SJRIP SOW 11-29

2011 INTEGRATED PIT TAG DATABASE SUMMARY OF COLORADO PIKEMINNOW AND RAZORBACK SUCKER IN THE SAN JUAN RIVER

Final Annual Report

To Bureau of Reclamation

From

Scott Durst
U.S. Fish and Wildlife Service
San Juan River Basin Recovery Implementation Program
2105 Osuna Road NE
Albuquerque, NM 87113
505-761-4739

Agreement number: R10PG40086 (07-AA-40-2629)

10/1/2010 to 9/30/2011

2011 INTEGRATED PIT TAG DATABASE SUMMARY OF COLORADO PIKEMINNOW AND RAZORBACK SUCKER IN THE SAN JUAN RIVER

Scott L. Durst
San Juan River Basin Recovery Implementation Program
U.S. Fish and Wildlife Service
Albuquerque, NM

Final – 28 June 2012

ABSTRACT

I integrated and summarized the PIT tag data for endangered Colorado pikeminnow and razorback sucker from the San Juan River Basin Recovery Implementation Program's non-native fish removal, adult monitoring, small-bodied monitoring, larval monitoring, stocking, fish passage projects, and Lake Powell survey effort. Most Colorado pikeminnow encountered in 2011 were stocked at age-0 and relatively few pikeminnow were encountered in the San Juan River after three years post-stocking, although more than four times as many age-3 and older pikeminnow were captured in 2011 compared to 2009 and 2010. The majority of pikeminnow detections since 2009 have been in Reach 2, near the Mancos River confluence, and in Reach 6 at the PNM fish weir. The return rate of stocked razorback suckers varied through time but numerous individuals were detected three or more years post-stocking. Since 2009 most razorback suckers were encountered in Reaches 5 and 6, near where they were stocked at the Shiprock Bridge, Hogback Diversion, PNM fish weir, and Animas River confluence. The proportion of razorback suckers captured without PIT tags has been declining as those razorback stocked without PIT tags in 2006 and 2007 from the NAPI ponds continue to age and grow in the San Juan River. Razorback sucker recruitment will be confirmed when numerous fish smaller than 300 mm are captured without PIT tags. The San Juan Recovery Implementation Program should continue to integrate PIT tag data across all projects in order to inform the adaptive management process and evaluate the status of the species' progress toward recovery.

INTRODUCTION

The San Juan River Basin Recovery Implementation Program (Program) conducts efforts in the San Juan River Basin to recover endangered Colorado pikeminnow (*Ptychocheilus lucius*; pikeminnow) and razorback sucker (*Xyrauchen texanus*; razorback). These efforts include management actions such as the stocking of hatchery-reared endangered fish, non-native fish removal, and managed releases of peak and base flows from Navajo Dam. Annual monitoring provides information on the fish community response to management actions. Numerous endangered fishes are handled and collected through the course of carrying out management and monitoring actions. Information on individual fish is gathered through the reading of uniquely identified passive integrated transponder (PIT) tags implanted in these individuals. PIT tags are implanted in all endangered fish ≥ 150 mm total length (TL) prior to stocking and in all endangered fish captured in the San Juan River ≥ 150 mm that do not have one. These encounters form the basis of a database that can be used to create encounter histories of each individual. I used the integrated database to create the summaries and analyses of each species presented herein. The information that can be produced from this database ranges from summaries detailing the recapture rate of stocked individuals to inform the Program's adaptive management process; to mark-recapture analyses to estimate annual survival of stocked individuals (Bestgen et al. 2009); and population estimates that can be used to evaluate the Program's progress toward recovery for both species (Duran et al. 2011, Elverud 2011).

I used the integrated PIT tag databases to examine patterns across all management and monitoring projects that collect PIT tag information to present a broader view of the status of each species. Herein I present the summary of the stocking, capture, recapture, and distribution information for Colorado pikeminnow and razorback sucker in the San Juan River.

METHODS

All management and monitoring efforts in the San Juan River that collect PIT tag data contributed to this report. Data were provided by Dexter National Fish Hatchery and Technology Center (Dexter), Uvalde National Fish Hatchery (Uvalde), Navajo Agricultural

Production Industry (NAPI) Ponds; larval, small-bodied, and adult monitoring; Lake Powell razorback sucker survey; upper, middle, and lower San Juan non-native fish removal; and the fish passage at PNM Weir. These activities covered the San Juan River from the Animas Confluence (RM 180.2) to Clay Hills Crossing (RM 2.9) (Figure 1).

I received most source files in Excel formats. I confirmed all fields were in the same format as the integrated PIT tag databases, removed duplicate data, and ensured imported data did not violate the integrated databases' validation rules. Cases where the number of records in the source file differ from the number imported into the database indicated errors such as duplicate PIT tag values or PIT tag values with missing or extra characters. PIT tag records I could not reconcile were not imported. I imported the proofed PIT tag data for Colorado pikeminnow and razorback sucker into two separate MS Access 2007 files for each species (Microsoft Office 2007; Appendix 1). Each database contains a table recording each individual's first encounter in the San Juan River (FIRST_ENC). The FIRST_ENC table contains records of individuals stocked with a PIT tag, noted as "STOCK" in the CONTACT_TYPE field and individuals encountered in the San Juan River and implanted with a PIT tag, noted as "TAG" in the CONTACT_TYPE field. All records of individuals' subsequent recaptures are in a CAPTURE table. The PIT tag numbers between the two tables are linked via a one-to-many relationship that is referentially enforced, meaning that no record can appear in the CAPTURE table without a corresponding PIT tag number in the FIRST_ENC table (i.e., PIT tag numbers are unique in the FIRST_ENC table but not in the CAPTURE table). I created a series of queries within and between the FIRST_ENC and CAPTURE tables to produce the raw data and summary tables for this analysis.

Colorado pikeminnow stocked at age-0 were too small to be implanted with a PIT tag. All pikeminnow recaptured in the San Juan River without a PIT tag are thought to be the result of the Program's age-0 stocking efforts. Too few larval Colorado pikeminnow have been detected to assume there is any recruitment of wild-produced individuals (Brandenburg and Farrington 2011). Only those pikeminnow ≥ 150 mm TL captured in the San Juan River are implanted with a PIT tag (and entered in to the FIRST_ENC table as TAG records). The numerous pikeminnow < 150 mm that are captured during management and monitoring efforts are not included in this

study. I assigned pikeminnow TAG records a year class based on their size and the month when they were first encountered in the San Juan River (D. Ryden, personal communication; Table 1). This allowed me to assign TAG records to a particular stocking year to calculate overall recapture rates for all age-0 pikeminnow stocked in a given year. Pikeminnow > 400 mm captured without a PIT tag could not be reliably assigned to an age class because of variation in growth rates for fish of that size. However, these cases are relatively rare (there are only 78 Colorado pikeminnow TAG records of fish > 400 mm that could not be assigned to a year class).

I summarized the number of individuals captured from particular stocking classes for pikeminnow stocked with and without PIT tags and for razorbacks stocked with PIT tags. For pikeminnow stocked without and with PIT tags, I reviewed stocking classes since 2002 and 2003, respectively. For razorbacks, I summarized stocking classes since 2000. For both species, I also examined the capture/recapture distribution by river segment (Figure 1) for encounters occurring from 2009-2011.

To further investigate returns from specific razorback stocking events, I summarized the number of individual recaptures from stocking events from 2006-2010 by stocking source, month stocked, and stocking location. I conducted additional investigation of razorback returns for NAPI stockings in 2009 and 2010 to determine if there were any difference in return rates of razorback sucker that were actively or passively harvested from NAPI. Fyke nets were used to passively harvest razorback suckers from NAPI and ponds were drained and fish were collected with seines during active harvest (Morel 2011). I examined return rates from stockings by year, grow-out pond, and harvest type.

To investigate potential razorback sucker wild recruitment, I first examined the proportion of untagged razorbacks captured in relation to the total number of individuals captured for 2004-2011. Large numbers of untagged razorback suckers were harvested and stocked from NAPI in 2006 and 2007 (Ryden 2008). Secondly, to disentangle potential wild recruitment from the untagged razorbacks stocked from NAPI, I examined a length-frequency histogram of untagged razorback sucker detected from 2004-2011.

RESULTS AND DISCUSSION

Following the 2011 update, the Colorado pikeminnow and razorback sucker PIT tag databases contained 52,509 and 111,565 records, respectively. The FIRST_ENC tables, containing both STOCK and TAG records, had a total of 48,070 Colorado pikeminnow records and 105,044 razorback sucker records. The CAPTURE tables had 4,839 and 6,521 records for Colorado pikeminnow and razorback sucker, respectively. Because there are some recaptures of the same individuals, the number of encounters and number of individuals presented in this report are likely different. Because no Colorado pikeminnow < 150 mm are included in this report, pikeminnow numbers presented here may differ from other San Juan River Basin Recovery Implementation Program reports.

Summary of Colorado pikeminnow stockings, recaptures, and distribution

Across all management and monitoring efforts, a total of 2,164 individual Colorado pikeminnow were captured in 2011 (Tables 2 and 3). Almost 90% of these individuals were originally stocked at age-0 (i.e. without PIT tags). However, the 214,720 untagged Colorado pikeminnow stocked in May 2011 were not stocked as age-0 fish like other pikeminnow stocked without PIT tags. These fish were 2010 year class pikeminnow held at Dexter through 2010 due to quarantine issues at the hatchery. Following the quarantine, these pikeminnow were stocked in 2011 as age-1 (in addition to Dexter's age-0 Colorado pikeminnow fall stocking that will be reported in the 2012 report since there was no opportunity to sample them in 2011). Because the large number of age-1 pikeminnow held over from 2010, they were not implanted with PIT tags prior to stocking. For analysis purposes I classified all pikeminnow stocked without PIT tags together and refer to them as age-0.

There were 1,922 individual Colorado pikeminnow captured in 2011 that were stocked as age-0 fish (Table 2). Most of these fish were assigned to the 2009 and 2010 stocking classes, but 20% of individuals were from 2008 or earlier stocking classes (Table 2). Note that the total number of individuals captured includes Colorado pikeminnow TAG records that could not reliably be assigned to a year class. Additional non-native fish removal trips commenced in the reach of the

San Juan River between Shiprock, NM (RM 147.9) and Mexican Hat, UT (RM 52.9) in 2008, increasing the overall sampling effort in the San Juan River (Duran et al. 2011). However, during 2008-2011 year-to-year sampling effort remained relatively constant, between 1,160 and 1,260 hours of electrofishing. The number of Colorado pikeminnow captured that were stocked at age-0 increased from 661, to 1,470, to 2,252 in 2008, 2009, and 2010, respectively, and slightly dropped to 1,922 in 2011. These captures represented individuals from multiple stocking years and may represent a general increasing trend in the Colorado pikeminnow population because sampling effort has remained relatively constant. Colorado pikeminnow stocked at age-0 are normally available for capture one year post-stocking, however no age-0 fish were stocked in 2010 but were instead stocked in May 2011 (Table 2). Although the overall recapture rate of pikeminnow stocked at age-0 remains low, such large numbers of age-0 pikeminnow are stocked on an annual basis that subsequent sampling efforts result in numerous captures from recent stocking classes. The 1,042 pikeminnow captured from the 2009 stocking class in 2010 remained abundant in 2011, as 962 individuals were captured from the same stocking class in 2011. Although the number of age-3 and older pikeminnow captured (that were stocked at age-0) represents only a small portion of the total number of pikeminnow captured, in 2011 over 20% of individuals captured were age-3 and older. Some individuals from stocking classes as old as 2005 continue to persist in the San Juan River, suggesting that these stocked individuals could form a group of reproducing adult pikeminnow.

Only 294 Colorado pikeminnow stocked as age-1+ were recaptured in 2011 (Table 3). This was over three-times fewer than the number of pikeminnow recaptured in 2009 stocked as age-1+ but only 353 and 3,724 age-1+ were stocked in 2010 and 2011, respectively, compared to 8,942 age-1+ pikeminnow in 2009 (Table 3). Although pikeminnow stocked as age-1+ recaptured in 2011 were from as long ago as the 2006 stocking class, most (90%) recaptures in 2011 were from PIT tagged individuals stocked in 2011 (Table 3). The 930 pikeminnow captured in 2009 that were stocked as age-1+ were in part driven by the capture of numerous pikeminnow stocked as age-1+ one year post-stocking and represented the first year that numerous pikeminnow stocked at age-1+ were recaptured one year post-stocking. The 439 pikeminnow from the 2008 stocking class captured in 2009 was more than twice the number captured from that stocking class in 2008. This pattern did not repeat in 2010 or 2011, when only 108 and 8 pikeminnow were captured

one-year post-stocking. Although the decline in the number of Colorado pikeminnow stocked as age-1+ captures appear largely driven by reduced stocking number, the number captured three or more years post-stocking has remained relatively constant indicating that there are some, although few, older Colorado pikeminnow that persist in the San Juan River. The Program ceased production and stocking of age-1+ Colorado pikeminnow in 2011 based on their relatively higher cost and limited return rate compared to fish stocked as age-0 (Durst 2009). As the length of time between future monitoring efforts and this last year of stocking age-1+ Colorado pikeminnow increases, fewer and fewer fish from these past stocking should be detected if current patterns persist.

From 2007-2011, a total of 1,428,924 age-0 Colorado pikeminnow were stocked in the San Juan River at Mosquito Point (RM 134.5), PNM (RM 166.6), downstream of the Animas River confluence (RM 170.5 to RM 180.2), and in the lower Animas River. Most age-0 Colorado pikeminnow (78%) were stocked at PNM (RM 166.6) from 2007 to 2011. From 2007 to 2011 a total of 21,117 age-1+ Colorado pikeminnow were stocked in the San Juan River near Mosquito Point (RM 133.5 to RM 134.9), PNM (RM 166.6), near the Animas River confluence (RM 180.6), and in the lower Animas River. Most all of these (76%) were stocked in the lower portion of Reach 5 at Mosquito Point (RM 133.5 to RM 134.9). All Colorado pikeminnow stocking in the Animas River occurred in 2011. Subsequent management and monitoring efforts from 2009-2011 resulted in 8,469 pikeminnow encounters, 97% of these encounters were from stocking events from 2007-2011. From 2009-2011, about 34% of all pikeminnow encounters occurred in Reach 2, 13% of encounters were around the Mancos River confluence (RM 114 to RM 131), and 9% occurred at PNM (RM 166.6) (Figure 2).

Summary of razorback sucker stockings, recaptures, and distribution

Across all management and monitoring efforts there were a total of 1,633 individual razorback sucker captured in 2011 (Tables 4 and 7). About 53% of all razorback sucker individuals captured in 2011 were 2006, 2007, 2008, and 2009 year class fish stocked in 2010 (Table 4). Although many razorback sucker recaptures came from the 2010 and 2011 stocking classes, 424 razorback suckers were captured in 2011 that were stocked in the San Juan River in 2009 or

earlier (Table 4). From 2000 to 2011 there was high variability in the recapture rate of stocked razorback sucker (Table 4). Typically there were many recaptures of razorback suckers in the same year they were stocked, but there were also recaptures of individuals from particular stocking classes that persisted for many years after they were stocked (Table 4). Note that because 15,775 razorback suckers were stocked following fish management and monitoring efforts in the San Juan River in 2011, the recapture rate of the 93 razorbacks captured in 2011 should be based on only 3,032 stocked individuals. The persistence of hatchery-reared razorback sucker, along with the collection of larval razorback sucker (Brandenburg and Farrington 2011), are the first steps toward establishing a self-sustaining population of this species in the San Juan River. Wild-spawned razorback sucker recruitment will be detected by capturing fish without PIT tags in the appropriate size classes. There were 254 newly captured TAG records in 2011 that averaged 429 mm TL (Table 7; range: 225-619 mm). Because razorback suckers as small as 208 mm TL were stocked in 2011 (Furr 2011), potential tag loss, and the persistence of razorbacks stocked without PIT tags from NAPI ponds in 2006 and 2007, wild-recruitment does not seem the most likely explanation for the capture of these individuals without PIT tags.

From 2007-2010 a total of 58,065 razorback suckers were stocked into the San Juan River. These stockings were distributed among Shiprock Bridge (23% of total stocked; RM 147.9), Hogback Diversion (31%; RM 158.6), PNM weir (35%; RM 166.6), and the Animas River confluence (11%; RM 180.2). Subsequent fish management and monitoring efforts from 2009-2011 encountered 4,144 razorback sucker, of which 83% were from stockings in 2007-2010. Most (64%) razorback sucker encounters from 2009-2011 were between Chaco Wash (RM 147) and PNM weir (RM 166.6). The high degree of retention of razorback suckers in Reaches 5 and 6 suggests most razorback sucker remain close to the area where they are stocked into the San Juan River (Figure 3). Alternatively, the retention of razorback sucker in Reaches 5 and 6 may indicate the habitat suitability of those reaches.

Razorback sucker stocking events and recapture investigation

From 2006-2010 razorback suckers were stocked into the San Juan River from Dexter, Uvalde, NAPI 6-Pack Ponds, NAPI Avocet East, NAPI Avocet West, and NAPI Hidden Pond (Table 5).

I did not include 2011 stocking data in this summary because monitoring efforts that produce recapture data had ended prior to most razorback sucker stockings. Razorback sucker were stocked in every month except January and March at Shiprock Bridge (RM 147.9), around Hogback Diversion (RM 158.3 and 158.6), PNM Weir (RM 166.6), and the Animas River confluence (RM 180.2) (Table 5). I calculated return rates based on recaptures occurring through 2011, so fish stocked in earlier years have been subject to more sampling effort than those stocked in later years. There were multiple stocking events that to date have yielded zero recaptures; Uvalde 2006, Uvalde 2007, Uvalde 2009, and the Uvalde 2010 February and December stockings (Table 5). Alternatively, some stocking events have yielded relatively high return rates; Dexter 2007 (24%), NAPI Avocet East 2007 (26%), NAPI Avocet East 2009 (19%), NAPI Avocet West 2009 (29%), and NAPI Hidden Pond 2010 (18%). Many factors, including length at stocking, season, and hatchery source have been identified as important for the post-stocking survival of hatchery-reared razorback suckers (Bestgen et al. 2009). From 2006-2010 a total of 30,189 razorback sucker stocked into the San Juan River from Uvalde resulted in only a single recapture. Starting in 2011 Uvalde revised management actions, primarily hauling fish in smaller batches, in an effort to improve return rates. Although recaptures from 2012 and beyond will be used to evaluate the effect of this revised management, 87 razorback suckers stocked from Uvalde were recaptured in 2011, suggesting that the revised management may already be producing positive results.

NAPI stockings include both passive and active harvest management strategies. Harvest type was only reliably recorded for 2009-2011 in the PIT tag database. However, monitoring data in 2011 was collected prior to the active harvest in 2011 so stockings from 2011 were not included in the analysis. I calculated return rates based on recaptures occurring through 2011, so fish stocked in 2009 have been subject to more sampling effort than those stocked in 2010. More razorback suckers were actively harvested in both 2009 and 2010 (Table 6). Across 2009 and 2010, active harvest from NAPI resulted in a 12.8% return rate while the earlier passive harvest resulted in a 13.2% return rate (Table 6). Return rate varied by year, 16% in 2009 versus 11% in 2010, but there was no consistency in return rate by harvest type or source pond. I hypothesized that return rates would be higher for passively harvested razorback suckers; however, both harvest techniques are stressful (J. Morel, personal communication). Given the equivalent return

rates for the two harvest techniques, both management activities should continue into the future to reduce the number of fish that need to be processed during active harvest. Starting in 2012 all razorback sucker delivered to NAPI from Dexter will be implanted with a PIT tag prior to delivery, possibly reducing stress during harvest and increasing PIT tag retention.

Capture of razorback sucker without PIT tags

Because almost all razorbacks stocked prior to 2005 had PIT tags (Furr 2011) and because of limited evidence of natural recruitment (Golden et al. 2006, Brandenburg and Farrington 2011), I hypothesized that the proportion of untagged razorback suckers observed in 2004 and 2005 (8-10%) represented the rate of PIT tag loss of razorback suckers in the San Juan River. The high proportion (> 30%) of razorback sucker captured from 2006-2008 without PIT tags were likely the result of stocking approximately 10,000 untagged fish from NAPI ponds in 2006 and 2007 as part of the effort to start a single cohort harvest strategy at NAPI (Ryden 2008, Morel 2011). The proportion of untagged razorback suckers declined toward the presumed baseline PIT tag loss levels as more PIT tagged razorback suckers were captured from subsequent stocking events and fewer untagged NAPI razorbacks were detected (Table 7). The untagged razorback suckers captured in 2006 and 2007 covered multiple size classes and fish < 300 mm were especially abundant (Figure 4). Starting in 2008 fewer untagged razorback suckers were in the < 300 mm size class and more were detected > 400 mm as presumed NAPI fish aged and grew in the San Juan River. Additional evidence that NAPI fish from 2006 and 2007 have grown in the San Juan River is the declining proportion of fish < 350 mm through time. Starting in 2012 all razorback suckers stocked into the San Juan River will be PIT tagged at hatcheries, hopefully reducing PIT tag loss. If PIT tag loss is reduced it increases the likelihood that untagged razorback sucker < 300 mm detected in the San Juan River could be considered wild recruits.

MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

To determine the biological response to management actions and inform adaptive management decisions, it is important to periodically summarize and analyze the Program's monitoring data. The recent stocking experiments to investigate the importance of factors like stocking season and

stocking location on subsequent survival of stocked razorback sucker have been based on large razorback sucker from Uvalde (Furr 2010, Furr 2011). Because there have been so few recaptures of razorback sucker stocked from Uvalde, these experiments should be replicated in the future to test the recommendations from Bestgen et al. (2009). The same type of survival analyses conducted by Bestgen et al. (2009) for razorback sucker could be conducted for stocked Colorado pikeminnow to further refine that augmentation effort. Additionally, because recovery goals are based on demographic criteria, the recent efforts of Duran et al. (2011) and Elverud (2011) to estimate population size of endangered Colorado pikeminnow and razorback sucker should continue into the future. Both of these analyses are based on an integrated PIT tag database, highlighting the need to continue to update this database to inform adaptive management and evaluate species status toward recovery.

The small number of razorback sucker recaptured from Uvalde is worrisome. Management efforts by Uvalde have been implemented in 2011 to minimize fish stress associated with the hauling density from Uvalde to the San Juan River to improve retention of these fish so Uvalde razorback suckers can contribute to the San Juan River's recovery demographic criteria. Although some of these individuals were recaptured during sampling efforts in the mainstem of the San Juan River and San Juan arm of Lake Powell in 2011, this revised management by Uvalde will be evaluated following a full year of monitoring in 2012.

The successful reproduction by Colorado pikeminnow and razorback sucker (Brandenburg and Farrington 2011) and recruitment of their offspring will lead to the establishment of self-sustaining population of both endangered fishes. Recruitment will be documented by capturing Colorado pikeminnow and razorback sucker in the San Juan River of appropriate size without PIT tags. Tag loss and the stocking of untagged individuals will confound the documentation of wild-spawned individuals recruiting to adult size classes. Efforts to address this include PIT tagging all razorback suckers under controlled hatchery conditions prior to delivery to NAPI or stocking into the San Juan River.

ACKNOWLEDGEMENTS

I would like to thank Howard Brandenburg, Jason Davis, Bobby Duran, Darek Elverud, Mike Farrington, Travis Francis, Weston Furr, Eliza Gilbert, Andrew Monié, James Morel, and Dale Ryden for providing the stocking and capture data used in this report. Also thanks to Steve Ross, Manuel Ulibarri, Grant Webber, and Tom Wesche for providing productive comments to improve quality of this report.

LITERATURE CITED

Bestgen K.R., K.A. Zelasko, and G.C. White. 2009. Survival of hatchery-reared razorback suckers *Xyrauchen texanus* stocked in the San Juan River Basin, New Mexico, Colorado, and Utah. Larval Fish Laboratory Contribution 160. Colorado State University, Fort Collins, CO.

Bliesner R. and V. Lamarra. 2000. San Juan River Basin Recovery Implementation Program hydrology, geomorphology, and habitat studied 1992-1998. Report to San Juan River Basin Recovery Implementation Program. Keller-Bliesner Engineering and Ecosystem Research Institute, Logan, UT.

Brandenburg, W.H. and M.A. Farrington. 2011. Colorado pikeminnow and razorback sucker larval fish survey in the San Juan River during 2010. Report to San Juan River Basin Recovery Implementation Program. American Southwest Ichthyological Researchers, Albuquerque, NM.

Duran, B.R., Davis, J.E, and E. Teller Sr. 2011. Endangered fish monitoring and nonnative fish control in the upper/middle San Juan River 2010. Report to San Juan River Basin Recovery Implementation Program. New Mexico Fish and Wildlife Service Conservation Office, U.S. Fish and Wildlife Service, Albuquerque, NM.

Durst, S.L. 2009. Evaluation of age-0 versus age-1+ Colorado pikeminnow stocking. White paper report to the San Juan River Basin Recovery Implementation Program Biology Committee. San Juan River Basin Recovery Implementation Program, Albuquerque, NM.

Elverud, D.S. 2011. Endangered fish monitoring and nonnative fish control in the lower San Juan River 2010. Draft report to the San Juan River Basin Recovery Implementation Program. Utah Division of Wildlife Resources, Moab, UT.

Furr, D.W. 2010. San Juan River razorback sucker population augmentation 2009. Report to the San Juan River Basin Recovery Implementation Program. New Mexico Fish and Wildlife Service Conservation Office, U.S. Fish and Wildlife Service, Albuquerque, NM.

Furr, D.W. 2011. San Juan River razorback sucker population augmentation 2010. Report to the San Juan River Basin Recovery Implementation Program. New Mexico Fish and Wildlife Service Conservation Office, U.S. Fish and Wildlife Service, Albuquerque, NM.

Golden, M.E., P.H. Holden, and B. Albrecht. 2006. Retention, growth, and habitat use of Colorado pikeminnow stocking as age-0 fish in the San Juan River from 2002-2005. Report to the San Juan River Basin Recovery Implementation Program. BIO-WEST, Logan, UT.

Microsoft Office. 2007. Microsoft Access.

Morel, J. 2011. Navajo Agricultural Products Industry (NAPI) razorback sucker rearing ponds 2010 annual report. Report to San Juan River Basin Recovery Implementation Program. Navajo Nation Department of Fish and Wildlife, Window Rock, AZ.

Ryden, D.W. 2008. Augmentation of the San Juan River razorback sucker population 2007. Report to the San Juan River Basin Recovery Implementation Program. Colorado River Fishery Project, U.S. Fish and Wildlife Service, Grand Junction, CO.

San Juan River Basin Recovery Implementation Program. 2011. Long-range plan. San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, NM.

TABLES AND FIGURES

Table 1. Age matrix for untagged Colorado pikeminnow based on size and date of capture. Fish > 400mm TL without a PIT tag could not be reliably aged. The breakdown of age based on size at capture and month of capture was based on personal communication with Dale Ryden.

	Month of capture											
Size at capture (TL)	Jan	Feb	Mar	April	May	June	Jul	Aug	Sept	Oct	Nov	Dec
< 100mm	Age-0											
100-190mm	Age-1											
191-240mm	Age-2									Age-1		
241-300mm	Age-2											
301-350mm	Age-3								Age-2			
351-400mm	Age-3											

Table 2. Number of Colorado pikeminnow stocked at age-0 from 2002-2011 and recaptured from 2003-2011. The number of recaptures is based only on individuals large enough to be implanted with a PIT tag during their TAG record (≥ 150 mm TL). The total number of individuals recaptured may be less than the sum of the number of individuals recaptured by year because some individuals are recaptured in multiple years. The number of individuals from a particular stocking class can be examined looking across rows. The number of individuals captured by year from different stocking classes can be examined looking across columns. Note that the total number of pikeminnow captured in any year includes those fish that could not be assigned to a particular year class. The 2010 year class pikeminnow stocked in May 2011 were age-1 fish that should have been stocked in 2010 as age-0. For the purpose of this report, all pikeminnow stocked into the San Juan River without PIT tags are considered age-0. This table does not include 426,588 age-0 (2011 year class) pikeminnow that were stocked in fall 2011 after they could have been sampled during the Program's monitoring efforts.

Year stocked	Year class	Number stocked	Total captured	Individuals captured by year								
				2003	2004	2005	2006	2007	2008	2009	2010	2011
2002	2002	210,418	211	73	132	11	0	1	0	0	0	0
2003	2003	175,928	446	-	190	233	33	2	0	0	0	0
2004	2004	280,000	341	-	-	155	183	22	5	4	2	0
2005	2005	302,270	547	-	-	-	393	138	37	11	1	4
2006	2006	313,854	507	-	-	-	-	270	224	80	7	3
2007	2007	475,970	872	-	-	-	-	1	395	476	76	20
2008	2008	270,234	2,108	-	-	-	-	-	-	899	1124	353
2009	2009	468,000	1,921	-	-	-	-	-	-	-	1042	962
2011	2010	214,720	553	-	-	-	-	-	-	-	-	553
Total individuals captured				76	323	401	624	441	662	1,482	2,271	1,922

Table 3. Number of Colorado pikeminnow stocked as age-1+ and recaptured by year, 2003-2011. The total number of individuals recaptured may be less than the sum of the number of individuals recaptured by year because some individuals are recaptured in multiple years. The number of individuals from a particular stocking class can be examined looking across rows. The number of individuals captured by year from different stocking classes can be examined looking across columns. Note that the relatively small number of age-1+ Colorado pikeminnow stocked in 2010 was due to the detection of largemouth bass virus at Dexter resulting in a quarantine of fish held at that hatchery. Those fish held over from 2010 were stocked in 2011.

Year stocked	Number stocked	Total captured	Individuals captured by year								
			2003	2004	2005	2006	2007	2008	2009	2010	2011
2003	1002	3	3	0	0	0	0	0	0	0	0
2004	1217	79	-	66	13	1	0	0	0	0	0
2005	4119	89	-	-	84	5	0	0	0	0	0
2006	12661	356	-	-	-	294	53	6	6	2	2
2007	3250	229	-	-	-	-	141	79	16	1	3
2008	4848	628	-	-	-	-	-	203	439	16	2
2009	8942	557	-	-	-	-	-	-	469	108	14
2010	353	35	-	-	-	-	-	-	-	35	8
2011	3724	265	-	-	-	-	-	-	-	-	265
Total individuals captured			11	68	99	300	194	228	930	162	294

Table 4. Number of razorback sucker stocked and recaptured by year, 2000-2011. The total number of individuals recaptured may be less than the sum of the number of individuals recaptured by year because some individuals are recaptured in multiple years. The number of individuals from a particular stocking class can be examined looking across rows. The number of individuals captured by year from different stocking classes can be examined looking across columns. Because 15,775 razorback suckers were stocked in 2011 after fish management and monitoring activities, they were not available for recapture. Thus the 93 recaptures of the 2011 stocking class should be based on 3,032 stocked individuals for the purposes of calculating a recapture rate from that stocking event. The total number of individuals captured in any year also includes individuals stocked before 2000.

			Individuals captured by year											
Year stocked	Total stocked	Total captured	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2000	1044	60	0	26	7	9	8	12	7	7	5	7	5	4
2001	688	228	-	0	43	73	61	43	32	34	26	19	18	13
2002	140	36	-	-	5	13	12	3	6	2	3	2	3	4
2003	887	71	-	-	-	54	11	5	1	2	3	1	2	2
2004	2979	570	-	-	-	-	288	174	113	65	48	56	33	55
2005	1993	139	-	-	-	-	-	68	42	25	24	15	16	20
2006	13764	234	-	-	-	-	-	-	133	72	38	38	24	33
2007	16906	768	-	-	-	-	-	-	-	499	188	115	90	74
2008	4424	227	-	-	-	-	-	-	-	-	46	144	46	31
2009	8316	685	-	-	-	-	-	-	-	-	-	43	526	186
2010	28419	961	-	-	-	-	-	-	-	-	-	-	108	862
2011	18807	93	-	-	-	-	-	-	-	-	-	-	-	93
Total individuals recaptured			14	43	68	156	381	307	338	708	382	440	873	1379

Table 5. Razorback sucker recaptures by stocking year, source, month, and location, from 2006-2010. Return rate and recapture number are based on fish collected through the 2011 monitoring effort.

Year	Source	Stocking Month	Location	Number	Recapture Number	Return Rate (%)
2006	Uvalde	11	158.6	1129	0	0.00
	6-Pack Pond 1	6,7	158.6	565	12	2.12
	6-Pack Pond 2	6,7	158.6	424	7	1.65
	6-Pack Pond 3	6,7	158.6	504	10	1.98
	6-Pack Pond 4	6,7	158.6	1002	15	1.50
	6-Pack Pond 5	6,7	158.6	260	4	1.54
	6-Pack Pond 6	6,7	158.6	530	13	2.45
	Avocet East	8	158.6	6437	131	2.04
	Hidden Pond	8	158.6	2913	42	1.44
2007	Uvalde	11	147.9	4845	0	0.00
	Dexter	4,6	158.6	1344	329	24.48
	6-Pack Pond 1	5,6	158.6	2034	63	3.10
	6-Pack Pond 2	5,6	158.6	1566	15	0.96
	6-Pack Pond 3	5,6	158.6	3073	143	4.65
	6-Pack Pond 4	5,6	158.6	1794	47	2.62
	6-Pack Pond 5	4	158.6	338	1	0.30
	6-Pack Pond 6	4	158.6	188	24	12.77
	Avocet East	7,8	158.6	180	47	26.11
	Avocet West	7,8	158.6	271	36	13.28
	Hidden Pond	8	158.6	1273	63	4.95
2008	Dexter	10	158.6	2051	76	3.71
	Hidden Pond	8	147.9	558	45	8.06
		11	166.6	1815	106	5.84
2009	Uvalde	10	158.3	1997	1	0.05
			180.2	1969	0	0.00
	Avocet East	9,10,11	166.6	1569	304	19.38
	Avocet West	9,10,11	166.6	930	266	28.60
	Hidden Pond	10,11	166.6	1851	114	6.16
2010	Uvalde	2	147.9	1999	0	0.00
			180.2	2021	0	0.00
		12	158.6	2004	0	0.00
			180.2	2110	0	0.00
		10	147.9	5988	30	0.50
		11	166.6	6127	2	0.03
	Avocet East	8,9,10,11	166.6	3122	96	3.07
	Avocet West	9,10,11	166.6	2613	387	14.81
	Hidden Pond	10,11	166.6	2435	446	18.32

Table 6. Razorback sucker recaptures by stocking year, NAPI grow out pond, and harvest type. Return rate and recapture number are based on fish collected through the 2011 monitoring effort.

Year	Source	Harvest type	Number		Return rate (%)
			Stocked	Recaptured	
2009	NAPI-Avocet East	Active	1293	256	19.80
		Passive	276	48	17.39
	NAPI-Avocet West	Active	560	170	30.36
		Passive	370	96	25.95
	NAPI-Hidden Pond	Active	1798	109	6.06
		Passive	53	5	9.43
2010	NAPI-Avocet East	Active	2297	22	0.96
		Passive	825	74	8.97
	NAPI-Avocet West	Active	1621	263	16.22
		Passive	992	124	12.50
	NAPI-Hidden Pond	Active	2236	433	19.36
		Passive	199	13	6.53

Table 7. Number of individual razorback sucker captured with and without PIT tags, 2004-2011. Percent without PIT tags represents the percent of razorback sucker captured without PIT tags out of total number of razorback sucker individuals captured.

Year	Individuals captured			Percent without PIT tags
	Total	with PIT tags	without PIT tags	
2004	415	381	34	8.19
2005	341	307	34	9.97
2006	551	338	213	38.66
2007	1065	708	357	33.52
2008	566	382	184	32.51
2009	624	440	184	29.49
2010	1037	873	164	15.81
2011	1633	1379	254	15.55

Figure 1. Map of San Juan River including river mile (RM) and Reach designations. Top panel (A) shows the lower San Juan River and the bottom panel (B) shows the upper San Juan River.

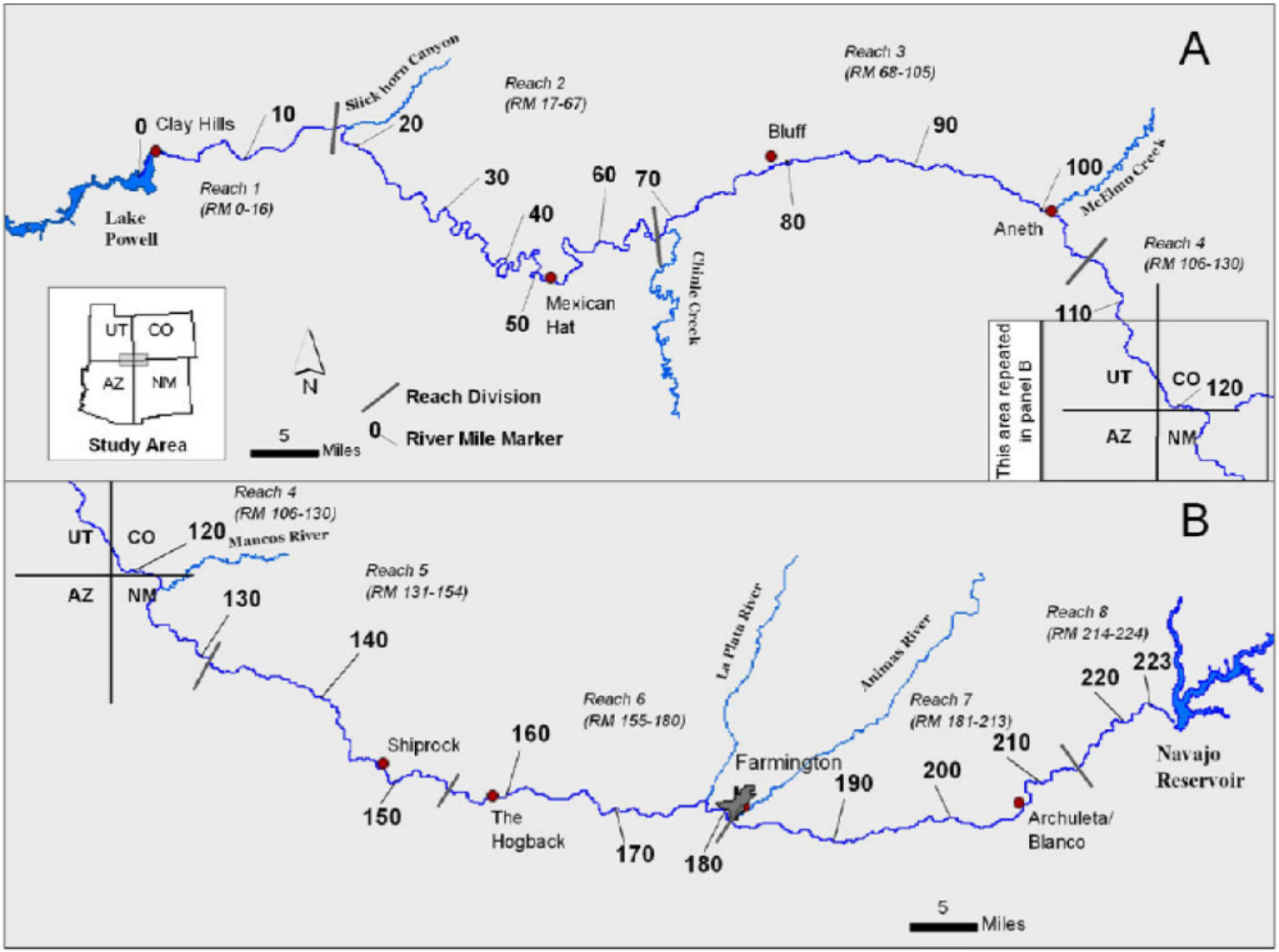


Figure 2. Distribution of Colorado pikeminnow encounters from 2009-2011. Pikeminnow stocked at age-0 and age-1+ are included in this figure. Numeric locations on the x-axis represent river miles within the San Juan River.

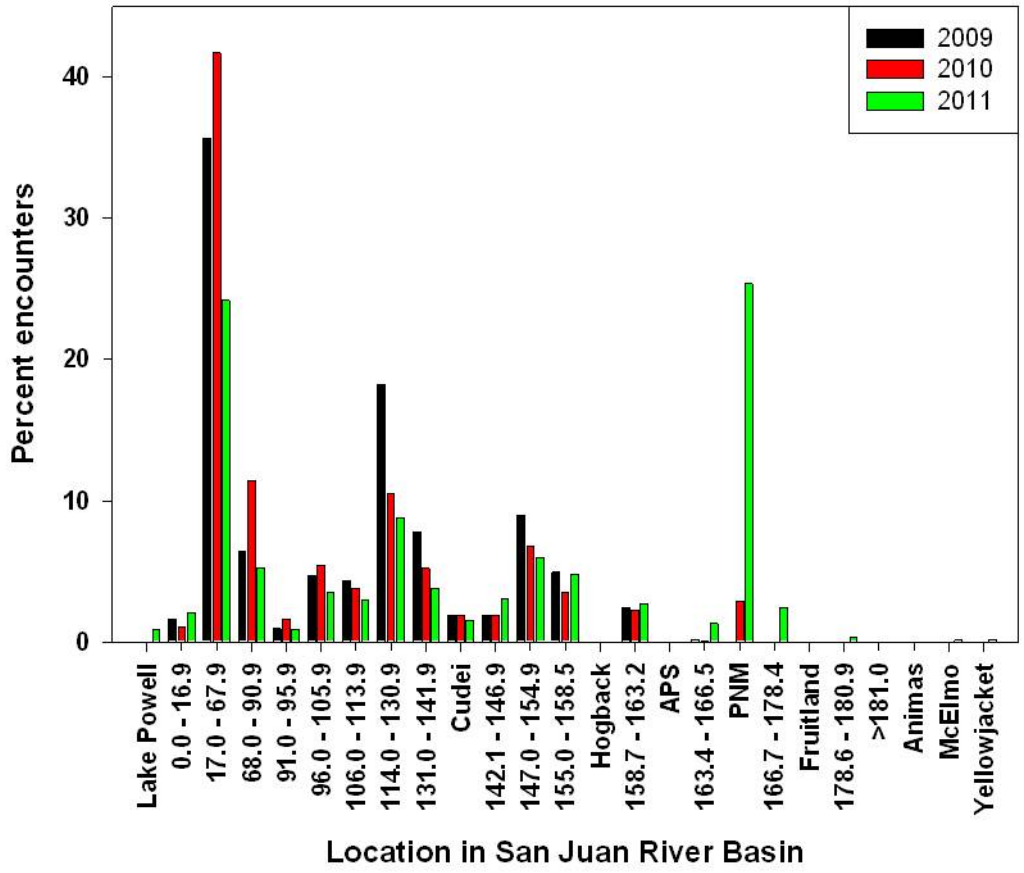


Figure 3. Distribution of razorback sucker encounters from 2009-2011. Numeric locations on the x-axis represent river miles within the San Juan River.

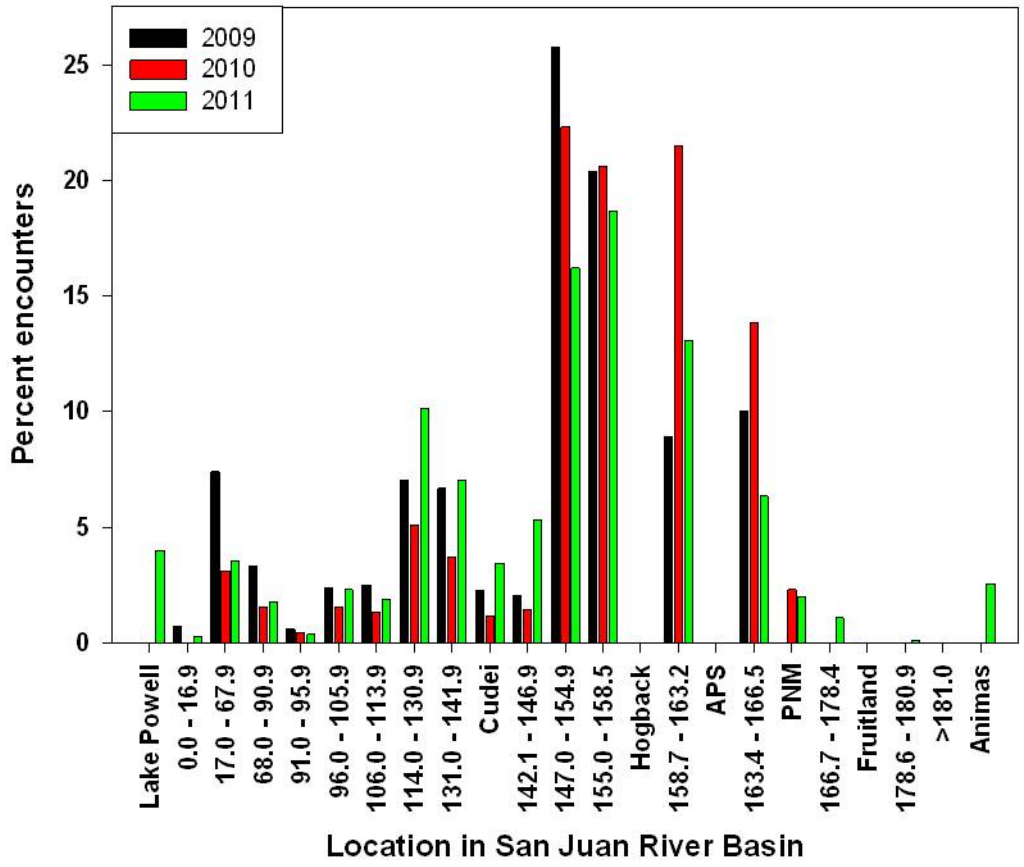
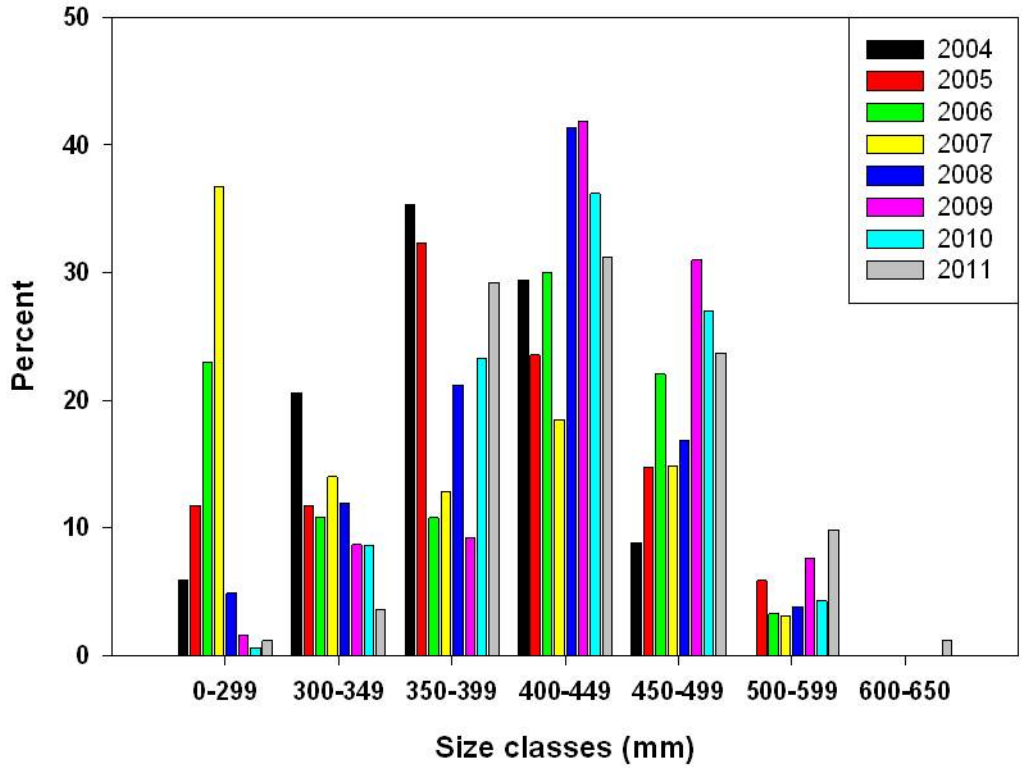


Figure 4. Length frequency distribution of razorback sucker individuals captured without PIT tags by year, 2004-2011.



Appendix 1. The flowing table and field definitions are the metadata document that describes the FIRST_ENC and CAPTURE tables in both the Colorado pikeminnow and razorback sucker databases. There is a one-to-many relationship on the MR_TAG field between the FIRST_ENC and CAPTURE tables.

Field name and data types for CAPTURE and FIRST_ENC Tables

Field Name	Data Type	Type	Size
MR_TAG	Text	Text	20
Species	Text	Text	6
Sample	Text	Text	50
Study	Text	Text	50
Date	Date/Time	Date/Time	
RIVER	Text	Text	50
RM	Number	Decimal	
Gear	Text	Text	50
PITIDNO_400khz	Text	Text	10
PITIDNO_134khz	Text	Text	13
Other_Tag	Text	Text	50
TL	Number	Decimal	
WT	Number	Decimal	
Sex	Text	Text	1
Tubercles	Text	Text	1
Ripe	Text	Text	1
YearClass	Number	Integer	
Source	Text	Text	50
ReCap_Number	Number	Integer	
Days_In_River	Number	Integer	
Contact_Type	Text	Text	10
Mortality	Text	Text	2
Harvest	Text	Text	1
Comments	Memo	Memo	

Field Descriptions:

MR_TAG = Most Recent Tag – If fish is implanted with 134 khz tag then this tag number appears here (superseding 400 khz tag if it is also present), if the fish has only been implanted with an older 400 khz tag then that number appears here. This field is used to link the CAPTURE and FIRST_ENC Tables. It is an indexed field in each table, duplicates are allowed in the CAPTURE Table but not the FIRST_ENC Table. I can update this field when I compile the data each January.

Species = Species – Fish species code: PYTLUC = *Ptychocheilus lucius* (Colorado pikeminnow); XYRTEX = *Xyrauchen texanus* (razorback sucker). This field is limited to 6 characters.

Sample = Sample – Sample number of collection or sighting.

Study = Study – The name of the study that this fish encounter occurred.

Date = Date – Date of fish encounter, formatted: yyyy/mm/dd. Note that if the date field is in numeric format it needs to be changed to the appropriate date format. To change number to date in Excel use formula: =DATE(LEFT(A1,4),MID(A1,5,2),RIGHT(A1,2)).

RIVER = River – River where encounter occurred.

RM = River Mile – River mile where encounter occurred recorded to one decimal point.

Gear = Gear – Method that fish was encountered.

PITIDNO_400khz = PIT Tag Number (400khz) – Old PIT tag number (10 digits). This field is formatted to only accept 10 digit entries.

PITIDNO_134khz = PIT Tag Number (134khz) – New PIT tag number (13 digits). This field is formatted to accept only 13 digit entries

Other_Tag = Other Tag – Other indentify tag or number on fish. PIT tags that are not in a 10 or 13 digit format should also be entered here.

TL = Total Length – Total length of fish (mm). No decimal places.

WT = Weight – Weight of fish (g). No decimal places.

Sex = Sex – Sex of fish; F = Female, M = Male, I = Indeterminate. The field has formatted to only accept F, M, or I values.

Tubercles = Tubercles? – Did the fish have tubercles (Y = Yes, N = No). The field is formatted to only accept Y or N. Consider null field as “No.”

Ripe = Ripe? – Was the fish freely expressing gametes (Y = Yes, N = No). The field is formatted to only accept Y or N. Consider null field as “No.”

YearClass = Year Class – Year class that fish was grown from prior to stocking. Note that Colorado pikeminnow captured and tagged (TAG Contact Type) do not have a record of a stocking event and thus

do not have a known year class. Based on conversation with Dale Ryden, these pikeminnow can be assigned a year class based on their size and the date of their first capture (TAG).

Source = Stocking Source – The source of stocked fish, including hatchery or growout pond.

ReCap_Number = Recapture Number – Number of times fish has been recaptured, stocked fish (STOCK) or new captures (TAG) have a recapture number of zero. I update this field using formula in Excel =COUNTIF(K2:K16,K2) with PIT tag number in first column and date in second column in order to get a count of number of records. PIT tags are arranged in alphabetical order and date is from newest to oldest.

Days_In_River = Day in river – Number of days between stocking (or initial capture) and this recapture. For TAG fish with estimated year class, this number is not back calculated to their estimated stocking date. It only reflects the difference in dates between a CAPTURE record and a FIRST ENCOUNTER record (TAG or STOCK). I use a query in Access to update this field.

Contact_Type = Contact type – How the fish was encountered; "STOCK" for initially stocked fish, "TAG" for an individual captured and implanted with a PIT tag (also includes individuals without stocking information), and "CAPTURE" for all subsequent encounters

Mortality = Mortality – Indicates a fish that was encountered dead or died during handling (M = Mortality, RA = Released alive). Any mortality should be detailed in the comments field. Consider null field as "RA."

Harvest = Harvest – Indicate that the fish was actively (A) or passively (P) harvested out of growout ponds.

Comments = Comments – Any notes related to fish encounter