Rio Grande Silvery Minnow Rescue and Salvage Report
Fiscal Year 2003

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RIO GRANDE SILVERY MINNOW SALVAGE: 2003

INTRODUCTION

Despite recent water management to benefit the Rio Grande silvery minnow (silvery minnow), some portions of the Rio Grande have gone intermittent yearly since 1996. The location, magnitude, and duration of the intermittency are dependent on many environmental events including spring runoff, summer thunderstorms, amount of supplemental water stored in upstream reservoirs, and other general climatic conditions. Stream drying causes direct mortality to fish when the pools in which they are trapped in dry up.

The fate of fish trapped in isolated pools has been studied in the Rio Grande and other drainages to determine the effects of river drying on the fish community. These studies have determined that the trapped fish become stressed due to crowding, increasing water temperatures, increasing ambient temperatures, decreasing dissolved oxygen, aquatic predation, terrestrial predation, interspecific competition, and intraspecific competition (Trammer 1977, Capone and Kushlan 1991, Smith and Hoagstrom 1997, Ostrand and Marks 2000, and McClinton et al. 2000). All of these potential factors make survival of fish in isolated pools questionable.

Over the last 5 years, the U.S. Fish and Wildlife Service New Mexico Ecological Services Field Office (Service) with assistance from other agencies, has salvaged silvery minnows from isolated pools during river intermittency and translocated these fish to areas with permanent flowing water. In 2001, the Service determined that salvage of silvery minnows was an appropriate reasonable and prudent measure for minimizing incidental take of the silvery minnow during river intermittency. This determination was based on the available information on fish survival in isolated pools, the endangered status of the silvery minnow, and the possibility of the minnow population declining throughout the middle Rio Grande.

The first notable silvery minnow salvage was performed in 1996 and salvages have continued to some degree each year since then. Prior to 2001, one attempt was usually made to collect as many silvery minnows stranded in isolated pools as possible. These early attempts usually consisted of one crew entering the Rio Grande at available access points, collecting silvery minnows, and translocating them upstream to flowing water. These salvages were usually conducted only once a year, and in most cases no attempts were made to collect silvery minnows from isolated pools in remote and inaccessible portions of the Rio Grande. During 2001 and 2002 organized and extensive minnow salvage was accomplished by the service.

In 2003, the Service performed approximately 54 individual silvery minnow salvages within the Isleta and San Acacia Reaches, salvaging 713 silvery minnows. Access points were located for all drying portions of the Rio Grande, regardless of how remote. Approximately 70 river miles were salvaged with some river miles being salvaged several times due to re-wetting caused by rainstorm events (“acts of nature”), bringing the total up to approximately 90 river miles salvaged.

The main objective of silvery minnow salvage is to relocate stranded silvery minnows from isolated pools to flowing portions of the river or to a propagation facility. There are subordinate objectives, however, designed to add to our knowledge about silvery minnow, as well as assist in future projects. These include documentation of qualitative conditions of the Rio Grande during each low flow event, regardless of river intermittency. Drying events are fully documented, including the number of miles, duration of river drying, and the number of isolated pools during each intermittent event. The number of silvery minnows salvaged from each isolated pool is documented, as is the incidental take. The numbers of determined silvery minnows attributed to river management action is documented to ensure that the limits set forth in the Incidental Take Statement (ITS) of the Biological Opinion (Opinion) are not exceeded. Starting in 2003, water quality parameters were collected on a random number of pools to enhance our data on pool temperatures and other water quality parameters that could potentially affect the survival of the silvery minnow.

Description of Study Area

The area for this project extends from Cochiti Dam to the headwaters of Elephant Butte Reservoir in New Mexico.

METHODS AND MATERIALS

A Rio Grande Silvery Minnow Rescue Coordinator (Coordinator) and field crew were employed by the Service. The Coordinator is responsible for directing and coordinating all efforts pertaining to the salvage of silvery minnows. The Coordinator ensures that silvery minnows are collected from isolated pools and placed back into the river where continuous flows is guaranteed (e.g., Isleta or Angostura Reaches) or transported to a propagation facility. The Coordinator is also responsible for documenting all take associated with the Incidental Take Statement (ITS) issued in the current Opinion.

The Coordinator determines when silvery minnow salvage is necessary by evaluating river conditions and by communicating with other agencies involved in river operations. River conditions were evaluated by examining flow discharges on web sites, by visually reading staff gauges located at several locations within the river and LFCC, and by making visual estimates of water velocity at specific locations on the river. Cooperating agencies were contacted to provide assistance in their areas of expertise.

Six temporary biological technicians were hired to assist in silvery minnow salvage operations, and a daily crew leader was assigned. The crew leader was responsible for leading the technicians in salvage and non-salvage field situations including “river eyes”assessments that consisted of qualitative descriptions of general river conditions throughout the San Acacia and Isleta Reaches. The crew leader coordinated each crew’s activities and reported to the Coordinator daily.

Depending on the location, magnitude, and duration of drying events, a crew of 3 to10 individuals performed silvery minnow salvages at one or more locations on the river. The crew consisted of Service biologists and technicians and cooperating agencies as necessary. Field data was collected daily on pre-made data sheets. Global Positioning System units (GPS) were generally used to mark the upstream and downstream points of drying events and were used to calculate the number of dry river miles during each intermittent event. Time spent salvaging each intermittent reach was recorded. The number and size (length, width and depth) of isolated pools was measured, and water temperature was taken from selected pools. The number of silvery minnows salvaged from each pool was recorded, and age was recorded as young-of-year or adults. Other fish species found in the pool were also recorded. The number of silvery minnows found dead during each intermittent event was closely documented to ensure that the limits set forth in the ITS of the Opinion were not exceeded. A weekly update on salvage activities was provided to the cooperating agencies and other appropriate entities.

Rio Grande silvery minnows were collected from isolated pools using beach seines of varying sizes. Salvaged minnows were immediately placed into 5 gallon buckets containing at least 2.5 gallons of water. To reduce stress, silvery minnows were handled minimally using wet hands. Silvery minnows were transferred from the buckets into plastic bags containing 1 to 2 gallons of water with a specific proportion of stress coat and NaCl to alleviate stress. The bags were placed in ice chests containing a small amount of ice to maintain approximate natural living conditions. The ice chests were attached to an ATV or amphibious vehicle and transported to the distribution truck where minnows were prepared for relocation upstream in accordance with Protocol 3 detailed below.

It was determined through experience that bagging fish in the field reduced the amount of handling and associated stress each fish experienced. The fewer times the fish are handled, the less likely they are to sustain external or internal injuries that could promote secondary bacterial infections or other injuries. Generally, one-quarter to one-half of the bag consisted of water with the remainder of the bag filled with pure oxygen. Fish densities in the bags were kept to a minimum, with no more than18 adult fish and 30 YOY fish per bag.

Protocols were established for documenting marked Rio Grande silvery minnows collected during salvage operations to ensure that the mark color and placement, collection point, and condition of silvery minnow was recorded. All information pertaining to marked fish was provided to the University of New Mexico and the New Mexico Fishery Resources Office.

All silvery minnows were translocated to the Albuquerque area and released in slow water, such as side channels and pools within 2 meters of available cover. Care was used not to release fish directly into cover (i.e., debris) where minnows could be entangled and possibly trapped, adding to the stress of the translocation. The silvery minnows were typically handled in the field under Protocol 1, and then transported to the vehicles and prepared and transferred under Protocol 3. Finally, the minnows were released under Protocol 5.

Protocols

2) *Handling Protocol for bagging minnows in the field*
The protocol is as follows:

1. Isolated pools will be seined and any minnows captured are placed into a five gallon bucket that is filled with water from the isolated pools.
2. Minnows are then placed in 2.5 gallon bags either through pouring the contents of the bucket into the bag, or by capturing the minnows with small Delta mesh (1/16") nets and placing them in bags with river water.
3. NaCl (18.9 grams/gallon) and stress coat (.26 ml/L) will be put in the plastic bags.
4. The plastic bags with minnows are placed into a cooler.
5. The water in the bags is measured every in 10 minutes.
6. The bags are transported to the vehicles and prepared for transportation for their release at the end of rescuing isolated pools, or earlier if temperatures during monitoring require this action sooner to reduce temperature changes that may be harmful to silvery minnows.

2) *Handling Protocol for distribution truck.*
Handling and transportation of Rio Grande silvery minnow after reaching the distribution truck will follow the proposed protocol set forth by Dr. Gary Carmichael formerly of the Service's Mora National Fish Hatchery. The protocol is as follows:

3. Temperature (determined with thermometers) should be about 5^{o}F lower in the hauling truck than in the river.
4. Drivers must be informed of and follow a specific route.
5. Hauling water will contain 0.5 percent NaCl (18.9 grams/gallon) and 0.26ml/L stress coat (1 ml/gallon).
6. Oxygen levels will be >6.0 mg/L as determined with an oxygen meter.
7. Nets must be functional. Aeration equipment must be in place and must be used. A fish holding container will be at least 5 gallons in size and fish densities will not exceed 10 grams of fish per liter of water. Small Delta mesh (1/16") nets will be present to transfer the fish from one container to another, although it is preferred to have water to water transfer. Oxygenation/aeration equipment will be in place and working.
8. Prior to loading and after the fish are concentrated, they should be quickly placed in the transport tank. When using nets to place fish in the transfer buckets, nets should not be overloaded or the fish on the bottom could be crushed. Using a "wet transfer" with buckets or other containers which contain water is preferable. When emptying the nets and buckets, care will be taken to avoid adding algae and mud to the transport tank. Before loading, dissolved oxygen levels should be at saturation.
9. Immediately after loading, all equipment on the transport vehicle should be re-checked and then the vehicle should depart. Oxygen concentrations and temperatures should be monitored at a minimum of every 30 minutes.
10. During unloading, water will be tempered, and thermometers should be used to match

water temperatures. Hauling water temperature should be equal to receiving water temperature.

11. Dead specimens will be preserved and given to the University of New Mexico or disposed of properly.

3) ***Hauling Protocol when transporting silvery minnows in bags.***

This protocol is modified and similar to that of Protocol 2 for the distribution truck. In some instances, it may be more feasible to transport silvery minnows in aerated plastic bags rather than a distribution truck. This determination will be made by the designated crew leader with concurrence from the Coordinator.

The Protocol is as follows:

1. Only plastic bags designed for fish transport will be used.
2. Plastic bags will contain no less than half their capacity in water.
3. Ice chests of sufficient size to hold 1 to 3 bags will be used to protect bags from ambient conditions.
4. Temperature (determined with thermometers) should be about 5^{o}C lower in the bags than in the river.
5. Water in the bags will contain approximately 0.5 percent salt (18.9 grams/gallon) and 0.26ml/L stress coat (1 ml/gallon). This will be measured by scales and graduated cylinders.
6. Oxygen levels will be >6.0 mg/L as determined with an oxygen meter.
7. Fish densities should not exceed 10 grams of fish per liter of water.
8. Small Delta mesh (1/16") nets will be present to transfer the fish from one container to another. Using a "wet transfer" with buckets to bags containing water is preferable.
9. When emptying the nets and buckets, care will be taken to avoid adding algae and mud to the transport bag.
10. Dead silvery minnow specimens will be preserved and provided to the University of New Mexico or disposed of properly.

4) ***Transporting of silvery minnows in the field and distribution to flowing water.***

This will occur when it is feasible to distribute fish to flowing water near a dry reach. This method will be used when the crew leader and the Coordinator determine that transporting fish to distribution trucks will cause undue stress to the silvery minnows. This will reduce silvery minnow mortality in some cases. The protocol is as follows:

11. Each ATV and/or amphibious craft (ARGO) will be outfitted with an ice chest with a water capacity of greater than 10 gallons.
12. Temperature (determined with thermometers) should be equal or lower in the ice chests than in the river.
13. Water in the ice chest will contain approximately 0.5 percent salt (18.9 grams/gallon) and 0.26ml/L stress coat (1 ml/gallon). This will be measured by scales and graduated cylinders.

14. Fresh water will be added to the ice chest every 15 minutes if available. If water is not available, then existing water will be agitated within the ice chest using a bucket. This will ensure some level of dissolved oxygen within the ice chest during transport.
15. Fish densities should not exceed 10 grams of fish per liter of water. When estimated densities exceed this concentration, fish should be transported to the distribution truck, then placed in plastic bags at the truck, or released into flowing portions of the river.
16. Small Delta mesh (1/16") nets will be present to transfer the fish from one container to another. Using a "wet transfer" with buckets to ice chest containing water is preferable.
17. When emptying the nets and buckets, care will be taken to avoid adding algae and mud to the ice chest.
18. Before fish are released into flowing river, temperatures should be equal to or within 1^{o} C of receiving water.

5) General Distribution and Release

The following protocol will be used for distribution and release of silvery minnows. This will insure that the silvery minnows are not subjected to any undue stress during transport and release.

1. Drivers must be informed of and follow a specific route.
2. Immediately after loading, all equipment on the transport vehicle should be re-checked and then the vehicle should depart. Oxygen concentrations and temperatures should be monitored at a minimum of every 30 minutes.
3. During unloading, a tempering water pump should be present and functional, and thermometers should be used to match water temperatures. Hauling water should be equal to receiving water. Bags should be placed in the receiving waters until temperatures within the bags are equal to or within 1^{o} C of receiving water.

RESULTS

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 National Wildlife Refuge (BDA) and between US 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 ("acts of nature"), bringing the total up to approximately 90 river miles salvaged.

The first silvery minnow salvage occurred within BDA on June 13, 2003. Silvery minnow salvage occurred throughout the remainder of the irrigation season with the last silvery minnow salvage occurring on BDA on October 3, 2003. 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 approximate number of river miles (APRMs) salvaged varied based on the magnitude of drying events, ambient conditions, and in some cases the river bed composition (e.g. sands, silts,etc.) or condition. Salvage crews noted that the river receded slower following high flow events from the Rio Puerco. After flow events from the Rio Puerco there appeared to be a higher amount of fine clays in the river bed, which may have lessened the permeability of the river channel, lowering the loss of water to the shallow water table and causing the river to dry slower. The opposite was noted after high flow events that contained little or no little flow from the Rio Puerco. After these events, the river bed appeared to be composed mostly of sands and river drying was quicker.

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 only 3 to 8 individuals to effectively salvage that section of river. Cooperating agencies were contacted to assist in salvage based on the need and expertise of the individuals from the cooperating agency. Assisting agencies include NM Interstate Stream Commission, SWCA Environmental Consultants, Bureau of Reclamation, and Army Corps of Engineers, see Appendix 1.

From the beginning of June 2003 through mid-October 2003, the Service salvaged 713 silvery minnows from the Isleta and San Acacia Reaches combined. Generally, the largest number of silvery minnows collected were during the first drying event in each section. The overall number of silvery minnows collected during drying events declined after July of 2003.

Age structure of the silvery minnows identified was 57 percent adult and 43 percent young-of-year (YOY). However, it is likely that more YOY silvery minnows were moved during salvage events throughout June and early July. Due to the difficulties in accurately identifying small silvery minnows this time of year, all YOY fish collected were salvaged. 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 1,006 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^3. The estimated average volume of each pool was 58.9 m^3.

The overall condition of silvery minnows at time of release was good. We noted that some fish showed outward signs of stress such as loss of equilibrium, flaring of gills, hemorrhages, external parasites, and erratic swimming. We could not always determine what caused the silvery minnows to be stressed at time of release, but it was also noted that some silvery minnows were already stressed at the time of collection from isolated pools. Therefore, it is likely that the few fish showing signs of stress at the time of release may have already been affected by river intermittency at the time of collection from isolated pools. In general, most silvery minnows were outwardly healthy and active at time of release.

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.

DISCUSSION

Silvery minnows and their congeners have been handled and transported for at least 10 years (Platania and Altenbach 1998). Reproductively active silvery minnows were collected from the Rio Grande as early as 1993 to document their reproductive behavior and egg type (Platania and Altenbach 1998). Platania and Altenbach (1998) also collected numerous other species of cyprinids from the Pecos river to determine their reproductive biology. During this study fish were inoculated with hormones to induce spawning, which proved successful. Since that time the same methods have been used and improved to increase the success of spawning silvery minnows in captivity (C. Altenbach, City of Albuquerque, personal communication 2002).

Since 1996, silvery minnows have been salvaged during drying events and transported to flowing water in an attempt to minimize mortality. Significant steps have been made within the last 7 years to improve the survivability of salvaged silvery minnows, during collection, transport, and release (Smith and Munoz 2002). Starting in 1998, the Service developed and has followed specific protocols for handling and transporting silvery minnows during river intermittency and other salvage operations (J. Smith, Service, personal communication 2002). Since that time, many improvements through trial and error have been made in transportation of silvery minnows and the different protocols are followed given certain circumstances (Smith and Mu_oz 2002).

Survivability of silvery minnows after handling has been documented since 2000. In 2000, two

sampling events occurred during the spring to collect adult silvery minnows for captive spawning. During these two events the Service, in conjunction with the City of Albuquerque, collected approximately 198 adult silvery minnows during low flows near San Marcial. Due to unavoidable circumstances collections were made in the mid-morning during the first collection event (J. Smith, Service, personal communication 2000). It was determined that the salvage should proceed due to timing constraints by both the Service and City. Collections were made regrettably, when ambient conditions were around 30 degrees Celsius and water temperatures ranging from 16 to 20 degrees Celsius (J. Smith, Service, personal communication 2000). Even under these harsh collecting conditions, we experienced no initial mortality. With time, only about 5 percent of salvaged minnows perished, and that mortality was likely an artifact of the induced spawning (C. Atenbach, City of Albuquerque, personal communication 2000).

Although some success has been made in the transport of fish to propagation facilities, other attempts have had lower than desired outcomes. In June of 2001, the Service attempted to salvage YOY silvery minnows. During this attempt, approximately 5,000 YOY were captured near San Marcial and transported to the NMFRO propagation facility. Handling protocol was strictly followed during this salvage attempt; however, these fish experienced high mortality levels (J. Brooks, Service, *in litt.* 2001). Although no firm evidence for the cause of the high mortality rate was determined, it was speculated that collection conditions caused the fish to become overly stressed. Young fish are not as resistant to stress as adults, so more care should be taken when transporting these fish from the wild. It is likely that the mortality can be decreased when moving YOY by using oxygenated plastic bags rather than a large distribution truck, which was used during the event in 2001.

In Summary, in 2003 the silvery minnow salvage crew salvaged 713 silvery minnow during 54 salvage events over 90.22 river miles. Most of these silvery minnow were translocated to the Angostura Reach of the Rio Grande. Handling and transport protocols that have been refined over the past few years of silvery minnnow salvage have resulted in improved survivability of silvery minnow during transport. There is no data on whether or not salvaged silvery minnows survive after being translocated. However, Colleen Caldwell, at New Mexico State University, began a silvery minnow physiology study in 2003 to examine various factors that cause stress to silvery minnow, how long it takes for recovery from stress, and what are the survival rates after conditions causing stress have occurred. This study will be continued in 2004 and results will be used to continue to improve our salvage and translocation program.

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Appendix 1

Agencies and Individuals Assisting in Silvery Minnow Salvage 2003

Interstate Stream Commission
Greg Pargas

SWCA
Mike Balestrieri
John Kienhemier

Bureau of Reclamation
Lester Brennan
Mike Hatch
Tamara Massong
Robert Padilla
Mickey Porter

Army Corps of Engineers
Janet Brocklehurst
Mark Horner
Danielle Pekastine

New Mexico Game and Fish
Rick Castell
Bill Cole
Marty Frentzel
Mike Guston
Amber Hobbes
Chad James
Robert Livingston
Don Paramillo
Dave Propst
Norman Sanchez
Ray Sanchez
Billy Sands
Luke Shelby
Eloy Trujillo
Victor Trujillo
Rick Winslow

U.S. Fish and Wildlife Service
Janelle Allman
Keith Basham
Stephanie Coleman
Carrie Chalcraft
Leslie Cryan
Steve Davenport
Gina DelloRusso
Weston Furr
Dan Garcia
Eric Kraft
Lisa Kerbol
Melissa Kreutzian
Luke Montoya
Anna Maria Muñoz
Emily Myer
Chris Neery
Joy Nicholopoulos
Jason Remshardt
Sara Rinkovich
Aimee Roberson
Vanessa Sanchez
Zachary Simpson
Jude Smith
Paula Stubbs
Leanna Torres
Elyse Tryon
Hilary Watts
Evan (Bosque Del Apache)
Liter (Bosque Del Apache- volunteer)

Middle Rio Grande Conservancy District
David Gensler