

**AUGMENTATION OF THE
SAN JUAN RIVER RAZORBACK
SUCKER POPULATION: 2007**

Interim Progress Report
(Final Report)

Submitted By:

Dale W. Ryden
Fish Biologist

22 May 2008

U. S. Fish and Wildlife Service
Colorado River Fishery Project
764 Horizon Drive, Building B
Grand Junction, Colorado 81506

EXECUTIVE SUMMARY

- 54,472 razorback sucker stocked into the San Juan River from 1994-2007
 - 41,629 (76.4%) of these stocked in the last two years (2006 and 2007)

- 22,836 razorback sucker were stocked into the San Juan River in 2007
 - Second consecutive year that the target stocking number for razorback sucker (n = 11,400 fish) was met or exceeded
 - By far the most razorback sucker ever stocked in a single year
 - However, most (about 13,800; ~60.6%) of the stocked fish did not meet the target stocking size of ≥ 300 mm TL
 - About 9,000 fish (~39.4%) were ≥ 300 mm TL
 - 16,647 razorback sucker harvested from the NAPI grow-out ponds and stocked in 2007
 - Fish came from all nine of the grow-out ponds
 - Ponds were first passively harvested using fyke nets, then drained and emptied of all remaining fish
 - 2,818 (16.9%) of these fish were ≥ 300 mm TL (i.e., the target stocking size)
 - 13,829 (83.1%) of these fish were < 300 mm TL
 - 6,189 razorback sucker from other sources were stocked in 2007
 - Dexter NFH&TC stocked 1,343 razorback sucker
 - 1,060 stocked on 18 April 2007 (mean TL = 389 mm; range = 264-573 mm TL)
 - 283 stocked on 28 June 2007 (mean TL = 462 mm; range = 405-548 mm TL)
 - Uvalde NFH stocked 4,846 razorback sucker
 - All stocked on 13 November 2007 (mean TL = 300 mm; no range of lengths was specified)

- Future of the NAPI grow-out ponds
 - The 6-Pack ponds will no longer be used to rear razorback sucker
 - East Avocet, West Avocet, and Hidden Pond
 - Will be stocked annually with a single year-class of 200+ mm TL fish from Dexter NFH&TC
 - Each fall all fish will be harvested, PIT-tagged, and stocked
 - Ponds will be drained and left to dry over the winter

TABLE OF CONTENTS

EXECUTIVE SUMMARY	i
TABLE OF CONTENTS.....	ii
LIST OF TABLES.....	ii
INTRODUCTION.....	1
Relationship To The Recovery Program	2
Objectives.....	3
METHODS	3
RESULTS	4
DISCUSSION	6
ACKNOWLEDGEMENTS.....	8
LITERATURE CITED	9
APPENDIX A (Information on razorback sucker stocked from 1994-2007)	12

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1 Razorback sucker stocked into the San Juan River in 2007.....	5
A-1 Year by year summary of razorback stocked into the San Juan River, 1994-2007	13

INTRODUCTION

Razorback sucker (*Xyrauchen texanus*), is one of three San Juan River native fish species (the Colorado pikeminnow, *Ptychocheilus lucius*, and the roundtail chub, *Gila robusta* being the other two) that have become greatly reduced in numbers and range since the mid 1900's (Bestgen 1990, Minckley 1973). Physical alterations of riverine habitats, water impoundment in the form of Navajo Reservoir and Lake Powell and their associated effects on flow and thermal regimes, introduction of non-native fish species, and contaminants have probably all contributed to the decline of these native species (Platania 1990, Brooks et al. 1993, Ryden and Pfeifer 1994a). Extremely small numbers of wild razorback sucker and the long-term lack of recruitment led to this species being listed as endangered under the Endangered Species Act on 22 November 1991 (U.S. Fish and Wildlife Service {USFWS} 1991). The razorback sucker is also currently protected by state laws in Arizona (AZ), California (CA), Colorado (CO), Nevada (NV), New Mexico (NM), Utah (UT), and by the Navajo Nation.

One of the two goals of the San Juan River Recovery Implementation Program (SJRIP) is to protect and recover endangered fishes in the San Juan River Basin with the ultimate goal of establishing self-sustaining populations of razorback sucker and Colorado pikeminnow (SJRIP 1995). Due to the paucity of historic and recent collections of this species, including the failure to collect any wild razorback sucker during three years (1991-1993) of intensive studies on all life stages of the San Juan River fish community (Buntjer et al. 1993, 1994, Lashmett 1993, 1994, Ryden and Pfeifer 1993, 1994b, Gido and Propst 1994) the SJRIP's Biology Committee (BC) initiated an experimental stocking program for razorback sucker in the San Juan River (Ryden and Pfeifer 1994a). Experimental stocking was implemented to provide needed insight about recovery potential and habitat suitability for the razorback sucker in the San Juan River between Farmington, NM and Lake Powell, UT (i.e., the area designated as Critical Habitat for razorback sucker; Maddux et al. 1993, USFWS 1994).

Between March 1994 and October 1996, 942 razorback sucker were stocked into the San Juan River at four stocking sites (RM 158.6, 136.6, 117.5, and 79.6). Data gathered on these fish identified habitat types being used year-round by razorback sucker in the San Juan River, and provided information on movements, survival, and growth rates. Based on the successes of the experimental stocking study, a full-scale augmentation effort for razorback sucker in the San Juan River was initiated by the SJRIP.

In 1997 a ***Five-Year Augmentation Plan For Razorback Sucker In The San Juan River*** was completed (Ryden 1997). The 1997 razorback sucker augmentation plan identified a target population of 15,900 razorback sucker in the San Juan River between Hogback Diversion (RM 158.6) and Lake Powell (RM 0.0). In order to meet this target population, it was estimated that 73,482 razorback sucker would have to be stocked between 1997 and 2001. To this end, stocking of razorback sucker began in September 1997. Between September 1997 and

November 2001, a total of 5,890 razorback sucker were stocked into the San Juan River, with all stockings taking place at RM 158.6. This represented a 92.0% shortfall (n = of 67,592 fish) compared to the target stocking numbers specified in the 1997 augmentation plan.

Despite this shortfall, numerous encouraging observations were made among the relatively few fish that were stocked. To begin with, despite the low numbers of fish stocked, razorback sucker were recaptured during every spring and fall fish community monitoring trip from 1997-2001 (Ryden 2001). Second, aggregations of spawning adults were collected in spring 1997, 1999, and 2001 at RM 100.2 just downstream of Aneth, UT (Ryden 2001, 2003a). And third, larval razorback sucker have been collected every year from 1998-2007 (Brandenburg 2000, Brandenburg et al. 2005, Brandenburg and Farrington 2007, M. Farrington pers. comm.).

Based on these observations, the SJRIP-BC extended the augmentation effort for razorback sucker. *An Augmentation Plan For Razorback Sucker In The San Juan River: An addendum to the five-year augmentation plan for razorback sucker in the San Juan River* was completed in February 2003 (Ryden 2003b). This addendum outlines an additional eight-year augmentation period for razorback sucker. This eight-year augmentation period was scheduled to begin in 2004 and continue through 2011.

However, because of several mitigating circumstances (detailed in Ryden 2005), the timeline for beginning this eight-year augmentation effort has been pushed back, probably until 2009. Therefore, the razorback sucker stocking and augmentation efforts that occurred from 2002-2007 were considered to be interim efforts, separate from the two distinct razorback sucker augmentation efforts. This report provides an overview of the 2007 razorback sucker augmentation efforts.

Relationship To The Recovery Program

In the absence of a wild population, the main reason for augmentation was to restore razorback sucker to appropriate historic habitat, with the eventual goal of recovering this species in the San Juan River (Ryden 1997, SJRIP-BC 1995). While augmentation increases population numbers, it also provides individuals for research purposes, adds genetic diversity to the existing gene pool, and provides a riverine refugia population that will, hopefully, remain stable until further research can identify factors limiting successful recruitment of this species in the San Juan River. The San Juan River Long Range Plan (SJRIP-BC 1995) identified the need to assess the feasibility of, and then implement the augmentation of razorback sucker. The revised augmentation plan (Ryden 2003b) provides the necessary guidance for those efforts as well as directly fulfilling objective 5.3.8.2 of the Long Range Plan. The Long Range Plan is undergoing revision. However, the need to artificially augment the San Juan River's razorback sucker population is specified in tasks 1.1.1, 1.1.3, 1.1.4, 3.1.3, 4.1.1, and 4.1.2 of the draft dated October 30, 2006 (SJRIP-BC 2006).

The objectives of this workplan for Fiscal Year 2007 (FY-2007) were as follows:

Objectives:

- 1) Obtain, rear, harvest, and stock razorback sucker in order to fulfill the tasks and objectives outlined in the current version of the razorback sucker augmentation plan addendum (*Ryden 2003b final*)
- 2) Monitor stocked razorback sucker in the wild for various parameters, including:
 - a) Spawning season habitat use and movement patterns
 - b) Survival and growth rates
 - c) Determine whether hatchery-reared razorback sucker will recruit into the adult population and successfully spawn in the wild
- 3) Remove nonnative fish species which prey upon and compete with native fish species in the San Juan River.

In February 2007, the SJRIP-BC mandated a switch in rearing strategies at the grow-out ponds (i.e., after the FY-2007 workplan had already been approved). Due to this decision, the workload associated with the grow-out ponds increased markedly. This necessitated the elimination of the riverine monitoring of stocked fish (i.e., Objectives 2 and 3 above) in order to accomplish the harvest, draining, and salvage efforts at all nine grow-out ponds. Therefore, this report only includes information on the numbers, dates, and locations of razorback sucker that were stocked in 2007.

METHODS

In 2007, all nine of the NAPI grow-out ponds were passively harvested for a minimum of two weeks each, with some being passively harvested up to four weeks. Passive harvest of grow-out ponds was done using fyke nets (6-8 nets per pond). Fyke nets were set from a 14-foot aluminum jon boat and allowed to fish overnight. In the morning, nets were run and all fish collected were placed in live wells. Razorback sucker were measured (TL to the nearest mm), implanted with a 134 kHz PIT tag, and placed in oxygenated holding tanks for transport to the San Juan River. After passive harvest efforts were completed, ponds were drained using either industrial pumps or, in the case of Hidden Pond and West Avocet Pond, using the gravity drain structures located in the pond bottoms. Any remaining razorback sucker collected during the draining process were actively salvaged (using dip nets and seines) and placed in oxygenated holding tanks for transport to the San Juan River. Due to high stress levels observed among actively-salvaged fish, these fish were not PIT-tagged prior to being stocked in order to reduce further handling stress. All razorback sucker collected from the NAPI grow-out ponds in 2007 were stocked at RM 158.6, just downstream of the Hogback irrigation diversion structure.

The 6-Pack ponds were not stocked in 2007. However, these ponds still contained several different year-classes of razorback sucker from prior years' stockings. Since the new strategy for the razorback sucker augmentation program will use just a single year-class of fish each year (whether pond-reared or hatchery-reared), all fish collected from the 6-Pack ponds were removed and stocked in the river, regardless of their size or age. The 6-Pack ponds were then drained completely (via pumping) and left to dry. The decision made by the SJRIP-BC in February 2007 was that these ponds would no longer be used for rearing razorback sucker for the foreseeable future.

By contrast, The two Avocet ponds and Hidden pond contained just a single year-class of fish in 2007. On 7 November 2006, East and West Avocet ponds had been stocked with razorback sucker (3,500 per pond) from Dexter National Fish Hatchery and Technology Center (NFH&TC). Hidden Pond was stocked with razorback sucker ($n = 3,467$) from Dexter NFH&TC on 9 May 2007. These fish were all 2006 year-class razorback sucker. These fish represented the first shipments of 200+ mm TL fish from Dexter NFH&TC to the NAPI grow-out ponds. It was anticipated that the return from these stockings of 200+ mm TL fish would be 2,000 fish per pond at the time of harvest (a 57.3% return rate), for a total of 6,000 fish from these three ponds. Passive harvest, draining, and salvage of these three ponds in 2007 followed the previously-detailed procedures. After draining, these three ponds were left to dry over the winter. The plan is for these three ponds to be refilled with water in spring 2008 and to be stocked with 2007 year-class razorback sucker from Dexter NFH&TC, which will then be harvested, PIT-tagged and stocked into the San Juan River in fall 2008.

RESULTS

A total of 16,647 razorback sucker were harvested or salvaged from all nine NAPI grow-out ponds in 2007 (Table 1). Of those, 10,710 (64.3%) were PIT-tagged prior to being stocked (Table 1). Razorback sucker from the 6-Pack ponds (i.e., those representing multiple year-classes of fish) accounted for 14,661 (88.1%) of the fish stocked from the NAPI ponds in 2007. Size-class distribution of the 14,661 razorback sucker stocked from the 6-Pack ponds was as follows: 3,943 (26.9%) from 101-200 mm TL; 8,342 (56.9%) from 201-300 mm TL; 2,126 (14.5%) from 301-400 mm TL; 249 (1.7%) from 401-500 mm TL; and, 1 (0.01%) that was 501+ mm TL. Of the 8,342 fish from 201-300 mm TL (i.e., larger sub-adults), there were 5,161 (35.2%) from 201-250 mm TL; 1,686 (11.5%) from 251-275 mm TL; and 1,495 (10.2%) from 276-300 mm TL.

By contrast, razorback sucker from East and West Avocet ponds and Hidden Pond (i.e., those fish stocked into the ponds at 200+ mm TL and representing a single year-class) accounted for just 1,986 (11.9%) of the fish that were stocked from the NAPI ponds in 2007 (Table 1).

Table 1. Razorback sucker stocked into the San Juan River in 2007.

Source	Number Stocked	Mean Total Length (in mm)	Range Of Total Lengths (in mm)	Year-Classes Stocked
6-Pack Pond # 1	3,358 (1,321 without PIT tags)	228	118-373	2002, 2004-2005
6-Pack Pond # 2	2,478 (911 without PIT tags)	246	124-470	2002, 2004-2005
6-Pack Pond # 3	4,139 (1,056 without PIT tags)	220	122-448	2003-2005
6-Pack Pond # 4	2,510 (716 without PIT tags)	287	152-490	2003-2005
6-Pack Pond # 5	1,903 (1,563 without PIT tags)	206	110-414	2002, 2004-2005
6-Pack Pond # 6	273 (83 without PIT tags)	377	232-510	2002, 2004-2005
Hidden Pond	1,531 (256 without PIT tags)	270	195-386	2006
East Avocet Pond	180 (17 without PIT tags)	324	206-419	2006
West Avocet Pond	275 (14 without PIT tags)	301	198-425	2006
Dexter NFH&TC	1,343	404	264-573	2003 and 2006
Uvalde NFH	4,846	300	Not Specified	2006

The overall return rate on the 200+ mm TL fish stocked into East and West Avocet ponds and Hidden Pond was 1,986 fish (a 19.0% return rate). However, the return rate for 200+ mm TL fish stocked in fall 2006 was much lower for East Avocet Pond (n = 180 fish; 5.1% of the 3,500 fish stocked) and West Avocet Pond (n = 275 fish; 7.9% of the 3,500 fish stocked) than it was for Hidden Pond (n = 1,531 fish; 44.2% of the 3,467 fish stocked) which was stocked in spring 2007 (Table 1).

Size-class distribution of the 455 razorback sucker stocked from the East and West Avocet ponds (stocked in fall 2006) was as follows: 3 (0.7%) from 101-200 mm TL; 230 (50.5%) from 201-300 mm TL; 214 (47.0%) from 301-400 mm TL; and, 8 (1.8%) that were 401+ mm TL. Of the 230 fish from 201-300 mm TL (i.e., larger sub-adults), there were 104 (22.9%) from 201-250 mm TL; 76 (16.7%) from 251-275 mm TL; and 50 (10.9%) from 276-300 mm TL.

By comparison, size-class distribution of the 1,531 razorback sucker stocked from Hidden Pond (stocked in spring 2007) was as follows: 2 (0.1%) from 101-200 mm TL; 1,309 (85.5%) from 201-300 mm TL; and, 220 (14.4%) that were 301+ mm TL. Of the 1,309 fish from 201-300 mm TL (i.e., larger sub-adults), there were 393 (25.7%) from 201-250 mm TL; 617 (40.3%) from 251-275 mm TL; and 299 (19.5%) from 276-300 mm TL.

In addition to the razorback sucker stocked from the nine grow-out ponds, a total of 6,189 razorback sucker from other sources were stocked into the San Juan River in 2007. These fish came from two different hatcheries -- 1,343 from Dexter NFH&TC and 4,846 from Uvalde NFH (Table 1).

Razorback sucker from Dexter NFH&TC were stocked on two separate dates in 2007. The first stocking on 18 April consisted of 2006 year-class fish ($n = 1,060$). The second stocking on 28 June consisted of 2003 year-class fish ($n = 283$). All razorback sucker stocked by Dexter NFH&TC were PIT-tagged prior to their being stocked at RM 158.6. Exact size-class distributions for fish stocked by Dexter NFH&TC were not specified in the data files I received, but for the 2006 year-class razorback sucker stocked on 18 April the mean TL was 389 mm (range = 264-573 mm TL), while for the 2003 year-class razorback sucker stocked on 28 June the mean TL was 462 mm (range = 405-548 mm TL).

The 4,846 razorback sucker from Uvalde NFH were all stocked on 13 November 2007 at RM 147.9. These fish were all PIT-tagged prior to their being stocked. Neither the exact size-class distributions nor the range of TL's for fish stocked by Uvalde NFH were specified in the data files I received. However, the mean TL of this lot of fish was stated as being 300 mm.

The addition of the razorback sucker stocked by Dexter NFH&TC and Uvalde NFH brought the total number of razorback sucker stocked in 2007 to 22,836 fish. This was by far the largest number of razorback sucker stocked in any single year since augmentation began in 1994 (Appendix A). While the exact number of fish that met the target stocking size of ≥ 300 mm TL is unknown, my best estimate is that about 9,000 (39.4%) of the 22,836 razorback sucker stocked in 2007 met this criterion. That means that about 13,800 (60.6%) of the 22,836 razorback sucker stocked in 2007 were < 300 mm TL.

In total, between 1994 and 2007, 54,472 razorback sucker have been stocked into the San Juan River. Of this total, 41,629 (76.4%) were stocked in the last two years (Appendix A).

DISCUSSION

The 22,836 razorback sucker stocked into the San Juan River in 2007 were by far the largest group of razorback sucker to be stocked since augmentation efforts for this species began in 1994. For the second consecutive year, the target stocking number of 11,400 fish called for in the 2003 augmentation plan addendum (Ryden 2003b) was exceeded. However, approximately 80.5% of all razorback sucker stocked in 2006 (~14,200 fish) and approximately 60.6% of all razorback sucker stocked in 2007 (~13,800 fish) were smaller than the target stocking size of ≥ 300 mm TL.

It is not anticipated that stocking large numbers of undersized razorback sucker in 2006 and 2007 will necessarily lead to large increases in catch rates during future fish community monitoring efforts. It has been documented that razorback sucker stocked at < 300 mm TL tend to not be collected in large percentages, when compared to the numbers stocked. For example, between 1994 and 2000 razorback sucker stocked at < 300 mm TL consistently accounted for < 20% (and sometimes as low as 8%) of all recaptures during spring and fall fish community monitoring efforts, while composing from 70-90% of all fish being stocked in any given year (Ryden 2000a, 2000b, 2001; SRIP database). In addition, smaller razorback sucker (\leq 300 mm TL) collected during nonnative fish removal efforts were not being recaptured for as long post-stocking (mean = 47 days; range = 4-345 days post-stocking) as were razorback sucker that were > 500 mm TL (mean = 589 days post-stocking; Davis and Furr 2008). The fate of these smaller stocked razorback sucker is unknown, but it is thought that predation by nonnative channel catfish (e.g. pers. obs., Jackson 2006, Davis and Furr 2007) as well as movement downstream into Lake Powell are likely factors in the low return rates observed among razorback sucker stocked at < 300 mm TL.

The number of fish being stocked in 2008 from the SJRIP's NAPI grow-out ponds will drop markedly from the totals seen in 2006 and 2007. The biggest reason for this will be the elimination of the 6-Pack ponds from the razorback sucker augmentation program. East and West Avocet ponds as well as Hidden Pond are all scheduled to be restocked with around 3,500 razorback sucker (200+ mm TL fish from Dexter NFH&TC) in spring 2008 and it is anticipated that these three ponds will yield a return of around 6,000 fish in fall 2008. However, given the relatively low observed return rates for 200+ mm TL razorback sucker stocked into these ponds in fall 2006 and spring 2007, there is a strong possibility that the new target number of 6,000 fish from these three ponds may not be met.

The fairly sizeable differences in return rates among these three ponds observed in 2007 may be a factor of the time of the year during which they were stocked. Both East and West Avocet ponds were stocked in fall 2006 and the fish stocked into those ponds had to deal with at least two potential adverse events that fish stocked into Hidden Pond in spring 2007 did not. The first potential adverse event is the 2006-2007 overwinter period and associated low temperatures. Cold winter temperatures have the potential to be a strong selective factor, especially when fish are stocked late in the year, as were those that were stocked into East and West Avocet ponds in November 2006. The second potential adverse event would be the annual bird migrations that occur in the spring and fall of each year. Large numbers of mergansers and other piscivorous birds are known to frequent the NAPI grow-out ponds to rest and feed during these events. The fact that fish stocked in fall 2006 had to survive through two such migration periods versus those being stocked in May 2007, which were likely stocked near or after the end of the spring 2007 bird migration, may have accounted for at least some of the differences in return rates observed among stocked fish in these three ponds.

The recent documentation of largemouth bass virus at Uvalde NFH has caused a hold to be put on the stocking of razorback sucker being reared there for the SJRIP until at least 2009. The earliest that those fish are now likely to be stocked is in 2009. This event combined with the lower numbers of razorback sucker that will be produced at the NAPI ponds in 2008 makes the possibility of reaching the stocking goal of 11,400 razorback sucker that are ≥ 300 mm TL in 2008 unlikely.

ACKNOWLEDGEMENTS

Written comments on an earlier draft of this report were provided by Dr. Paul Holden and Dr. Stephen Ross. The author wishes to thank these individuals for their time and efforts in helping to improve this document

LITERATURE CITED

- Bestgen, K. R. 1990. Status review of the razorback sucker, Xyrauchen texanus. Contribution No. 44, Colorado State University Larval Fish Laboratory, Fort Collins. Submitted to the Bureau of Reclamation, Salt Lake City, UT. 92 pp.
- Brandenburg, W. H. 2000. Razorback sucker larval fish survey: San Juan River 1998 and 1999. Division of Fishes, Museum of Southwestern Biology, University of New Mexico, Albuquerque. 46 pp.
- Brandenburg, W. H., M. A. Farrington, and S. J. Gottlieb. 2005. Colorado pikeminnow and razorback sucker larval fish survey in the San Juan River during 2004. Division of Fishes, Museum of Southwestern Biology, University of New Mexico, Albuquerque. 92 pp.
- Brandenburg, W. H., and M. A. Farrington. 2007. Colorado pikeminnow and razorback sucker larval fish survey in the San Juan River during 2006. Division of Fishes, Museum of Southwestern Biology, University of New Mexico, Albuquerque. 86 pp.
- Brooks, J. E., L. Crist, L. A. Ahlm, R. Bliesner, M. J. Buntjer, W. P. Goettlicher, K. Lashmett, W. J. Miller, D. L. Propst, and D. W. Ryden. 1993. San Juan River Seven Year Research Program: Summary Report 1992. San Juan River Recovery Implementation Program, Dexter, NM. 20 pp.
- Buntjer, M. J., T. Chart, and L. Lentsch. 1993. Early life history investigations. Utah Division of Wildlife Resources, Salt Lake City, UT. 35 pp.
- Buntjer, M. J., T. Chart, and L. Lentsch. 1994. Early life history fishery survey of the San Juan River, New Mexico and Utah. Utah Division of Wildlife Resources, Salt Lake City, UT. 48 pp.
- Davis, J. E., and D. W. Furr. 2007. Non-native species monitoring and control in the upper San Juan River, New Mexico: 2006. U.S. Fish and Wildlife Service, Albuquerque, NM. 44 pp.
- Davis, J. E., and D. W. Furr. 2008. Non-native species monitoring and control in the upper San Juan River, New Mexico: 2007. U.S. Fish and Wildlife Service, Albuquerque, NM. 38 pp.
- Gido, K. B., and D. L. Propst. 1994. San Juan River secondary channel community studies permanent study sites: 1993 Annual Report (Final). New Mexico Department of Game and Fish, Santa Fe, NM. 42 pp.
- Jackson, J. A. 2006. Nonnative control in the lower San Juan River: 2005. Interim Progress Report (Final). Utah Division of Wildlife Resources, Moab. 32 pp.
- Lashmett, K. 1993. Fishery survey of the lower San Juan River and the upper Arm of Lake Powell (RM 4.0-[-]11.0) 1991/92 - Annual Report. Bureau of Reclamation, Durango, CO. 29 pp.
- Lashmett, K. 1994. Fishery survey of the lower San Juan River and the upper Arm of Lake Powell (RM 4.0-[-]0.8) 1993 - Annual Report. Bureau of Reclamation, Durango, CO. 11 pp. + Appendix.

- Maddux, R. H., L. A. Fitzpatrick, and W. A. Noonan. 1993. Colorado River endangered fishes Critical Habitat: Draft Biological Support Document and appendices. U.S. Fish and Wildlife Service, Salt Lake City, UT. 222 pp. + appendices.
- Minckley, W. L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix, AZ.
- Platania, S. P. 1990. Biological summary of the 1987-1989 New Mexico-Utah ichthyofaunal study of the San Juan River. Report to the New Mexico Dept. of Game and Fish, Santa Fe, NM, and the U.S. Bureau of Reclamation, Salt Lake City, UT. 143 pp.
- Ryden, D. W. 1997. Five-year augmentation plan for razorback sucker in the San Juan River. U.S. Fish and Wildlife Service, Grand Junction, CO. 27 pp.
- Ryden, D. W. 2000a. Monitoring of experimentally-stocked razorback sucker in the San Juan River: March 1994 through October 1997. U.S. Fish and Wildlife Service, Grand Junction, CO. 132 pp.
- Ryden, D. W. 2000b. Monitoring of razorback sucker stocked into the San Juan River as part of a five-year augmentation effort: 1997-1999 Interim Progress Report (Final). U.S. Fish and Wildlife Service, Grand Junction, CO. 49 pp.
- Ryden, D. W. 2001. Monitoring of razorback sucker stocked into the San Juan River as part of a five-year augmentation effort: 2000 Interim Progress Report (Final). U.S. Fish and Wildlife Service, Grand Junction, CO. 83 pp.
- Ryden, D. W. 2003a. Long-term monitoring of sub-adult and adult large-bodied fishes in the San Juan River: 1999-2001 Integration Report. U.S. Fish and Wildlife Service, Grand Junction, CO. 127 pp. + Appendices.
- Ryden, D. W. 2003b. An augmentation plan for razorback sucker in the San Juan River: An addendum to the five-year augmentation plan for razorback sucker in the San Juan River (Ryden 1997). U.S. Fish and Wildlife Service, Grand Junction, CO. 32 pp.
- Ryden, D. W. 2005. An augmentation plan for razorback sucker in the San Juan River. Addendum # 2: Justification for changing the beginning date of the eight-year stocking period (Final). U.S. Fish and Wildlife Service, Grand Junction, CO. 4 pp.
- Ryden, D. W., and F. K. Pfeifer. 1993. Adult fish collections on the San Juan River (1991-1992): Annual Progress Report. U.S. Fish and Wildlife Service, Grand Junction, CO. 69 pp.
- Ryden, D. W., and F. K. Pfeifer. 1994a. An experimental stocking plan for razorback sucker in the San Juan River. U.S. Fish and Wildlife Service, Grand Junction, CO. 26 pp.
- Ryden, D. W., and F. K. Pfeifer. 1994b. Adult fish community monitoring on the San Juan River: 1993 Annual Progress Report. U.S. Fish and Wildlife Service, Grand Junction, CO. 84 pp.
- San Juan River Basin Recovery Implementation Program Biology Committee. 1995. Long Range Implementation Plan: San Juan River Recovery Implementation Plan. U. S. Fish and Wildlife Service, Albuquerque, NM. 19 pp. + appendices.
- San Juan River Basin Recovery Implementation Program. 2006. Long Range Plan (draft dated October 30, 2006). U. S. Fish and Wildlife Service, Albuquerque, NM. 20 pp. + appendices.

- U.S. Fish and Wildlife Service. 1991. Endangered and threatened wildlife and plants: the razorback sucker (Xyrauchen texanus) determined to be an endangered species. Dept. of the Interior, U.S. Fish and Wildlife Service, Federal Register, 23 October 1991, 56:54957-54967.
- U.S. Fish and Wildlife Service. 1994. Determination of critical habitat for the Colorado River endangered fishes; razorback sucker, Colorado pikeminnow, humpback chub, and bonytail chub. Dept. of the Interior, U.S. Fish and Wildlife Service, Federal Register, 21 March 1994, 59:13374-13400.

APPENDIX A

Information on razorback sucker stocked from 1994-2007.

Table A-1. Year by year summary of razorback sucker stocked into the San Juan River, 1994-2007.

Year	Total Number Of Razorback Sucker Stocked (Sizes of Fish Stocked)
Experimental Stocking Study: 1994-1996 (n = 942 fish stocked)	
1994	688 (Mean TL = 251 mm TL; Range = 100-446 mm TL)
1995	16 (Mean TL = 424 mm TL; Range = 397-482 mm TL)
1996	238 (Mean TL = 336 mm TL; Range = 204-434 mm TL)
Five-Year Augmentation Effort: 1997-2001 (n = 5,890 fish stocked)	
1997	2,883 (Mean TL = 192 mm TL; Range = 104-412 mm TL)
1998	1,275 (Mean TL = 250 mm TL; Range = 185-470 mm TL)
1999	0 N/A
2000	1,044 (Mean TL = 214 mm TL; Range = 111-523 mm TL)
2001	688 (Mean TL = 410 mm TL; Range = 288-560 mm TL)
Interim Stocking Years: 2002-2007 (n = 47,675 fish stocked)	
2002	140 (Mean TL = 319 mm TL; Range = 110-470 mm TL)
2003	887 (Mean TL = 327 mm TL; Range = 100-495 mm TL)
2004	2,988 (Mean TL = 353 mm TL; Range = 225-559 mm TL)
2005	1,996 (Mean TL = 355 mm TL; Range = 223-534 mm TL)
2006	18,793 (Mean TL = 265 mm TL; Range = 68-537 mm TL) *** 5,000 of these fish didn't have PIT tags when they were stocked
2007	22,836 (Mean TL = 268 mm TL; Range = 110 – 573 mm TL) *** 5,937 of these fish didn't have PIT tags when they were stocked
TOTAL: 1994-2007	54,472