawning periodicity under multiple flow regimes.

1.1.2 Determine distances and rates of dispersal for various life stages of Rio Grande silvery minnow.

1.1.3 Determine spatial and temporal recruitment rates of Rio Grande silvery minnow.

1.2 Investigate and determine habitat requirements.

1.2.1 Determine habitats occupied by early life stages of Rio Grande silvery minnow.

1.2.2 Determine the relationship between water discharge (timing, magnitude, amplitude, duration) and Rio Grande silvery minnow distribution and abundance.

1.2.3 Determine stream flows that will provide suitable habitat for all life stages of Rio Grande silvery minnow.

1.2.4 Based on knowledge of Rio Grande silvery minnow habitat needs and the research above, determine potential habitats available for Rio Grande silvery minnow in the middle Rio Grande and elsewhere in its historical range.

1.3 Conduct periodic genetic studies on Rio Grande silvery minnow populations.

1.4 Determine the nature, extent, and role of water quality degradation in the decline of the Rio Grande silvery minnow, as well as the water quality standards necessary for its protection and recovery.

1.4.1 Collect and evaluate existing data on water quality and sediment quality and identify future investigations that are needed. Identify the toxic compounds that are now found in both point and non-point sources.

1.4.2 Design and undertake toxicity tests to assess the effects of contaminants on various life stages of Rio Grande silvery minnow.

1.4.3 Design and undertake studies to assess the effects of point and non-point source discharges on Rio Grande silvery minnow food sources.

1.4.4 Design and undertake studies to assess the effects of stormwater pulse-flows (water quality and contaminants) on Rio Grande silvery minnow and other cyprinids.

1.4.5 Design and undertake studies to determine the effects of various flow regimes and pollutant loading on water quality in Rio Grande silvery minnow habitat.

1.4.6 Determine turbidity and sediment levels that reflect historical ecological conditions suitable for the Rio Grande silvery minnow.

1.4.7 Develop technical feasible water quality criteria for protection of the Rio Grande silvery minnow.

1.5 Determine the nature and extent of interaction between other fish species (native and non-native) and Rio Grande silvery minnow, and the role of these species in the decline of Rio Grande silvery minnow.

1.5.1 Determine the distribution and extent of non-native fish species.

1.5.2 Determine predation and competition effects on Rio Grande silvery minnow by other native Rio Grande fish species.

1.5.3 Determine effects of different flow regimes (timing, magnitude, amplitude, duration) on non-native fishes.

1.5.4 Review and update existing regulations and policies on stocking of non-native sport fishes and bait fish use.

1.5.5 Develop and implement a long-term monitoring program to identify changes in the populations, status, distribution, and habitat conditions of endangered and other native fish species.

1.6 Determine threats to Rio Grande silvery minnow from congener competition

and hybridization.

1.6.1 Determine the level and rate of hybridization between Rio Grande silvery minnow and plains minnow.

1.6.2 Investigate interactions (competition) between congeners at various life stages.

1.7 Determine the nature and extent of predation on Rio Grande silvery minnow by avian and other predators.

2.0 Restore, protect, and modify habitats as necessary to alleviate threats to the Rio Grande silvery minnow.

2.1 Modify existing habitats as needed.

2.1.1 Develop and implement a strategic habitat restoration program, based on the results of actions in section 1.2, to create essential Rio Grande silvery minnow habitat.

2.1.2 Develop and implement conceptual designs for Rio Grande silvery minnow habitat.

2.1.3 Provide main channel fish passage at irrigation diversion structures.

2.1.4 Evaluate the impact of entrainment of Rio Grande silvery minnow in irrigation canals as a function of flow regime and habitat restoration.

2.1.5 Implement management strategies to reduce entrainment of Rio Grande silvery minnow into irrigation canals and the Low Flow Conveyance Channel.

2.1.6 Seek review of all proposed instream and floodplain projects by biologists and geologists, in order to enhance the potential for increased habitat value.

2.2 Provide suitable habitat for the Rio Grande silvery minnow using water management strategies for the middle Rio Grande valley.

2.2.1 Identify constraints (climate, depletions and other losses, reservoir operations, diversions) that affect habitat during periods of low flow.

2.2.2 Implement, if appropriate, changes in river and dam operations (and

other options) to enhance habitat for Rio Grande silvery minnow in the Rio Grande valley.

2.2.2.1 Retrofit or modify, if necessary, the operation of dams where sediment retention may be effectively managed for partial restoration of historic geomorphology.

2.2.2.2 Within existing legal authorities, provide storage space for water to augment streamflow.

2.2.2.3 Identify how water supply and flood control operations affect riverine habitat development and habitat availability, and seek benefits for Rio Grande silvery minnow.

2.2.2.4 Within existing legal authorities, provide more flexibility in water releases and/or storage for spawning and larval survivorship in the middle Rio Grande.

2.2.3 Within existing legal authorities, encourage conjunctive use of surface water and groundwater in the Rio Grande.

2.2.4 Implement measures to increase water use efficiencies, water conservation, and forbearance in the middle Rio Grande valley to maintain river flows.

2.2.5 Establish policies that limit floodplain development and educate the public on the need to limit such development.

2.3 Within existing legal authorities, develop and implement water management strategies that will provide suitable habitat for the Rio Grande silvery minnow in areas where the species will be reintroduced (outside the middle Rio Grande).

2.3.1 Work with Mexico to provide water delivery to the Rio Grande/Rio Bravo del Norte (Big Bend region).

2.3.2 Encourage flows within the Big Bend reach that support Rio Grande silvery minnow populations.

2.3.3 Evaluate and implement, if appropriate, changes in river and reservoir operations to enhance habitat for Rio Grande silvery minnow.

2.3.3.1 Within existing legal authorities, provide for storage of water to augment streamflow.

2.3.3.2 Within existing legal authorities, identify how reservoir operations for water conveyance affect riverine habitat development and habitat availability.

2.3.4 Investigate legal, institutional, and technical feasibility of implementing a program of conjunctive use of surface and groundwater.

2.3.5 Within existing legal authorities, implement all measures to increase water use efficiencies and conservation.

2.3.6 Implement a comprehensive program of data collection on water supply and use for improvement of water and habitat management.

2.3.7 Use standard geological and GIS techniques to determine extent of floodplain in all reaches.

2.3.8 Measure channel degradation and aggradation trends.

2.3.9 Retrofit or change the operation of inflow gates at dams where sediment retention is detrimental to the appropriate geomorphology.

2.3.10 Establish policies that limit floodplain development and educate the public on the need to limit such development.

2.3.11 Investigate the potential of habitat construction that, during periods of low flow, will provide suitable habitat for the Rio Grande silvery minnow.

3.0 Ensure the survival of the Rio Grande silvery minnow in its current habitat and reestablish the species into suitable habitats in its historical range.

3.1 Continue Rio Grande silvery minnow captive propagation activities.

3.1.1 Develop, implement, and annually update a controlled propagation plan for long-term Rio Grande silvery minnow propagation activities.

3.1.2 Evaluate and annually refine methods of Rio Grande silvery minnow propagation.

3.1.3 Continue genetic monitoring and study of propagated Rio Grande silvery minnow.

3.1.4 Continue the use of propagated Rio Grande silvery minnow for

scientific research.

3.1.4.1 Develop a larval fish key for the middle Rio Grande and for stream segments where reintroductions are likely.

3.1.4.2 Determine the efficacy of various methods for marking Rio Grande silvery minnow (all life stages).

3.1.4.3 Determine the role of environmental parameters in sex determination of Rio Grande silvery minnow.

3.1.4.4 Determine the rate of development and hatching success under various environmental conditions for Rio Grande silvery minnow.

3.2 Continue Rio Grande silvery minnow augmentation activities.

3.2.1 Develop, follow, and annually update a master plan for Rio Grande silvery minnow augmentation.

3.2.2 Coordinate augmentation needs with propagation activities.

3.2.3 Determine the effects of various stocking conditions and release sites on Rio Grande silvery minnow.

3.2.4 Determine the effects of hatchery-to-release site transport conditions on stocked Rio Grande silvery minnow.

3.2.5 Estimate the minimum viable population size for maintaining healthy populations within each reach and for re-introduction areas.

3.3 Reestablish Rio Grande silvery minnow at appropriate locations in its historical range.

3.3.1 Develop a master plan for reestablishment of Rio Grande silvery minnow in new locations within its historical range.

3.3.2 Develop and implement a plan (for each reintroduction location) that delineates actions necessary for reestablishment of Rio Grande silvery minnow.

3.3.3 Monitor the reintroduced populations of Rio Grande silvery minnow.

4.0 Implement and maintain an adaptive management program so that appropriate research and management activities are implemented in a timely manner to achieve recovery of the Rio Grande silvery minnow.

4.1 Utilize an independent and autonomous scientific advisory panel to the Middle Rio Grande Endangered Species Act Collaborative Program (and also for any other programs that are formed to guide and implement recovery actions).

4.2 Continue long-term Rio Grande silvery minnow monitoring programs through downlisting and post delisting.

4.2.1 Use the Middle Rio Grande Long-Term Fish Population Monitoring Program methodology as the model in the development and implementation of a sampling protocol for a long-term fish monitoring program.

4.2.2 Develop and implement a sampling methodology of sufficient rigor to generate a statistically reliable population estimate for each population of Rio Grande silvery minnow.

4.2.3 Establish and maintain a single, centralized, standardized database for storage and retrieval of hydrologic, biologic, economic, and social data, including both stockings and captures of target species, and collect and maintain specimens in a research museum.

4.3 Periodically review, evaluate, and revise research and management activities to ensure progress toward recovery of the Rio Grande silvery minnow.

5.0 Design and implement a public awareness and education program.

5.1 Issue notices regarding status of Rio Grande silvery minnow recovery effort.

5.2 Develop and implement an outreach and communications plan that will help all interested parties to better understand the Rio Grande silvery minnow and its habitat, as well as related conservation and water management issues.

5.2.1 Identify key audiences.

5.2.2 Identify key messages.

5.2.3 Develop targeted outreach programs and materials.

5.0 ADDRESSING THREATS

5.1 Summary of Listing Factors and Threats, and the Recovery Criteria and Recovery Actions That Address Them (Threats Tracking Table)

The table below provides a cross-check of how the recovery criteria and recovery actions contained in the Rio Grande Silvery Minnow Recovery Plan address the five listing factors and the specific threats to the species. For a thorough review of the threats, see Section 1.7.

Table 1. Threats Tracking Table

LISTING FACTOR	THREAT	RECOVERY CRITERIA	RECOVERY ACTIONS
A. The present or threatened destruction, modification, or curtailment of its habitat or range	Dewatering and Diversion • Annual dewatering of a large percentage of the species' habitat • Risk of two consecutive below-average flow years, which can affect short-lived species • Increase in non-native and exotic fish species • Increase in contaminant concentrations during low flows, which may exacerbate other stresses • Entrainment of eggs and young-of-year in diversion structures • Fragmented habitat	1-A-1 1-A-2 2-A-1 2-A-2 2-B-1 2-B-2 3-A-1 3-A-2 3-B-1 3-B-2	1.1 Investigate biological factors 1.2 Determine habitat needs 2.1 Modify existing habitats 2.2 Provide suitable habitat using water management strategies 2.3 Develop habitat-enhancing water mgmt strategies for reintroduction areas 3.3 Conduct reintroductions 4.1 Utilize independent scientific advisory panel 4.2 Continue long-term monitoring 4.3 Practice adaptive management 5.1 Issue notices of recovery effort

LISTING FACTOR	THREAT	RECOVERY CRITERIA	RECOVERY ACTIONS
			5.2 Develop outreach plan
	Water impoundment • Altered flow regimes • Prevention of overbank flooding • Trapped nutrients • Altered sediment transport regimes • Prolonged summer base flows • Reduced food supply • Altered preferred habitat • Prevention of species' dispersal • Creation of reservoirs and altered flow regimes that favor non-native fish species that may compete with or prey upon the species • Stored spring runoff and summer inflow, which would normally cause flooding • Reduced flows, which may limit the amount of preferred habitat and limit dispersal of the species • Lack of suitable habitat for young-of-year • Fragmented habitat	1-A-1 1-A-2 2-A-1 2-A-2 2-B-1 2-B-2 3-A-1 3-A-2 3-B-1 3-B-2	1.1 Investigate biological factors 1.2 Determine habitat needs 2.1 Modify existing habitats 2.2 Provide suitable habitat using water management strategies 2.3 Develop habitat-enhancing water mgmt strategies for reintroduction areas 3.3 Conduct reintroductions 4.1 Utilize independent scientific advisory panel 4.2 Continue long-term monitoring 4.3 Practice adaptive management 5.1 Issue notices of recovery effort 5.2 Develop outreach plan
	River modification • Confined flood flows • Trapped sediment • Establishment of stabilizing vegetation	1-A-1 1-A-2 2-A-1 2-A-2	1.1 Investigate biological factors 1.2 Determine habitat needs

LISTING FACTOR	THREAT	RECOVERY CRITERIA	RECOVERY ACTIONS
	• Elimination of meanders, oxbows and other components of historic aquatic habitat • Replacement of preferred sand and silt substrate with gravel and cobble • Reduction of floodplain areas where young can develop • Geomorphological changes to the river channel	2-B-1 2-B-2 3-A-1 3-A-2 3-B-1 3-B-2	2.1 Modify existing habitats 2.2 Provide suitable habitat using water management strategies 2.3 Develop habitat-enhancing water management strategies for reintroduction areas 3.3 Conduct reintroductions 4.1 Utilize independent scientific advisory panel 4.2 Continue long-term monitoring 4.3 Practice adaptive management 5.1 Issue notices of recovery effort 5.2 Develop outreach plan
	Water pollutants • Poor water quality caused by agriculture and urbanization in the Rio Grande basin, especially during low flows and storm events	2-B-1 2-B-2 2-D-1 3-B-1 3-B-2 3-C-1	1.4 Determine water quality 4.1 Utilize independent scientific advisory panel 4.2 Continue long-term monitoring 4.3 Practice adaptive management 5.1 Issue notices of recovery effort 5.2 Develop outreach plan

LISTING FACTOR	THREAT	RECOVERY CRITERIA	RECOVERY ACTIONS
B. Overutilization for commercial, recreational, scientific, or educational purposes	• Possible over-utilization through scientific collecting • Licensed commercial bait dealers possibly selling bait minnows • Incidental utilization of species during legal collection of bait minnows for personal use	1-A-1 1-A-2 2-A-1 2-A-2 3-A-1 3-A-2	4.1 Utilize independent scientific advisory panel 4.2 Continue long-term monitoring 4.3 Practice adaptive management 5.1 Issue notices of recovery effort 5.2 Develop outreach plan
C. Disease or predation	Disease • Risk of stress and disease when RGSM are confined to pools during periods of low flows • Increased risk of stress-induced disease outbreaks possibly exacerbated when high levels of pollutants or other stresses are present Predation • Predation by non-native fishes, as well as birds and mammals, • Competition for space and food with non-native fish	1-A-1 1-A-2 2-A-1 2-A-2 2-B-1 2-B-2 3-A-1 3-A-2 3-B-1 3-B-2	1.5 Determine interactions with other fish species 1.7 Determine predation by other species 4.1 Utilize independent scientific advisory panel 4.2 Continue long-term monitoring 4.3 Practice adaptive management 5.1 Issue notices of recovery effort 5.2 Develop outreach plan
D. Inadequacy of existing regulatory mechanisms	• No protection of habitat under State law • Inability to acquire instream water rights for the benefit of fish and wildlife • Inadequate regulations to restrict the use of bait fish,	1-A-1 1-A-2 2-A-1 2-A-2 2-B-1 2-B-2	1.4 Determine water quality 1.5 Determine interactions with other fish species 4.1 Utilize independent

LISTING FACTOR	THREAT	RECOVERY CRITERIA	RECOVERY ACTIONS
	illegal use of bait fish, introduction of non-natives via bait bucket, introduction of disease or parasites by importation of bait fish.	3-A-1 3-A-2 3-B-1 3-B-2	scientific advisory panel 4.2 Continue long-term monitoring 4.3 Practice adaptive management 5.1 Issue notices of recovery effort 5.2 Develop outreach plan
E. Other natural or manmade factors affecting its continued existence	• Reduced population numbers and potential loss of genetic diversity • Introduction and subsequent competition from non-native fish	1-A-1 1-A-2 1-B-1 2-A-1 2-A-2 2-C-1 3-A-1 3-A-2	1.1 Investigate biological factors 1.2 Determine habitat needs 1.3 Conduct periodic genetic studies 1.5 Determine interactions with other fish species 1.6 Determine threats from congeners 3.1 Continue captive propagation 3.2 Continue augmentation activities 3.3 Conduct reintroductions 4.1 Utilize independent scientific advisory panel 4.2 Continue long-term monitoring 4.3 Practice adaptive management 5.1 Issue notices of recovery effort 5.2 Develop outreach plan

6.0 IMPLEMENTATION SCHEDULE AND COSTS

6.1 Introduction

The Implementation Schedule below outlines actions and estimated costs for the recovery program for the Rio Grande silvery minnow, as set forth in this plan. It is a guide for meeting the recovery goals. This schedule indicates action priorities, action numbers, action descriptions, duration of actions, the parties responsible for actions, the threats that are addressed by specific actions, and estimated costs. A brief description of the agencies involved also follows.

The implementation of actions identified in this plan is not the sole responsibility of the Service. Although the Service provides leadership in the recovery of listed species, other Federal, State, and local agencies, as well as Indian pueblos and private citizens, all play a vital role. In particular, the MRGESACP coordinates Federal and other activities that promote the protection and recovery of the Rio Grande silvery minnow, and thus serves as an implementation vehicle for many of the actions described in this plan.

Parties with authority, responsibility, or expressed interest to implement a specific recovery action are identified in the Implementation Schedule. Where more than one party is identified, the proposed lead party is indicated by an asterisk. The listing of a party in the schedule does not require the identified party to implement the action(s) or to secure funding for implementing the action(s).

The priority levels assigned to actions are defined as follows:

- Priority Level 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.
- Priority Level 2: An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.
- Priority Level 3: All other actions necessary to provide for full recovery of the species.

6.2 Implementation Schedule

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
1	1.5.5	Develop and implement a long-term monitoring program to identify changes in the populations, status, distribution, and habitat conditions of endangered and other native fish species.	15 yrs	Initial 5 yrs requires overlap with current sampling methodology	MRGESCP	3000	250	250	250	250	250	1750	
1	3.1.1	Develop, implement, and annually update a controlled propagation plan for long-term Rio Grande silvery minnow propagation activities.	25 yrs	$50K in '06 to develop plan, $15 to refine annually	MRGESCP	10000	400	400	400	400	400	4M	4M
1	3.1.2	Evaluate and annually refine methods of Rio Grande silvery minnow propagation.	25 yrs		MRGESCP	425	50	50	75	25	25	100	100
1	3.2.1	Develop, follow, and annually update a master plan for Rio Grande silvery minnow augmentation.	25 yrs	Same as 3.1.1	MRGESCP	425	50	50	75	25	25	100	100
1	3.1.3	Continue genetic monitoring and study of propagated Rio Grande	25 yrs	Methods refined after initial reintro	MRGESCP	475	50	50	75	25	25	100	100

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
		silvery minnow.											
1	4.2.1	Use the Middle Rio Grande Long-Term Fish Population Monitoring Program methodology as the model in the development and implementation of a sampling protocol for a long-term fish monitoring program.	5 yrs	Phased out in 5 yrs after 1.5.5 is in place	MRGESCP	1250	250	250	250	250	250		
1	4.2.3	Establish and maintain a single, centralized, standardized database for storage and retrieval of hydrologic, biologic, economic, and social data, including both stockings and captures of target species, and collect and maintain specimens in a research museum.	25 yrs	Database development in 08 then $10k/yr to maintain	FWS	320			100	10	10	100	100
2	1.1.1	Determine the environmental factors and flow regimes that cue spawning in the Rio Grande silvery minnow, and spawning periodicity under multiple flow regimes.	3 yrs	$75k/yr through 2011	MRGESCP	225				75	75	75	

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
2	1.1.2	Determine distances and rates of dispersal for various life stages of Rio Grande silvery minnow.	3 yrs		MRGESCP	150				75	75		
2	1.2.1	Determine habitats occupied by early life stages of Rio Grande silvery minnow.	3 yrs	$50k/yr through 2012	MRGESCP	150					50	100	
2	1.3	Conduct periodic genetic studies on Rio Grande silvery minnow populations.	1 ea. 3 yrs		MRGESCP	575				75		250	250
2	1.1.3	Determine spatial and temporal recruitment rates of Rio Grande silvery minnow.	5 yrs	$75k for startup; then $25k/yr	MRGESCP	175					75	100	
2	1.2.2	Determine the relationship between water discharge (timing, magnitude, amplitude, duration) and Rio Grande silvery minnow distribution and abundance.	5 yrs	$50k for startup; then $25k/yr	MRGESCP	150					50	100	
2	1.2.3	Determine stream flows that will provide suitable habitat for all life stages of Rio Grande silvery minnow.	5 yrs		MRGESCP	250					50	200	
2	1.4.2	Design and undertake toxicity tests to assess the effects of	3 yrs		MRGESCP	600			200	200	200		

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
		contaminants on various life stages of Rio Grande silvery minnow.											
2	1.4.5	Design and undertake studies to determine the effects of various flow regimes and pollutant loading on water quality in Rio Grande silvery minnow habitat.	3 yrs		MRGESCP	450				150	150	150	
2	2.1.1	Develop and implement a strategic habitat restoration program to create essential Rio Grande silvery minnow habitat.	10 yrs		MRGESCP	45600	3000	4500	4500	4800	4800	24000	
2	2.1.2	Develop and implement conceptual designs for Rio Grande silvery minnow habitat.	10 yrs		MRGESCP	4200	200	200	300	500	500	2500	
2	2.2.1	Identify constraints (climate, depletions and other losses, reservoir operations, diversions) that affect habitat during periods of low flow.	5 yrs		BOR, COE	400		100	100	100	100		
2	3.2.2	Coordinate augmentation needs with propagation activities.	25 yrs		MRGESCP	150	10	10	10	10	10	50	50
2	3.3.1	Develop a master plan for reestablishment of	2 yrs		FWS	40		20	20				

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
		Rio Grande silvery minnow in new locations within its historical range.											
2	3.3.2	Develop and implement a plan (for each reintroduction location) that delineates actions necessary for reestablishment of Rio Grande silvery minnow.	16 yrs		FWS	880		20	20	20	20	400	400
2	3.1.4.1	Develop a larval fish key to the middle Rio Grande and for stream segments where reintroductions are likely.	1 yrs		MRGESCP	75			75				
2	3.1.4.2	Determine the efficacy of various methods for marking Rio Grande silvery minnow (all life stages)	3 yrs		MRGESCP	150			50	50	50		
2	3.1.4.3	Determine the role of environmental parameters in sex determination of Rio Grande silvery minnow.	3 yrs		MRGESCP	150			50	50	50		
2	3.1.4.4	Determine the rate of development and hatching success under various environmental conditions for Rio Grande silvery minnow.			MRGESCP	150			50	50	50		

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
2	4.1	Utilize an independent and autonomous scientific advisory panel to the Middle Rio Grande Endangered Species Act Collaborative Program (and also for any other programs that are formed to guide and implement recovery actions).	1 per 5 yrs		MRGESCP	600			100		100	200	200
2	4.2.2	Develop and implement a sampling methodology of sufficient rigor to generate a statistically reliable population estimate for each population of Rio Grande silvery minnow.	25 yrs		MRGESCP	6250	250	250	250	250	250	2500	2500
3	1.4.1	Collect and evaluate existing data on water quality and sediment quality and identify future investigations that are needed. Identify the toxic compounds that are now found in point and non-point sources.	3 yrs		MRGESCP	600			200	200	200		
3	1.2.4	Based on knowledge of Rio Grande silvery minnow habitat needs and the research,	5 yrs		MRGESCP	250						250	

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
		determine potential habitats available for Rio Grande silvery minnow in the middle Rio Grande and elsewhere in its historical range.											
3	1.5.1	Determine the distribution and extent of non-native fish species.	5 yrs		MRGESCP	250						250	
3	1.4.3	Design and undertake studies to assess the effects of point and non-point source discharges on Rio Grande silvery minnow food sources.	3 yrs		MRGESCP	600				200	200	200	
3	1.5.2	Determine predation and competition effects on Rio Grande silvery minnow by other Rio Grande fish species.	3 yrs		MRGESCP	650					150	500	
3	1.6.1	Determine the level and rate of hybridization between Rio Grande silvery minnow and plains minnow.	3 yrs		MRGESCP	400					150	250	
3	1.7	Determine the nature and extent of predation on Rio Grande silvery minnow by avian and other predators.	3 yrs		MRGESCP	275				100	100	75	
3	1.4.4	Design and undertake	3 yrs		MRGESCP	450				150	150	150	

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
		studies to assess the effects of stormwater pulse-flows (water quality and contaminants) on Rio Grande silvery minnow and other cyprinids.											
3	1.5.3	Determine effects of different flow regimes (timing, magnitude, amplitude, duration) on non-native fishes.	5 yrs		MRGESCP	625					125	500	
3	1.6.2	Investigate interactions (competition) with congeners at various life stages.	3 yrs		MRGESCP	300				100	100	100	
3	1.5.4	Review and update existing regulations and policies on stocking of non-native sport fishes and bait fish use.	1 yr		NMDGF	150						150	
3	1.4.6	Determine turbidity and sediment levels that reflect historical ecological conditions suitable for the Rio Grande silvery minnow.	5 yrs		States, tribes, EPA	300					100	200	
3	1.4.7	Develop technical feasible water quality criteria for protection of the Rio Grande silvery	5 yrs.		States, tribes, EPA	200					100	100	

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
		minnow.											
3	2.1.3	Provide main channel fish passage at irrigation diversion structures.	10 yrs	2 structures. Planning in 1st 2 yrs., construction in 3rd yr.	MRGESCP	15370	200	100	450	5900	720	8000	
3	2.3.1	Work with Mexico to provide water delivery to the Rio Grande/Rio Bravo del Norte (in the Big Bend region).	15 yrs		IBWC, FWS	60				5	5	50	
3	2.3.10	Establish policies that limit floodplain development and educate the public on the need to limit such development.	5 yrs	Policy development followed by outreach	COE, States	35				10	10	15	
3	2.3.11	Investigate the potential for habitat construction that, during periods of low flow, will provide suitable habitat for the Rio Grande silvery minnow.	3 yrs		MRGESCP	300				100	100	100	
3	2.1.4	Evaluate the impact of entrainment of Rio Grande silvery minnow in irrigation canals as a function of flow regime and habitat restoration.	5 yrs		BOR, COE	250			50	50	150		
3	2.2.2.1	Retrofit or modify, if necessary, the operation of dams where sediment	5 yrs		COE, BOR	30						30	

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
		retention may be effectively managed for partial restoration of historic geomorphology.											
3	2.2.3	Within existing legal authorities, encourage conjunctive use of surface water and groundwater in the Rio Grande.	10 yrs		MRGESCP	25		5	5	5	5	5	
3	2.3.2	Encourage flows within the Big Bend reach that support Rio Grande silvery minnow populations.	15 yrs		IBWC, COE, BOR	75				5	5	5	60
3	2.1.5	Implement management strategies to reduce entrainment of Rio Grande silvery minnow into irrigation canals and the Low Flow Conveyance Channel.	5 yrs		BOR, COE	750				150	150	450	
3	2.2.2.2	Within existing legal authorities, provide storage space for water to augment streamflow.	5 yrs		MRGESCP	1275		175	275	275	275	550	
3	2.2.4	Implement measures to increase water use efficiencies, water conservation, and forbearance in the	10 yrs		MRGCD, COE, BOR	900		100	100	100	100	500	

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
		middle Rio Grande valley to maintain river flows.											
3	2.1.6	Have all proposed instream and floodplain projects reviewed by biologists and geologists, in order to enhance their potential for increased habitat value.	25 yrs		BOR, COE	625	25	25	25	25	25	250	250
3	2.2.2.3	Identify how water supply and flood control operations affect riverine habitat development and habitat availability, and seek benefits for Rio Grande silvery minnow.	8 yrs		MRGESCP	400				50	50	300	
3	2.2.5	Establish policies that limit floodplain development and educate the public on the need to limit such development.	5 yrs	Policy development followed by outreach	COE, BOR	40		10	10	10	5	5	
3	2.3.3.1	Within existing legal authorities, provide for storage of water to augment streamflow.	5 yrs		COE, BOR	5000				1000	1000	3000	
3	2.3.4	Investigate legal, institutional, and technical feasibility of implementing a program of conjunctive use of	5 yrs		ISC, MRGCD, BOR, COE	25				5	5	15	

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
		surface and ground water.											
3	2.2.2.4	Within existing legal authorities, provide more flexibility in water releases and/or storage for spawning and larval survivorship in the middle Rio Grande.	10 yrs		COE	1750		175	175	175	175	1050	
3	2.3.3.2	Within existing legal authorities, identify how reservoir operations for water conveyance affect riverine habitat development and habitat availability.	5 yrs		COE, BOR	500			100	100	100	200	
3	2.3.5	Within existing legal authorities, implement all measures to increase water use efficiencies and conservation.	10 yrs		MRGCD	600		100	100	50	50	300	
3	2.3.6	Implement a comprehensive program of data collection on water supply and use for improvement of water and habitat management.	25 yrs	Database dev. in 1st yr. $25k/yr to maintain	BOR, COE	700			150	25	25	250	250
3	2.3.7	Use standard geological and GIS techniques to determine extent of	5 yrs		BOR, COE	500			100	100	100	200	

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
		floodplain in all reaches.											
3	2.3.8	Measure channel degradation and aggradation trends.	10 yrs		BOR, COE	450			75	75	75	225	
3	2.3.9	Retrofit or change the operation of inflow gates at dams where sediment retention is detrimental to the appropriate geomorphology.	10 yrs		COE	30						30	
3	3.2.3	Determine the effects of various stocking conditions and release sites on Rio Grande silvery minnow.	5 yrs		MRGESCP	125		25	25	25	25	25	
3	3.2.4	Determine the effects of hatchery-to-release site transport conditions on stocked Rio Grande silvery minnow.	2 yrs		MRGESCP	100				50	50		
3	3.3.3	Monitor the reintroduced populations of Rio Grande silvery minnow.	15 yrs		FWS	1125				75	75	750	225
3	3.2.5	Estimate the minimum viable population size for maintaining healthy populations within each reach and for re-introduction areas.	3 yrs		MRGESCP	250				75	75	100	
3	4.3	Periodically review,	25 years	1 each 5 yrs	FWS	125				25		50	50

Priority #	Action #	Action Description	Duration	Comments	Lead Agency & Partners	Estimated Costs ($1000s)							
						Total	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11-20	FY 21-30
		evaluate, and revise research and management activities to ensure progress toward recovery of the Rio Grande silvery minnow.											
3	5.1	Issue notices regarding status of Rio Grande silvery minnow recovery effort.	25 years	1 each 5 yrs	FWS	50				10		20	20
3	5.3	Develop and implement an outreach and communications plan that will help all interested parties to better understand the Rio Grande silvery minnow and its habitat, as well as related conservation and water management issues.	1 yr		FWS	25					25		
3	5.2.2	Identify key messages.	1 yr		FWS	10					10		
3	5.3.1	Identify key audiences.	1 yr		FWS	10					10		
3	5.2.3	Develop targeted outreach programs and materials.	1 yr		FWS	25					25		
Totals						**114125**	**4410**	**6540**	**8490**	**16240**	**11965**	**52135**	**4755**

6.3 Responsible Parties

For the purposes of recovery planning, the Service defines 'Responsible Parties" as the best lead party or parties to accomplish a given recovery action. Inclusion under this section does not obligate any party to implement the Recovery Plan, but merely identifies the best candidate for completing the action. In some cases, tribes or pueblos may be the most appropriate party for implementing certain recovery activities. Implementation of recovery actions by tribes, pueblos, or any other entity, is strictly voluntary.

Following are brief descriptions of some of the entities participating in the recovery of the Rio Grande silvery minnow.

6.3.1 U.S. Fish and Wildlife Service (FWS, Service)

The Mission of the Service is: working with others to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. Protecting endangered and threatened species and restoring them to a secure status in the wild is the primary objective of the endangered species program of the Service, an agency of the U.S. Department of the Interior. Responsibilities of the endangered species program include: listing, reclassifying, and delisting species under the Endangered Species Act; consulting with Federal agencies on their activities that may affect listed species; overseeing recovery activities for listed species; providing for the protection of important habitat; and providing grants to States to assist with endangered species conservation efforts.

6.3.2 U.S. Bureau of Reclamation (BOR)

The mission of BOR is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. The agency operates and maintains all or part of the works associated with the following major water supply projects, all of which affect the water resources within the historic habitat of the Rio Grande silvery minnow: the San Luis Valley Project, the San Juan-Chama Project, the Middle Rio Grande Project and the Rio Grande Project, the Carlsbad Project, and the Brantley Project.

6.3.3 U.S. Army Corps of Engineers (COE)

The COE is authorized to operate and maintain the following projects affecting the water resources within the historic habitat of the Rio Grande silvery minnow: Platoro Dam (flood control pool only), Middle Rio Grande Project (Abiquiu, Cochiti, Jemez Canyon, and Galisteo Dams) and Santa Rosa, Sumner, Brantley (flood control pools only) and Two Rivers Dam in the Pecos River Basin. The Corps is also responsible for issuing permits for the discharge of dredged or fill material into the navigable waters of the United States, under section 404 of the Clean Water Act (Federal Water Pollution Control Act).

6.3.4 U.S. Environmental Protection Agency (EPA)

The mission of the EPA is to protect human health and to safeguard the natural environment — air, water, and land — upon which life depends. Among other things, the agency is responsible for the administration of certain provisions of the Clean Water Act, including the issuance of permits for the discharge of pollutants under the National Pollution Discharge Elimination System.

6.3.5 New Mexico Interstate Stream Commission (ISC) and Office of the State Engineer

The ISC and the Office of the State Engineer are separate but companion agencies charged with administering the State's water resources. The agencies have authority over the supervision, measurement, appropriation, and distribution of almost all surface and groundwater in New Mexico, including streams and rivers that cross State boundaries. The State Engineer is also secretary to the ISC and oversees the staff of both agencies.

6.3.6 New Mexico Environment Department – Surface Water Quality Bureau

The mission of the Surface Water Quality Bureau is to preserve, protect, and improve New Mexico's surface water quality for present and future users of these resources. Emphasis is placed on the maintenance of water quality adequate to guarantee the continuation, in perpetuity, of the potential and existing uses of the water through evaluation, education, and outreach activities, point and nonpoint source controls, and wastewater operator training and certification. The Surface Water Quality Bureau utilizes the authorities described in the Federal Clean Water Act and Safe Drinking Water Act, as well as the New Mexico Water Quality Act and Utility Operators Act, and their attendant regulations and standards.

6.3.7 New Mexico Department of Game and Fish (NMDGF)

Under the authority of the New Mexico Wildlife Conservation Act (NMSA 17-2-37 through 17-2-46, 1978), the NMDGF is responsible for identifying and protecting endangered wildlife in New Mexico.

6.3.8 Texas Parks and Wildlife Department (TPWD)

TPWD maintains a list of endangered species in the State and manages their recovery. "Endangered" species are those that the Executive Director of TPWD has named as being threatened with statewide extinction. "Threatened" species are those that the TPWD Commission has determined are likely to become endangered in the future.

6.3.9 The Texas Commission on Environmental Quality

The mission of the Texas Commission on Environmental Quality is to protect the State's human and natural resources consistent with sustainable economic development. The Commission's goal is clean air, clean water, and safe management of waste, with an

emphasis on pollution prevention.

6.3.10 Texas-New Mexico Water Commission

The Texas-New Mexico Water Commission, which includes representatives of water user groups from the lower Rio Grande in New Mexico and Texas, was formed after a negotiated settlement of disputes surrounding the use of groundwater resources and the effect of surface water uses on aquifer levels in the Mesilla Basin. A goal of the settlement agreement entered into between the parties in 1991 was to work together to study, identify, and address common concerns, especially the interaction between the surface water and the groundwater in the Mesilla Basin of New Mexico and Texas.

6.3.11 Middle Rio Grande Conservancy District (MRGCD)

MRGCD, a political subdivision of the State of New Mexico, was organized under the 1927 New Mexico Conservancy Act. The District prepared the Official Plan of the Middle Rio Grande Conservancy District, which was filed with the District Court of the Second Judicial District of the State of New Mexico. The District Court approved the Plan on August 15, 1928. The Plan proposed the construction of El Vado Dam on Rio Chama, the construction of levees on both sides of the Rio Grande, a system of interior and riverside drains, four diversion dams, 168.6 miles of main canals, and 378.2 miles of laterals.

The District currently operates and maintains about 200 miles of riverside levees and about 1,100 miles of canals, laterals, wasteways, and drains.

6.3.12 Middle Rio Grande Endangered Species Act Collaborative Program (MRGESACP)

The MRGESACP is a partnership involving 20 current signatories organized to protect and improve the status of endangered species along the middle Rio Grande of New Mexico while simultaneously protecting existing and future regional water uses. Two species of particular concern to the program are the Rio Grande silvery minnow and the Southwestern willow flycatcher.

6.3.13 Middle Rio Grande Pueblos

The middle Rio Grande is home to the six Indian pueblos of Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, and Isleta. They range in size from 19,000 acres (Santa Ana) to 205,000 acres (Isleta). These pueblos, which in part are located within the Middle Rio Grande Conservancy District, were diverting water from the Rio Grande and cultivating irrigated lands long before the arrival of the Spanish in 1540. The waters of the Rio Grande also play an important role in the spiritual and ceremonial aspects of the lives of the native Americans who reside along the river.

By the Act of March 13, 1928, Congress authorized the Secretary of the Interior to enter into a contract with the Middle Rio Grande Conservancy District that would provide for

the conservation, irrigation, drainage, and flood control for the pueblo lands in the middle Rio Grande Valley. The legislation required the MRGCD to recognize a first and immemorial priority for 8,847 acres of irrigated lands, and also required the MRGCD to recognize that the water rights for reclaimed new lands are equal to those of like MRGCD lands and are to be protected from discrimination in the division and the use of water. The water rights associated with the old lands, as well as the newly reclaimed lands, are not subject to loss by nonuse or abandonment.

On June 5, 1997, the Secretaries of the U.S. Departments of Interior and Commerce issued a Secretarial Order, "American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the Endangered Species Act," which clarifies the responsibilities of the two agencies when actions taken under the authority of the Endangered Species Act might affect Indian lands, tribal trust resources, or the exercise of American Indian tribal rights. The Order acknowledges the trust responsibility and treaty obligations of the United States toward Indian tribes and tribal members and its government-to-government relationship in dealing with tribes. The Order provides that the Departments will carry out their responsibilities under the Endangered Species Act in a manner that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the Departments, and that strives to ensure that Indian tribes do not bear a disproportionate burden for the conservation of listed species, so as to minimize the potential for conflict and confrontation.

7.0 LITERATURE CITED

Alò, D., and T.F. Turner. 2005. Effects of habitat fragmentation on effective population size in the endangered Rio Grande silvery minnow. *Conservation Biology* 19: 1138 – 1148.

Bestgen, K.R. and S.P. Platania. 1990. Extirpation of *Notropis simus simus* (Cope) and *Notropis orca* Woolman (Pisces: Cyprinidae) from the Rio Grande in New Mexico, with notes on their life history. Occasional Papers of the Museum of Southwestern Biology 6:1-8.

Bestgen, K.R. and S.P. Platania. 1991. Status and conservation of the Rio Grande silvery minnow, *Hybognathus amarus*. Southwestern Naturalist 36(2):225-232.

Bestgen, K.R. and D.L. Propst. 1996. Redescription, geographic variation, and taxonomic status of Rio Grande silvery minnow, *Hybognathus amarus* (Girard 1856). Copeia 1996:41-55.

Buhl, 2004. On-site toxicological evaluation of point source discharges on young silvery minnow. USGS, Columbia Environmental Research Center, Yankton Field Research Station. 13 pp.

Bullard, T.F. and S.G. Wells. 1992. Hydrology of the Middle Rio Grande from Velarde to Elephant Butte Reservoir, New Mexico. U.S. Fish and Wildlife Service, Resource Publication 179.

Caldwell, C.A. 2003. Hybridization potential and spawning behavior of Rio Grande silvery minnow (*Hybognathus amarus*) and plains minnow (*Hybognathus placitus*). U.S. Fish and Wildlife Service, Ecological Services Office, Albuquerque, New Mexico. 18 pp.

Chernoff, B., R.R. Miller, and C.R. Gilbert. 1982. *Notropis orca* and *Notropis simus*, cyprinid fishes from the American Southwest, with description of a new subspecies. Occasional Papers of the Museum of Zoology, University of Michigan, 698:1-49.

Cook, J.A., K.R. Bestgen, D.L. Propst, T.L. Yates. 1992. Allozymic divergence and systematics of the Rio Grande silvery minnow, *Hybognathus amarus* (Teleostei: Cyprinidae). Copeia 1992:36-44.

Cowley, D.E. 1979. Temporal and spatial distribution of fishes in the Black River, Eddy County, New Mexico. Unpublished M.S. thesis, Eastern New Mexico University, Portales, 120 pp.

Dudley, R.K., and S.P. Platania. 1996. Rio Grande silvery minnow winter population-habitat use monitoring project. Portion of monitoring report (Evacuation of carry-over storage at Abiquiu Reservoir, November 1, 1995, to March 31, 1996; analysis of potential effects on Rio Grande silvery minnow) for U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service. 11 pp.

Dudley, R.K., and S.P. Platania. 1997. Habitat use of Rio Grande silvery minnow. Report to the New Mexico Department of Game and Fish, Santa Fe, and U.S. Bureau of Reclamation, Albuquerque, New Mexico. 96 pp.

Dudley, R.K, S.J. Gottlieb, and S.P. Platania. 2003. 2002 population monitoring of Rio Grande silvery minnow, *Hybognathus amarus*. Final report to U.S. Bureau of Reclamation, Albuquerque, New Mexico. 32 pp.

Dudley, R.K., Platania, S.P., Gottlieb, S.J. 2005. Rio Grande Silvery Minnow Population Monitoring Program Results from 2004. Final Report. A Middle Rio Grande Endangered Species Act Collaborative Program Funded Research Project. Report submitted to U.S. Bureau of Reclamation, Albuquerque, NM. 184 pp.

Edwards, R.J. and S. Contreras-Balderas. 1991. Historical changes in the ichthyofauna of the lower Rio Grande (Río Bravo del Norte), Texas and Mexico. Southwestern Naturalist 36(2):201-212.

Edwards, R.J., G.P. Garrett, and E. Marsh-Matthews. 2003. Fish assemblages of the Río Conchos basin, México, with emphasis on their conservation and status. Pp. 75-89, *In* Aquatic Fauna of the Northern Chihuahuan Desert, Contributed Papers from a Special Session within the Thirty-Third Annual Symposium of the Desert Fishes Council (G. P. Garrett and N. L. Allan, eds.), Special Publications, Museum of Texas Tech University, No. 46, 160 pp.

Falconer, D.S. 1981. *Introduction to Quantitative Genetics*. 2nd Edition. Longman, London. 279 pp.

Frankham, R. 1995. Conservation genetics. Annual Review of Genetics 29: 305-327

Girard, C. 1856. Researches upon the cyprinoid fishes inhabiting the freshwaters of the United States of America, west of the Mississippi Valley, from specimens in the museum of the Smithsonian Institution. Proceedings of the Academy Natural Sciences, Philadelphia 8:165-213.

Higgins, K. and M. Lynch. 2001. Metapopulation extinction caused by mutation accumulation. Proceedings of the National Academy of Sciences 98(5):2928-2933.

Hubbs, C., R.R. Miller, R.J. Edwards, K.W. Thompson, E. Marsh, G.P. Garrett, G.L. Powell, D.J. Morris, and R.W. Zerr. 1977. Fishes inhabiting the Rio Grande between New Mexico and the Pecos confluence. Symposium on Importance, Preservation and Management of Riparian Habitat: 91-97.

International Boundary and Water Commission (IBWC). 2003. 2003 Regional Assessment of Water Quality in the Rio Grande Basin. Texas Clean Rivers Program United States Section, International Boundary and Water Commission, 142 pp.

Middle Rio Grande Endangered Species Act Collaborative Program. 2004. Annual Report. 17 pp.

New Mexico Department of Game and Fish.1988. Handbook of Species Endangered in New Mexico. Santa Fe, N.M. 253 pp.

Oad, Ramchand, and J. Phillip King. July 28, 2005. Irrigation Forbearance Feasibility Study in the Middle Rio Grande Conservancy District. Final Report by MBK International for the Middle Rio Grande Conservancy District. 48 pp.

Osborne, M.J., M.A. Benavides, D. Alo, and T.F. Turner. 2006. Genetic Effects of Hatchery Propagation and Rearing in the Endangered Rio Grande Silvery Minnow, *Hybognathus amarus*. Reviews in Fisheries Science 14: 127-138.

Osborne, M.J., M.A. Benavides, and T.F. Turner. 2005. Genetic heterogeneity among pelagic egg samples and variance in reproductive success in an endangered freshwater fish, *Hybognathus amarus*. Environmental Biology of Fishes 73: 463-472.

Pease, A.A; J.J. Davis; M.S. Edwards; T.F. Turner. 2006. Habitat and resource use by larval and juvenile fishes in an arid-land river (Rio Grande, New Mexico). Freshwater Biology 51(3): 475-486.

Pease, A.A. 2004. An assessment of critical nursery habitat features for larval and juvenile fishes in the Middle Rio Grande, New Mexico. Unpublished M.S. thesis, University of New Mexico, Albuquerque, New Mexico. 34 pp.

Pflieger, W.L. 1980. *Hybognathus nuchalis Agassiz*, central silvery minnow. Pp. 177 *In*: Atlas of North American Freshwater Fishes (D.S. Lee et al., eds.). North Carolina State Museum of Natural History, Raleigh, 867 pp.

Platania, S.P. 1991. Fishes of the Rio Chama and Upper Rio Grande, New Mexico, with preliminary comments on their longitudinal distribution. Southwestern Naturalist 36(2):186-193.

Platania, S.P. 1993a. The fishes of the Rio Grande between Velarde and Elephant Butte

Reservoir and their habitat associations. Report to the New Mexico Department of Game and Fish, Santa Fe, and U.S. Bureau of Reclamation, Albuquerque, New Mexico. 188 pp.

Platania. S.P. 1993b. Ichthyofaunal survey of the Rio Grande and Santa Fe River, Cochiti Pueblo, New Mexico, July 1993. Report to the U.S. Army Corps of Engineers, Albuquerque, New Mexico. 28 pp.

Platania, S.P. 1995a. Ichthyofaunal survey of the Rio Grande, Santo Domingo and San Felipe pueblos, New Mexico, July 1994. Report to the U.S. Army Corps of Engineers, Albuquerque, NM. 56 pp.

Platania, S.P. 1995b. Reproductive biology and early life-history of Rio Grande silvery minnow, *Hybognathus amarus.* Report to the U.S. Army Corps of Engineers, Albuquerque, New Mexico. 23 pp.

Platania, S.P. 2000. Effects of four water temperature treatments on survival, growth, and developmental rates of Rio Grande silvery minnow (*Hybognathus amarus*) eggs and larvae. Report to U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico. 35 pp.

Platania, S.P. and C.S. Altenbach. 1998. Reproductive strategies and egg types of seven Rio Grande basin cyprinids. Copeia 1998 (3):559-569.

Platania, S.P. and R.K. Dudley. 2002. Spawning periodicity of Rio Grande silvery minnow during 2001. Report to U.S. Bureau of Reclamation, Albuquerque, New Mexico. 14 pp.

Platania, S.P. and R.K. Dudley. 2003a. Summary of the biology of Rio Grande silvery minnow, an endangered species in the Middle Rio Grande, New Mexico. American Southwest Ichthyological Research Foundation and Division of Fishes, Museum of Southwestern Biology, University of New Mexico, Albuquerque, New Mexico. 30 pp.

Platania, S.P. and R.K. Dudley. 2003b. Spawning periodicity of Rio Grande silvery minnow, *Hybognathus amarus*, during 2002. Report to U.S. Bureau of Reclamation, Albuquerque, New Mexico. 47 pp.

Platania, S.P., M.A. Farrington, W.H. Brandenburg, S.J. Gottlieb, and R.K. Dudley. 2003. Movement patterns of Rio Grande silvery minnow *Hybognathus amarus*, in the San Acacia Reach of the Rio Grande during 2002. Final Report. U.S. Bureau of Reclamation, Contract 01-PG-40-187, 10 June 2003, Albuquerque, NM. 38 pp.

Plateau Ecosystems Consulting, Inc. 2001. Fish studies of the middle Rio Grande, New Mexico. Report to U. S. Bureau of Reclamation, Denver, CO. 91 pp.

Porter, M.D. and Massong, T.M. 2003. Progress Report on Rio Grande Silvery Minnow Egg Habitat Study – FY 2003. Technical Report (draft), Bureau of Reclamation, Albuquerque, NM. Unpublished Technical Report, Bureau of Reclamation, Albuquerque, NM, 11 pp.

Porter, M.D. and Massong, T.M. 2004. Analyzing changing river channel morphology using GIS for Rio Grande silvery minnow habitat assessment. *In* Proceedings of the Second International Symposium on GIS/Spatial Analysis in Fishery and Aquatic Sciences, 3-6 September, 2002, University of Sussex, Brighton, U.K. Nishida, T., Kailola, P.J., Hollingworth, C.E. (Editors): 435-448.

Propst, D.L., G.L. Burton, and B.H. Pridgeon. 1987. Fishes of the Rio Grande between Elephant Butte and Caballo reservoirs, New Mexico. Southwestern Naturalist 32: 408-411.

Ralls, K., and J. Ballou. 1983. Extinction: Lessons from zoos. Pp. 164–184 *In* C. M. Schoenwald-Cox, S.M. Chambers, B. MacBryde, and W. L. Thomas, eds. Genetics and Conservation: A Reference for Managing Wild Animals and Plant Populations. Menlo Park, California: Benjamin/Cummings.

Remshardt, W.J. 2001. Augmentation and Monitoring Plan for the Rio Grande silvery minnow in the Middle Rio Grande, New Mexico. 2001. U.S. Fish and Wildlife Service, New Mexico Fishery Resources Office. Albuquerque, New Mexico. 17 pp.

Remshardt, W.J. and S.R. Davenport. 2003. Augmentation and monitoring of Rio Grande silvery minnow in the Rio Grande. Report to the Middle Rio Grande Endangered Species Collaborative Program. 41 pp.

S.S. Papadopulos & Associates,Inc. 2002. Middle Rio Grande Supply Study, Phase 3. Report to U.S. Army Corps of Engineers and New Mexico Interstate Stream Commission. 339 pp.

S.S. Papadopulos & Associates, Inc. 2001. Analysis of Paleo-Climate and Climate-Forcing Information for New Mexico and Implications for Modeling in the Middle Rio Grande Water Supply Study, Technical Memorandum prepared as part of the Middle Rio Grande Water Supply Study. 22 pp.

Secretaria de Desarrollo Social (SDS). 1994. Que determina las especies y subespecies de flora y fauna silvestres terrestres y acuaticas en peligro de extincion amenazadas, raras y las sujetas a proteccion especial, y que establece especificaciones para su proteccion. Diario Oficial de la Federacion, Mexico, CDLXXXVIII (10):2-60.

Shupe, S.J. and J. Folk-Williams. 1988. The Upper Rio Grande: a guide to decision-making. Western Network, Santa Fe, N.M. 51 pp.

Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. The Fishes of New Mexico. University of New Mexico Press, Albuquerque, N.M. 393 pp.

Tetra Tech EM Inc. 2004. Habitat Restoration Plan for the Middle Rio Grande. Report to the Middle Rio Grande Endangered Species Act Collaborative Program, Habitat Restoration Subcommittee. 145 pp.

Texas Natural Resources Conservation Commission. 1994. 1994 Regional Assessment of Water Quality in the Rio Grande Basin including the Pecos River, the Devils River, the Arroyo Colorado and the Lower Laguna Madre. Watershed Management Division, Texas Natural Resource Conservation Commission Publication AS-34, 377 pp. + appendices.

Treviño-Robinson, D.T. 1959. The ichthyofauna of the lower Rio Grande, Texas and Mexico. Copeia 1959:253-256.

Turner T.F., and M. J. Osborne. 2004. Genetic Consequences of Supportive Breeding in the Endangered Rio Grande Silvery Minnow (Hybognathus amarus): Genetic Evaluation of Wild and Captively Reared and Propagated Stocks, 1999-2004. An annual report submitted to the Middle Rio Grande ESA Collaborative Program, 31pp.

Turner T.F., M.J. Osborne, G.R. Moyer, D. Alò. 2005. Conservation genetics of Rio Grande silvery minnow. Final report submitted to the Middle Rio Grande ESA Collaborative Program, 87 pp.

Turner T. F., M.J. Osborne, and D. Alo. 2003. Conservation Genetics of Rio Grande silvery minnow, *Hybognathus amarus*: genetic evaluation of wild and captive stocks, 1999 to 2003. Annual Report to the Middle Rio Grande ESA Collaborative Workgroup - Fiscal Year 2002 - 80 pp.

U.S. Geological Survey, 2001, National Water Information System (NWISWeb) data available on the World Wide Web, accessed August 31, 2005, at URL http://waterdata.usgs.gov/nm/nwis/sw.

U.S. Fish and Wildlife Service. 1999. Rio Grande silvery minnow recovery plan. Albuquerque, NM. 141 pp.

U.S. Fish and Wildlife Service. 2003a. Biological and Conference Opinions of the Effects of Actions Associated with the Programmatic Biological Assessment of Bureau of

Reclamation's Water and River Maintenance Operations, Army Corps of Engineers' Flood Control Operation, and Related Non-Federal Actions of the Middle Rio Grande, New Mexico. March 17, 2003. Albuquerque, NM. 128 pp. Appendices A-E.

U.S. Fish and Wildlife Service. 2005. Rio Grande Silvery Minnow Rescue and Salvage: Fiscal Year 2004. 11 pp.

U.S.D.O.I. (United States Department of the Interior). 1998. Guidelines for interpretation of the biological effects of selected constituents in biota, water, and sediment. National Irrigation Water Quality Program Information Report 3, Bureau of Reclamation, Denver, CO. 214 pp.

Watts, H.E., C.W. Hoagstrom, and J.R. Smith. 2002. Observations on Habitat Associated with Rio Grande Silvery Minnow, *Hybognathus amarus* (Girard). Submitted to U.S. Army Corps of Engineers, Albuquerque District and City of Albuquerque Water Resources Division, June 28, 2002. 18 pp.

Wesche et al. 2005. Evaluating middle Rio Grande flow alteration at a river network scale to enhance water management opportunities. FY2003 Project Report on Contract No. 03CR408035. Middle Rio Grande ESA Collaborative Program. 59 pp.

APPENDIX A

1994 PRESIDENTIAL MEMO: GOVERNMENT-TO-GOVERNMENT RELATIONS WITH NATIVE AMERICAN TRIBAL GOVERNMENTS

OFFICIAL AMERICAN INDIAN POLICY
The White House
Washington
April 29, 1994

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

SUBJECT: Government-to-Government Relations With Native American Tribal Governments

The United States Government has a unique legal relationship with Native American tribal governments as set forth in the Constitution of the United States, treaties, statutes, and court decisions. As executive departments and agencies undertake activities affecting Native American tribal rights or trust resources, such activities should be implemented in a knowledgeable, sensitive manner respectful of tribal sovereignty. Today, as part of an historic meeting, I am outlining principles that executive departments and agencies, including every component bureau and office, are to follow in their interactions with Native American tribal governments. The purpose of these principles is to clarify our responsibility to ensure that the Federal Government operates within a government-to-government relationship with federally recognized Native American tribes. I am strongly committed to building a more effective day-to-day working relationship reflecting respect for the rights of self-government due the sovereign tribal governments.

In order to ensure that the rights of sovereign tribal governments are fully respected, executive branch activities shall be guided by the following:

a. The head of each executive department and agency shall be responsible for ensuring that the department or agency operates within a government-to-government relationship with federally recognized tribal governments.

b. Each executive department and agency shall consult, to the greatest extent practicable and to the extent permitted by law, with tribal governments prior to taking actions that affect federally recognized tribal governments. All such consultations are to be open and candid so that all interested parties may evaluate for themselves the potential impact of relevant proposals.

c. Each executive department and agency shall assess the impact of Federal Government plans, projects, programs, and activities on tribal trust resources and assure that tribal government rights and concerns are considered during the development of such plans, projects, programs, and activities.

d. Each executive department and agency shall take appropriate steps to remove any procedural impediments to working directly and effectively with tribal governments on activities that affect the trust property and/or governmental rights of the tribes.

e. Each executive department and agency shall work cooperatively with other Federal departments and agencies to enlist their interest and support in cooperative efforts, where appropriate, to accomplish the goals of this memorandum.

f. Each executive department and agency shall apply the requirements of Executive Orders Nos. 12875 ("Enhancing the Intergovernmental Partnership") and 12866 ("Regulatory Planning and Review") to design solutions and tailor Federal programs, in appropriate circumstances, to address specific or unique needs of tribal communities.

The head of each executive department and agency shall ensure that the department or agency's bureaus and components are fully aware of this memorandum, through publication or other means, and that they are in compliance with its requirements.

This memorandum is intended only to improve the internal management of the executive branch and is not intended to, and does not, create any right to administrative or judicial review, or any other right or benefit or trust responsibility, substantive or procedural, enforceable by a party against the United States, its agencies or instrumentalities, its officers or employees, or any other person.

The Director of the Office of Management and Budget is authorized and directed to publish this memorandum in the Federal Register.

WILLIAM J. CLINTON

[FR Doc. 94-10877]

APPENDIX B

1997 SECRETARIAL ORDER #3206: AMERICAN INDIAN TRIBAL RIGHTS, FEDERAL-TRIBAL TRUST RESPONSIBILITIES, AND THE ENDANGERED SPECIES ACT

SECRETARIAL ORDER #3206

Subject: American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act

Sec. 1. Purpose and Authority. This Order is issued by the Secretary of the Interior and the Secretary of Commerce (Secretaries) pursuant to the Endangered Species Act of 1973, 16 U.S.C. 1531, as amended (the Act), the Federal-tribal trust relationship, and other Federal law. Specifically, this Order clarifies the responsibilities of the component agencies, bureaus and offices of the Department of the Interior and the Department of Commerce (Departments), when actions taken under authority of the Act and associated implementing regulations affect, or may affect, Indian lands, tribal trust resources, or the exercise of American Indian tribal rights, as defined in this Order. This Order further acknowledges the trust responsibility and treaty obligations of the United States toward Indian tribes and tribal members and its government-to-government relationship in dealing with tribes. Accordingly, the Departments will carry out their responsibilities under the Act in a manner that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the Departments, and that strives to ensure that Indian tribes do not bear a disproportionate burden for the conservation of listed species, so as to avoid or minimize the potential for conflict and confrontation.

Sec. 2. Scope and Limitations. (A) This Order is for guidance within the Departments only and is adopted pursuant to, and is consistent with, existing law.

(B) This Order shall not be construed to grant, expand, create, or diminish any legally enforceable rights, benefits or trust responsibilities, substantive or procedural, not otherwise granted or created under existing law. Nor shall this Order be construed to alter, amend, repeal, interpret or modify tribal sovereignty, any treaty rights, or other rights of any Indian tribe, or to preempt, modify or limit the exercise of any such rights.

(C) This Order does not preempt or modify the Departments' statutory authorities or the authorities of Indian tribes or the States.

(D) Nothing in this Order shall be applied to authorize direct (directed) take of listed species, or any activity that would jeopardize the continued existence of any listed

species or destroy or adversely modify designated critical habitat. Incidental take issues under this Order are addressed in Principle 3(C) of Section 5.

(E) Nothing in this Order shall require additional procedural requirements for substantially completed Departmental actions, activities, or policy initiatives.

(F) Implementation of this Order shall be subject to the availability of resources and the requirements of the Anti-Deficiency Act.

(G) Should any tribe(s) and the Department(s) agree that greater efficiency in the implementation of this Order can be achieved, nothing in this Order shall prevent them from implementing strategies to do so.

(H) This Order shall not be construed to supersede, amend, or otherwise modify or affect the implementation of, existing agreements or understandings with the Departments or their agencies, bureaus, or offices including, but not limited to, memoranda of understanding, memoranda of agreement, or statements of relationship, unless mutually agreed by the signatory parties.

Sec. 3. Definitions. For the purposes of this Order, except as otherwise expressly provided, the following terms shall apply:

(A) The term “Indian tribe” shall mean any Indian tribe, band, nation, pueblo, community or other organized group within the United States which the Secretary of the Interior has identified on the most current list of tribes maintained by the Bureau of Indian Affairs.

(B) The term “tribal trust resources” means those natural resources, either on or off Indian lands, retained by, or reserved by or for Indian tribes through treaties, statutes, judicial decisions, and executive orders, which are protected by a fiduciary obligation on the part of the United States.

(C) The term “tribal rights” means those rights legally accruing to a tribe or tribes by virtue of inherent sovereign authority, unextinguished aboriginal title, treaty, statute, judicial decisions, executive order or agreement, and which give rise to legally enforceable remedies.

(D) The term “Indian lands” means any lands title to which is either: 1) held in trust by the United States for the benefit of any Indian tribe or individual; or 2) held by any Indian tribe or individual subject to restrictions by the United States against alienation.

Sec. 4. Background. The unique and distinctive political relationship between the United States and Indian tribes is defined by treaties, statutes, executive orders, judicial decisions, and agreements, and differentiates tribes from other entities that deal with, or are affected by, the Federal Government. This relationship has given rise to a special Federal trust responsibility, involving the legal responsibilities and obligations of the United States toward Indian tribes and the application of fiduciary standards of due care with respect to Indian lands, tribal trust resources, and the exercise of tribal rights.

The Departments recognize the importance of tribal self-governance and the protocols of a government-to-government relationship with Indian tribes. Long-standing Congressional and Administrative policies promote tribal self-government, self-sufficiency, and self-determination, recognizing and endorsing the fundamental rights of tribes to set their own priorities and make decisions affecting their resources and distinctive ways of life. The Departments recognize and respect, and shall consider, the value that tribal traditional knowledge provides to tribal and Federal land management decision-making and tribal resource management activities. The Departments recognize that Indian tribes are governmental sovereigns; inherent in this sovereign authority is the power to make and enforce laws, administer justice, manage and control Indian lands, exercise tribal rights and protect tribal trust resources. The Departments shall be sensitive to the fact that Indian cultures, religions, and spirituality often involve ceremonial and medicinal uses of plants, animals, and specific geographic places.

Indian lands are not Federal public lands or part of the public domain, and are not subject to Federal public land laws. They were retained by tribes or were set aside for tribal use pursuant to treaties, statutes, judicial decisions, executive orders or agreements. These lands are managed by Indian tribes in accordance with tribal goals and objectives, within the framework of applicable laws.

Because of the unique government-to-government relationship between Indian tribes and the United States, the Departments and affected Indian tribes need to establish and maintain effective working relationships and mutual partnerships to promote the conservation of sensitive species (including candidate, proposed and listed species) and the health of ecosystems upon which they depend. Such relationships should focus on cooperative assistance, consultation, the sharing of information, and the creation of government-to-government partnerships to promote healthy ecosystems.

In facilitating a government-to-government relationship, the Departments may work with intertribal organizations, to the extent such organizations are authorized by their member tribes to carry out resource management responsibilities.

Sec. 5. Responsibilities. To achieve the objectives of this Order, the heads of all agencies, bureaus and offices within the Department of the Interior, and the Administrator of the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce, shall be responsible for ensuring that the following directives are followed:

Principle 1. THE DEPARTMENTS SHALL WORK DIRECTLY WITH INDIAN TRIBES ON A GOVERNMENT-TO-GOVERNMENT BASIS TO PROMOTE HEALTHY ECOSYSTEMS.

The Departments shall recognize the unique and distinctive political and constitutionally based relationship that exists between the United States and each Indian tribe, and shall view tribal governments as sovereign entities with authority and responsibility for the

health and welfare of ecosystems on Indian lands. The Departments recognize that Indian tribes are governmental sovereigns with inherent powers to make and enforce laws, administer justice, and manage and control their natural resources. Accordingly, the Departments shall seek to establish effective government-to-government working relationships with tribes to achieve the common goal of promoting and protecting the health of these ecosystems. Whenever the agencies, bureaus, and offices of the Departments are aware that their actions planned under the Act may impact tribal trust resources, the exercise of tribal rights, or Indian lands, they shall consult with, and seek the participation of, the affected Indian tribes to the maximum extent practicable. This shall include providing affected tribes adequate opportunities to participate in data collection, consensus seeking, and associated processes. To facilitate the government-to-government relationship, the Departments may coordinate their discussions with a representative from an intertribal organization, if so designated by the affected tribe(s).

Except when determined necessary for investigative or prosecutorial law enforcement activities, or when otherwise provided in a Federal-tribal agreement, the Departments, to the maximum extent practicable, shall obtain permission from tribes before knowingly entering Indian reservations and tribally-owned fee lands for purposes of ESA-related activities, and shall communicate as necessary with the appropriate tribal officials. If a tribe believes this section has been violated, such tribe may file a complaint with the appropriate Secretary, who shall promptly investigate and respond to the tribe.

Principle 2. THE DEPARTMENTS SHALL RECOGNIZE THAT INDIAN LANDS ARE NOT SUBJECT TO THE SAME CONTROLS AS FEDERAL PUBLIC LANDS.

The Departments recognize that Indian lands, whether held in trust by the United States for the use and benefit of Indians or owned exclusively by an Indian tribe, are not subject to the controls or restrictions set forth in Federal public land laws. Indian lands are not Federal public lands or part of the public domain, but are rather retained by tribes or set aside for tribal use pursuant to treaties, statutes, court orders, executive orders, judicial decisions, or agreements. Accordingly, Indian tribes manage Indian lands in accordance with tribal goals and objectives, within the framework of applicable laws.

Principle 3. THE DEPARTMENTS SHALL ASSIST INDIAN TRIBES IN DEVELOPING AND EXPANDING TRIBAL PROGRAMS SO THAT HEALTHY ECOSYSTEMS ARE PROMOTED AND CONSERVATION RESTRICTIONS ARE UNNECESSARY.

(A) The Departments shall take affirmative steps to assist Indian tribes in developing and expanding tribal programs that promote healthy ecosystems. The Departments shall take affirmative steps to achieve the common goals of promoting healthy ecosystems, Indian self-government, and productive government-to-government relationships under this Order, by assisting Indian tribes in developing and expanding

tribal programs that promote the health of ecosystems upon which sensitive species (including candidate, proposed and listed species) depend.

The Departments shall offer and provide such scientific and technical assistance and information as may be available for the development of tribal conservation and management plans to promote the maintenance, restoration, enhancement and health of the ecosystems upon which sensitive species (including candidate, proposed, and listed species) depend, including the cooperative identification of appropriate management measures to address concerns for such species and their habitats.

(B) The Departments shall recognize that Indian tribes are appropriate governmental entities to manage their lands and tribal trust resources. The Departments acknowledge that Indian tribes value, and exercise responsibilities for, management of Indian lands and tribal trust resources. In keeping with the Federal policy of promoting tribal self-government, the Departments shall respect the exercise of tribal sovereignty over the management of Indian lands, and tribal trust resources. Accordingly, the Departments shall give deference to tribal conservation and management plans for tribal trust resources that: (a) govern activities on Indian lands, including, for the purposes of this section, tribally-owned fee lands, and (b) address the conservation needs of listed species. The Departments shall conduct government-to-government consultations to discuss the extent to which tribal resource management plans for tribal trust resources outside Indian lands can be incorporated into actions to address the conservation needs of listed species.

(C) The Departments, as trustees, shall support tribal measures that preclude the need for conservation restrictions.

At the earliest indication that the need for Federal conservation restrictions is being considered for any species, the Departments, acting in their trustee capacities, shall promptly notify all potentially affected tribes, and provide such technical, financial, or other assistance as may be appropriate, thereby assisting Indian tribes in identifying and implementing tribal conservation and other measures necessary to protect such species.

In the event that the Departments determine that conservation restrictions are necessary in order to protect listed species, the Departments, in keeping with the trust responsibility and government-to-government relationships, shall consult with affected tribes and provide written notice to them of the intended restriction as far in advance as practicable. If the proposed conservation restriction is directed at a tribal activity that could raise the potential issue of direct (directed) take under the Act, then meaningful government-to-government consultation shall occur, in order to strive to harmonize the Federal trust responsibility to tribes, tribal sovereignty and the statutory missions of the Departments. In cases involving an activity that could raise the potential issue of an incidental take under the Act, such notice shall include an analysis and determination that all of the following conservation standards have been met: (i) the restriction is reasonable and

necessary for conservation of the species at issue; (ii) the conservation purpose of the restriction cannot be achieved by reasonable regulation of non-Indian activities; (iii) the measure is the least restrictive alternative available to achieve the required conservation purpose; (iv) the restriction does not discriminate against Indian activities, either as stated or applied; and, (v) voluntary tribal measures are not adequate to achieve the necessary conservation purpose.

Principle 4. THE DEPARTMENTS SHALL BE SENSITIVE TO INDIAN CULTURE, RELIGION AND SPIRITUALITY.

The Departments shall take into consideration the impacts of their actions and policies under the Act on Indian use of listed species for cultural and religious purposes. The Departments shall avoid or minimize, to the extent practicable, adverse effects upon the noncommercial use of listed sacred plants and animals in medicinal treatments and in the expression of cultural and religious beliefs by Indian tribes. When appropriate, the Departments may issue guidelines to accommodate Indian access to, and traditional uses of, listed species, and to address unique circumstances that may exist when administering the Act.

Principle 5. THE DEPARTMENTS SHALL MAKE AVAILABLE TO INDIAN TRIBES INFORMATION RELATED TO TRIBAL TRUST RESOURCES AND INDIAN LANDS, AND, TO FACILITATE THE MUTUAL EXCHANGE OF INFORMATION, SHALL STRIVE TO PROTECT SENSITIVE TRIBAL INFORMATION FROM DISCLOSURE.

To further tribal self-government and the promotion of healthy ecosystems, the Departments recognize the critical need for Indian tribes to possess complete and accurate information related to Indian lands and tribal trust resources. To the extent consistent with the provisions of the Privacy Act, the Freedom of Information Act (FOIA) and the Departments' abilities to continue to assert FOIA exemptions with regard to FOIA requests, the Departments shall make available to an Indian tribe all information held by the Departments which is related to its Indian lands and tribal trust resources. In the course of the mutual exchange of information, the Departments shall protect, to the maximum extent practicable, tribal information which has been disclosed to or collected by the Departments. The Departments shall promptly notify and, when appropriate, consult with affected tribes regarding all requests for tribal information relating to the administration of the Act.

Sec. 6. Federal-Tribal Intergovernmental Agreements. The Departments shall, when appropriate and at the request of an Indian tribe, pursue intergovernmental agreements to formalize arrangements involving sensitive species (including candidate, proposed, and listed species) such as, but not limited to, land and resource management, multi-jurisdictional partnerships, cooperative law enforcement, and guidelines to accommodate Indian access to, and traditional uses of, natural products. Such agreements shall strive to

establish partnerships that harmonize the Departments' missions under the Act with the Indian tribe's own ecosystem management objectives.

Sec. 7. Alaska. The Departments recognize that section 10(e) of the Act governs the taking of listed species by Alaska Natives for subsistence purposes and that there is a need to study the implementation of the Act as applied to Alaska tribes and natives. Accordingly, this Order shall not apply to Alaska and the Departments shall, within one year of the date of this Order, develop recommendations to the Secretaries to supplement or modify this Order and its Appendix, so as to guide the administration of the Act in Alaska. These recommendations shall be developed with the full cooperation and participation of Alaska tribes and natives. The purpose of these recommendations shall be to harmonize the government-to-government relationship with Alaska tribes, the Federal trust responsibility to Alaska tribes and Alaska Natives, the rights of Alaska Natives, and the statutory missions of the Departments.

Sec. 8. Special Study on Cultural and Religious Use of Natural Products. The Departments recognize that there remain tribal concerns regarding the access to, and uses of, eagle feathers, animal parts, and other natural products for Indian cultural and religious purposes. Therefore, the Departments shall work together with Indian tribes to develop recommendations to the Secretaries within one year to revise or establish uniform administrative procedures to govern the possession, distribution, and transportation of such natural products that are under Federal jurisdiction or control.

Sec. 9. Dispute Resolution. (A) Federal-tribal disputes regarding implementation of this Order shall be addressed through government-to-government discourse. Such discourse is to be respectful of government-to-government relationships and relevant Federal-tribal agreements, treaties, judicial decisions, and policies pertaining to Indian tribes. Alternative dispute resolution processes may be employed as necessary to resolve disputes on technical or policy issues within statutory time frames; provided that such alternative dispute resolution processes are not intended to apply in the context of investigative or prosecutorial law enforcement activities.

(B) Questions and concerns on matters relating to the use or possession of listed plants or listed animal parts used for religious or cultural purposes shall be referred to the appropriate Departmental officials and the appropriate tribal contacts for religious and cultural affairs.

Sec. 10. Implementation. This Order shall be implemented by all agencies, bureaus, and offices of the Departments, as applicable. In addition, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service shall implement their specific responsibilities under the Act in accordance with the guidance contained in the attached Appendix.

Sec. 11. Effective Date. This Order, issued within the Department of the Interior as Order No. 3206, is effective immediately and will remain in effect until amended, superseded, or revoked.

This Secretarial Order, entitled "American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act," and its accompanying Appendix were issued this 5th day of June, 1997, in Washington, D.C., by the Secretary of the Interior and the Secretary of Commerce.

_____

Secretary of the Interior
Secretary of Commerce

Date: June 5, 1997

APPENDIX

Appendix to Secretarial Order issued within the Department of the Interior as Order No. 3206

Sec. 1. Purpose. The purpose of this Appendix is to provide policy to the National, regional and field offices of the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS), (hereinafter "Services"), concerning the implementation of the Secretarial Order issued by the Department of the Interior and the Department of Commerce, entitled "American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act." This policy furthers the objectives of the FWS Native American Policy (June 28, 1994), and the American Indian and Alaska Native Policy of the Department of Commerce (March 30, 1995). This Appendix shall be considered an integral part of the above Secretarial Order, and all sections of the Order shall apply in their entirety to this Appendix.

Sec. 2. General Policy. (A) Goals. The goals of this Appendix are to provide a basis for administration of the Act in a manner that (1) recognizes common Federal-tribal goals of conserving sensitive species (including candidate, proposed, and listed species) and the ecosystems upon which they depend, Indian self-government, and productive government-to-government relationships; and (2) harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and the statutory missions of the Departments, so as to avoid or minimize the potential for conflict and confrontation.

(B) Government-to-Government Communication. It shall be the responsibility of each Service's regional and field offices to maintain a current list of tribal contact persons within each Region, and to ensure that meaningful government-to-government communication occurs regarding actions to be taken under the Act.

(C) Agency Coordination. The Services have the lead roles and responsibilities in administering the Act, while the Services and other Federal agencies share responsibilities for honoring Indian treaties and other sources of tribal rights. The Bureau of Indian Affairs (BIA) has the primary responsibility for carrying out the Federal

responsibility to administer tribal trust property and represent tribal interests during formal Section 7 consultations under the Act. Accordingly, the Services shall consult, as appropriate, with each other, affected Indian tribes, the BIA, the Office of the Solicitor (Interior), the Office of American Indian Trust (Interior), and the NOAA Office of General Counsel in determining how the fiduciary responsibility of the Federal government to Indian tribes may best be realized.

(D) Technical Assistance. In their roles as trustees, the Services shall offer and provide technical assistance and information for the development of tribal conservation and management plans to promote the maintenance, restoration, and enhancement of the ecosystems on which sensitive species (including candidate, proposed, and listed species) depend. The Services should be creative in working with the tribes to accomplish these objectives. Such technical assistance may include the cooperative identification of appropriate management measures to address concerns for sensitive species (including candidate, proposed and listed species) and their habitats. Such cooperation may include intergovernmental agreements to enable Indian tribes to more fully participate in conservation programs under the Act. Moreover, the Services may enter into conservation easements with tribal governments and enlist tribal participation in incentive programs.

(E) Tribal Conservation Measures. The Services shall, upon the request of an Indian tribe or the BIA, cooperatively review and assess tribal conservation measures for sensitive species (including candidate, proposed and listed species) which may be included in tribal resource management plans. The Services will communicate to the tribal government their desired conservation goals and objectives, as well as any technical advice or suggestions for the modification of the plan to enhance its benefits for the conservation of sensitive species (including candidate, proposed and listed species). In keeping with the Services' initiatives to promote voluntary conservation partnerships for listed species and the ecosystems upon which they depend, the Services shall consult on a government-to-government basis with the affected tribe to determine and provide appropriate assurances that would otherwise be provided to a non-Indian.

Sec. 3. The Federal Trust Responsibility and the Administration of the Act.

The Services shall coordinate with affected Indian tribes in order to fulfill the Services' trust responsibilities and encourage meaningful tribal participation in the following programs under the Act, and shall:

(A) Candidate Conservation.

(1) Solicit and utilize the expertise of affected Indian tribes in evaluating which animal and plant species should be included on the list of candidate species, including conducting population status inventories and geographical distribution surveys;

(2) Solicit and utilize the expertise of affected Indian tribes when designing and implementing candidate conservation actions to remove or alleviate threats so that the species' listing priority is reduced or listing as endangered or threatened is rendered unnecessary; and

(3) Provide technical advice and information to support tribal efforts and facilitate voluntary tribal participation in implementation measures to conserve candidate species on Indian lands.

(B) The Listing Process.

(1) Provide affected Indian tribes with timely notification of the receipt of petitions to list species, the listing of which could affect the exercise of tribal rights or the use of tribal trust resources. In addition, the Services shall solicit and utilize the expertise of affected Indian tribes in responding to listing petitions that may affect tribal trust resources or the exercise of tribal rights.

(2) Recognize the right of Indian tribes to participate fully in the listing process by providing timely notification to, soliciting information and comments from, and utilizing the expertise of, Indian tribes whose exercise of tribal rights or tribal trust resources could be affected by a particular listing. This process shall apply to proposed and final rules to: (i) list species as endangered or threatened; (ii) designate critical habitat; (iii) reclassify a species from endangered to threatened (or vice versa); (iv) remove a species from the list; and (v) designate experimental populations.

(3) Recognize the contribution to be made by affected Indian tribes, throughout the process and prior to finalization and close of the public comment period, in the review of proposals to designate critical habitat and evaluate economic impacts of such proposals with implications for tribal trust resources or the exercise of tribal rights. The Services shall notify affected Indian tribes and the BIA, and solicit information on, but not limited to, tribal cultural values, reserved hunting, fishing, gathering, and other Indian rights or tribal economic development, for use in: (i) the preparation of economic analyses involving impacts on tribal communities; and (ii) the preparation of "balancing tests" to determine appropriate exclusions from critical habitat and in the review of comments or petitions concerning critical habitat that may adversely affect the rights or resources of Indian tribes.

(4) In keeping with the trust responsibility, shall consult with the affected Indian tribe(s) when considering the designation of critical habitat in an area that may impact tribal trust resources, tribally-owned fee lands, or the exercise of tribal rights. Critical habitat shall not be designated in such areas unless it is determined essential to conserve a listed species. In designating critical habitat, the Services shall evaluate and document the extent to which the conservation needs of the listed species can be achieved by limiting the designation to other lands.

(5) When exercising regulatory authority for threatened species under section 4(d) of the Act, avoid or minimize effects on tribal management or economic development, or the exercise of reserved Indian fishing, hunting, gathering, or other rights, to the maximum extent allowed by law.

(6) Having first provided the affected Indian tribe(s) the opportunity to actively review and comment on proposed listing actions, provide affected Indian tribe(s) with a written explanation whenever a final decision on any of the following activities conflicts with comments provided by an affected Indian tribe: (i) list a species as endangered or threatened; (ii) designate critical habitat; (iii) reclassify a species from endangered to threatened (or vice versa); (iv) remove a species from the list; or (v) designate experimental populations. If an affected Indian tribe petitions for rulemaking under Section 4(b)(3), the Services will consult with and provide a written explanation to the affected tribe if they fail to adopt the requested regulation.

(C) ESA Section 7 Consultation.

(1) Facilitate the Services' use of the best available scientific and commercial data by soliciting information, traditional knowledge, and comments from, and utilizing the expertise of, affected Indian tribes in addition to data provided by the action agency during the consultation process. The Services shall provide timely notification to affected tribes as soon as the Services are aware that a proposed Federal agency action subject to formal consultation may affect tribal rights or tribal trust resources.

(2) Provide copies of applicable final biological opinions to affected tribes to the maximum extent permissible by law.

(3)(a) When the Services enter formal consultation on an action proposed by the BIA, the Services shall consider and treat affected tribes as license or permit applicants entitled to full participation in the consultation process. This shall include, but is not limited to, invitations to meetings between the Services and the BIA, opportunities to provide pertinent scientific data and to review data in the administrative record, and to review biological assessments and draft biological opinions. In keeping with the trust responsibility, tribal conservation and management plans for tribal trust resources that govern activities on Indian lands, including for purposes of this paragraph, tribally-owned fee lands, shall serve as the basis for developing any reasonable and prudent alternatives, to the extent practicable.

(b) When the Services enter into formal consultations with an Interior Department agency other than the BIA, or an agency of the Department of Commerce, on a proposed action which may affect tribal rights or tribal trust resources, the Services shall notify the affected Indian tribe(s) and provide for the participation of the BIA in the consultation process.

(c) When the Services enter into formal consultations with agencies not in the Departments of the Interior or Commerce, on a proposed action which may affect tribal rights or tribal trust resources, the Services shall notify the affected Indian tribe(s) and encourage the action agency to invite the affected tribe(s) and the BIA to participate in the consultation process.

(d) In developing reasonable and prudent alternatives, the Services shall give full consideration to all comments and information received from any affected tribe, and shall strive to ensure that any alternative selected does not discriminate against such tribe(s). The Services shall make a written determination describing (i) how the selected alternative is consistent with their trust responsibilities, and (ii) the extent to which tribal conservation and management plans for affected tribal trust resources can be incorporated into any such alternative.

(D) Habitat Conservation Planning.

(1) Facilitate the Services' use of the best available scientific and commercial data by soliciting information, traditional knowledge, and comments from, and utilizing the expertise of, affected tribal governments in habitat conservation planning that may affect tribal trust resources or the exercise of tribal rights. The Services shall facilitate tribal participation by providing timely notification as soon as the Services are aware that a draft Habitat Conservation Plan (HCP) may affect such resources or the exercise of such rights.

(2) Encourage HCP applicants to recognize the benefits of working cooperatively with affected Indian tribes and advocate for tribal participation in the development of HCPs. In those instances where permit applicants choose not to invite affected tribes to participate in those negotiations, the Services shall consult with the affected tribes to evaluate the effects of the proposed HCP on tribal trust resources and will provide the information resulting from such consultation to the HCP applicant prior to the submission of the draft HCP for public comment. After consultation with the tribes and the non-Federal landowner and after careful consideration of the tribe's concerns, the Services must clearly state the rationale for the recommended final decision and explain how the decision relates to the Services' trust responsibility.

(3) Advocate the incorporation of measures into HCPs that will restore or enhance tribal trust resources. The Services shall advocate for HCP provisions that eliminate or minimize the diminishment of tribal trust resources. The Services shall be cognizant of the impacts of measures incorporated into HCPs on tribal trust resources and the tribal ability to utilize such resources.

(4) Advocate and encourage early participation by affected tribal governments in the development of region-wide or state-wide habitat conservation planning efforts and in the development of any related implementation documents.

(E) Recovery.

(1) Solicit and utilize the expertise of affected Indian tribes by having tribal representation, as appropriate, on Recovery Teams when the species occurs on Indian lands (including tribally-owned fee lands), affects tribal trust resources, or affects the exercise of tribal rights.

(2) In recognition of tribal rights, cooperate with affected tribes to develop and implement Recovery Plans in a manner that minimizes the social, cultural and economic impacts on tribal communities, consistent with the timely recovery of listed species. The Services shall be cognizant of tribal desires to attain population levels and conditions that are sufficient to support the meaningful exercise of reserved rights and the protection of tribal management or development prerogatives for Indian resources.

(3) Invite affected Indian tribes, or their designated representatives, to participate in the Recovery Plan implementation process through the development of a participation plan and through tribally-designated membership on recovery teams. The Services shall work cooperatively with affected Indian tribes to identify and implement the most effective measures to speed the recovery process.

(4) Solicit and utilize the expertise of affected Indian tribes in the design of monitoring programs for listed species and for species which have been removed from the list of *Endangered and Threatened Wildlife and Plants* occurring on Indian lands or affecting the exercise of tribal rights or tribal trust resources.

(F) Law Enforcement.

(1) At the request of an Indian tribe, enter into cooperative law enforcement agreements as integral components of tribal, Federal, and State efforts to conserve species and the ecosystems upon which they depend. Such agreements may include the delegation of enforcement authority under the Act, within limitations, to full-time tribal conservation law enforcement officers.

(2) Cooperate with Indian tribes in enforcement of the Act by identifying opportunities for joint enforcement operations or investigations. Discuss new techniques and methods for the detection and apprehension of violators of the Act or tribal conservation laws, and exchange law enforcement information in general.

APPENDIX C

2000 EXECUTIVE ORDER 13175: CONSULTATION AND COORDINATION WITH INDIAN TRIBAL GOVERNMENTS

Executive Order 13175 of November 6, 2000

Consultation and Coordination With Indian Tribal Governments

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in order to establish regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications, to strengthen the United States government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates upon Indian tribes; it is hereby ordered as follows:

Section 1. Definitions. For purposes of this order:

a. "Policies that have tribal implications" refers to regulations, legislative comments or proposed legislation, and other policy statements or actions that have substantial direct effects on one or more Indian tribes, on the relationship between the Federal Government and Indian tribes, or on the distribution of power and responsibilities between the Federal Government and Indian tribes.

b. "Indian tribe" means an Indian or Alaska Native tribe, band, nation, pueblo, village, or community that the Secretary of the Interior acknowledges to exist as an Indian tribe pursuant to the federally Recognized Indian Tribe List Act of 1994, 25 U.S.C. 479a.

c. "Agency" means any authority of the United States that is an "agency" under 44 U.S.C. 3502(1), other than those considered to be independent regulatory agencies, as defined in 44 U.S.C. 3502(5).

d. "Tribal officials" means elected or duly appointed officials of Indian tribal governments or authorized intertribal organizations.

Sec. 2. Fundamental Principles. In formulating or implementing policies that have tribal implications, agencies shall be guided by the following fundamental principles:

a. The United States has a unique legal relationship with Indian tribal governments as set forth in the Constitution of the United States, treaties, statutes, Executive Orders, and court decisions. Since the formation of the Union, the United States has recognized Indian tribes as domestic dependent nations under its protection. The Federal Government has enacted numerous statutes and promulgated numerous regulations that establish and define a trust relationship with Indian tribes.

b. Our Nation, under the law of the United States, in accordance with treaties, statutes, Executive Orders, and judicial decisions, has recognized the right of Indian tribes to self-government. As domestic dependent nations, Indian tribes exercise inherent sovereign powers over their members and territory. The United States continues to work with Indian

tribes on a government-to-government basis to address issues concerning Indian tribal self-government, tribal trust resources, and Indian tribal treaty and other rights.

c. The United States recognizes the right of Indian tribes to self-government and supports tribal sovereignty and self-determination.

Sec. 3. Policymaking Criteria. In addition to adhering to the fundamental principles set forth in section 2, agencies shall adhere, to the extent permitted by law, to the following criteria when formulating and implementing policies that have tribal implications:

a. Agencies shall respect Indian tribal self- government and sovereignty, honor tribal treaty and other rights, and strive to meet the responsibilities that arise from the unique legal relationship between the Federal Government and Indian tribal governments.

b. With respect to Federal statutes and regulations administered by Indian tribal governments, the Federal Government shall grant Indian tribal governments the maximum administrative discretion possible.

c. When undertaking to formulate and implement policies that have tribal implications, agencies shall:

    1. encourage Indian tribes to develop their own policies to achieve program objectives;

    2. where possible, defer to Indian tribes to establish standards; and

    3. in determining whether to establish Federal standards, consult with tribal officials as to the need for Federal standards and any alternatives that would limit the scope of Federal standards or otherwise preserve the prerogatives and authority of Indian tribes.

Sec. 4. Special Requirements for Legislative Proposals. Agencies shall not submit to the Congress legislation that would be inconsistent with the policymaking criteria in Section 3.

Sec. 5. Consultation.

a. Each agency shall have an accountable process to ensure meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications. Within 30 days after the effective date of this order, the head of each agency shall designate an official with principal responsibility for the agency's implementation of this order. Within 60 days of the effective date of this order, the designated official shall submit to the Office of Management and Budget (OMB) a description of the agency's consultation process.

b. To the extent practicable and permitted by law, no agency shall promulgate any regulation that has tribal implications, that imposes substantial direct compliance costs on Indian tribal governments, and that is not required by statute, unless:

    1. funds necessary to pay the direct costs incurred by the Indian tribal government or the tribe in complying with the regulation are provided by the Federal Government; or

    2. the agency, prior to the formal promulgation of the regulation,

A. consulted with tribal officials early in the process of developing the proposed regulation;

B. in a separately identified portion of the preamble to the regulation as it is to be issued in the Federal Register, provides to the Director of OMB a tribal summary impact statement, which consists of a description of the extent of the agency's prior consultation with tribal officials, a summary of the nature of their concerns and the agency's position supporting the need to issue the regulation, and a statement of the extent to which the concerns of tribal officials have been met; and

C. makes available to the Director of OMB any written communications submitted to the agency by tribal officials.

c. To the extent practicable and permitted by law, no agency shall promulgate any regulation that has tribal implications and that preempts tribal law unless the agency, prior to the formal promulgation of the regulation,

1. consulted with tribal officials early in the process of developing the proposed regulation;

2. in a separately identified portion of the preamble to the regulation as it is to be issued in the Federal Register, provides to the Director of OMB a tribal summary impact statement, which consists of a description of the extent of the agency's prior consultation with tribal officials, a summary of the nature of their concerns and the agency's position supporting the need to issue the regulation, and a statement of the extent to which the concerns of tribal officials have been met; and

3. makes available to the Director of OMB any written communications submitted to the agency by tribal officials.

d. On issues relating to tribal self-government, tribal trust resources, or Indian tribal treaty and other rights, each agency should explore and, where appropriate, use consensual mechanisms for developing regulations, including negotiated rulemaking.

Sec. 6. Increasing Flexibility for Indian Tribal Waivers.

a. Agencies shall review the processes under which Indian tribes apply for waivers of statutory and regulatory requirements and take appropriate steps to streamline those processes.

b. Each agency shall, to the extent practicable and permitted by law, consider any application by an Indian tribe for a waiver of statutory or regulatory requirements in connection with any program administered by the agency with a general view toward increasing opportunities for utilizing flexible policy approaches at the Indian tribal level in cases in which the proposed waiver is consistent with the applicable Federal policy objectives and is otherwise appropriate.

c. Each agency shall, to the extent practicable and permitted by law, render a decision upon a complete application for a waiver within 120 days of receipt of such application by the agency, or as otherwise provided by law or regulation. If the application for waiver is not granted, the agency shall provide the applicant with timely written notice of the decision and the reasons therefore.

d. This section applies only to statutory or regulatory requirements that are discretionary and subject to waiver by the agency.

Sec. 7. Accountability.

a. In transmitting any draft final regulation that has tribal implications to OMB pursuant to Executive Order 12866 of September 30, 1993, each agency shall include a certification from the official designated to ensure compliance with this order stating that the requirements of this order have been met in a meaningful and timely manner.

b. In transmitting proposed legislation that has tribal implications to OMB, each agency shall include a certification from the official designated to ensure compliance with this order that all relevant requirements of this order have been met.

c. Within 180 days after the effective date of this order the Director of OMB and the Assistant to the President for Intergovernmental Affairs shall confer with tribal officials to ensure that this order is being properly and effectively implemented.

Sec. 8. Independent Agencies. Independent regulatory agencies are encouraged to comply with the provisions of this order.

Sec. 9. General Provisions.

a. This order shall supplement but not supersede the requirements contained in Executive Order 12866 (Regulatory Planning and Review), Executive Order 12988 (Civil Justice Reform), OMB Circular A-19, and the Executive Memorandum of April 29, 1994, on Government-to-Government Relations with Native American Tribal Governments.

b. This order shall complement the consultation and waiver provisions in sections 6 and 7 of Executive Order 13132 (Federalism).

c. Executive Order 13084 (Consultation and Coordination with Indian Tribal Governments) is revoked at the time this order takes effect.

d. This order shall be effective 60 days after the date of this order.

Sec. 10. Judicial Review. This order is intended only to improve the internal management of the executive branch, and is not intended to create any right, benefit, or trust responsibility, substantive or procedural, enforceable at law by a party against the United States, its agencies, or any person.

(Presidential Sig.)

THE WHITE HOUSE, November 6, 2000.

APPENDIX D

2004 PRESIDENTIAL MEMORANDUM: GOVERNMENT-TO-GOVERNMENT RELATIONSHIP WITH TRIBAL GOVERNMENTS

The White House
Washington
September 23, 2004

Memorandum for the Heads of Executive Departments and Agencies
Government-to-Government Relationship with Tribal Governments

The United States has a unique legal and political relationship with Indian tribes and a special relationship with Alaska Native entities as provided in the Constitution of the United States, treaties, and Federal statutes. Presidents for decades have recognized this relationship. President Nixon announced a national policy of self-determination for Indian tribes in 1970. More recently, Executive Order 13175, entitled Consultation and Coordination with Indian Tribal Governments, was issued in 2000. I reiterated my Administration's adherence to a government-to-government relationship and support for tribal sovereignty and self-determination earlier this year in Executive Order 13336, entitled American Indian and Alaska Native Education.

My Administration is committed to continuing to work with federally recognized tribal governments on a government-to-government basis and strongly supports and respects tribal sovereignty and self-determination for tribal governments in the United States. I take pride in acknowledging and reaffirming the existence and durability of our unique government-to-government relationship and these abiding principles.

This commitment begins at the White House, where my Director of Intergovernmental Affairs serves as my White House liaison with all Indian nations and works with fly recognized tribal governments on an intergovernmental basis. Moreover, it is critical that all departments and agencies adhere to these principles and work with tribal governments in a manner that cultivates mutual respect and fosters greater understanding to reinforce these principles.

Accordingly, the head of each executive department and agency (agency) shall continue to ensure to the greatest extent practicable and as permitted by United States law that the agency's working relationship with federally recognized tribal governments fully respects the rights of self-government and self-determination due tribal governments. Department or agency inquiries regarding this memorandum, specifically those related to regulatory, legislative, or budgetary issues, should be directed to the Office of Management and Budget.

This memorandum is intended only to improve the internal management of the executive branch and is not intended to, and does not, create any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or in equity, by a party against the United States, its agencies, entities, or instrumentalities, its officers or employees, or any other person.

GEORGE W. BUSH

APPENDIX E

MIDDLE RIO GRANDE LONG-TERM FISH POPULATION MONITORING PROGRAM

The following describes the population monitoring sampling protocol that has been used in recent years in the middle Rio Grande to monitor Rio Grande silvery minnow populations. This protocol is to be used to assess whether future Rio Grande silvery minnow populations meet the recovery objectives and criteria outlined in this Recovery Plan.

A total of 20 sampling sites have been monitored monthly to assess general trends in abundance, distribution, and composition of middle Rio Grande fishes, including Rio Grande silvery minnow, over time (Dudley et al. 2005). The Angostura Reach has five sampling localities, the Isleta Reach has six, and the San Acacia Reach has nine. The 20 sampling sites in the middle Rio Grande overlap the current range of Rio Grande silvery minnow. Sites were chosen based on access.

Sampling sites were chosen from more than 100 possibilities, based on a variety of factors, including access, land ownership, spatial location within reaches and between reaches, and overall suitability for effective and efficient sampling. Most have been sampled consistently since 1993, although several sites were added over time to increase the spatial extent of sampling (e.g., Angostura Diversion Dam, Isleta Reach area, and downstream of the San Marcial railroad bridge). Also, the temporal frequency of monitoring has increased from quarterly (1993-1997), to bimonthly (1999-2001), to monthly (2002-2005).

Fish are collected by rapidly drawing a two-person 3.1 m (wide) x 1.8 m (high) small mesh (ca. 5 mm) seine through discrete mesohabitats. The effective width of the seine during active sampling was 2.5 m. During spring and summer, a 1.0 m x 1.0 m fine mesh (ca. 1.5 mm) seine is used to selectively sample shallow, low-velocity habitats for larval fish. The total length of each sampling site is 200 m upstream to downstream. A total of about 15-20 seine hauls (median=17 seine hauls) are typically made at each sampling site unless conditions do not permit this (i.e., extremely high discharge or lack of flow). Each mesohabitat type (see Dudley et al. 2005 for definitions) present at the site (e.g., main channel pool, backwater, riffle, side channel run, etc.) is sampled. There are usually about 5-10 mesohabitat types present at a site. The total length of each seine haul varies, based on the size and availability of mesohabitats (i.e., some mesohabitats, like backwaters, are small or absent) but is generally about 15 m. Overall sampling area per site is about 600 m^2. Similar mesohabitat locations are sampled within a site during monthly monitoring efforts, with the exception of during extremely high or low discharge periods. The percent allocation of sampling effort (by mesohabitat type) is approximately

equal among reaches (Dudley et al. 2005). Catch-per-unit-effort (CPUE) is calculated as the total number (#) of fish collected · area sampled^{-1} · 100 (i.e., N [fish] · effective seine width [m^{-1}] · haul length [m^{-1}] · 100), to yield #/100m^2. Isolated pools are not included in the calculation of CPUE as fish are artificially concentrated in these areas.

Annual reproduction is documented using an egg collecting device (Moore Egg Collector, MEC) developed specifically for the collection of large numbers of live and undamaged semibuoyant fish eggs (Altenbach et al. 2000). Catch rate of Rio Grande silvery minnow eggs in the middle Rio Grande is determined following the sampling protocol described in Altenbach et al. (2000). A mechanical flow-meter is attached to the MEC so that volume of water filtered can be calculated and catch rate per unit of water determined. The CPUE of drifting eggs is calculated as the total number of eggs collected · volume of water sampled^{-1} · 100 (i.e., N [eggs] · m^3 water^{-1} · 100), to yield #/100m^3.

Previous studies have demonstrated May and June as the primary period of Rio Grande silvery minnow spawning activity. The normal sampling regime is comprised of three daily efforts (morning, noon, and evening), each of two-hour duration. Two MECs are operated simultaneously to increase the volume of water and number of eggs sampled per unit of time.

References

Altenbach, C.S., Dudley, R.K., and S.P. Platania. 2000. A new device for collecting drifting semibuoyant fish eggs. Transactions of the American Fisheries Society, 129:296-300.

Dudley, R.K., S.P. Platania, and S.J. Gottlieb. 2005. Rio Grande silvery minnow population monitoring program results from 2004. Report to the U.S. Bureau of Reclamation, Albuquerque, New Mexico.

APPENDIX F

RIO GRANDE AND PECOS RIVER: REACH-BY-REACH ANALYSIS OF POTENTIAL FOR REESTABLISHMENT OF RIO GRANDE SILVERY MINNOW

Reach-By-Reach Analysis and Reestablishment Site Selection Process

The Recovery Team undertook a reach-by-reach analysis of the Rio Grande and Pecos River basins to identify the salient hydrological, chemical, and biological features of each reach, to address the threats to the Rio Grande silvery minnow, and to consider the suitability of each reach for the potential for reestablishment. The analysis of each reach is based not upon detailed investigations made by the Recovery Team, but upon the combined experience and observations of the team members and evaluation and consideration of research that has been completed.

Identification of the river reaches proposed for recovery was based upon the presence of dams (upstream) and reservoirs (downstream), with the intervening sections being conterminous. In such reaches, the potential for unimpeded movement by the various life stages of Rio Grande silvery minnow appeared to exist. The Recovery Team recognizes that, if reestablishment in a selected reach were to occur, not all sections within the reach would be suitable macrohabitat for this taxon (i.e., dam outfalls and river-reservoir confluence). The extent and impact of these unfavorable macrohabitats on Rio Grande silvery minnow would probably vary annually and be dependent on antecedent and current hydrologic conditions. The extent of unfavorable habitats was deemed minimal compared with cumulative length of the potential suitable habitat within a reach.

Habitat within a particular reach is also an important factor in selecting reestablishment sites. The drifting early life history stages of Rio Grande silvery minnow are subject to downstream displacement and the extent of this movement is, in part, dictated by the stream habitats available in a particular reach. Areas where a river channel has been greatly reduced in width and where river meandering has been largely eliminated are generally typified by deeper and faster-velocity waters. There is also an associated reduction in the relative frequency of lower-velocity mesohabitats (i.e., pools and backwaters) that are favored by Rio Grande silvery minnow. The loss of lower-velocity

habitats could result in increased downstream displacement of Rio Grande silvery minnow (especially drifting eggs and larvae). River reaches that were typified by these degraded habitats were not favored as highly by the Recovery Team as were reaches where the river channel was wider and allowed more freedom of movement.

Based upon the following reach-by-reach analysis and consideration of 1) the understanding of reasons for the species' extirpation from the selected reach; 2) the presence of other members of the reproductive guild (pelagic spawner; non-adhesive, semibuoyant eggs); 3) habitat conditions (including susceptibility to river drying and presence of diversion structures); and 4) the presence of congeners (i.e., other species of *Hybognathus*), the following list of reaches or portions of reaches were selected to be most suitable for reestablishment and prioritized as follows:

1. Rio Grande, Presidio to Amistad Reservoir
2. Rio Grande, Amistad Reservoir to Falcon Reservoir
3. Pecos River, Sumner Dam to Brantley Reservoir
4. Pecos River, Red Bluff Reservoir to Amistad Reservoir
5. Rio Grande, Elephant Butte Reservoir to Presidio
6. Pecos River, Brantley Dam to Red Bluff Reservoir

Reach-by-Reach Descriptions

Rio Grande - Rio Grande Above Cochiti Lake

Hydrology: This reach has perennial flow. The hydrograph has a relatively natural shape with a spring peak that follows snowmelt runoff. On the Rio Chama below Abiquiu Dam, the summer and fall flows are higher than natural due to increased reservoir releases, including releases from the San Juan-Chama Project. This reach is likely not subject to a large increased diversion demand from future growth. There will be average increases in population growth and increased use of groundwater but this will require transfer of existing water rights to offset these uses.

The majority of this reach is canyon-bound with the remainder in open flood plain. From Otowi bridge upstream to the Velarde-Embudo reach it is non-canyon bound. Channel widths for 1935 averaged 300 ft. In 1972, the channel averaged only 155 ft, though it widened to an average of 190 ft by 1992. The canyon-bound reach has a high gradient, with a lower gradient in the open reaches. The substrate is dominated by gravel, cobble, and boulder, with little fine material. The overall amount of overbank flooding is not significant. There is low sinuosity and little segmentation, with the exception of several concrete instream diversion structures near Velarde.

Sections of the Rio Chama have levees and the Española valley has a history of channel maintenance activities. This area on the Rio Chama also contains instream diversions. In general, this reach appears stable in location and elevation with little aggradation or

degradation. However, the planform is changing towards a meandering channel with sections of multiple channels or braids, causing the main channel to become less stable. Physically, the channel is widening and sediment is decreasing in grain size.

Water quality: This is a cold-water reach with low conductivity and turbidity. Some tributary streams that enter this section can introduce high sediment loads during storm events. There are point discharges from wastewater effluent from the communities upstream, but the water quality of the reach is most influenced by non-point sources. There are historic and current sources from mining and heavy metals in the Red River drainage that then enter the Rio Grande. The Rio Grande in this reach does not always fully support the designated fishery use due to turbidity, reduction of riparian vegetation, streambank destabilization, and metals.

Fish community: This reach is dominated by cool- and cold-water species, including longnose dace. There has been a replacement of most native species by introduced non-natives. Predation in this reach is from trout and northern pike. The Rio Grande silvery minnow was historically present but has not been collected since 1949 in the Rio Chama and the 1970s in the Rio Grande. There is no niche competition from other fish in this reach.

Last collection of Rio Grande silvery minnow: 1962-1963

Further study: Contaminants from Red River and Los Alamos, additional fish studies.

Reestablishment potential: Low. Only 50-60 miles of marginal habitat available; flows are perennial.

Cause of extirpation: Loss of habitat, dam construction, cold water temperatures, loss of suitable substrate, change in hydrology, chronic/acute contaminants exposure, competition with introduced non-native fish species.

Rio Grande - Cochiti Reach

Hydrology: This reach has perennial flow. The hydrograph is modified to reduce the peak in some years, with extended release in years of high inflow. Under flood control operations, Cochiti Dam passes flows ranging from about 5,000 cubic feet per second (cfs) to 8,500 cfs, depending upon downstream channel conditions. There is a spring peak that coincides with snowmelt runoff. Storm runoff can enter from Galisteo and Tonque arroyos.

This reach has levees on the east side and is incised in the upper sections. The amount of sand-sized material from upstream sources has dropped to almost zero due to sediment capture by Cochiti Dam and a lack of upstream sources of sediment (Lagasse 1980). The substrate is armored cobble in the upper section. The arroyos introduce sediment to the lower sections of this reach and a higher percentage of finer sediments is found on the

surface of the armored cobble, resulting in a bi-modal sediment distribution (Massong et al. 2002). This finer sediment moves downstream with higher flows. The streambed gradient is moderate and lower than the reach above Cochiti.

This reach has low sinuosity and routine channel maintenance activities are performed (mainly bank stabilization activities). The channel planform has changed from a mostly straight, low-flow braided morphology to a more sinuous meandering morphology (Massong et al. 2002b). The wetted width was less than 300 ft in 1998, indicating that the channel has continued its narrowing trend. The segmentation in this reach is limited to the Angostura Diversion Dam on the downstream end and Cochiti Dam on the upstream end. There is low habitat variability in this reach. Current estimates of overbank flooding are similar to levels found in the 1960s (10-15 percent of the wetted surface as overbank), while the amount was higher between the 1970s and 1990s (30-40 percent overbank surface area). Channel depth has increased from less than 3 ft to 4 ft, coinciding with the channel conversion to meandering. Significant aggradation has occurred just upstream and downstream of the Arroyo Tonque since 1992, possibly indicating an increased supply of sediment from this tributary.

Water quality: The water temperature is cold, due to release from Cochiti Reservoir. The water temperature warms during summer in the downstream reaches. This reach has low conductivity and turbidity except for when sediments are introduced during storm events. The water quality is most influenced by non-point sources throughout the reach. This reach of the river does not always fully support its designated fishery uses, due to metals, reduction of riparian vegetation, and streambank destabilization.

Fish community: The fish community in this reach is almost exclusively non-native fish, dominated by white suckers and black bass and sunfish escapement from Cochiti Lake. There is no niche competition and this reach likely has the lowest density of Rio Grande silvery minnow of the areas currently containing populations of Rio Grande silvery minnow.

Further study: Habitat quality (temperature and substrate), return flows, flow management, institutional constraints (e.g., Cochiti re-regulation, Rio Grande Compact), channel management studies, monitoring fish populations.

Reasons for decline: Physical alterations in the channel (width/depth ratios, temperatures, substrate), fragmentation, flow regime changes, Cochiti Dam acting as a physical barrier with colder clean tailwater, loss of low water/high water refugia, channelization, contaminants (past acute exposures resulting from mine waste spills), colder temperatures and clearer water generated by establishment of a permanent recreation pool at Cochiti Lake, Galisteo sediment and flood control structure, non-native fish introductions.

Rio Grande – Angostura Reach

Hydrology: This reach has perennial flow. The hydrograph follows the seasonal peaks released from Cochiti Dam, reduced by the water diverted for irrigation at Angostura. Downstream demands for irrigation augment flows in this reach during the summer season. Flows in this reach are highly managed. There are significant storm events that add to the runoff in this reach. The channel now fully conveys the two-year event without using the floodplain.

This reach has a low gradient with a slightly meandering form in the upper section of the reach, and a much more highly braided channel in the lower section (Massong et al. 2002b). Vegetated islands have created multiple channels within this braided morphology. The river channel is leveed with jetty jacks at various locations. There is a high level of channel maintenance activity in the channel. A small amount of channel bed incision has generally occurred, with higher abandoned floodplain surfaces found near the N.M. Hwy. 550 bridge. This reach has high habitat variability due to the channel braiding. Population growth remains high in the urban areas of this reach. The City of Albuquerque is developing a surface diversion to utilize its contracted water from the San Juan-Chama Project. This could result in partial habitat segmentation from the diversion structure within the reach. There are a number of return flows from riverside drains and inflows from the Jemez River.

Although the channel width has not changed much over time, the maximum channel depth has doubled, increasing from about 3 ft to over 6 ft during the 1990s. This change in channel bed depth is consistent with increased sediment size, bed incision, and reduced flooding, while changing from a shallow and consistently braided channel to a deeper, meandering channel.

Water quality: This is a warm-water reach. Conductivity is low and turbidity is low to moderate, except during storm runoff events. There are major urban point source inflows in this reach and non-point sources from both urban and agricultural areas.

This reach does not fully support the fishery, irrigation, and recreational designated uses, due to habitat alteration as well as metals, un-ionized ammonia, chlorine, and pathogens. During the past few years there have been several sewage spills and the reach is highly vulnerable to acute toxicity, due to treatment of these and other spill events.

Fish community: This reach is dominated by a warm-water fish community. There is a low predator population, mostly dominated by channel catfish. The Rio Grande silvery minnow is present. There is no niche competition in this reach for the Rio Grande silvery minnow.

Further study: Water quality impacts and sources, diversion structure modification, river and canal transmission losses, and conjunctive use of municipal supply.

Threats: Full use of all water in the system leading to dry reaches of river, contaminants (both acute and chronic).

Reasons for decline: Channel maintenance activities, Jemez flood and sediment control dam, contaminants (storm drains and municipal water treatment effluent discharge), dewatering.

Rio Grande – Isleta Reach

Hydrology: This reach is not perennial. The river has a spring peak that reflects the Cochiti releases and storm peaks. The flow in this reach is highly managed for human uses. There are several riverside drains that can maintain flows in some sections of the reach. These drains are near Bernardo and San Acacia. More urbanization is anticipated in this reach, but it may not result in a change in river flows.

The river is leveed on both banks, especially through Belen. There are channel maintenance activities and jetty jacks in the reach. This is a low-gradient reach dominated by sand substrate, with significant sediment inflows from Rio Puerco and Rio Salado. Since the 1960s, the main channel has widened to about 500 ft; it remained about this wide from 1972 to 1998 (Massong et al. 2002). The upstream channel has become shallower, decreasing from 3.5 ft to 2.5 ft, while the downstream channel depth has increased about 1 foot since 1962. The emergence of stable vegetating islands has coincided with a decrease in the amount of overbank flooding, from an estimated 60 percent of wetted surface area down to 1 percent in 1998. The river bed within the lower reach aggrades due to sediment load, principally due to discharge from the Rio Puerco and Rio Salado. There is increased channel mobility downstream of the Rio Puerco. Habitat variability is high within the reach. There are no constructed barriers within the reach but it becomes fragmented due to ephemeral flows. Although the channel width appears stable in this reach, the channel will continue to incise with coarsening sediment, and will possibly become meandering.

Water quality: Water temperature, conductivity, and turbidity are higher than in the upstream reach. Water quality is dominated by non-point source discharges. Portions of this reach do not fully support the fishery designated use, due to metals and habitat alteration.

Fish community: This reach is predominantly a warm-water native fish community. There may be predation by channel catfish. The Rio Grande silvery minnow is present in the reach with no niche competition.

Further study: Water quality and sediment quality impacts from the Rio Puerco, Rio Salado and return flows, channel loss studies, phreatophyte evapotranspiration water use budgets, channel conveyance efficiencies, efficient application of irrigation water, and conjunctive use of municipal supply.

Threats: Full use of all water in the system leading to dry reaches of river; contaminants.

Reasons for decline: Dewatering and water quality.

Rio Grande - San Acacia Reach

Hydrology: This reach is not perennial, although the spring runoff peaks and summer storm peaks often maintain surface flow. There is a high degree of flow manipulation outside of storm events. There is a stable human population base and the demand should be relatively stable.

The river is leveed on the west bank and open on the east. The Low Flow Conveyance Channel begins at San Acacia Diversion Dam. The first 21 miles of the Socorro Reach is a straight and incised river with extensive channel sections exhibiting a bi-modal bed composition with distinct layers of sand and gravel (Massong et al. 2002a, b). Gravel-sized sediment has become abundant since the late 1990s. This section of channel is changing towards a single-threaded channel with a slightly meandering thalweg. However, sections are still wide and sandy, with a braided morphology. Sediment transport and stable slope calculations indicate that the current channel is relatively stable for the gravel sizes present, rather than the historic sand substrate.

In the middle section of the reach, the channel has a sand-silt substrate, is aggrading, and typically has a braided morphology (Massong et al. 2002). The lack of flooding in 1992 may be a direct result of the larger flows in the 1980s, increasing channel width to 525 ft. The channel width decreased in the 1990s with the relatively smaller peak flows. Terraces mapped in 2000 (Makar and Klawon 2000), indicate that just downstream of the N.M. Hwy. 380 bridge, only low terraces exist (~3 ft), and they do not confine the channel. Habitat variability is moderate, due to channelization.

The last 30 miles of this reach is mostly a single-threaded channel, due to past channelization activities (Massong et al. 2002). Below San Marcial, in the 1990s overbank flooding increased up to 70-80 percent of the wetted surface area. The lower reach begins flooding when discharges reach 2,000 to 3,000 cfs. The river channel in the section near San Marcial has been reconstructed, following inundation from the previous times when Elephant Butte Reservoir was full. Excavation within maximum reservoir pool is used to open pilot channels to maintain flows into the lake. Increases in the level of channel flooding with a lower discharge are consistent with an aggrading system. Two features that do not meet the classic features of the aggrading system are the channel width and depth. Ideally, the width would increase and the depth would decrease; however, with a dense riparian zone and clay banks creating stable channel boundaries, the channel will probably maintain constant width and depth.

Water quality: This is a warm-water reach with higher levels of conductivity and turbidity than upstream. The water quality is dominated by non-point source discharges.

Portions of this reach do not fully support its fishery designated use, due to pesticides, reduction of riparian vegetation, and streambank destabilization.

Fish community: The fish community is dominated by warm-water native species. There is a predatory channel catfish population. There is no niche competition. When Elephant Butte Reservoir is low, there is increased riverine habitat in the lower sections of the reach.

Further study: Water quality and sediment quality impacts, channel loss studies, phreatophyte evapotranspiration water use budgets, channel conveyance efficiencies, efficient application of irrigation water, and conjunctive use.

Threats: Full use of all water in the system, leading to dry reaches of river; contaminants.

Reasons for decline: Dewatering and water quality.

Rio Grande - Elephant Butte Reservoir to Presidio

Hydrology: The river is not perennial in this reach. There is a highly regulated flow regime and no spring runoff peak. There is an anticipated above-average change in demand with an increased possibility for perennial flow in this reach, due to change in water use from agricultural to urban uses. Releases in this reach are constrained by the Rio Grande Compact and downstream water demands.

There are many barriers in this reach, with the major structure being Caballo Dam. Portions of the river are completely channelized with sand substrate, straight channel, high channel-maintenance activity, and levees in most areas. Water flows in the stretch below El Paso to near Presidio, Texas, come primarily from irrigation return flows and wastewater returns.

Water quality: This is a warm-water reach with higher levels of conductivity than in upstream areas. The water quality is dominated by significant point and non-point source discharges. Within the reach, the El Paso area is heavily industrialized, compared to upstream reaches. The reach also receives both point and non-point source discharges from the Mexican side of the river, which are subject to different water quality regulations than are discharges in the United States.

Portions of this reach do not fully support its fishery and irrigation designated uses, due to metals, siltation, un-ionized ammonia, chlorine, pH, reduction of riparian vegetation, and streambank destabilization.

Fish community: This reach has a mixed cold- and warm-water fishery between the Elephant Butte release and Caballo Reservoir. The river from Caballo Dam to Fort

Quitman has many elements of a warm-water, non-native fish community. The Rio Grande silvery minnow was historically present, but no longer is found in the reach. There are predators present, such as black bass and catfish, but no niche competitors.

Last collection of Rio Grande silvery minnow: 1944; Caballo Reservoir to the Texas-New Mexico state boundary.

Further study: None at this time.

Reestablishment potential: Low; a short distance from Elephant Butte Dam to Caballo Reservoir, low temperatures downstream of dams, and low dissolved oxygen levels are all problems. The reach below Caballo Dam is channelized, and the section from below El Paso to Presidio, Texas, is heavily overgrown with salt cedar (*Tamarix*).

Cause of extirpation: Water quality degradation, channelization, change in hydrology, diversion (physical barriers and de-watering).

Rio Grande - Presidio to Amistad Reservoir

Hydrology: The river in this reach is perennial, and is dominated by the Rio Conchos entering from the Mexican side of the river. Flow reductions only occurred during the severest droughts of the 1950s, until 2003, when portions of this reach again ceased to flow. There is a seasonal peak modified by upstream dams on the Rio Conchos. The peak is short due to water diversions and upstream dams in the Rio Conchos. There are large storm event peaks in October and November. There are increases in depletion anticipated, due to increased irrigation on the Mexican side of the river. The Treaty of 1944 sets the upper limit for the amount of diversion, but this may not be enforced.

This reach is not leveed and has small rock dam weirs. The substrate ranges from silt to cobble and boulder, depending on local conditions. There are no channel maintenance activities in this reach. Almost half of this reach is in canyons, including Big Bend National Park. The lower canyon reach is outside the park, but land use is managed by the National Park Service as a part of the Rio Grande's Wild and Scenic River designation in this stretch.

The channel is not mobile in the canyon sections. Outside the canyon reaches, the river is braided in some sections with a moderate gradient on average but higher gradient relative to the immediate upstream reach. Base flow in this reach is approximately 400 cfs.

Water quality: The river in this reach has high salinity and turbidity. This reach has both point and non-point source discharges, with the water quality dominated by contributions from the Rio Conchos.

Fish community: This reach has a warm-water native fish community with some non-natives. The reach has a high number of large river species, such as smallmouth buffalo.

The main predator is blue catfish. The Rio Grande silvery minnow was historically present in this reach, but is no longer present. There is no niche competition.

Last collection of Rio Grande silvery minnow: 1960.

Further study: Existing fish community, water quality data from Rio Conchos gage.

Reestablishment potential: Good.

Cause of extirpation: Poor water quality (Rio Conchos), loss of natural hydrograph, diversion (de-watering).

Rio Grande - Amistad Reservoir to Falcon Reservoir

Hydrology: This reach is perennial with a small seasonal peak due to delivery schedules. Flow in this reach is highly regulated, due to water releases to satisfy demands for irrigation in both Texas and Mexico. This reach is administered by a water master. The base flow is approximately 1,000-3,000 cfs. The demand in this reach is relatively stable but there is a conversion from agricultural to municipal uses. This reach is also subject to daily fluctuations to meet the downstream demands and for hydroelectric generation.

This section of the river is not leveed and there is no channel maintenance. The river is nearly straight with no braiding. The channel's gradient is lower than that of the immediate upstream reach and its substrate is variable, ranging from coarse material downstream of Amistad to a predominately sand substrate in the lower section of the reach. There are several barriers in this reach.

Water quality: This section of the river has warm water with relatively high salinity and low turbidity. There are both point and non-point source discharges.

Fish community: The fish in the reach are dominated by species with relatively high predator populations, including centrarchids and striped bass. There are several native minnow species, but Rio Grande silvery minnow is absent.

Last collection of Rio Grande silvery minnow: Inferred, prior to 1960.

Further study: Water quality, fish collection data, reestablishment potential.

Reestablishment potential: Moderate; significant flows are removed for irrigation near Quemado and non-native riparian vegetation (especially giant reed) is problematic.

Cause of extirpation: Poor water quality (agriculture discharge, saline intrusion), change in hydrology (regulated flows).

Rio Grande - Falcon Dam to Gulf of Mexico
Hydrology: This reach is perennial and is highly regulated by releases from Falcon Dam. Base flow is approximately 500 to 1,000 cfs. There is a high level of urbanization. The peak flows are caused by spills from the reservoir, due to storm peaks or reservoir releases for irrigation. The river channel is stable with a low gradient and levees along some sections. There are barriers in the form of flood control structures. The substrate is dominated by sand with other particle size-classes present.

Water quality: Water quality in this reach is brackish, due to influences from the Gulf of Mexico. Turbidity is low near Falcon Dam and increases in the downstream direction. There are both point and non-point source discharges from the increased urbanization and agriculture.

Fish community: A significant component of the fish community is warm-water non-natives, including estuarine species in the lower river near Brownsville. There is a high predator population and no niche competitors.

Last collection of Rio Grande silvery minnow: 1961.

Further study: Evaluate reestablishment potential.

Reestablishment potential: Low.

Cause of extirpation: Estuarine conditions, predation, water quality, change in hydrology, diversion (physical barriers).

Pecos River - Santa Rosa to Carlsbad
Hydrology: This reach is not perennial. The flows are regulated by dams near Santa Rosa and Fort Sumner. The reach from Santa Rosa Dam to Sumner Dam is short relative to the length needed by the Rio Grande silvery minnow.

There are storm peaks during rain events, but significant spring peaks do not occur every year. There is no change in demand anticipated. The reach of river from Santa Rosa to Roswell loses flow, but that from Roswell downstream to Carlsbad gains flow. The channel from Sumner Dam to Roswell has a moderate gradient with braiding within the stream margins, as well as small sections of multiple channels. Substrate in this reach is variable, with gradations from small to large substrate sizes. The upper section of this reach is similar in characteristics to the upper Rio Grande near Velarde.

The section from Roswell to Carlsbad is perennial. The gradient is moderate to low from Roswell to Carlsbad. The channel from Santa Rosa Dam to Sumner Dam is single with in-channel braiding. There is a single channel with channel braiding from Sumner Dam to Roswell. The lowest section of the reach has no braiding. Substrate in the river is cobble from Santa Rosa Dam to Sumner Dam, sand from Sumner Dam to Roswell, and sand/silt

from Roswell to Brantley Reservoir. There is low channel mobility in the entire reach.

Water quality: The upper portion of this reach has cool water downstream of Santa Rosa Dam and warm water downstream of Sumner Dam. The conductivity and turbidity are low in the upper sections. The reach from Sumner Dam to Roswell has high turbidity and is highly variable in the downstream section. Salinity is high in the lower section of the reach.

Portions of this reach do not fully support the fishery designated uses, due to metals, pathogens, reduction of riparian vegetation, streambank destabilization, dissolved oxygen, un-ionized ammonia, and total dissolved solids.

Fish community: The fish community is dominated by warm-water native species. The Rio Grande silvery minnow was historically present, but is not currently found here. There is a low predator population in the upper sections and a low-to-moderate predator population in the section from Roswell to Brantley Reservoir. There are no niche competitors from Santa Rosa Dam to Sumner Dam, but there is potential niche competition by non-native plains minnow from Sumner Dam downstream.

Last collection of Rio Grande silvery minnow: 1968 (Roswell).

Further study: Pecos hydrology (Sumner Dam to Acme), additional fish recovery areas.

Reestablishment potential: Low above Sumner Dam (short reach); moderate below Sumner Dam. Prior to any attempt to reestablish Rio Grande silvery minnow in the Pecos River, the plains minnow must be extirpated.

Cause of extirpation: Santa Rosa Dam to Sumner Dam: short reach (reproductive strategy requires more river channel). Below Sumner Dam: salinity, plains minnow, dams, loss of suitable substrate, intermittent flow in river channel, change in flow regime, loss of spring peak flows, diversion (de-watering).

Pecos River - Red Bluff Reservoir to Amistad Reservoir

Hydrology: This reach is perennial. It does have storm events evident in the hydrograph in the lower sections of the river. Flows in the upper portion are dominated by releases from Red Bluff Dam. The lower section has significant spring sources and groundwater inflows that contribute to the discharge. There are no anticipated changes to flow regimes from increased demands for human uses.

This reach is a single channel, braided within the channel margins but without levees. The river gradient is high in the lower half of the reach with variable substrate types. There are some barriers in the upper section.

Water quality: This reach is typified by warm water with high conductivity and low turbidity, and is dominated by non-point source contaminants. It is subject to algal blooms from unknown causes, which have caused massive fish die-offs. Portions of this reach do not fully support the fishery, irrigation, and livestock and wildlife watering designated uses, due to metals, un-ionized ammonia, siltation, salinity, reduction of riparian vegetation, and streambank destabilization.

Fish community: The fish community is composed of warm-water native and non-natives species, with moderate predation from catfish and black bass. The Rio Grande silvery minnow was historically present but no longer inhabits the reach. There are no niche competitors present in this reach.

Last collection of Rio Grande silvery minnow: 1954 (low numbers in collection).

Further study: Study hydrology below Fort Stockton, evaluate reestablishment potential.

Reestablishment potential: Unknown.

Cause of extirpation: Salinity, limited habitat, change in hydrology due to wells, diversions (physical obstructions & dewatering).

References

Klawon, J., and Makar, P. 2002. Historical Terrace Mapping: Escondida Bridge to Pool of Elephant Butte Reservoir. U.S. Department of the Interior, Bureau of Reclamation Technical Report, Technical Services Center, Sedimentation and River Hydraulics Group, Denver, Colorado.

Lagasse, P.F. 1980. An assessment of the response of the Rio Grande to Dam construction-Cochiti to Isleta Reach. Technical Report submitted to U.S. Army Corps of Engineers, Albuquerque, New Mexico.

Massong, T., K.I. Smith, A. Glover, K. Candelaria, M. Bullard. 2002. Overview of Geomorphology for the Middle Rio Grande. Technical Report. Bureau of Reclamation. Albuquerque, New Mexico. 8pp.

Texas Natural Resources Conservation Commission. 1994. 1994 Regional Assessment of Water Quality in the Rio Grande Basin including the Pecos River, the Devils River, the Arroyo Colorado and the Lower Laguna Madre. AS 34.

APPENDIX G

GLOSSARY

Back water – a body of water, connected to the main channel, with no appreciable flow; often created by a drop in flow that partially isolates a former channel.

Congener – an organism that belongs to the same taxonomic group as another organism.

Cyprinid – a member of the family Cyprinidae, which includes minnows, carps, and shiners.

Eddy – a pool with current moving opposite to that in the channel.

Flat – a region of uniform shallow depth, moderate velocity, and sand substrate.

Isolated pool – a pool that is not connected to the main or secondary channel; frequently a former backwater that is no longer connected to the main or secondary channel.

Main channel – the section of the river that carries the majority of the flow; there can be only one main channel.

Pool – the portion of the river that is deep and has relatively little velocity compared to the rest of the channel.

Riffle – a shallow and high-velocity habitat where the water surface is irregular and broken by waves; generally indicates gravel-cobble substrate.

Run – a reach of relatively high-velocity water with laminar flow and a non-turbulent surface.

Secondary channel – all channels not designated as the main channel; there may be zero or several secondary channels at a site.

Standard length – the distance between the tip of the snout and the base of the tail (versus the end of the tail).

Substrate – substrates are defined in part by their particle size (diameter).

- Boulder: > 256 mm
- Cobble: 64-256 mm
- Gravel: 2-64 mm

- Sand: 0.0625-2 mm
- Silt: < 0.0625 mm

APPENDIX H

ACRONYMS

BO – Biological Opinion
BOR – U.S. Bureau of Reclamation
BWC – Boundary and Water Commission
CFS – cubic feet per second
COA – City of Albuquerque
COE – U.S. Army Corps of Engineers
CPE – carp pituitary extract
CPUE – catch per unit effort
CWA – Conservation Water Agreement
EDWA – Emergency Drought Water Agreement
EPA – Environmental Protection Agency
ESA – Endangered Species Act
FWS – U.S. Fish and Wildlife Service (Service)
ISC – Interstate Stream Commission
LFCC – Low Flow Conveyance Channel
MOA – Memorandum of Agreement
MRG – middle Rio Grande
MRGCD – Middle Rio Grande Conservancy District
MRGESACP – Middle Rio Grande Endangered Species Act Collaborative Program
NMDGF – New Mexico Department of Game and Fish
SL – standard length
SOR – Statement of Relationship
TPWD - Texas Parks and Wildlife Department
TL – total length
USGS – U.S. Geological Survey
VIE – visible implant elastomer
YOY – Young-of-year

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