

**5-Year Report  
for  
Rio Grande Silvery Minnow  
Rescue and Salvage  
2001-2005**

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## Introduction

Until the 1950s, the Rio Grande silvery minnow (*Hybognathus amarus*, silvery minnow) was distributed throughout many of the larger order streams of the Rio Grande Basin upstream of Brownsville, Texas to points north in New Mexico primarily below 5,500 ft elevation (1,676 m). This elevation coincides with the approximate vicinities of Abiquiu on the Chama River, Velarde on the Rio Grande, and Santa Rosa on the Pecos River. Today, absent from much of its historic range, the silvery minnow is restricted to a variably perennial reach of the Rio Grande in New Mexico, from the vicinity of Bernalillo downstream to the headwaters of Elephant Butte Reservoir, a distance that fluctuates as the size of the pool of water in storage in Elephant Butte Reservoir changes, but that approximates 150 river miles (241 km). Most descriptions of the contemporary range of silvery minnow cite the entire reach of the Rio Grande between Cochiti Dam and Elephant Butte Reservoir. However, that assertion cannot be made with certainty. The species' status in the Rio Grande between Cochiti Dam and Angostura Irrigation Diversion Dam is unknown because that reach of river has not been surveyed in recent years.

The silvery minnow is currently listed as endangered by the State of New Mexico, having first been listed May 25, 1979 as an endangered endemic population of the Mississippi silvery minnow (*Hybognathus nuchalis*; New Mexico Department of Game and Fish, 1988). The species is also listed as endangered by Texas (Sections 65.171 - 65.184 of Title 31 T.A.C.) and the Republic of Mexico (Secretaria de Desarrollo Social, 1994). On July 20, 1994, the U. S. Fish and Wildlife Service (Service) published a final rule to list the silvery minnow as a Federal endangered species with proposed critical habitat (Federal Register, 1994). In 2003, the Service designated critical habitat for the silvery minnow in the Middle Rio Grande. The designation extends from Cochiti Dam downstream about 157 mi (252 km) to the utility line crossing the Rio Grande in Socorro County. This location is at 4,450 feet of elevation (1,356 m), corresponding to the elevation of the spillway crest for Elephant Butte Dam. The lateral limits (width) of critical habitat extend between the existing levees or, in areas without levees, the riparian zone, extending 300 feet (91.4 m) laterally from each side of the bankfull stage of the Middle Rio Grande. Portions of the Pueblos of Santo Domingo, Santa Ana, Sandia, and Isleta fall within the broader area designated as critical habitat, but the Pueblos are specifically excluded from the critical habitat designation.

On March 17, 2003, the Service issued a Biological Opinion on 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 on the Middle Rio Grande, New Mexico," (U. S. Fish and Wildlife Service, 2003; March 17, 2003 BO). The consultation involved two federal agencies, U. S. Bureau of Reclamation and the Army Corps of Engineers, and two non-federal entities. The Service concluded that water operations and river maintenance activities in the Middle Rio Grande, as proposed (Reclamation and Corps,

2003), were likely to jeopardize the continued existence of the silvery minnow (along with the southwestern willow flycatcher (*Empidonax traillii extimus*; flycatcher) and adversely modify critical habitat of the silvery minnow (U. S. Fish and Wildlife Service, 2003). The March 17, 2003 BO describes a Reasonable and Prudent Alternative, Reasonable and Prudent Measures, and Conservation Measures that serve in part to secure baseline conditions for the silvery minnow and flycatcher. As a part of the March 17, 2003 BO, the Service established the annual incidental take limit for silvery minnows. That limit was amended on August 15, 2005 (U. S. Fish and Wildlife Service, 2005a) and June 15, 2006 (U. S. Fish and Wildlife Service, 2006a), incorporating a formula that incorporates October monitoring data, habitat conditions during the spawn (spring runoff), and augmentation. Action agencies are apprised of the limit for incidental take by April 1 each year. Estimates of incidental take are derived from surveys in which observed mortality is multiplied by 50, based on the assumption that the probability of observing a single mortality is 0.02. The August 15, 2005 amendment also specified that the incidental take statement applies to silvery minnow 30 mm standard length or approximately 35 mm total length.

This report documents efforts during 2001-2005 salvage seasons to reduce the mortality of post-larval Rio Grande silvery minnows when flow in the Middle Rio Grande became intermittent and it discusses the effectiveness of those efforts using the permitted limit of incidental take defined in the March 17, 2003 BO (U. S. Fish and Wildlife Service, 2003) and subsequently amended on August 15, 2005 (U. S. Fish and Wildlife Service, 2005a) and June 15, 2006 (U. S. Fish and Wildlife Service, 2006a), as the standard of performance.

By convention, the “Middle Rio Grande” is defined as the area of the Rio Chama watershed and the Rio Grande, including all tributaries, from the Colorado/New Mexico state line downstream to the elevation of the spillway crest of the Elephant Butte Dam (4450 feet mean Sea Level). The Middle Rio Grande below Cochiti Dam is further designated by four divisions/reaches defined by locations of mainstream irrigation diversion dams. The Cochiti Reach extends from Cochiti Dam to Angostura Diversion Dam. The reach from Angostura Diversion Dam to Isleta Diversion Dam is called the Albuquerque Reach. The Isleta Division/Reach is bounded upstream by Isleta Diversion Dam and downstream by San Acacia Diversion Dam. Finally, the reach below San Acacia Diversion Dam to the headwaters of Elephant Butte Reservoir is the Socorro Division/Reach.

## Methods

### *Rescue of Silvery Minnows*

Using beach seines of various sizes, fish were collected from pools that formed as flow in the Middle Rio Grande becomes discontinuous. Prior to handling silvery minnows, personnel washed their hands to remove the residue of lotions (e.g., suntan lotions and mosquito repellent). Fish were handled with care using wetted hands. All captured fish were identified to the species level and silvery minnows were quickly culled from collections. Silvery minnows that exhibited advanced clinical signs of poor health (e.g., lethargy and hemorrhagic lesions) were not salvaged. Taxonomic keys for fish identification in the Middle Rio Grande appear in Sublette et al 1990; phylogenetic classification followed Nelson et al. (2004). Captured silvery minnows were placed into five gallon buckets filled with river water and subsequently transferred to transport tanks or plastic bags for transport to a release site. Tanks were employed to transport silvery minnows in instances when their use was logistically possible and when it was impractical to put fish in bags; bags were used to transport silvery minnows in antithetical situations.

Transport tanks equipped with water-tight lids were filled with water to near capacity to reduce sloshing and vibration within the tank during fish transport. Every effort was made to fill transport tanks with water that was relatively free of pollutants (river water will be avoided when possible). Bags were filled with water to approximately 2/3 capacity (approximately 3 liters, approximately equivalent to 0.8 gallons); the remaining volume of the bag was inflated with pure oxygen and its opening sealed to prevent the loss of the bag's contents. Rock salt (NaCl) was added to water in hauling vessels at the rate of 18.9 grams/gallon (to achieve a 0.5 % NaCl solution), and Stress Coat was added at the rate of 0.26 ml/L (1 ml/gallon).

Pure oxygen was supplied to transport tanks through micro-bubble oxygen diffusers. The flow of oxygen was adjusted with varying water temperatures and loading rates of fish to maintain dissolved oxygen levels at or above 8.0 mg/L. Ice was added slowly to the tanks to maintain water temperature approximately 5° C lower than the river. Care was taken to insure that densities of silvery minnows in transport vessels would not contribute to an unusually high rate of silvery minnow mortality. Bags with fish were inflated with oxygen as soon as practical. Plastic bags containing silvery minnows were placed in ice chests. Ice was employed to maintain water temperatures in transport vessels at about 5° C lower than the river. At times, bags were cushioned with bubble wrap or other materials to reduce trauma to transported fish from impact and vibration associated with transport.

Rescued silvery minnows were transported to perennial portions of the Middle Rio Grande where live fish were released to the river. Generally, rescued silvery minnows were transported to the Albuquerque Reach where they were released, but occasionally rescued silvery minnows were transported and released at select locations in the Isleta and Socorro reaches when hydrologic conditions there insured perennial flow. Release of

rescued fish was postponed until the rate of mortality of transported silvery minnows decreased to a barely detectable level. At times, rescued silvery minnows were subjected to a 0.75 percent solution of NaCl (i.e., half again the concentration prescribed for transport) for approximately 15 minutes prior to stocking to reduce the load of certain pathogens carried by the species (Hattingh et al. 1975). Lots<sup>1</sup> of fish that exhibited advanced clinical signs of poor health (e.g., lethargy and hemorrhagic lesions) were not released to perennial portions of the Middle Rio Grande. Silvery minnow mortality was not regarded as incidental take or transport loss if the apparent cause of silvery minnow death could be attributable to poor health at the time of capture. Prior to releasing healthier silvery minnows into the river, water in the transport tanks was tempered (by slowly<sup>2</sup> adding river water to the transport tanks) until it was within 1° C of the water temperature of the river at the release site. Bags of silvery minnows were placed in the river to equilibrate the temperature of the water in the bags to within 1° C of the water temperature of the river at the release site.

For each day that rescue operations were conducted, counts or estimates of the number of silvery minnows rescued were made by river reach. The number of silvery minnows rescued often precluded their quantification by absolute counts. It was often necessary to estimate the number of silvery minnows rescued by counting the number of silvery minnows in subsamples representative of the density of the total catch, and subsequently multiplying that count by the reciprocal of the subsample proportion of the total. Counts or estimates of silvery minnow transport loss were made and general stocking locations were noted.

Data regarding rescue operations pertain to a segment of aquatic habitat. The longitudinal limits of the sample segments are recorded to the nearest half (0.5) river mile and positioned laterally on the presumed thalweg. Northing and easting coordinates are associated in a one-to-one relationship with the center point of each half-mile coordinate. Accuracy in spatial geographic depictions of sample locations outside of the main river channel was achieved by algebraically adjusting the easting coordinate by a standard factor (e.g.,  $\pm 125$  meters), depending on whether the sampling was conducted in the east or west floodplain. It is emphasized that the data presented in this report regarding the number of silvery minnows rescued are not derived from a random sample, and counts (or estimates) of silvery minnows rescued imperfectly reflect the abundance of silvery minnow populations.

The age of silvery minnows was inferred from their standard length, using the age-length relationship reported by Cowley et al. (2006) as a guideline, to form a general impression of the age class distribution of rescued silvery minnows (although the lengths of individual silvery minnows were generally not precisely measured). Nonetheless, it is acknowledged that length is an imperfect index of age on a regional scale because growth in fish varies longitudinally with energy inputs and length of the growing season. It is also because the species' extended spawning season does not always provide for a clear demarcation of age by size.

In a separate study, hatchery-produced silvery minnows have been stocked into various

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<sup>1</sup> A "lot" is defined as an aggregate unit of collection. A lot can be a bag or a tank of fish.

<sup>2</sup> Adjustment of water temperature was accomplished at the approximate rate of 1° C per 20 minutes.

reaches of the Middle Rio Grande. Each batch of the hatchery-produced silvery minnows was distinguished by a unique visible implant elastomer mark before being released. The location, condition, and fate of these marked silvery minnows were noted as they were encountered during rescue operations.

### ***Determination of Incidental Take***

Rio Grande silvery minnow (silvery minnow) mortality can occur with channel drying resulting from drought conditions, and conditions resulting from federal mediated water operations. In the recent past, intermittent conditions have existed in significant portions (e.g., up to 68.0 miles – approximately 45 percent of the silvery minnow's contemporary range) of the river between Isleta Diversion Dam and Elephant Butte Reservoir that, without management intervention, would result in substantial silvery minnow mortality. Efforts to salvage silvery minnows from intermittent reaches of river are intended to reduce silvery minnow mortality that can occur with channel drying resulting from drought conditions. It will also reduce the probability that the mortality associated with water operations will exceed the limit for incidental take.

Silvery minnow rescue operations progressed in synchrony with river recession, with priority given to river reaches in which the death of silvery minnows due to federal water operations would be considered incidental take. Silvery minnow mortality that occurs as a result of federal water operations in the Middle Rio Grande is evaluated under limitations established in the March 17, 2003 Biological Opinion (U. S. Fish and Wildlife Service, 2003) and as modified on June 15, 2006 (U. S. Fish and Wildlife Service, 2006a). As amended, the incidental take is now estimated annually using a formula that incorporates October monitoring data, habitat conditions during the spawn (spring runoff), and augmentation. Estimates of incidental take are derived from surveys in which observed mortality is multiplied by 50, based on the assumption that the probability of observing a single mortality is 0.02. The June 15, 2006 amendment also specifies that the incidental take statement applies to silvery minnows larger than 30 mm standard length<sup>3</sup> or approximately 35 mm total length<sup>4</sup>.

Incidental take of post embryonic silvery minnows is defined for two size classes, i.e., for those shorter or longer than 30 mm standard length or approximately 35 mm total length. All smaller sized post embryonic silvery minnows are presumed to be taken as a result of federal water operations when the river dries downstream of Isleta Diversion (U. S. Fish and Wildlife Service, 2003).

Determination of incidental take of the larger size class of post embryonic silvery minnows was conditional. Mortality of the larger sized post embryonic silvery minnows that occurs in portions of the river that are rewetted due to forces that are not directly or indirectly related to the operations of the Action Agencies was not considered to be incidental take under the March 17, 2003 BO (U. S. Fish and Wildlife Service, 2003). In contrast, rewetting of river reaches that were previously dried in violation of the BO was

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<sup>3</sup> Standard length is defined as the distance from the anteriormost projection of the head to the hypural notch; the hypural notch is the point between the end of the body vertebrae and the beginning of the caudal fin, generally denoted as the crease in the caudal peduncle made by bending the caudal fin to one side or the other.

<sup>4</sup> Total length is defined as the distance from the anteriormost projection of the head to the tip of the caudal fin when the lobes of the caudal fin are arranged to achieve the maximum length.

directly or indirectly related to the operations of the Action Agencies; in such instances, silvery minnow mortality (the larger sized post embryonic individuals) associated with subsequent drying was regarded as incidental take. Silvery minnow mortality, involving the larger sized post embryonic individuals, that occurs outside of the active river channel was generally not considered to be incidental take under the March 17, 2003 BO (U. S. Fish and Wildlife Service, 2003); the exception to this generalization involves areas outside of the active channel that are wetted as a consequence of federal water pumping operations (i.e., water pumped from the low flow conveyance channel in an effort to maintain specified flows in the river). Finally, the larger sized post embryonic silvery minnows that are “rescued” and that die in transit to relocation sites were not considered to be incidental take. Likewise silvery minnows that died and exhibited advanced clinical signs of poor health (e.g., lethargy and hemorrhagic lesions) were not considered to be incidental take.

A diurnal expansion-contraction cycle attends river recession. The rate and timing of this cycle varies with rates and timing of evaporation and transpiration. As such, the upstream extent of river recession generally fluctuates diurnally, sometimes by as much as a mile per day. This phenomenon generally serves to reduce mortality to silvery minnows by refreshing/replenishing the supply of water in isolated pools at the upstream terminus of river recession. However, silvery minnow mortality can attend any event of river contraction, including that associated with the diurnal expansion-contraction cycle. Such mortality is regarded as an indirect effect of water operations, i.e., an effect caused or induced by an action that is “reasonably certain to occur” (50 C.F.R §402.02). As such, silvery minnow mortality, involving the larger sized post embryonic individuals, that may occur in the proximity of the upstream terminus of river recession and that occurs indirectly as a result of the diurnal expansion-contraction cycle was regarded as incidental take. In contrast, events of river expansion (i.e., river channel rewetting) that occur as a result of storm events are stochastic in nature and are usually short-lived. Generally, flows in the river retract quickly following a storm event and may result in silvery minnow mortality. However, such mortality cannot be said to be a direct or indirect effect of water operations.

#### ***Enumeration of Larger Post Embryonic Silvery Minnow Incidental Take***

A numeric standard for incidental take requires that silvery minnow mortality attributable to water operations be enumerated. This process presumes that it has been established that specimens qualify as incidental take in terms of specimen identification, specimen size, and the circumstances of death (see “Determination of Incidental Take” above). This process of qualification can be formidable and time consuming in the event that large numbers of candidate incidental take are encountered. In such circumstances, it may be necessary to preserve samples for processing at a future date. It may be necessary to postpone processing many large samples of candidate incidental take to insure that such activities do not interfere with other time sensitive tasks such as silvery minnow salvage.

It may be possible that collections of incidental take can be sub-sampled to relate probable numbers of silvery minnows to sample weight. However, it is cautioned that this relationship will vary with time (silvery minnows will grow larger over the course of



a growing season), with location, the degree of variability in fish size, the integrity of specimens (e.g., relative degree of specimen hydration and decomposition), and the amount of debris in samples. This implies that a unique relationship is probable between the number of silvery minnows and weight for each collection.

To determine this relationship, each sample of candidate incidental take specimens will first be processed to remove as much debris as practical, species of fish other than silvery minnows will be removed, and specimens of silvery minnows that are obviously undersized (i.e., < 30 mm SL or < 35 mm TL) will be removed from the sample. The sample will be placed on a sieve with 0.589 mm openings and excess fluids will be allowed to drain from the sample until no drips are observed over any 30 second interval. The total sample will be weighed to the nearest 0.10 of a gram after excess fluids have drained. Immediately after the total sample is weighed, the sample will be sub-sampled at least three times (without replacement) and sub-samples will be weighed to the nearest 0.10 of a gram. Silvery minnows in each sub-sample will be counted, taking care to insure that only silvery minnows that are > 30 mm SL or > 35 mm TL are included in the count. These data will yield at least three proportion estimates of the number of silvery minnows to sub-sample weight. A mean and sample standard deviation will be calculated for the proportion estimates, and a 95 percent small-sample confidence interval will be calculated for the mean (i.e.,  $\bar{y} \pm t_a s / \sqrt{n}$ , where  $t_a$  is obtained from a  $t$ -distribution table, with  $a = 0.025$  and  $df = n - 1$ ). To error on the conservative side, the lower bound of this interval will be multiplied times the total sample weight to derive an estimate of total incidental take in the sample.

Data regarding counts or estimates of silvery minnow incidental take pertain to a segment of aquatic habitat. The longitudinal limits of the sample segments are recorded to the nearest half (0.5) river mile. Counts or estimates of silvery minnow incidental take will be used to assess the effectiveness of silvery minnow rescue operations using the limit of incidental take as the standard of performance.

## **Results**

Silvery minnow rescue operations generally progressed in synchrony with river, involving both floodplain and main channel habitats. Rescue operations in main channel habitats were given priority over rescue operations in floodplain habitats. The Socorro Reach of the Middle Rio Grande has been the first reach to dry in recent past generally located between Neil Cupp (approximately 4.0 miles upstream of U. S. 380) and the south boundary of Bosque del Apache NWR.

### ***Rescue of Silvery Minnows: 2001***

Three periods of discontinuous river events had occurred during 2001. The first occurrence was on July 14, 2001 at the San Marcial railroad bridge, which extended 2.5 miles downstream. The Service salvaged 240 silvery minnows. These fish were relocated below the Fort Craig pumping station. The river disconnected again on July 26, 2001, with a drying range of 200 feet upstream above the Fort Craig pumping station. No fish were rescued due to the river rewetting shortly thereafter.

The river had become intermittent for the last time on September 10, 2001 and it remained dry for five days. The extent of the dry river bed was from the middle of the Bosque del Apache NWR (river mile 78.75) to the south boundary line of Bosque del Apache NWR (river mile 74), a total of 4.5 miles. The Service salvaged 140 silvery minnows. These fish were released back into the river below the south boundary pumping station at Bosque del Apache NWR.

A total of 380 silvery minnows had been rescued and salvaged. There were a total of 3 silvery minnows found during the 2001 irrigation season that were documented as incidental take.

### ***Rescue of Silvery Minnows: 2002***

During 2002, the Service performed 32 individual silvery minnow salvages within the Isleta and San Acacia Reaches. Approximately 18.2 river miles and 25 river miles were salvaged in the Isleta and San Acacia Reaches, respectively. Though this was the approximate amount of river that dried during the 2002 season these reaches were salvaged numerous times due to periodic rewetting from thunderstorm events, which adds up to approximately 102 miles of river salvaged in 2002. The Service rescued within the Isleta and Socorro reaches 3 to 4 approximate number of river miles (APRMs) drying per day.

The first and last silvery minnow salvages occurred within Bosque del Apache NWR on June 3, 2002 and ceased on October 3, 2002. The Service salvaged 3,662 silvery minnows from the Isleta and San Acacia Reaches combined. During this four month period, the bulk of silvery minnow salvage occurred within the months of June, July, and August with only one salvage being conducted during September and October. The overall number of silvery minnows collected during drying events declined after July

2002; 13 percent (n=427) of the silvery minnows collected were found after this date.

The APRMs salvaged varied depending on the magnitude of drying events, ambient conditions, and river bed composition (e.g. sands, silts, etc). During a few events, up to 8 APRMs were dried in a single day; these events were rare and occurred most often within Bosque del Apache NWR and between U.S. 60 and the Jarales Bridge crossing. Most salvages were completed within 4 to 8 hours depending on the number of fish collected and the number of available personnel to assist in salvages. In most cases, events consisting of 4 or less APRMs needed 3 to 8 individuals to effectively salvage that section of river. In some cases, two crews were formed to work two geographically separated dry reaches.

Age structure of the silvery minnows identified was 98 percent adult and 2 percent young-of-year (YOY). Due to the high numbers of YOY fish during June and July, only cursory examinations were made in hopes of identifying some silvery minnows. These YOY fish were not included in the total number of minnows salvaged, but it is without doubt that some of the YOY were silvery minnows. However, it is likely that many of these small fish were fathead minnows or other non target species.

A total of 1,639 individual pools were seined and recorded from the beginning of June 2002 through mid-October 2002. Overall effort for the field season was estimated at 162,568 m<sup>3</sup>. The estimated average volume of each pool was 99 m<sup>3</sup>. The estimated average length of each pool was 26.95 meters, the estimated average width was 2.56 meters, and the estimated average depth was .36 meters.

### ***Rescue of Silvery Minnows: 2003***

During 2003, the Service performed 54 individual silvery minnow salvages within the Isleta and San Acacia Reaches. Flow recessions were manageable, with approximately 2.44 approximate river miles (APRM) drying per day. During a few isolated events, up to 5 APRMs dried in a single day, but these events were rare and occurred most often within Bosque del Apache NWR and between U.S. 60 and the Jarales Bridge crossing. Approximately 70 river miles were salvaged with some river miles being salvaged several times due to rewetting caused by rainstorm events, bringing the total up to approximately 90 river miles salvaged.

The first and last silvery minnow salvages occurred within Bosque del Apache NWR on June 13, 2003 and ceased on October 3, 2003. The Service salvaged 713 silvery minnows from the Isleta and San Acacia Reaches combined. Most of these silvery minnows were translocated to the Angostura Reach of the Rio Grande. The majority of the silvery minnow salvage occurred during the months of June, July, and August with only one salvage being conducted in both September and October. The overall number of silvery minnows collected during drying events declined after July 2003. Age structure of the silvery minnows identified was 57 percent adult and 43 percent YOY.

A total of 1,006 individual isolated pools were documented and seined from the beginning of June 2003 through mid-October 2003. Overall effort for the field season

was estimated at 49,000 m<sup>3</sup>. The estimated average volume of each pool was 58.9 m<sup>3</sup>. There were a total of 28 silvery minnows found during the 2003 irrigation season that were documented as incidental take. Of the incidental take specimens, 13 were adults and 15 were YOY.

#### ***Rescue of Silvery Minnows: 2004***

Prevailing drought conditions in 2004 resulted in water shortages throughout the Middle Rio Grande, New Mexico. Beginning on June 16, 2004, and as described in the March 17, 2003 BO, flow in the Rio Grande first became discontinuous in the vicinity of Bosque del Apache NWR. Ultimately, several discontinuous sections of the Middle Rio Grande totaling 68.0 miles (109.4 km) were dewatered. Such channel drying resulted in the incidental take of 521 adult silvery minnows. This level of incidental take was within the amount of incidental take (760) established in the March 17, 2003 BO. Of the total amount of incidental take, one silvery minnow death occurred in the Isleta Reach and the rest (520 silvery minnows) occurred in the Socorro Reach.

The first occurrence of incidental take (involving a single post-larval silvery minnow) was observed on June 20, 2004, near the northern boundary of Bosque del Apache NWR. Nearly two months later, the next silvery minnow mortality occurred as a result of water operations. Most of the incidental take of silvery minnows occurred between August 12, 2004, and September 9, 2004. The last occurrence of incidental take was on September 16, 2004.

The sections of river that went dry extended north from the South Boundary of Bosque del Apache NWR (river mile 74.0) to a point several miles downstream of the Isleta Diversion Dam (approximately river mile 165.0). Between these geographic limits, the river remained perennial from a point about four miles downstream of the San Acacia Irrigation Diversion Dam (river mile 111.0) to Bernardo (river mile 130.0). Isolated perennial pools also persisted between the LP2DR irrigation outfall (river mile 144.0) and the Jarales Bridge (river mile 140.8).

Silvery minnows were salvaged from isolated pools that formed as the river receded to reduce the probability that the mortality associated with water operations would exceed the limit of incidental take as established in the March 17, 2003 BO. A total of 12,865 silvery minnows were salvaged from the dewatered reaches of river. Most of these were *in situ* produced young-of-year (i.e., most were not marked, indicating that they were not of immediate hatchery origin). This number of salvaged silvery minnows greatly exceeds that salvaged in the recent past: 713 during 2003, 3,662 during 2002, and 240 during 2001 (Smith and Basham, 2003; Smith and Munoz, 2002; Smith, 2001). Of the silvery minnows salvaged during 2004, approximately 92.5% were transported alive to the Albuquerque Reach of the Rio Grande where they were released (usually at the Alameda Bridge).

Silvery minnow salvage operations were initiated on June 16, 2004 at the South Boundary of Bosque del Apache NWR, and progressed upstream in synchrony with river recession over the course of the 2004 irrigation season. River recession generally occurred at or below the rate allowed in the March 17, 2003 BO (4.0 miles/reach/day).

The river became discontinuous in the Isleta Reach on June 24, 2004. Of the silvery

minnows salvaged during the 2004 irrigation season, most (10,158; 79.0%) were captured in the Isleta Reach (primarily upstream of Belen). The abundance of silvery minnows in this reach progressively increased with distance upstream (i.e., the greatest densities of silvery minnows were observed proximal to the next upstream irrigation diversion).

Very few silvery minnows were captured in the Socorro Reach before August 3, 2004. Up to that date, sampling in this reach did not progress upstream beyond Brown's Arroyo (river mile 94.1). It wasn't until salvage operations resumed in that reach on August 03, 2004, following a flood pulse on July 24, 2004 that rewet the entire Socorro Reach of the Rio Grande, that many silvery minnows were found there (silvery minnows apparently descended downstream with the July 24, 2004 flood pulse). Over the duration of sampling during 2004, decisively fewer (2,707) silvery minnows were found in the Socorro Reach compared to the number of silvery minnows found in the Isleta Reach. The number collected there represents 21.0% of the total number of silvery minnows salvaged during the 2004 irrigation season. Like the Isleta Reach, abundance of silvery minnows in the Socorro Reach progressively increased with distance upstream.

Four distinct size classes of silvery minnows, likely indicative of four age classes, comprised the sample of salvaged silvery minnows. The 2004 year class of salvaged silvery minnows exhibited a tri-modal distribution in sizes – evidence of multiple spawning bouts by the species during the year. Further, it seems that recruitment was relatively strong, judging from the large number of unmarked young of year silvery minnows observed during the 2004 fish salvage operation.

Four hatchery-produced silvery minnows were encountered during surveys to locate and salvage silvery minnows from isolated pools that formed as the river receded. These fish were distinguished by a unique visible implant elastomer mark that signified the location, date and size of the fish at the time of stocking. These fish have been introduced into the Rio Grande as a part of an experimental augmentation study being conducted by the Service's Fishery Resources Office. The significance of these observations will be addressed in a separate report for that study. Observations of these collections are presented here for documentation purposes. On June 17, 2004, one silvery minnow, with a red left predorsal mark, was captured adjacent to Bosque del Apache NWR (river mile 83.0). That fish was part of a batch of fish that was stocked adjacent to Sandia Pueblo (river mile 198.0) on April 3, 2003. The point of recapture was approximately 115.0 miles (185.0 km) downstream of its point of release. On July 7, 2004, one silvery minnow, with an orange left predorsal mark, was captured adjacent to Bosque Farms at (river mile 164). That fish was part of a batch of fish that was stocked adjacent to Corrales (river mile 194.0) on December 9, 2002. The point of recapture was approximately 30.0 miles (48.3 km) downstream of its point of release. Finally, on August 1, 2004, two silvery minnows, both with a green left predorsal mark, were collected adjacent to the Los Lunas Airport (river mile 157). These fish were part of a batch of fish that was stocked adjacent to Bernalillo (river mile 203.0) on January 2, 2003. The point of recapture was approximately 46.0 miles (74.0 km) downstream of their point of release.

During the week of January 10, 2005, 27 silvery minnows were collected from one site just downstream of Alameda Bridge. These fish were variously marked indicating their release in the reach between Bernalillo and Sandia Pueblo during November 2004.

### ***Rescue of Silvery Minnows: 2005***

Rescue operations were conducted on 82 days during the 2005 irrigation season. The average daily longitudinal extent of aquatic habitat involved in rescue operations per reach was 0.84 river miles (ranging from 0.25 – 4.0 river miles per day; standard deviation 0.7796). One or more river miles were rescued per reach on 24 of the days of rescue activities (approximately 29.0% of the total days of rescue). River recession occurred at or below the rate allowed in the March 17, 2003 BO (4.0 miles/reach/day; U. S. Fish and Wildlife Service, 2003).

Rescue operations began on June 20, 2005 within floodplain habitats. A month later, rescue operations targeted the main channel habitats and ceased operations on September 28, 2005. Ultimately, 28.5 miles of the main channel of the Middle Rio Grande were dried, while surface water over an additional 7 miles of the main channel was restricted to isolated pools. Surface water in the main channel of the Isleta Reach became reduced to isolated pools in a 2-mile section of river (just downstream of the Los Chavez Irrigation Wasteway). This reach was bracketed by a total of 4 river miles in which surface water became entirely absent on multiple occasions. Discontinuous main channel segments of the Socorro Reach, totaling 24.5 miles and located generally between Fort Craig and Socorro became dry.

The greatest extent of drying occurred in the river upstream of Fort Craig to a point approximately 2.5 river miles downstream of Socorro. Such channel drying resulted in the incidental take of 5,640 silvery minnows. Of the total amount of incidental take, 274 silvery minnow deaths occurred in the Isleta Reach and the rest (5,366 silvery minnows) occurred in the Socorro Reach. The first occurrence of incidental take was observed on July 24, 2005, in the lowermost four mile portion of the Bosque del Apache NWR. Most (71.6%) of the incidental take occurred in a 5.5 mile portion of river that centered approximately on Brown Arroyo. The last occurrence of incidental take was on September 28, 2005.

An estimated total of 626,444 silvery minnows were rescued from the dewatered portions of river, including main channel and floodplain habitats. Ninety-six point three percent were transported alive to the Albuquerque and Isleta reaches of the Rio Grande where they were released. Most of these were *in situ* produced young-of-year (i.e., most were not marked, indicating that they were not of immediate hatchery origin). This number of rescued silvery minnows greatly exceeds that rescued in the recent past: 12,865 during 2004, 713 during 2003, 3,662 during 2002, and 240 during 2001 (U. S. Fish and Wildlife Service, 2005b; Smith and Basham 2003; Smith and Munoz 2002; Smith 2001).

Of the silvery minnows rescued during the 2005 irrigation season, most (an estimated 370,416; 59.13% of the estimated total number of silvery minnows rescued) were captured in the Isleta Reach (upstream of Belen). An estimated total of 256,028 silver minnows were captured in the Socorro Reach between Fort Craig and a point approximately 2.5 river miles downstream of the center of Socorro, New Mexico (40.87% of the estimated total number of silvery minnows rescued). The abundance of

silvery minnows from main channel habitats in the Socorro Reach progressively increased with distance upstream.

The number of incidental take also progressively increased with distance upstream in the Socorro Reach. An insufficient portion of the Isleta Reach was sampled during 2005 to determine if the silvery minnow exhibited any discernable patterns of distribution. The number of silvery minnows rescued from main channel habitats progressively increased over the duration of the 2005 rescue operation. Of the silvery minnows rescued during the 2005 irrigation season, most (an estimated 418,698; 66.84%) were captured in the floodplain, while an estimated 207,746 (33.16%) were captured in the main channel of the river.

Four distinct size classes of silvery minnows, likely indicative of four age classes, comprised the sample of rescued silvery minnows. As would be expected, 2005 was the most abundant year class; silvery minnows from older age classes were progressively and dramatically less numerous. The 2005 year class of rescued silvery minnows exhibited a multi-modal distribution in sizes – evidence of multiple spawning bouts by the species during the year. Further, it seems that recruitment was relatively strong, judging from the large number of unmarked young of year silvery minnows observed during the 2005 fish rescue operation.

One hatchery-produced silvery minnow was encountered during surveys to locate and rescue silvery minnows from isolated pools that formed as the river receded. These fish were distinguished by a unique visible implant elastomer mark that signified the location, date and size of the fish at the time of stocking. These fish have been introduced into the Rio Grande as a part of an experimental augmentation study being conducted by the Service's Fishery Resources Office. The significance of these observations will be addressed in a separate report for that study. Observations of these collections are presented here for documentation purposes. On September 14, 2005, one silvery minnow, with a green right dorsal mark, was captured adjacent to Peralta Wasteway at river mile 152.5.

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