

**SAN JUAN RIVER
RAZORBACK SUCKER
POPULATION AUGMENTATION
2010
Annual Report**



Photo by USFWS

Submitted By:

D. Weston Furr, Fish Biologist
U. S. Fish and Wildlife Service
New Mexico Fish and Wildlife Conservation Office
3800 Commons Ave NE
Albuquerque, NM 87109

August 22, 2011

To:

The San Juan River Basin Recovery Implementation Program

EXECUTIVE SUMMARY

- 28,485 razorback sucker stocked during 2010 augmentation efforts
 - 2.5 times the annual target of 11,400 stocked, an additional 17,085 fish
 - most razorback sucker ever stocked in a single year
 - Second year of 8 year augmentation plan
 - two consecutive years of exceeding stocking targets

- 12,138 fish stocked as part of Uvalde NFH's annual commitment
 - 6,005 fish stocked at Shiprock Bridge (RM 147.9) on Oct. 27, 2010
 - Mean TL= 351 mm, Range 241-470 mm
 - 2009 Year Class
 - 6,133 fish stocked at PNM weir (RM 166.6) on Nov. 3, 2010
 - Mean TL= 362 mm, Range 230-460 mm
 - 2009 Year Class

- 8,142 fish from Uvalde NFH stocked as part of seasonal stocking study in 2010
 - 4,021 razorback sucker stocked in Winter 2010
 - 2,000 stocked at Shiprock Bridge on Feb. 9, 2010
 - Mean TL= 455 mm, Range 333-560 mm
 - 2006 Year Class
 - 2,021 stocked below Animas confluence (RM 180.2) on Feb. 12, 2010
 - Mean TL= 438 mm, Range 318-545 mm
 - 2006 Year Class
 - 4,121 razorback sucker stocked in Late Fall 2010
 - 2,004 stocked at Hogback Diversion (RM 158.4), Dec. 1, 2010
 - Mean TL= 473 mm, Range 340-575 mm
 - 2006 Year Class
 - 2,117 stocked in Animas River at Berg Park (A-RM 3), Dec. 8, 2010
 - Mean TL= 477 mm, Range 370-572 mm
 - 2006 & 2007 Year Class

Executive Summary continued:

- 8,205 fish harvested and stocked from NAPI ponds
 - Approximately 10,500 stocked by Dexter NFH&TC into NAPI ponds
 - 78.1% return, highest returns to date
 - Mean TL = 366 mm, Range 222-511 mm
 - Passive harvest ran Aug. 26 – Oct. 22, 2010
 - Active harvest occurred Nov. 3rd – 5th
 - stocked at PNM weir

Table of Contents

EXECUTIVE SUMMARY	i
INTRODUCTION	1
Relationship To The Recovery Program.....	3
Objectives for Augmentation Fiscal Year 2010.....	5
STOCKINGS	6
Uvalde NFH Annual Commitment Stocking	6
Uvalde NFH Seasonal Stockings	6
Summary Results from NAPI Ponds.....	9
SUMMARY	10
Literature Cited	12
Appendix A. Razorback sucker stocked into the San Juan River 2010.	15
Appendix B. Yearly summary of razorback sucker stocked into the San Juan River, 1994-2010.....	16

List of Tables

Table 1	Summary of seasonal stocking of razorback sucker into the San Juan River, 2009 and 2010.	7
Table 2	Summary of 2010 NAPI pond harvest results.....	9

INTRODUCTION

Razorback sucker (*Xyrauchen texanus*), is one of three San Juan River native fish species, along with the Colorado pikeminnow (*Ptychocheilus lucius*) and the roundtail chub (*Gila robusta*), that have become greatly reduced in numbers and range since the mid 1900's (Minckley 1973, Bestgen 1990). 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 may have contributed to the decline of these native species (Platania 1990, Brooks et al. 1993, Ryden and Pfeifer 1994a). Razorback sucker was listed as endangered under the Endangered Species Act on November 22, 1991 due to diminished numbers and lack of recruitment of this species in the wild (U.S. Fish and Wildlife Service {USFWS} 1991). In addition to federal protection, razorback sucker is currently a protected species in Arizona, California, Colorado, Nevada, New Mexico, Utah, and 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 collections of razorback sucker, 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 Biology Committee 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 river mile (RM) 158.6 at the Hogback Diversion structure, NM and Lake Powell, UT RM 0 (Maddux et al. 1993). Based on these studies Critical Habitat for razorback sucker was designated from RM 158.6 downstream to Neskahi Canyon in Lake Powell (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 year-round habitat utilization 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 (Ryden 2003b).

In 1997 a *Five-Year Augmentation Plan For Razorback Sucker In The San Juan River* was completed (Ryden 1997). This plan identified the establishment of 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 goal, it was estimated that 73,482 razorback sucker would have to be stocked between 1997 and 2001. From September 1997 to November 2001, a total of 5,896 razorback sucker were stocked into the San Juan River, with all stockings taking place at RM 158.6. The shortfalls were a direct result of insufficient numbers of razorback sucker available to the SJRIP augmentation program. In an attempt to rectify the deficit, between 1997 and 2001 the SJRIP acquired for use, or constructed, ponds on the Navajo Agricultural Products Industry (NAPI) lands. These ponds were to be the primary source of razorback sucker for the SJRIP's augmentation program. Ponds would be stocked with young razorback sucker each Spring, establishing a multiple year-class cohort of fish from which appropriately sized individuals (≥ 300 mm TL) could be harvested each Fall and stocked into the San Juan River. The continued shortfalls (only 43% of augmentation target was met) experienced between 1997 and 2007 were an artifact of the unpredictability of production, grow-out, and harvest numbers at the NAPI ponds.

Despite this stocking shortfall, useful recapture data were collected. First, 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 the spring of 1997, 1999, and 2001 at RM 100.2 (McElmo Creek) just downstream of Aneth, UT (Ryden 2001, 2003a). Lastly, larval razorback sucker have been collected every year since 1998, with the largest number being collected in 2010 (Brandenburg and Farrington 2011). Although larval razorback sucker have been collected for the last 13 years, documented recruitment to juvenile life stages has been limited (Ryden 2008).

Based on these observations, the SJRIP-BC extended the augmentation effort for razorback sucker and approved *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* in February 2003 (Ryden 2003b). This addendum outlined an additional eight-year augmentation period for razorback sucker. The eight-year augmentation period was scheduled to begin in 2004 and continue through 2011. Between 2002 and 2008, 52,084 razorback sucker were stocked with 41,629 (79.9%) of those stocked in 2006 and 2007. The large number of fish stocked in those years was attributable to the harvest of all razorback sucker from the Navajo Agricultural Products Industry (NAPI) ponds in preparation for a shift from multiple cohort to a single cohort rearing strategy in East and West Avocet ponds, and Hidden Pond. Many of the fish stocked were under the target size of ≥ 300 mm (2006 mean TL = 265 mm (range of 68-537 mm), 2007 mean TL = 268 mm (range of 110-573 mm) and due to complicating factors during harvesting roughly 25% of those fish were stocked without PIT tags.

In response to changes in the augmentation strategy the timeline for beginning the eight-year augmentation effort was delayed with full implementation beginning in 2009. This report provides an overview of the second year (2010) of the eight-year effort (2009-2016) for razorback sucker augmentation in the San Juan River. However, details of razorback sucker grown out at NAPI ponds will be covered under a separate report

Relationship To The Recovery Program

The main objective for augmentation was to restore a wild population of razorback sucker to appropriate historic habitat, with the eventual goal of recovering this species in the San Juan River (Ryden 1997, SJRIP 2010). Augmentation is intended to increase overall population numbers, provide opportunities for research (i.e., movement studies, habitat and spawning site preferences), add genetic diversity to the existing gene pool, and continue the persistence of a spawning adult population. Subsequent data collection may identify factors limiting successful recruitment of this species in the San Juan River.

The San Juan River Long Range Plan (SJRIP 2010) identifies the need to assess the feasibility and implementation of razorback sucker augmentation. The revised augmentation plan (Ryden 2003b) and stocking plan and protocols for the NAPI ponds (Furr and Davis 2009) provides the necessary guidance for those efforts to fulfill the goals, actions and tasks defined in the 2010 draft Long Range Plan. The requirements of the augmentation program for the San Juan River's razorback sucker population are specified in the 2010 Long Range Plan draft as follows:

- ***Goal 1.2 - Establish a Genetically and Demographically Viable, Self-Sustaining RBS Population.***
 - ***Action 1.2.1 Develop plans for rearing and stocking RBS.***
 - ***Task 1.2.1.3 Estimate and adjust stocking goals of augmentation plan.***
 - ***Task 1.2.1.4 Review and update RBS augmentation plan as needed.***
 - ***Action 1.2.2 Produce, rear, and stock sufficient numbers of RBS to meet stocking goals of augmentation plan.***
 - ***Task 1.2.2.1 Produce and rear RBS at Dexter NFH for stocking to grow-out facilities.***
 - ***Task 1.2.2.2 Annually stock three NAPI grow-out ponds with 3,000-3,500 fish per pond (> 200 mm TL) hatchery-reared RBS.***
 - ***Task 1.2.2.3 Produce 12,000 RBS per year (>300 mm TL) at Uvalde NFH.***
 - ***Task 1.2.2.4 Stock at least 91,200 RBS (> 300 mm TL) during 2003-2011* or 11,400 per year.[* timeline rescheduled for 2009-2016]***
 - ***Task 1.2.2.7 Opportunistically stock available RBS in excess of the 11,400 described above.***
- ***Goal 1.4 - Support Operations and Maintenance of Facilities to Support RBS and CPM Stocking Programs.***
 - ***Action 1.4.1. Support Production and Grow-out Facilities.***
 - ***Task 1.4.1.1 Support operation and maintenance of hatchery facilities (Dexter and Uvalde NFH) for RBS production.***
 - ***Task 1.4.1.2 Operate and maintain NAPI grow-out ponds.***

In February 2007, the SJRIP-BC approved a shift in rearing strategies and management at the NAPI grow-out ponds, contracted Uvalde National Fish Hatchery (Uvalde NFH) to meet the yearly stocking requests of the SJRIP, and charged the USFWS's New Mexico Fish & Wildlife Conservation Office (NMFWCO) with San Juan River augmentation oversight.

Stocking of fish reared at USFWS hatcheries in the Southwest Region are subject to Regional Policy No. 03-06, "Stocking of fish and other aquatic species". This policy applies to production, transport, and stocking for USFWS hatchery production and incorporates guidance and requirements from USFWS Fish Health Policy (713 FWM 1-5), Policy for Controlled Propagation of Species Listed under the Endangered Species Act (Federal Register 65:183), and goals and objectives of the USFWS's Strategic Plan for the Fisheries Program. The USFWS's Fish and Wildlife Conservation Offices are the primary conduit for satisfaction of policy requirements and ensure compliance with needs relative to fish health, stocking requests and priorities, deviation from approved stocking requests, pre-stocking treatments (e.g. nonnative fish removal from stocking sites), and applicable environmental regulation. New Mexico FWCO is the pertinent field office for processing of SJRIP stocking requests.

Objectives for Augmentation Fiscal Year 2010

- 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*).
- 2) Finalize three seasonal stockings with 2006 and 2007 year class (YC) razorback sucker from the Uvalde National Fish Hatchery to quantify differences among stocking seasons on retention and movement.

STOCKINGS

Uvalde NFH Annual Commitment Stocking

On October 27, 2010 personnel from Uvalde NFH and NMFWCO stocked 6,005 razorback sucker immediately downstream of Shiprock Bridge (RM 147.9). The mean TL of these 2009 YC razorback sucker was 351 mm (range = 241-470 mm) with a mean WT of 424 g (range = 91-1089 g). A second stocking occurred on November 3, 2010 with a total of 6,133 2009 YC razorback sucker stocked at PNM weir (RM 166.6). The mean TL was 362 mm (range = 230-460 mm) with a mean WT of 466 g (range = 181-998 g). In fulfillment of their annual stocking commitment, Uvalde NFH stocked 12,138 razorback sucker, a 6.5% surplus, in 2010.

Uvalde NFH Seasonal Stockings

In a report to the SJRIP by Bestgen et al (2009), survivorship and recaptures rates for razorback sucker post-stocking varied by source of fish, length at stocking, and season of stocking.

Recommendations from this report included consideration of stocking larger fish and continuing with stocking in the spring, summer and fall while avoiding winter stockings until more evidence is available. This information was presented concurrently with an opportunity to acquire older and larger razorback sucker than are usually available to the SJRIP augmentation program. These large fish were available since Uvalde NFH had been unable to deliver razorback sucker in 2007 and 2008 due to concerns over Largemouth Bass virus (LMBv). Uvalde NFH retained these fish until the facility reacquired their class A status in 2009. It was the recommendation of the SJRIP Biology Committee to use these fish to continue to investigate the seasonal effects on survival and retention.

A seasonal stocking schedule was created that would stock approximately 4,000 razorback sucker at two sites (2,000 fish per site) during Fall (2009), Winter (2010), and Spring (2010). Two sites were identified based upon their upstream location or their proximity to historically

recognized spawning bars. One site was identified just below the Animas River confluence (Animas site, RM 180.2) and the second just downstream of the Hogback Diversion (Hogback site, RM 158.4). Fish were stocked employing normal ‘hard’ release methodologies in which fish are acclimated to temperature only prior to release into the San Juan River. Seasonal effects on short and long-term retention post stocking will be evaluated through subsequent recapture data of these fish.

Table 1 Summary of seasonal stocking of razorback sucker into the San Juan River, 2009 and 2010.

Date	Site, River Mile	# of fish	Mean TL	Range TL	Mean WT
Oct. 27, 2009	Hogback Diversion, RM 158.4	2,000	417 mm	325-511 mm	766 g
Oct. 30, 2009	Animas River confluence, RM 180.2	1,997	420 mm	300-510 mm	770 g
Feb. 9, 2010	Shiprock Bridge, RM 147.9	2,000	455 mm	333-560 mm	1,099 g
Feb. 12, 2010	Animas River confluence, RM 180.2	2,021	438 mm	318-545 mm	945 g
Dec. 1, 2010	Hogback Diversion, RM 158.4	2,004	473 mm	340-575 mm	1,157 g
Dec. 8, 2010	Animas River at Berg Park	2,117	477 mm	370-572 mm	1,226 g
	Total	12,139	447 mm	318-575 mm	994 g

Uvalde NFH and NMFWCO personnel conducted the Fall seasonal stocking of 2006 YC razorback sucker on October 27th and 30th, 2009. On October 27, 2009, 2,000 razorback sucker were stocked at Hogback Diversion (RM 158.4) with a mean TL of 417 mm (range 325-511 mm) and mean WT of 766 g. The second load of 1,997 fish was stocked on October 30, 2009 at the Animas River confluence (RM 180.2) with a mean TL of 420 mm (range 300-510 mm) and mean WT of 770 g (Table 1). All fish were implanted with a 134.2 kHz PIT tag and measured for TL and WT by Uvalde NFH personnel.

The Winter seasonal stocking of 2006 YC razorback sucker was conducted by Uvalde NFH and NMFWCO personnel on February 9th and 12th, 2010. On Feb. 9, 2010, 2,000 razorback sucker with a mean TL of 455 mm (range 333-560 mm) and mean WT of 1099 g were stocked at Shiprock Bridge (RM 147.9). The stocking site at Shiprock Bridge had to be used due to inclement weather making access for the Regional Distribution Unit truck into the Hogback Diversion site unsafe. The second load of 2,021 fish was stocked on February 12, 2010 at the Animas River confluence with a mean TL of 438 mm (range 318-545 mm) and mean WT of 945

g (Table 1). All fish were implanted with a 134.2 kHz PIT tag and measured for TL and WT by Uvalde NFH personnel.

The final seasonal stocking was schedule to occur in Spring 2010 prior to run-off. However, Uvalde staff indicated that fish were found to be in spawning condition at that time so, in an effort to lessen additional stressors on the fish, it was decided not to attempt to PIT tag and haul these fish while in spawning condition. Therefore, the last seasonal stocking was rescheduled for late Fall 2010.

On December 1, 2010 Uvalde NFH and NMFWCO personnel stocked 2,004 razorback sucker with a mean TL of 473 mm (range 340-575 mm) and mean WT of 1,157 g (2006 & 2007 YC) at the Hogback Diversion site (RM 158.4). Upon arrival at the stocking site NMFWCO staff noted that up to 50% of the fish from tanks 1 and 3 appeared disoriented and were floating belly up; signs indicative of acute handling/hauling stress. The fish from tank 2 appeared to be in normal condition. All razorback sucker were acclimatized to the river temperature of 2° C and released. After release some fish were still observed to be listless and unable to maintain vertical orientation. Between 20 and 30 fish were spotted ensnared in a debris pile immediately downstream of the stocking locale and were considered mortalities. Possible reasons for these losses may have included hauling densities, rapid cooling of hauling water, recorded oxygen supersaturation, and long transport time. Although no specific reason could be determined, USFWS R2 and Uvalde NFH immediately implemented changes in hauling protocols to lessen primary sources of stress on fish prior to stocking. It is unknown how many of these fish suffered from immediate or delayed mortality directly due to handling/hauling stress but future recaptures of these stocked fish will aid researchers in determining the relative success of this individual stocking. The second load of 2,117 fish was stocked December 8th at the Animas River confluence with a mean TL of 477 mm (range 370-572 mm) and mean WT of 1,226 g (Table 1). None of the complications observed during the December 1, 2010 stocking occurred. All fish were implanted with a 134.2 kHz PIT tag and measured for TL and WT by Uvalde NFH personnel.

A total of 12,139 razorback sucker were stocked under the seasonal stocking protocols. Subsequent recapture data of these fish will be analyzed to better understand the effects of stocking larger sized razorback sucker and the season-at-stocking have on survival, retention, and movement of razorback sucker in the San Juan River. Future augmentation efforts will incorporate information learned from these stockings to maximize stocking efficacy.

Summary Results from NAPI Ponds

A total of 8,205 razorback sucker were stocked from the NAPI ponds into the San Juan River in 2010 (Table 2). This represents a 78.1% return from the original 10,500 fish stocked into the ponds by Dexter NFH&TC. Mean TL for all fish stocked from NAPI ponds was 366 mm and mean WT (extrapolated from the percentage of fish measured for WT) was 475 g. As indicated by the Dexter NFH&TC fish delivery record, fish were stocked into the ponds on April 8, 2010 with an estimated mean TL of 245 mm and mean WT of 249 g. Passive harvests began on August 26 and ran through October 22, 2010. A total of 2,031 razorback were harvested under passive methods (24.8% of all fish harvested from NAPI ponds). Active harvests occurred November 2-5, 2010, after approximately 30 weeks of grow-out in the NAPI ponds. Mean TL increased 121 mm and mean WT increased 226 g across all ponds during grow-out. This equates to a 49.4% increase in TL and a 90.1% increase in WT with a growth-rate of roughly 0.58 mm TL/day and 1.08 g WT/day over a 210 day grow-out cycle.

Table 2 Summary of 2010 NAPI pond harvest results.

Pond	Number Harvested	Mean TL in mm	Range TL in mm	# Stocked into pond (approximated)	% Return
East Avocet	3,135	351	222-500	3,500	89.6%
West Avocet	2,630	373	235-511	3,500	75.1%
Hidden Pond	2,440	372	240-475	3,500	69.7%
Total	8,205	366	222-511	10,500	78.1%

SUMMARY

Razorback sucker augmentation in the San Juan River for 2010 exceeded the annual stocking target of 11,400 \geq 300 mm TL razorback sucker by 17,085 fish. This marks the second consecutive year that the SJRIP surpassed the 11,400 fish stocking target; and constitutes the largest number of razorback sucker stocked in a single year. Moreover, when the fish stocked under the seasonal stocking protocols were excluded, the number of fish stocked in 2010 still exceeded the annual stocking target by 8,763 fish (77%). Therefore, future augmentation efforts are similarly expected to meet or exceed the annual augmentation target. With both Uvalde NFH committed to provide 11,400 \geq 300 mm TL razorback sucker and the NAPI grow-out ponds providing $>$ 5,000 fish annually, the potential exists to routinely stock upwards of 16,000 adult and sub-adult razorback sucker each year.

Based on recaptured data, it appears that razorback sucker exhibit some degree of site fidelity in the San Juan River (Davis and Furr 2007, 2008). Additionally, it has been reported that with the exception of spawning associated movement, adult razorback sucker tend to be predominantly sedentary (Tyus 1987; Tyus and Karp 1990). Previous augmentation efforts routinely stocked fish at RM 158.6 (Hogback Diversion), which is the upper-most boundary of critical habitat and near a known spawning area. Data indicate that a majority of razorback sucker recaptures have occurred \pm 10 miles of RM 158.6 (Davis and Furr 2007, 2008). Over eight years of augmentation, 2009-2016, continuing to only stock at Hogback Diversion (RM 158.6) would result in over 91,200 razorback sucker \geq 300 mm stocked at a single location. Therefore it has been requested by the SJRIP-Biology Committee that multiple stocking locations continue to be utilized to reduce overcrowding and intraspecific competition within specific geomorphic reaches of the San Juan River. As additional spawning sites are identified, stocking in proximity to those sites may be advantageous in promoting increases in reproductive effort. Additionally, an evaluation of stocking locations suitable for conducting soft releases upstream of the PNM weir (RM 166.6) will be conducted in 2011 to facilitate upstream range expansion for this species. Annual stockings of razorback sucker will continue to be scheduled in autumn, preferably after the end of irrigation and field sampling seasons, in an attempt to lessen entrainment and post-stocking disturbance issues.

The final seasonal stocking was originally scheduled for late April, 2010. However, it was discovered in March that the 2006 YC razorback sucker at Uvalde NFH were in spawning condition. Attempting to handle and process (measure, weigh, and tag) gravid females could place compounding stresses on the fish leading to an increase in mortality. Therefore, the final stocking was delayed until December 2010. Although this modification to the stocking timeline removes Spring as a season for comparison, the issue of gravid females had not been originally considered when determining seasons for analysis. With the probability of gravid fish reoccurring and complicating handling and stocking, Spring is not considered an ideal season for stocking mature individuals of this species.

As the effects of augmentation on the razorback sucker population, and on the San Juan River fish community as a whole, are better understood, management decisions will invariably be reconfigured to address these new data. Due to the stochastic nature of the San Juan River, an adaptive management approach can best respond to the myriad of issues that may arise during augmentation efforts. Stocking protocols, including the initiation of soft releases for razorback sucker, will be evaluated annually and changes made to subsequent stockings and production protocols in order to expedite recovery.

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.
- Bestgen, K. R., K. A. Zelasko, G. C. White. 2009. Survival of hatchery-reared razorback suckers *Xyrauchen texanus* stocked in the San Juan River Basin, New Mexico, Colorado, And Utah. San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 54 pp.
- Brandenburg, W. H., and M. A. Farrington. 2011. Colorado pikeminnow and razorback sucker larval fish survey in the San Juan River during 2010. Prepared by American Southwest Ichthyological Researchers L.L.C. for the San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, NM. 64 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.
- Furr, D. W and J.E. Davis. 2009. A stocking plan and production protocol for razorback sucker (*Xyrauchen texanus*) reared at NAPI ponds. Draft for the U.S. Fish and Wildlife Service, Albuquerque, NM. 9 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.

- 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 B 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 B Annual Report. Bureau of Reclamation, Durango, CO. 11 pp.
- 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.
- 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. 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: 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. 2008. Long term monitoring of sub-adult and adult large-bodied fishes in the San Juan River: 2007. Final report for the SJRIP, U.S. Fish and Wildlife Service, Albuquerque, NM. 55 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. 2010. Long-range plan. San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, NM.
- 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.
- Tyus, H.M. 1987. Distribution, reproduction, and habitat use of the razorback sucker in the Green River, Utah, 1979-1986. *Transactions of the American Fisheries Society* 116: 111-116.
- Tyus, H.M., and C.A. Karp. 1990. Spawning and movements of razorback sucker, *Xyrauchen texanus*, in the Green River Basin of Colorado and Utah. *Southwestern Naturalist* 35: 427-433.
- 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. Razorback sucker stocked into the San Juan River 2010. **details of NAPI stocking dates and numbers covered under a separate NAPI 2010 report.

<u>Date</u>	<u>Species</u>	<u>Year Class</u>	<u># of Fish</u>	<u>Mean TL mm</u>	<u>Tag type</u>	<u>Stocking Location</u>	<u>Release Type</u>	<u>Source/Age</u>
2/9/2010	Xyr tex	2006	2,000	455	PIT	147.9	Hard	Uvalde age-3+
2/12/2010	Xyr tex	2006	2,021	438	PIT	180.2	Hard	Uvalde age-3+
10/27/2010	Xyr tex	2009	6,005	350	PIT	147.9	Hard	Uvalde age-1+
11/3/2010	Xyr tex	2009	6,133	362	PIT	166.6	Hard	Uvalde age-1+
12/1/2010	Xyr tex	2006	2,004	473	PIT	158.6	Hard	Uvalde age-4+
12/8/2010	Xyr tex	2006/07	2,117	477	PIT	180.2	Hard	Uvalde age-3+ & 4+
8/26/2010- 11/5/2010	Xyr tex	2008	8,205	366	PIT	166.6	Hard	NAPI age-2+**

2010 RBS Totals = 28,485 stocked

Appendix B. Yearly summary of razorback sucker stocked into the San Juan River, 1994-2010

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; Range = 100-446 mm TL)
1995	16 (Mean TL = 424 mm; Range = 397-482 mm TL)
1996	238 (Mean TL = 336 mm; Range = 204-434 mm TL)
Five-Year Augmentation Effort: 1997-2001 (n=5,890 fish stocked)	
1997	2,883 (Mean TL = 192 mm; Range = 104-412 mm TL)
1998	1,275 (Mean TL = 250 mm; Range = 185-470 mm TL)
1999	0 N/A
2000	1,044 (Mean TL = 214 mm; Range = 111-523 mm TL)
2001	688 (Mean TL = 410 mm; Range = 288-560 mm TL)
Interim Stocking Years: 2002-2008 (n=52,084 fish stocked)	
2002	140 (Mean TL = 319 mm; Range = 110-470 mm TL)
2003	887 (Mean TL = 327 mm; Range = 100-495 mm TL)
2004	2,988 (Mean TL = 353 mm; Range = 225-559 mm TL)
2005	1,996 (Mean TL = 355 mm; Range = 223-534 mm TL)
2006	18,793 (Mean TL = 265 mm; Range = 68-537 mm TL)
2007	22,836 (Mean TL = 268 mm; Range = 110-573 mm TL)
2008	4,444 (Mean TL = 307 mm; Range = 225-390 mm TL)
Eight-year Augmentation Effort: 2009-2016 (n=36,903 fish currently stocked)	
2009	8,418* (Mean TL = 412 mm; Range = 136-560 mm TL)
2010	28,485 (Mean TL = 417 mm; Range = 222-575 mm TL)
TOTAL: 1994-2010	95,819
* 4,021 razorback sucker stocked in Feb. 2010 but attributed to the 2009 stocking effort have been reallocated to the 2010 stocking efforts.	