

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

**5-Year Review:**  
**Summary and Evaluation**

**U.S. Fish and Wildlife Service**  
**New Mexico Ecological Services Field Office**  
**New Mexico Fish and Wildlife Conservation Office**  
**Albuquerque, New Mexico**  
**July 2018**

## **5-YEAR REVIEW**

### **Rio Grande Silvery Minnow (*Hybognathus amarus*)**

#### **1.0 GENERAL INFORMATION**

##### **1.1 Reviewers**

**Lead Regional Office:** Southwest Regional Office, Region 2  
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##### **1.2 Methodology used to complete the review:**

This review was conducted through public review notification and a comprehensive review of documents regarding Rio Grande Silvery Minnow available to the U.S. Fish and Wildlife Service's (Service or USFWS, *in cite*) New Mexico Ecological Services Field Office. Federal Register notices were published on March 29, 2009 (75 FR 15454) and May 31, 2018 (83 FR 25034), which announced the Service's 5-year review of the status of Rio Grande Silvery Minnow. Both notices solicited the best available scientific and commercial data available about species biology, habitat conditions, conservation measures implemented, threats, and trends, from other agencies, both Federal and State, nongovernmental organizations, academia, and the general public. The basis of this review relied mainly on an assessment of progress toward meeting the fifteen established recovery criteria (USFWS 2010). Because the Rio Grande Silvery Minnow recovery plan contained objective and measurable recovery criteria, this review was relatively straightforward.

The Service reviewed and considered information received from the New Mexico Interstate Stream Commission (NMISC), the Middle Rio Grande Conservancy District (MRGCD), the U.S. Army Corps of Engineers (Corps), and Defenders of Wildlife (Defenders) in response to the notice for silvery minnow status information announced in 2009 (75 FR 15454). We also reviewed comments from the public, from WildEarth Guardians and Defenders (Guardians-Defenders 2018), and the NMISC (2018) received prior to July 3, 2018. The Service reviewed all analyses provided to us as to whether and how recovery criteria were met or were not met. These analyses included information compiled for biological opinions recently completed (USFWS 2016, 2018); unpublished reports on the status of the silvery minnow (Goodman 2012; Guardians-Defenders 2018),

and peer-reviewed literature. This review was drafted by Joel D. Lusk, senior fish and wildlife biologist and species lead for the Rio Grande Silvery Minnow. The U.S. Bureau of Reclamation (Reclamation, or USBR, *in cite*) has routinely funded the Rio Grande Silvery Minnow Population Monitoring Program and we incorporated their data in our review. Technical information was also provided or reviewed by Thomas Archdeacon, fisheries biologist and manager of the Rio Grande Silvery Minnow augmentation, monitoring, and fish rescue crews of the Service's New Mexico Fish and Wildlife Conservation Office.

### **1.3 Background:**

The Rio Grande Silvery Minnow is a small-bodied, short-lived cyprinid that once occurred throughout the Rio Grande basin including the Middle Rio Grande (MRG; New Mexico), through Big Bend National Park in Texas, to the Gulf of Mexico and in portions of the tributaries Rio Chama, Jemez River, and Pecos River (Sublette et al. 1990; Bestgen and Platania 1991; Horwitz et al. 2018). Currently, the species occupies less than seven percent of its historical range extending from Cochiti Lake south to Elephant Butte Reservoir within the MRG (five percent) and near Big Bend National Park, Texas (two percent) (Bestgen and Platania 1991; USFWS 2010). The majority of the wild population is represented by two year classes, with few fish living past Age-2 (Horwitz et al. 2018).

In 1994, identified threats to Rio Grande Silvery Minnow included dewatering, channelization, and regulation of river flow to provide water for irrigation, diminished water quality caused by municipal, industrial, and agricultural discharges, and competition or predation by introduced non-native fish species (USFWS 1994). Decline of Rio Grande Silvery Minnow has continued to be associated with a number of climate-related (Krabbenhoft et al. 2014; Lehner et al. 2017; Guardians-Defenders 2018) and anthropogenic factors that include hydrologic alteration, river fragmentation, and habitat degradation through operation of reservoirs and dams, river channelization, and loss of water (Archdeacon 2016; USFWS 2016, 2018; Dudley et al. 2018; NMISC 2018).

The cumulative effects of habitat fragmentation and altered river hydrology resulted in the species' listing under the Endangered Species Act (USFWS 1994). In 2003, nearly 157 miles of critical habitat was designated for the Rio Grande Silvery Minnow (68 FR 8088). In 2008, the Service established an experimental, nonessential population of Rio Grande Silvery Minnow in the Rio Grande near Big Bend, Texas (73 FR 74357). The Silvery Minnow Recovery Plan was revised with quantitative delisting criteria (USFWS 2010). Although annual Rio Grande Silvery Minnow population monitoring summaries have been provided (Dudley et al. 2003 through 2018), to date, no 5-year status review of the Rio Grande Silvery Minnow has been completed by the Service.

**1.3.1 FR Notice citation announcing initiation of this review:** 83 FR 25034, May 31, 2018.

### 1.3.2 Listing history

#### Original Listing

**FR notice:** 59 FR 36988

**Date listed:** August 19, 1994

**Entity:** Species listed as the Rio Grande Silvery Minnow (*Hybognathus amarus*)

**Classification:** Endangered

**1.3.3 Associated rulemakings** Critical habitat has been designated twice. An experimental nonessential population was established.

#### Critical Habitat

**FR notice:** 64 FR 39560

**FR notice:** 68 FR 8088

#### Nonessential Experimental Population

**FR notice:** 73 FR 74357

**1.3.4 Review History:** This is the first 5-year review for this species since the species was listed in 1994.

**1.3.5 Species' Recovery Priority Number at start of 5-year review:** 2C - This priority number indicates a species with high degree of threat and high potential for recovery.

### 1.3.6 Recovery Plan or Outline

**Name of plan or outline:** Rio Grande Silvery Minnow (*Hybognathus amarus*)  
Recovery Plan, First Revision

**Date issued:** February 22, 2010

**Dates of previous revisions, if applicable:** The first Rio Grande Silvery Minnow recovery plan was issued in 1999.

## 2.0 REVIEW ANALYSIS

### 2.1 Application of the 1996 Distinct Population Segment (DPS) policy

#### 2.1.1 Is the species under review a vertebrate?

**Yes**, go to section 2.1.2.

**No**, go to section 2.2.

#### 2.1.2 Is the species under review listed as a DPS?

**Yes**, go to section 2.1.3.

**No**, go to section 2.1.4

**2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?**

Yes, go to section 2.4, *Synthesis*.

No, go to section 2.2., *Recovery Criteria*.

**2.2 Recovery Criteria**

**2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?**

Yes, continue to section 2.2.2.

No, go to section 2.3., *Updated Information and Current Species Status*.

**2.2.2 Adequacy of recovery criteria.**

**2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?**

Yes, go to section 2.2.2.2.

No, go to section 2.2.3.

**2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?**

Yes, go to section 2.2.3.

No, go to section 2.2.3.

**2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:**

**Recovery Goals and Criteria**

Three goals have been established for the recovery of the Silvery Minnow:

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

**Recovery Criterion 1-A-1.** Using the standard sampling protocol (Appendix E of the recovery plan), and sampling at a minimum of 20 sites distributed throughout the MRG in New Mexico, document the presence of Rio Grande silvery minnow (all unmarked fish) at  $\frac{3}{4}$  of all sites, per reach, sampled during October.

**Met or Not Met:** Not Met. In 2012 (Dudley et al. 2013) and in 2014 (Dudley et al. 2015), no silvery minnows were detected using the standard sampling protocol.

**Recovery Criterion 1-A-2.** Annual reproduction in the middle Rio Grande below Cochiti Reservoir, as indicated by the presence of young-of-year at  $\frac{3}{4}$  of all sites, per reach, sampled during October.

**Met or Not Met:** Not Met. The presence of young-of-year silvery minnows has been indicated at  $\frac{3}{4}$  of all sites, per reach, in only four years (2005, 2009, 2016, and 2017) of twenty-four years of annual surveys (Dudley et al. 1994 through 2018; Goodman 2012; Guardians-Defenders 2018).

**Recovery Criterion 1-B-1.** [Establish] a captive population of 50,000 to 100,000 fish with a composition and distribution (among facilities) consistent with recommendations of the Rio Grande Silvery Minnow Genetics Management and Propagation Plan (USFWS 2007).

**Met or Not Met:** Met. The Rio Grande Silvery Minnow Genetics Management and Propagation Plan was updated (City of Albuquerque et al. 2018). The captive population has helped to prevent the extinction of Rio Grande Silvery Minnow in the wild (Osborne et al. 2012; Archdeacon 2016; Caldwell et al. 2018).

**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).**

**Demographic Criteria:**

**Recovery Criterion 2-A-1.** Using the standard sampling protocol (Appendix E of the 2010 recovery plan), and sampling at a minimum of 20 sites distributed throughout the middle Rio Grande in New Mexico, document for at least 5 consecutive years, an October catch per unit effort (CPUE) from all monitoring sites within each reach of  $> 5$  fish/100 m<sup>2</sup>.

**Met or Not Met:** Not Met. The October catch of silvery minnows per unit effort at all monitoring sites have been greater than five fish per 100 square meters (m<sup>2</sup>) in 9 of 24 annual monitoring events. Three consecutive years with high density ( $>5$  fish/100 m<sup>2</sup>) occurred during 1993-1995 and during 2007-2009 (Dudley et al. 2018). This criterion may be difficult to meet (Goodman 2012).

**Recovery Criterion 2-A-2.** Annual reproduction in the middle Rio Grande below Cochiti Reservoir, as indicated by the presence of young-of-year from  $\frac{3}{4}$  of the monitoring sites, per reach, for at least five consecutive years.

**Met or Not Met:** Not Met. The presence of young-of-year silvery minnows has been indicated at  $\frac{3}{4}$  of all sites, per reach, in only four years (2005, 2009, 2016, 2017) of twenty-four years of annual surveys (Dudley et al. 1994 through 2018).

**Recovery Criterion 2-A-3.** [Establish] two additional populations of Rio Grande silvery minnow, in the historical range of the species but outside the middle Rio Grande of New Mexico, that each demonstrate (by quantitative analysis) a probability of extinction in the wild of less than 10% within 50 years.

**Met or Not Met:** Not Met. Rio Grande Silvery Minnow was reintroduced into and near Big Bend National Park in Texas, beginning in 2008. Augmentation of the population with 2,600,000 silvery minnows has occurred over nine consecutive years (Edwards 2017). Biological monitoring in the Rio Grande at Big Bend National Park indicated that some survival of Rio Grande Silvery Minnow occurs at low densities and that some reproduction occurred in 2010 (Edwards 2017). However, this population is not self-sustaining and may need re-evaluation for delisting. A second, additional population has not been established.

**Threats-based Criteria:**

**Recovery Criterion 2-B-1.** Base flow within occupied habitat sufficient to generate survival rates necessary to achieve Criteria 2-A-1. Wetted habitat represents the overall carrying capacity of a particular area for Rio Grande silvery minnow and influences survival rates for the population. The amount and distribution of base flows necessary for recovery can be informed by a PVA.

**Met or Not Met:** Not Met. Base flow in combination with other factors affecting silvery minnow survival rates has been insufficient to generate survival rates necessary to achieve high Rio Grande Silvery Minnow densities. Goodman (2009) found that the separation of high-flow factors from low flow factors was not resolved because of autocorrelation in flow variables and wrapping together of reproduction and survival as the population response. A Population Viability Analysis was completed but without the hydrologic data to describe the amount and distribution of base flows necessary for recovery (Miller 2012). Dudley et al. (2018) found that prolonged low flows during summer were most predictive of decreased silvery minnow occurrence at sampling sites during their study.

**Recovery Criterion 2-B-2.** Recruitment flows that generate population growth rates necessary to achieve Criteria 2-A-1.

**Met or Not Met:** Not Met. The duration, magnitude, and timing of spring runoff is significantly and positively related to the estimated densities of Rio Grande Silvery Minnow sampled in the fall (Dudley et al. 2007 through 2018; Hoagstrom and Turner 2015; Archdeacon 2016; USFWS 2016; NMISC 2018). Enhanced spring runoff can occur through modified operations of the El Vado Reservoir (up to 10,000 acre-feet of water, USBR 2015) or Cochiti Reservoir (up to 50,000 acre-feet of water, USACE 2009). However, modified reservoir operations to improve Rio Grande Silvery Minnow recruitment are not routinely conducted (USACE 2014; USBR 2015). Woodhouse et al. (2013) concluded that extended periods of reduced streamflow have occurred in the MRG over the last three

centuries. Nonetheless, there appears to be a general downward trend in spring runoff volume and alteration of its timing in the MRG (Krabbenhoft et al. 2014; USBR 2016) that may negatively impact Rio Grande Silvery Minnow population growth rates (USFWS 2016).

**Recovery Criterion 2-B-3.** Habitat of sufficient quantity and quality to generate recruitment and survival rates that meet Criteria 2-A-1. Quantity and quality will vary by site but each location is likely to need increased nursery habitat and overall channel complexity. These increases can be achieved through restoration, flow management, and removing impediments to river migration, such as giant cane in the Big Bend area.

**Met or Not Met:** Not Met. Recovery of Rio Grande Silvery Minnow in the MRG could require over 5,000 acres daily of inundated nursery habitat during May and June (USFWS 2016). Combined with variable and declining spring runoff, the rates of inundation and habitat restoration have not been sufficient to routinely achieve adequate nursery habitat areas and result in sufficient Rio Grande Silvery Minnow densities estimated during the fall of each year.

**Recovery Criterion 2-B-4.** Improve water quality within occupied areas and reintroduction sites to support recruitment and survival rates necessary to achieve Criteria 2-A-1.

**Met or Not Met:** Not Met. While water quality improvements have occurred (NMED 2009) the water quality factors affecting Rio Grande Silvery Minnow recruitment and survival rates have not been adequately addressed.

**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).**

**Demographic Criteria:**

**Recovery Criterion 3-A-1.** Three populations of Rio Grande silvery minnow, in the historical range of the species, each of which demonstrate (using quantitative analysis) a probability of extinction in the wild of less than 10% within 100 years.

**Met or Not Met:** Not Met. There are currently two-out-of-three populations of Rio Grande Silvery Minnow and neither of the two existing populations are self-sustaining (Archdeacon 2016; Edwards 2017).

**Threats-based Criteria:**

**Recovery Criterion 3-B-1.** Base flows within occupied habitat sufficient to generate survival rates necessary to achieve Criteria 3-A-1.

**Met or Not Met:** Not Met. Base flow in combination with other factors affecting silvery minnow survival rates has been insufficient to generate survival rates necessary to achieve high Rio Grande Silvery Minnow densities in the MRG or in the Rio Grande in Texas (Archdeacon 2016; Edwards 2017).

**Recovery Criterion 3-B-2.** Recruitment flows that generate population growth rates necessary to achieve Criteria 3-A-1.

**Met or Not Met:** Not Met. The enhanced duration, magnitude, and timing of spring runoff has not occurred sufficiently to significantly increase the estimated densities of Rio Grande Silvery Minnow in the MRG or in the Rio Grande in Texas (Archdeacon 2016; Edwards 2017).

**Recovery Criterion 3-B-3.** Habitat of sufficient quantity and quality to generate recruitment and survival rates that meet Criteria 3-A-1.

**Met or Not Met:** Not Met. Recovery of Rio Grande Silvery Minnow in the MRG could require over 5,000 acres daily of inundated nursery habitat during May and June (USFWS 2016). Combined with variable and declining spring runoff, the rates of inundation and habitat restoration have not been sufficient to routinely achieve adequate nursery habitat areas and result in sufficient Rio Grande Silvery Minnow densities estimated during the fall of each year that meet Criteria 3-A-1. The amounts of inundated nursery habitat during spring runoff are not consistently available to recover Rio Grande Silvery Minnow and may decline due to the temperature effects of climate change (USBR 2016; USFWS 2016).

**Recovery Criterion 3-B-4.** Water quality within occupied areas and reintroduction sites to support survival rates of Rio Grande silvery minnow necessary to achieve Criteria 3-A-1.

**Met or Not Met:** Not Met. Water quality impairments by ammonia and chlorine have decreased while water quality impairments by aluminum, bacteria, oxygen sags, polychlorinated biphenyls, and high water temperatures have increased over time in portions of the MRG (NMED 2009, 2018). The NMED (2009) indicated that chemical water quality may be a contributing factor, but is not likely to be the most critical issue affecting the Rio Grande Silvery Minnow. The role of water quality impairments such as oxygen sags or high water temperatures affecting Rio Grande Silvery Minnow recruitment and survival rates has not been addressed.

**If you answered yes to both 2.2.2.1 and 2.2.2.2.; go to section 2.4., Synthesis.  
If you answered no to either 2.2.2.1 or 2.2.2.2, continue to section 2.3.**

## **2.3 Updated Information and Current Species Status**

## 2.3.1 Biology and Habitat

### 2.3.1.1 New information on the species' biology and life history:

A review by Medley and Shirey (2013) hypothesized that the Rio Grande Silvery Minnow is of a guild of floodplain-spawning species with an evolved demersal egg that is secondarily buoyant in high sediment environments rather than in a guild of pelagic spawning species. Noon et al. (2017) also cited evidence that Rio Grande Silvery Minnow were demersal, floodplain spawners. We found that the general viability of the demersal, floodplain spawning hypothesis had not been adequately tested nor supported by direct observations or physical evidence involving egg anatomy, molecular biology, or biogeography. Demersal spawners produce eggs that are heavier than their surrounding water, develop on the bottom, are either attached to the substrate, or float loosely on the bottom, and are generally adhesive (Balon 1975; Miller et al. 2009). Platania and Altenbach (1998) collected evidence that Rio Grande Silvery Minnow are pelagic broadcast-spawning cyprinids (based on classification by Balon (1975) where buoyant, non-adhesive eggs and sperm are cast into the water column). Additionally, numerous individual Rio Grande Silvery Minnow eggs have been collected near the water surface (Platania et al. 2003; Dudley et al. 2012b, 2013, 2018) during years (2002, 2012, 2013, and 2018) when there is no floodplain inundation (USACE 2010).

Worthington et al. (2018) also characterized Rio Grande Silvery Minnow as a pelagic-broadcast spawning species and summarized threats to similar species. Many pelagic-broadcast species have truncated home ranges showing declines in both distribution and abundance, especially the Rio Grande Silvery Minnow (Worthington et al. 2018). Hoagstrom (2015) and Worthington et al. (2018) reported that hydrologic alteration and habitat reduction were primary threats to pelagic-broadcast spawning species including Rio Grande Silvery Minnow.

Horwitz et al. (2018) confirmed the current maximum lifespan of wild Rio Grande Silvery Minnows as three years, nearly half of that reported by Cowley et al. (2006), and the extreme rarity of the oldest age classes. The absence of adequate conditions for reproduction and survival, even for a single year, was an extremely strong threat for short-lived Rio Grande Silvery Minnow, relative to taxa with more numerous and evenly balanced age classes (Horwitz et al. 2018). Rio Grande Silvery Minnow develops rapidly from eggs to reproducing adults in approximately 12 months, which can lead to substantial population increases under suitable spawning and recruitment conditions during prolonged and elevated spring runoff (citing Dudley et al. 2017). However, this population growth potential is tempered by its short lifespan, which can result in population collapse during consecutive drought years (Horwitz et al. 2018).

Caldwell et al. (2018) quantified fecundity and compared egg quality across four reproductive age classes (1-4) of hatchery-reared Rio Grande Silvery Minnow. Batch fecundity (total number of spawned eggs) ranged from 2,362 eggs in age-1

fish to 10,495 eggs in age-4 fish. Fecundity increased across all four reproductive age classes of Rio Grande Silvery Minnow with the larger portion of total fecundity occurring in the first spawn across all age classes (Caldwell et al. 2018). Timing of spawning with optimal conditions in the Rio Grande was critical for survival and recruitment into the wild fish population (Caldwell et al. 2018).

**2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:**

The occurrence and density of Rio Grande Silvery Minnow has fluctuated widely over the past two decades (1993–2017; Dudley et al. 2018). The natural hydrology of the Rio Grande has also fluctuated widely over the past two decades and is highly variable due to water availability and water demand (USBR 2016; Blythe and Schmidt 2018; NMISC 2018). Ecological models revealed that changes in the occurrence and density of Rio Grande Silvery Minnow were reliably predicted by seasonal differences in river flows across years (Archdeacon 2016; USFWS 2016; Dudley et al. 2018). Prolonged high flows during spring were most predictive of increased density and prolonged low flows during summer were most predictive of decreased occurrence of Rio Grande Silvery Minnow in the MRG over 24 years of study (Dudley et al. 2018).

**2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):**

In 1999, the University of New Mexico Biology Department scientists began monitoring the genetic diversity of the wild and hatchery stocks of Rio Grande Silvery Minnow (Osborne et al. 2012). Genetic diversity and heterozygosity were essentially unchanged from 2015-2016 (Osborne et al. 2018). However, other metrics seemed to be showing signs of decline. The average number of alleles was relatively stable during 2006-2016, but declined in 2017 (Osborne et al. 2018). In 2017, mitochondrial gene diversity and haplotype richness remained within the range seen in previous years but both values declined from those seen in 2016. Loss of allelic diversity observed in 2017 was likely related to a severe reduction of the wild population during 2013-2014 with replacement by hatchery progeny from a smaller number of breeding individuals (Osborne et al. 2018).

**2.3.1.4 Taxonomic classification or changes in nomenclature:**

No new information on classification of Rio Grande Silvery Minnow was found.

**2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):**

Rio Grande Silvery Minnow population and habitat is fragmented by three irrigation diversion dams (Alo and Turner 2005; USFWS 2016). Reclamation, NMISC, and MRGCD proposed fish passage at these facilities (USBR 2015). The Service's 2016 Biological Opinion (USFWS 2016) makes fish passage at each of these facilities within 5, 6, and 10 years nondiscretionary to Reclamation. The NMISC has begun coordinating an effort to implement fish passage at San Acacia Diversion Dam. A similar effort has begun for Isleta Diversion Dam by the Reclamation in coordination with the Pueblo of Isleta. When completed, river reconnection will result in a continuous reach that is approximately 172 miles (277 kilometers) long so it will be again be more capable of supporting Rio Grande Silvery Minnow survival, provide increased opportunities for dispersal and movement, and allow access to more critical habitat during long-duration drought events (USFWS 2016, 2018).

**2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):**

There has been extensive morphological manipulation and river engineering activity in the MRG to ensure efficient water delivery and to minimize flood damages (USBR 2015; Stone et al. 2017). River engineering included: 1) confining the floodway between spoil banks, levees, or high ground, 2) channel stabilization using jetty jacks; and, 3) construction of drains, water diversion dams and facilities, and flood control facilities. Operations of dams and reservoirs have decreased annual fluctuations in flow, which contributed to the simplification of the channel system, reduced the size and number of sandbars, side channels, or flooded areas, and reduced or simplified riparian vegetation (Crawford et al. 1993). The resulting channel incision is the dominant impact limiting floodplain connectivity in the upper portion of the MRG (Stone et al. 2017). Once flood control and erosion control measures (for example, thousands of Kellner jetty jacks) were implemented in the 1950s (Dodge et al. 2007), the river channel narrowed and during low flows, vegetation anchored onto bars, banks, and islands that are no longer scoured by peak floods (Tetra Tech 2004; USACE et al. 2007).

The preference for a narrower range of physical habitat conditions by Rio Grande Silvery Minnow means that individuals often persist in a smaller subset of areas within the river system, often at the river edges (Tetra Tech 2014). Crawford et al. (1993); Albert (2004); Tetra Tech (2004), USACE et al. (2007), Massong et al. (2010), Swanson et al. (2011); Makar and Aubuchon (2012), and Varyu (2013) have documented reductions of the active channel habitat by approximately 40 acres per year. As of 2015, as many as 300 habitat restoration sites including many acres of nursery habitat have been restored by lowering their elevation for spring flooding (approximately 30 acres per year; USFWS 2016). Additional large-scale habitat restoration projects are scheduled within the MRG (USBR 2015, USBR 2018), but it is unlikely that the habitat restoration by mechanical means will produce a fully functioning, flood-based ecosystem (Byrne 2017).

### **2.3.1.7 Other:**

In the 25 years since the Rio Grande Silvery Minnow was listed as endangered, a tremendous amount of resources has been expended to avoid extinction and contribute to its recovery (USFWS 2016; NMISC 2018). Water managers have become increasingly skilled at managing the diverse water demands by strategic use of reservoir storage, runoff predictions, and close coordination (NMISC 2018). The State of New Mexico also relinquishes credit water and administers surface water and groundwater resources to maintain hydrologic balance in the MRG (NMISC 2018).

The State of New Mexico, MRGCD, Reclamation, and others have worked extensively to help conserve and recover the Rio Grande Silvery Minnow while protecting valid water uses (NMISC 2018). The actions proposed and conservation measures provided maintain the necessary flow and habitat diversity for Rio Grande Silvery Minnow in the MRG (NMISC 2018). These measures include provisions for river operations and water management, river connectivity, large-scale habitat restoration and enhancement, and storage of conservation water (USBR 2015). Additional water management actions included: 1) annual reductions in irrigation diversions (up to 40%) that improve the likelihood of extending the irrigation season which results in keeping, at a minimum, the Albuquerque reach wet through the summer; 2) strategic releases of supplemental water to increase river flows in Isleta and San Acacia reaches and provide refugia habitats through drain outfalls; 3) managing gradual river recessions during drought years; 4) pumping water from the Low Flow Conveyance Channel to the river; and, 5) creation of a spring runoff hydrograph for spawning and recruitment through temporary storage in upstream reservoirs as approved by the Rio Grande Compact Commission (NMISC 2018). These measures, collectively with those activities of other natural resource managers, help to provide assurances for long-term conservation of the Rio Grande Silvery Minnow and should be recognized in the 5-year review as an additional regulatory mechanism to help conserve the species (NMISC 2018).

## **2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)**

### **2.3.2.1 Present or threatened destruction, modification, or curtailment of its habitat or range:**

There is a general downward trend in spring runoff volume and an altered timing in the MRG (USBR 2016; Krabbenhoft et al. 2014; Stone et al. 2017). Climate change has resulted in winter warming in the Southwest and that have advanced the timing of spring snowmelt runoff including in the MRG (Stewart et al. 2004; Regonda et al. 2005; Enquist et al. 2008; Rauscher et al. 2008; USBR 2016). Projected decreases in water availability and timing due to climate change will have significant impacts on water management (e.g. decreased reservoir storage,

increased need for flood control operations, decreased water quality, etc.). These projected decreases in the magnitude and timing of spring runoff will reduce the volume of spring runoff and timing necessary for recruitment and base flows necessary for survival of Rio Grande Silvery Minnow (USFWS 2016). Impacts of reduced water availability and altered runoff timing in the MRG threaten the Rio Grande Silvery Minnow and its critical habitat (USFWS 2016, 2018).

#### **2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:**

In 2015, proposals to monitor an additional 100,000 Rio Grande Silvery Minnow per year in the MRG were submitted (SWCA 2015). In 2018, the Middle Rio Grande Endangered Species Collaborative Program Science Workgroup and others proposed extensive monitoring of Rio Grande Silvery Minnow in the MRG on a yearly basis (WEST 2018; USACE 2018). An adaptive management framework report also described over 20 priority scientific studies of Rio Grande Silvery Minnow in the MRG (GSA 2018). Overutilization for scientific purposes now poses a threat to the Rio Grande Silvery Minnow in the MRG.

#### **2.3.2.3 Disease or predation:**

When fish are forced into confined habitats due to low flow, they are more susceptible to both diseases and predation (USFWS 1994, 2016; Archdeacon 2016). However, diseases can also be a disorder of structure or function in a fish, especially one that produces specific signs or that affects a specific location and is not simply a direct result of physical injury. During a health study, deformed opercula (the shortening of a bony cover over the gills), anomalies in the appearance and texture of the liver and gills were frequently observed in Rio Grande Silvery Minnow collected from the MRG (Lusk et al. 2012). Shortened opercula, a skeletal deformity, was observed in nearly all Rio Grande Silvery Minnow collected from the MRG, collected from hatcheries, and observed in archival specimens. Shortened opercula can affect fish feeding, respiration, swimming abilities, their immunity against pathogens, somatic growth, and productivity (Koumoundouros et al. 1997; Beraldo et al. 2003; Verhaegen et al. 2007). Lusk et al. (2012) reported that 1) changes in water temperature, 2) nutrition of larval fish diets, and 3) changes in discharge were the most likely factors affecting shortened opercula observed in Rio Grande Silvery Minnow.

#### **2.3.2.4 Inadequacy of existing regulatory mechanisms:**

In 2003, 100 cubic feet per second of instream flow at the Rio Grande at Albuquerque Gage was required by a Biological Opinion (USFWS 2003). There is no protection of instream flow for Rio Grande Silvery Minnow habitat in the MRG under State of New Mexico law (Fort 1998; Guardians-Defenders 2018).

#### **2.3.2.5 Other natural or manmade factors affecting its continued existence:**

**2.4 Synthesis** – Rio Grande Silvery Minnow remains endangered with extinction based on the current variable and projected hydrology. This includes hydrologic alterations of spring runoff magnitude, duration, and timing, low flows, and other indicators of habitat availability. The physical conditions produced by prolonged and elevated spring runoff events result in the inundation of shallow, low-velocity nursery habitats with increased nutrients, food, cover, and warm temperatures essential for the successful recruitment of Rio Grande Silvery Minnow (Dudley and Platania 1997; Valett et al. 2005; Pease et al. 2006; Porter and Massong 2006; Turner et al. 2010, Hoagstrom and Turner 2015; Dudley et al. 2018; NMISC 2018). Due to climate change, water extraction, and geomorphological changes, the inundated areas during spring runoff flooding will likely diminish and result in a decrease of nursery habitats and subsequent recruitment (USFWS 2016). Water management coordination has improved, genetic management and captive propagation have prevented extinction, and habitat restoration has been implemented, but these activities do not yet prevent population collapse during extended drought years (Archdeacon 2016; Horwitz et al. 2018). Rio Grande Silvery Minnow are short lived and will likely be extirpated with consecutive low spring runoff years followed by reduced flows and extensive river drying without fish passage to perennial water during long-term drought (Dudley et al. 2007b; Horwitz et al. 2018).

Rio Grande Silvery Minnow critical habitat in the MRG has been modified through water management, fragmentation, channelization, and loss of water resulting in reduced spring runoff and base flow conditions. However, there has been increases in flows during June (USBR 2015). Threats continue to include altered spring runoff magnitude, duration, and runoff timing, seasonal dewatering of portions of the river channel, fragmentation of population and habitat by main stem dams and diversions, and loss of nursery habitat and floodplain connection from channelization. Active channel habitat has continued to narrow. The cumulative effect of aquatic habitat loss through the channel narrowing process, combined with a hydrologically disconnected floodplain, and reduced spring runoff contributes to a severely degraded environment for Rio Grande Silvery Minnow. Because 14 out of 15 recovery criteria were not met, the species is short-lived, and threats can and do lead to population collapse in the MRG, we recommend that the Rio Grande Silvery Minnow remain listed as an endangered species with a listing priority of 2C.

#### 4.0 ADDITIONAL RECOMMENDATIONS FOR FUTURE ACTIONS

While extensive and diverse management efforts over the past two decades have provided invaluable protection against the extirpation of Rio Grande Silvery Minnow, ongoing and planned efforts (e.g., restoring dynamic river flows, reconnecting fragmented reaches, and reestablishing a functional floodplain) should help to promote resilient and self-sustaining populations of this imperiled species (Dudley et al. 2018). Recovery efforts should focus on ensuring prolonged and elevated spring flows resulting in overbank flooding, formation of inundated habitats within the river channel, and creation of shoreline pools and backwaters. Continued efforts to provide reasonable spring spawning and summer survival conditions will be essential for securing a self-sustaining wild population of Rio Grande Silvery Minnow in the MRG (Dudley et al. 2018).

Complete fish passage at Angostura Diversion Dam and reach agreements with affected Native American Pueblos for Rio Grande Silvery Minnow management during drought.

Design and support a National Academy of Sciences Study on Reservoir Operations in Upper Rio Grande Basin to evaluate the legal and operational flexibilities necessary to store, release, and time water to create essential peak and sustained flows in the Middle Rio Grande for the benefit of the riparian environment and Rio Grande Silvery Minnow. Evaluate storing water in upstream reservoirs. (Guardians-Defenders 2018).

Develop a collaborative Species Status Assessment with the State of New Mexico that can provide a comprehensive reevaluation of threats in the MRG considering the expanded body of science concerning the silvery minnow (NMISC 2018).

Conduct comprehensive instream flow assessments in the Middle Rio Grande to determine the optimum and minimum flows necessary, by season, to support habitat, life history needs, and recovery of the Rio Grande Silvery Minnow as part of the River Integrated Operations Adaptive Management Strategy (USBR 2015; USFWS 2016).

Continue to seek reestablishment of resilient populations of this species at other locations within its historical range to further ensure its long-term persistence in the wild. Evaluate the conditions attributable to the lack of a self-sustaining population in the Big Bend area.

Strengthen independent peer review process (across agencies) to remove stakeholder bias, safeguard scientific integrity, and ensure that fish sampling data continues to further survival and recovery actions and during fish monitoring (Guardians-Defenders 2018).

Use flow assessments to develop a program to protect instream flows for listed species under state law, acquire water, and enforce such flows (Guardians-Defenders 2018).

Conduct a comprehensive plan and environmental review for decommissioning the low-flow conveyance channel in the San Acacia Reach of the Middle Rio Grande to return the Rio Grande to a one-channel system to restore river flows (Guardians-Defenders 2018).

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**U.S. FISH AND WILDLIFE SERVICE**

**5-Year Review of Rio Grande Silvery Minnow (*Hybognathus amarus*)  
July 2018**

**5.0 SUMMARY and APPROVAL**

**5.1 Current Classification:** Endangered

**5.2 Recommended Classification:**

- Downlist to Threatened**
- Uplist to Endangered**
- Delist** (*Indicate reasons for delisting per 50 CFR 424.11*):
  - Extinction*
  - Recovery*
  - Original data for classification in error*
- No change is needed**

**5.3 Current Recovery Priority Number.** 2C

**5.4 New Recovery Priority Number:** No change is recommended.

**Brief Rationale:** The Rio Grande Silvery Minnow has a high degree of threat and a high potential for recovery.

**5.5 Listing and Reclassification Priority Number:** Not applicable.

**Reclassification (from Threatened to Endangered) Priority Number:** \_\_\_\_  
**Reclassification (from Endangered to Threatened) Priority Number:** \_\_\_\_  
**Delisting (Removal from list regardless of current classification) Priority Number:** \_\_\_\_

**Brief Rationale:**

**FIELD OFFICE SUPERVISOR APPROVAL:**

Signature  Date 26 July 2018  
Supervisor, New Mexico Ecological Services Field Office, U.S. Fish and Wildlife Service