# 2010 INTEGRATED PIT TAG DATABASE SUMMARY OF COLORADO PIKEMINNOW AND RAZORBACK SUCKER IN THE SAN JUAN RIVER

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## 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, stocking, and fish passage projects. Most Colorado pikeminnow encountered in 2010 were stocked at age-0 and relatively few pikeminnow stocked in any age class were encountered in the San Juan River after three years post-stocking. The majority of pikeminnow detections were in the same Reach where they were initially encountered but the recapture rate of pikeminnow first detected in Reach 2 was higher than other Reaches. The return rate of stocked razorback suckers varied through time but numerous individuals were detected three or more years post-stocking. Most razorback suckers were encountered in Reaches 5 and 6, near where they were stocked at the Hogback Diversion. Only one razorback sucker was recaptured out of all stocking events from Uvalde National Fish Hatchery but high flows following stocking did not account for the limited razorback sucker recaptures from these stocking events. 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 release 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 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 (Davis et al. 2010, Elverud 2010).

In this summary I was able to use the integrated PIT tag database 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. In this report I will present the summary of the stocking, capture, recapture, and distribution information for Colorado pikeminnow and razorback sucker along with an examination of razorback sucker stocking and subsequent recapture versus flow conditions at stocking.

## METHODS

The data I included in this summary and analysis came from all management and monitoring efforts in the San Juan River that collect PIT tag data. PIT tag data were provided by Dexter National Fish Hatchery and Technology Center (Dexter), Uvalde National Fish Hatchery (Uvalde), Navajo Agricultural Production Industry Ponds (NAPI), small-bodied and adult monitoring, upper and lower San Juan non-native fish removal, and the fish passage at PNM

Weir (Table 1). These activities cover 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 there number of records in the source file differ from the number imported into the database indicates errors such as duplicate PIT tag values or PIT tag values with missing or extra characters that were not imported (Table 1). I imported the proofed PIT tag data for Colorado pikeminnow and razorback sucker into two separate MS Access 2007 files (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 summary tables and raw data for the analyses presented in this report.

Colorado pikeminnow stocked at age-0 were too small to be implanted with a PIT tag when they were stocked. 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 are detected to assume that there is any recruitment of wild-produced individuals (Brandenburg and Farrington 2010). Only those pikeminnow ≥ 150 mm 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 the analyses presented herein because they were too small to implant with a PIT tag. 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 (personal communication Dale Ryden;

Table 2). This allowed me to assign TAG records to a particular stocking year to calculate overall recapture rates for all age-0 pikeminnow stocking 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. These fish that could not be assigned to a year class were not included in summaries or analyses based on a particular stocking class. Thus results presented herein are biased against large Colorado pikeminnow; however, these cases are relatively rare (there are only 49 Colorado pikeminnow TAG records of fish > 400 mm).

I examined the distribution and movement patterns of Colorado pikeminnow stocked as age-0 and age-1+ over 2007-2009 and razorback suckers stocked in 2004, 2007, and 2009. I used these three years because of the abundant numbers of recaptures of fish stocked during those years. To look at broad movement and distributional patterns, I examined the numbers of fish encountered by geomorphic reach (Bliesner and Lamarra 2000; Figure 1). For Colorado pikeminnow stocked at age-0, I examined the Reach of the TAG encounter, the first recapture, and lumped together all subsequent recaptures. For Colorado pikeminnow stocked at age-1+ and razorback sucker, I examined the Reach of the first recapture, second recapture, and lumped together all subsequent recaptures. Because there were relatively few individuals encountered more than three times, I combined all captures including and following the third encounter. In some cases the total number of captures by Reach across subsequent encounters may differ because of missing location information for particular records. Note that the captures of fish (both TAG and CAPTURE records) do not necessarily occur sequentially following a particular stocking year (i.e., there can be gaps in the encounter history when individuals are not detected). The analysis is only based on the sequential capture or recapture events so temporal factors associated with annual variation that influence fish distribution and movement patterns may be obscured.

I used the last four water years, 2007-2010, to examine relationships of flow conditions at the time of razorback sucker stocking on subsequent recaptures from those stocking events. I classified stockings that occurred over multiple days under relatively similar flow conditions (i.e. spring peak, base flow, or summer monsoon) into 15 “stocking events.” To characterize the average flow conditions surrounding each stocking event, I calculated a buffered daily mean flow at Bluff (USGS gage # 09379500) as the mean daily flow for the length of each stocking

event buffered by the week prior and following the stocking event. Because razorback sucker stocked in earlier years have been subject to more management and monitoring passes, all things being equal, it is likely that individuals from those stocking events will have higher recapture rates.

To identify those razorback sucker stocking events that resulted in few recaptures, I summarized the number of recaptures from stockings events from 2006-2010 by stocking source, month stocked, and stocking location.

## RESULTS AND DISCUSSION

Following the 2010 update, the Colorado pikeminnow and razorback sucker PIT tag databases contained 46,548 and 90,809 records, respectively. The FIRST_ENC tables, containing both STOCK and TAG records, had a total of 42,730 Colorado pikeminnow records and 85,983 razorback sucker records. The CAPTURE tables had 3,818 and 4,826 records for Colorado pikeminnow and razorback sucker, respectively. Because there are some recaptures of the same individual, the number of encounters and number of individuals presented in this report are likely different.

### Summary of stocked Colorado pikeminnow and razorback sucker recaptures

Across all management and monitoring efforts a total of 2,990 Colorado pikeminnow were encountered in 2010. About 85% of pikeminnow encountered in 2010 were fish that were either first captured and implanted with a PIT tag in 2010 or recaptures of pikeminnow that were implanted with a PIT tag earlier in 2010 (TAG records; Figure 2). Only 7.5% of pikeminnow encountered in 2010 were fish that were stocked into the San Juan River with a PIT tag (STOCK records; Figure 2). There were only nine encounters of pikeminnow that have been in the river for more than three years from their first encounter record (either STOCK or TAG). Note that the total number of pikeminnow encounters includes individuals that are not in the subsequent summaries because some individuals could not reliably be assigned to a year class. The relatively small number of Colorado pikeminnow encountered in 2010 that had STOCK records

was in part due to the small number of age-1+ pikeminnow that were stocked into the San Juan River in 2010. The limited numbers of Colorado pikeminnow encounters in 2010 that were first encountered in the San Juan River prior to 2009 (both STOCK and TAG records) suggests there are relatively few pikeminnow that persist multiple years post-stocking.

There were 2,252 individual Colorado pikeminnow captured in 2010 that were stocked as age-0 fish (Table 3). Most of these fish were assigned to the 2008 and 2009 year classes and only 4% of individuals were age-3 or older (Table 3). Note that there are Colorado pikeminnow TAG records from 2010 in the encounter summary that are not included in this total because they 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 (Davis et al. 2010). During the period from 2008-2010, with similar year-to-year sampling effort, 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. These captures represented individuals from multiple stocking years. Colorado pikeminnow stocked at age-0 are normally available for capture one year post-stocking and there was no upward trend in age-0 pikeminnow stocking numbers from 2007-2009 (Table 3). This increase in the number of Colorado pikeminnow (stocked at age-0) captured over time appears due to some factor or combination of factors apart from stocking numbers and sampling effort. While the overall recapture rate of pikeminnow stocked at age-0 remains low, such large numbers of age-0 pikeminnow can be stocked on an annual basis that subsequent sampling efforts have captured over 1,000 individuals from the last two stocking classes. The 1,042 pikeminnow captured from the 2009 stocking class will likely increase following sampling efforts in 2011 if the recent pattern of numerous individuals captured one and two years post-stocking repeats. 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, there are some individuals from stocking classes as old as 2004 that have persisted in the San Juan River, suggesting that these stocked individuals could form a small group of reproducing pikeminnow.

Only 162 Colorado pikeminnow stocked as age-1+ were recaptured in 2010 (Table 4). This was over five-times fewer than the number of pikeminnow recaptured in 2009 stocked as age-1+ but only 353 age-1 and age-2 pikeminnow were stocked in 2010 compared to 6,000 age-2 and 2,942 age-3 pikeminnow in 2009 (Table 4). 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, when only 108 pikeminnow from the 2009 stocking class were captured compared to the 469 pikeminnow from that same stocking class in 2009. Although the reasons for the decline in the number of Colorado pikeminnow stocked as age-1+ captures are unclear, the number captured three or more years post-stocking remained relatively constant indicating that there are some, although few, older Colorado pikeminnow that persist in the San Juan River. The Program will cease 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).

Across all management and monitoring efforts there were a total of 1,349 razorback sucker encountered in 2010 (Figure 3). About 48% of all razorback sucker encountered in 2010 were 2007 year class fish stocked in 2009 (Figure 3). Although most razorback sucker recaptures came from the 2009 and 2010 stocking classes, 104 razorback suckers were captured in 2010 that were first detected in the San Juan River from 1995-2005 (Figure 3). The persistence of hatchery-reared razorback sucker along with the collection of larval razorback sucker (Brandenburg and Farrington 2010) 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 class. There were 164 newly captured TAG records in 2010 that averaged 421 mm TL (range: 224-555 mm). Because razorback suckers as small as 222 mm TL were stocked in 2010 (Furr 2011), tag loss and not wild-recruitment seems the most likely explanation for the capture of these individuals without PIT tags.

From 2000 to 2010 there was high variability in the recapture rate of stocked razorback sucker (Table 5). The previous analysis by Bestgen et al. (2009) identified factors such as size at stocking, stocking location and month, and annual variation as important in predicting survival of stocked razorback sucker. Typically there were many captures of razorback suckers in the same year they were stocked and both new captures and recaptures of individuals from a particular stocking class persist for many years after they were stocked (Table 5). Note that because 22,383 razorback suckers were stocked following fish management and monitoring efforts in the San Juan River, the recapture rate of the 108 razorbacks captured in 2010 should be based on only 6,036 stocked individuals.

Movement and distribution patterns

In 2007, 2008, and 2009, a total of 1,214,204 age-0 Colorado pikeminnow were stocked at RM 134.5, 166.6, and 170.5-180.2. Most age-0 Colorado pikeminnow (over 75%) were stocked at RM 166.6 from 2007 to 2009. In subsequent management and monitoring efforts 3,853 of these pikeminnow stocked at age-0 were captured and implanted with a PIT tag (i.e., the TAG encounter). Most TAG encounters occurred in Reaches 5, 4, 3, and 2 (88%; Table 6). These four Reaches had between 713 and 1,090 TAG encounters each. Of the 630 first recaptures following the TAG encounter, 69% were in the same Reach as the TAG record, suggesting that pikeminnow stocked at age-0 tend not to move from the Reach they were initially detected. This pattern was largely driven by the 297 first recaptures of pikeminnow in Reach 2 that were initially encountered in Reach 2. Subsequent recaptures revealed similar patterns, 72% occurred in the same Reach as the first recapture, and again this pattern was largely driven by the 128 recaptures of pikeminnow in Reach 2 (of 351 pikeminnow that were first recaptured there). The higher recapture rate of pikeminnow stocked as age-0 that were initially detected in Reach 2 may indicate the habitat suitability of that Reach. While there were some cases of between Reach movement, they were rare compared to the overall pattern Colorado pikeminnow stocked as age-0 remaining within the Reach were they were first detected in the San Juan River.

From 2007 to 2009 a total of 17,040 age-1+ Colorado pikeminnow were stocked between RMs 133.5 and 134.9 and at RM 180.2. Almost all of these (94%) were stocked in the lower portion

of Reach 5 (between RMs 133.5 and 134.9). All age-1+ Colorado pikeminnow stocked into the San Juan River were implanted with a PIT tag prior to stocking. During subsequent fish management and monitoring efforts, there were 1,414 first recaptures of Colorado pikeminnow stocked at age-1+. The majority of these first recaptures (91%) were in Reaches 2, 4, and 5. Between 372 and 469 first recaptures occurred in each of these three Reaches. While numerous pikeminnow moved downstream to Reach 2 after stocking (469), many remained near their stocking location (817 were captured in the lower portion of Reach 5 and the upper portion of Reach 4). Of the 303 total second recaptures of Colorado pikeminnow stocked as age-1+, 72% were captured in the same Reach as the first recapture. This pattern was largely driven by the 159 second recaptures of pikeminnow in Reach 2 that were initially recaptured in Reach 2. Thus most Colorado pikeminnow stocked at age-1+ do not move from the Reach they were first detected following stocking. Subsequent recaptures revealed similar patterns, 76% of these were in the same Reach as the second encounter. The higher recapture rate of Colorado pikeminnow stocked as age-1+ that were initially encountered in Reach 2 was similar to the pattern observed for pikeminnow stocked as age-0 and may be further indication of the habitat suitability of this Reach for Colorado pikeminnow (Table 7).

In 2004, 2007, and 2009 there was a total of 28,166 razorback sucker stocked into the San Juan River. Most of these (69%) were stocked at the Hogback Diversion (RM 158.6; in the lower part of Reach 6). All razorback sucker stocked into the San Juan River were implanted with a PIT tag prior to stocking. Fish management and monitoring efforts collected 1,832 razorback sucker first recaptures, 76% were in Reaches 5 and 6, just up and downstream of the primary stocking location at Hogback. Most razorback sucker second recaptures were in Reaches 5 and 6, additionally 79% of second captures documented fish remaining in those same Reaches or moving between those two Reaches from their first recapture. Of 274 third and subsequent razorback sucker recaptures, 87% were again in Reaches 5 and 6, the same Reaches where they were captured their second time. The high degree of retention of razorback sucker in Reaches 5 and 6 and movements between these two Reaches suggests most razorback sucker remain close to the area where they are stocked into the San Juan River (Table 8). Alternatively, the retention of razorback sucker in Reaches 5 and 6 may indicate the habitat suitability of those Reaches.

While there were cases of razorback sucker long distance movements, these events are rare compared to the overall trend that razorback suckers remain near their stocking location.

Effect of flow during stocking on subsequent recaptures of razorback sucker

Razorback suckers were stocked under spring peak, summer monsoon, and base flow conditions from 2006 to 2010 (Table 9). I classified razorback sucker stockings into 15 events between the 2007 and 2010 water years. The buffered mean daily flow of these events averaged 1,120 cfs and was as high as 3,687 cfs during spring runoff in 2007 and less than 600 cfs during the summer of 2008 and fall of 2009 (Table 9). Some razorback sucker stocking events have yielded zero or one recaptures, I tested the hypothesis that high flow events temporally close to a stocking event would result in lower recapture rates of those stocked individuals. I plotted the recapture rates of those 15 stocking events against the buffered mean daily flow at Bluff and there was no significant linear relationship between these two variables ($R^2 = 0.048$, $p = 0.43$; Figure 4). Thus there appears to be some non-flow related factor driving cases of zero and one recaptures from multiple stocking events. Removing the one week buffer prior to the stocking event resulted in an average difference between the un-buffered and buffered mean daily flow of only 43.5 cfs, suggesting there was no effect of including the buffer on the interpretation of these results.

Further examination of cases of zero recapture from razorback sucker stocking events

From 2006-2010 razorback sucker were stocked into the San Juan River from Dexter National Fish Hatchery and Technology Center (Dexter), Uvalde National Fish Hatchery (Uvalde), and the Navajo Agricultural Product Industry (NAPI) grow out ponds: 6-Pack Ponds, Avocet East, Avocet West, and Hidden Pond (Table 10). 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 10). The stocking events with zero or one razorback sucker recapture were from Dexter in 2006, Uvalde in 2007, Uvalde in 2009, and Uvalde in 2010. A total of 29,060 razorback sucker were stocked into the San Juan River from Uvalde over 2007-2010. These stockings have resulted in

a single recaptured razorback sucker. Because 16,229 razorback suckers from Uvalde were stocked in the San Juan River in 2010 following fish management and monitoring activities, there was no opportunity to sample these individuals, thus the recapture rate for the single razorback sucker should be based on 12,831 rather than 29,060 stocked fish. Fish sampling efforts in Lake Powell and the mainstem San Juan River in 2011 may encounter some of these razorback sucker that have thus far gone undetected. The fate of these undetected individuals is unknown and in the absence of recaptures of these individuals in 2011, it seems safe to assume they have not survived.

## MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

In order to inform adaptive management decisions, the analysis of Bestgen et al. (2009) on the survival of stocked razorback sucker should be periodically repeated. The recent stocking experiments to tease apart 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. Because there have been so few recaptures of razorback sucker stocked from Uvalde, these experiments should be replicated in the future. The same type of survival analyses 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 Davis et al. (2010) and Elverud (2010) 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 recaptures from Uvalde is worrisome. While some of these individuals may be recaptured during sampling efforts in the mainstem of the San Juan River and San Juan arm of Lake Powell in 2011, especially of those stocked after the cessation of sampling efforts in 2010, investigations should be immediately started to determine the fate of razorback sucker from Uvalde. Hypotheses for why razorback sucker stocked from Uvalde are not being recovered in the San Juan River include fish stress associated with the hauling distance or hauling density from Uvalde to the San Juan River or differences in water chemistry between

Uvalde and the San Juan River. Because razorback suckers will continue to be stocked into the San Juan River, every effort should be made to identify and resolve these issues so Uvalde razorback suckers can contribute to the San Juan River's recovery demographic criteria.

The successful reproduction by Colorado pikeminnow and razorback sucker (Brandenburg and Farrington 2010) and eventual recruitment of their offspring will lead to eventual establishment of self-sustaining population of both endangered fishes. It should be noted that 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. At some point the Program will need to make efforts to minimize this confounding effect.

Because many Colorado pikeminnow and razorback sucker appear to be repeatedly captured near their stocking locations, investigations should be conducted to stock both species further upstream to both relieve densities in current stocking locations but to also encourage spawning further upstream allowing larvae additional space to drift in the San Juan River.

Colorado pikeminnow initially detected in Reach 2 appear to have a higher recapture rate compared to pikeminnow initially detected in other Reaches. Are there habitat features in Reach 2 that result in greater survival of Colorado pikeminnow that inhabit this Reach? It is also possible that Reach 2 contains features that result in higher detection probability of Colorado pikeminnow that use that Reach. As the Program moves forward investigating mechanical habitat enhancement, this observation should be explored to inform the Program's adaptive management process.

In order to more efficiently analyze and summarize the effects of factors such as fish condition or the effect of soft versus hard stocking, additional fields should be added to the database for both species. Analyses based on notes made in the comments field are cumbersome and time consuming and the process would be simplified if each factor of interest had a field in the database dedicated to it.

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TABLES AND FIGURES

Table 1. Colorado pikeminnow and razorback sucker PIT tag data by source imported into database, 2010. The difference in the number of records in the source file and the number imported into the database is largely due to internal duplicates within the source file and duplicates with records that were already in the database.

| | Colorado pikeminnow records | | Razorback sucker records | |
|---|---|---|---|---|
| Source | In source file | Imported to database | In source file | Imported to database |
| Stocking, Dexter | 355 | 353 | - | - |
| Stocking, Uvalde | - | - | 20,280 | 20,249 |
| Stocking, NAPI | - | - | 8,204 | 8,170 |
| Non-native removal, lower river | 1,191 | 1,183 | 42 | 40 |
| Non-native removal, upper river | 1,449 | 1,285 | 1,143 | 1,130 |
| Adult monitoring | 414 | 408 | 148 | 148 |
| Small-bodied monitoring | 11 | 9 | - | - |
| Fish passage | 89 | 87 | 31 | 31 |
| Tributary surveys | 6 | 6 | - | - |

Table 2. Age matrix for untagged Colorado pikeminnow based on size and date of capture. Fish over 400mm TL without a PIT tag could not be reliably aged. Pikeminnow that could not be reliably aged were left out of subsequent analyses. 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 3. Number of Colorado pikeminnow stocked at age-0 from 2002-2009 and recaptured from 2003-2010. The number of recaptures is based only on individuals large enough to be implanted with a PIT tag during their TAG record (≥ 150mm TL). Thus the total number of Colorado pikeminnow stocked at age-0 captured in any given year exceeds the numbers presented here. 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.

| Year class | Number stocked | Total captured | Individuals captured by year | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| 2002 | 210,418 | 211 | 73 | 132 | 11 | 0 | 1 | 0 | 0 | 0 |
| 2003 | 175,928 | 446 | - | 190 | 233 | 33 | 2 | 0 | 0 | 0 |
| 2004 | 280,000 | 341 | - | - | 155 | 183 | 22 | 5 | 4 | 2 |
| 2005 | 302,270 | 547 | - | - | - | 393 | 138 | 37 | 11 | 1 |
| 2006 | 313,854 | 507 | - | - | - | - | 270 | 224 | 80 | 7 |
| 2007 | 475,970 | 872 | - | - | - | - | 1 | 395 | 476 | 76 |
| 2008 | 270,234 | 1,945 | - | - | - | - | - | - | 899 | 1,124 |
| 2009 | 468,000 | 1,042 | - | - | - | - | - | - | - | 1,042 |

Table 4. Number of Colorado pikeminnow stocked as age-1+ and recaptured by year, 2003-2010. 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 will be stocked in 2011.

| Year | Number | Total | Individuals captured by year | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| stocked | stocked | captured | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| 2003 | 1,002 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2004 | 1,217 | 79 | - | 66 | 13 | 1 | 0 | 0 | 0 | 0 |
| 2005 | 4,119 | 89 | - | - | 84 | 5 | 0 | 0 | 0 | 0 |
| 2006 | 12,661 | 356 | - | - | - | 294 | 53 | 6 | 6 | 2 |
| 2007 | 3,250 | 229 | - | - | - | - | 141 | 79 | 16 | 1 |
| 2008 | 4,848 | 628 | - | - | - | - | - | 203 | 439 | 16 |
| 2009 | 8,942 | 557 | - | - | - | - | - | - | 469 | 108 |
| 2010 | 353 | 35 | - | - | - | - | - | - | - | 35 |

Table 5. Number of razorback sucker stocked and recaptured by year, 2000-2010. 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 16,229 razorback suckers were stocked in 2010 following fish management and monitoring activities when they would have had an opportunity to be recaptured. Thus the 108 recaptures of the stocking class in 2010 should be based on 12,190 stocked individuals for the purposes of calculating a recapture rate from that stocking event.

| | | | Individuals captured by year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year stocked | Total stocked | Total captured | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| 2000 | 1,044 | 58 | 0 | 26 | 7 | 9 | 8 | 12 | 7 | 7 | 5 | 7 | 5 |
| 2001 | 688 | 223 | - | 0 | 43 | 73 | 61 | 43 | 32 | 34 | 26 | 19 | 18 |
| 2002 | 140 | 34 | - | - | 5 | 13 | 12 | 3 | 6 | 2 | 3 | 2 | 3 |
| 2003 | 887 | 71 | - | - | - | 54 | 11 | 5 | 1 | 2 | 3 | 1 | 2 |
| 2004 | 2,979 | 547 | - | - | - | - | 288 | 174 | 113 | 65 | 48 | 56 | 33 |
| 2005 | 1,993 | 132 | - | - | - | - | - | 68 | 42 | 25 | 24 | 15 | 16 |
| 2006 | 13,764 | 222 | - | - | - | - | - | - | 133 | 72 | 38 | 38 | 24 |
| 2007 | 16,906 | 731 | - | - | - | - | - | - | - | 499 | 188 | 115 | 90 |
| 2008 | 4,424 | 216 | - | - | - | - | - | - | - | - | 46 | 144 | 46 |
| 2009 | 8,316 | 566 | - | - | - | - | - | - | - | - | - | 43 | 526 |
| 2010 | 28,419 | 108 | - | - | - | - | - | - | - | - | - | - | 108 |

Table 6. Distribution of Colorado pikeminnow stocked at age-0 in 2007-2009 by Reach for the TAG encounter, first recapture, and second and subsequent recaptures. The top table details the number of TAG encounters by Reach and the number of first recaptures of those previous TAG encounters by Reach. The bottom table details the number of first recaptures by Reach and the number of subsequent recaptures of those previous first recaptures by Reach. Reading across rows are the numbers of recaptures by Reach based on location of the previous encounter (TAG or first recapture). Reading down columns are the numbers of first and subsequent recaptures by Reach.

| TAG Encounters | | First Recapture by Reach | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number | Reach | Lake Powell | 1 | 2 | 3 | 4 | 5 | 6 | Total by row |
| 0 | Lake Powell | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 1 | 0 | 2 | 6 | 0 | 0 | 1 | 0 | 9 |
| 1,090 | 2 | 0 | 5 | 297 | 24 | 5 | 10 | 8 | 349 |
| 800 | 3 | 0 | 0 | 12 | 43 | 6 | 5 | 4 | 70 |
| 713 | 4 | 0 | 0 | 17 | 11 | 23 | 7 | 4 | 62 |
| 781 | 5 | 0 | 0 | 14 | 5 | 7 | 45 | 7 | 78 |
| 431 | 6 | 0 | 0 | 5 | 3 | 3 | 28 | 23 | 62 |
| Total by column | | 0 | 7 | 351 | 86 | 44 | 96 | 46 | 630 |

| First Recaptures | | Second and Greater Recapture by Reach | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number | Reach | Lake Powell | 1 | 2 | 3 | 4 | 5 | 6 | Total by row |
| 0 | Lake Powell | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| 351 | 2 | 0 | 0 | 128 | 14 | 6 | 10 | 6 | 164 |
| 86 | 3 | 0 | 0 | 2 | 6 | 1 | 3 | 3 | 15 |
| 44 | 4 | 0 | 0 | 1 | 0 | 4 | 1 | 0 | 6 |
| 96 | 5 | 0 | 0 | 4 | 1 | 0 | 9 | 2 | 16 |
| 46 | 6 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 6 |
| Total by column | | 0 | 0 | 137 | 21 | 11 | 26 | 14 | 209 |

Table 7. Distribution of Colorado pikeminnow stocked as at age-1+ in 2007-2009 by Reach for the first recapture, second recapture, and third and subsequent recaptures. The top table details the number of first recaptures by Reach and the number of second recaptures of those previous first recaptures by Reach. The bottom table details the number of second recaptures by Reach and the number of subsequent recaptures of those previous second recaptures by Reach. Reading across rows are the numbers of recaptures by Reach based on location of the previous encounter (first or second recapture). Reading down columns are the numbers of second and subsequent recaptures by Reach.

| First recaptures | | Second Recapture | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number | Reach | Lake Powell | 1 | 2 | 3 | 4 | 5 | 6 | Total by row |
| 0 | Lake Powell | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 59 | 1 | 0 | 3 | 8 | 0 | 0 | 0 | 0 | 11 |
| 469 | 2 | 0 | 3 | 159 | 6 | 2 | 2 | 1 | 173 |
| 53 | 3 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 4 |
| 445 | 4 | 0 | 1 | 14 | 9 | 33 | 10 | 0 | 67 |
| 372 | 5 | 0 | 4 | 13 | 2 | 8 | 18 | 2 | 47 |
| 16 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total by column | | 0 | 11 | 194 | 20 | 43 | 31 | 4 | 303 |

| Second Recaptures | | Third and Greater Recapture | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number | Reach | Lake Powell | 1 | 2 | 3 | 4 | 5 | 6 | Total by row |
| 0 | Lake Powell | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 1 | 0 | 2 | 2 | 1 | 0 | 0 | 0 | 5 |
| 194 | 2 | 0 | 1 | 49 | 1 | 1 | 1 | 2 | 55 |
| 20 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 4 | 0 | 0 | 0 | 2 | 2 | 1 | 0 | 5 |
| 31 | 5 | 0 | 0 | 2 | 0 | 0 | 1 | 3 | 6 |
| 4 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total by column | | 0 | 3 | 53 | 4 | 3 | 3 | 5 | 71 |

Table 8. Distribution of razorback sucker stocked in 2004, 2007, and 2009 by Reach for the first recapture, second recapture, and third and subsequent recaptures. The top table details the number of first recaptures by Reach and the number of second recaptures of those previous first recaptures by Reach. The bottom table details the number of second recaptures by Reach and the number of subsequent recaptures of those previous second recaptures by Reach. Reading across rows are the numbers of recaptures by Reach based on location of the previous encounter (first or second recapture). Reading down columns are the numbers of second and subsequent recaptures by Reach.

| First Recaptures | | Second Recapture | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number | Reach | Lake Powell | 1 | 2 | 3 | 4 | 5 | 6 | Total |
| 8 | Lake Powell | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 49 | 1 | 0 | 5 | 2 | 0 | 0 | 1 | 0 | 8 |
| 109 | 2 | 0 | 3 | 17 | 2 | 0 | 0 | 0 | 22 |
| 70 | 3 | 0 | 1 | 0 | 10 | 2 | 1 | 0 | 14 |
| 197 | 4 | 0 | 1 | 0 | 1 | 14 | 2 | 3 | 21 |
| 504 | 5 | 0 | 0 | 5 | 3 | 9 | 105 | 20 | 142 |
| 895 | 6 | 0 | 2 | 2 | 2 | 12 | 76 | 170 | 264 |
| Total by column | | 0 | 12 | 26 | 18 | 37 | 185 | 193 | 471 |

| Second Recaptures | | Third and Greater Recapture | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number | Reach | Lake Powell | 1 | 2 | 3 | 4 | 5 | 6 | Total |
| 0 | Lake Powell | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 1 | 0 | 6 | 0 | 0 | 0 | 1 | 0 | 7 |
| 28 | 2 | 0 | 0 | 10 | 0 | 0 | 1 | 0 | 11 |
| 13 | 3 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 5 |
| 37 | 4 | 0 | 0 | 0 | 0 | 6 | 1 | 1 | 8 |
| 185 | 5 | 0 | 0 | 0 | 0 | 4 | 92 | 19 | 115 |
| 193 | 6 | 0 | 0 | 0 | 1 | 0 | 37 | 90 | 128 |
| Total by column | | 0 | 6 | 10 | 5 | 11 | 132 | 110 | 274 |

Table 9. Flow conditions of razorback sucker stocking events and subsequent recaptures, water years 2007-2010. Stockings over multiple days under similar flow conditions were lumped into 15 stocking events. Recaptures represent the total number of razorback suckers that have been recaptured in the San Juan River from that particular stocking event. The buffered mean daily flow is the mean daily flow at the Bluff gauge a week prior to the event's first stocking day, the range of stocking dates, and the week following the week after the event's last stocking day.

| Water year | Stocked | Recaptured | Range of stocking dates | | Buffered mean daily flow at Bluff (cfs) |
|---|---|---|---|---|---|
| | | | First | Last | |
| 2007 | 1,129 | 0 | 11/14/2006 | 11/14/2006 | 1,173 |
| | 1,587 | 233 | 4/18/2007 | 4/26/2007 | 1,659 |
| | 8,750 | 371 | 5/7/2007 | 6/28/2007 | 3,687 |
| | 1,724 | 137 | 7/24/2007 | 8/24/2007 | 1,601 |
| 2008 | 4,845 | 0 | 11/7/2007 | 11/7/2007 | 1,138 |
| | 558 | 41 | 8/19/2008 | 8/22/2008 | 568 |
| 2009 | 2,051 | 72 | 10/9/2008 | 10/9/2008 | 724 |
| | 1,815 | 103 | 11/13/2008 | 11/13/2008 | 900 |
| | 204 | 38 | 9/18/2009 | 9/18/2009 | 681 |
| | 125 | 19 | 9/30/2009 | 9/30/2009 | 569 |
| 2010 | 370 | 70 | 10/1/2009 | 10/23/2009 | 588 |
| | 3,966 | 1 | 10/26/2009 | 10/29/2009 | 636 |
| | 3,651 | 438 | 11/3/2009 | 11/10/2009 | 687 |
| | 4,020 | 0 | 2/9/2010 | 2/12/2010 | 1,087 |
| | 1,926 | 92 | 8/26/2010 | 9/30/2010 | 1,108 |

Table 10. Razorback sucker recaptures by stocking year, source, month, and location, from 2006-2010.

| Year | Source | Stocking Month | Location | Number | Recapture Number | Notes |
|---|---|---|---|---|---|---|
| 2006 | Dexter | 11 | 158.6 | 1129 | 0 | |
| | 6-Pack Pond 1 | 6,7 | 158.6 | 565 | 11 | |
| | 6-Pack Pond 2 | 6,7 | 158.6 | 424 | 7 | |
| | 6-Pack Pond 3 | 6,7 | 158.6 | 504 | 9 | |
| | 6-Pack Pond 4 | 6,7 | 158.6 | 1002 | 13 | |
| | 6-Pack Pond 5 | 6,7 | 158.6 | 260 | 4 | |
| | 6-Pack Pond 6 | 6,7 | 158.6 | 530 | 13 | |
| | Avocet East | 8 | 158.6 | 6437 | 125 | |
| | Hidden Pond | 8 | 158.6 | 2913 | 40 | |
| 2007 | Uvalde | 11 | 147.9 | 4845 | 0 | |
| | Dexter | 4,6 | 158.6 | 1344 | 324 | |
| | 6-Pack Pond 1 | 5,6 | 158.6 | 2034 | 57 | |
| | 6-Pack Pond 2 | 5,6 | 158.6 | 1566 | 13 | |
| | 6-Pack Pond 3 | 5,6 | 158.6 | 3073 | 136 | |
| | 6-Pack Pond 4 | 5,6 | 158.6 | 1794 | 41 | |
| | 6-Pack Pond 5 | 4 | 158.6 | 338 | 1 | |
| | 6-Pack Pond 6 | 4 | 158.6 | 188 | 22 | |
| | Avocet East | 7,8 | 158.6 | 180 | 44 | |
| | Avocet West | 7,8 | 158.6 | 271 | 33 | |
| | Hidden Pond | 8 | 158.6 | 1273 | 60 | |
| 2008 | Dexter | 10 | 158.6 | 2051 | 72 | |
| | Hidden Pond | 8 | 147.9 | 558 | 41 | |
| | | 11 | 166.6 | 1815 | 103 | |
| 2009 | Uvalde | 10 | 158.3 | 1997 | 1 | |
| | | | 180.2 | 1969 | 0 | |
| | Avocet East | 9,10,11 | 166.6 | 1569 | 253 | |
| | Avocet West | 9,10,11 | 166.6 | 930 | 221 | |
| | Hidden Pond | 10,11 | 166.6 | 1851 | 91 | |
| 2010 | Uvalde | 2 | 147.9 | 1999 | 0 | |
| | | | 180.2 | 2021 | 0 | |
| | | 12 | 158.6 | 2004 | 0 | |
| | | | 180.2 | 2110 | 0 | Sampling in 2010 occurred before these fish were stocked |
| | | 10 | 147.9 | 5988 | 0 | |
| | | 11 | 166.6 | 6127 | 0 | |
| | Avocet East | 8,9,10,11 | 166.6 | 3122 | 42 | Sampling occurred before 6154 fish were stocked, so recaptures rates should be based on only 2016 fish stocked that were subject to sampling in 2010 |
| | Avocet West | 9,10,11 | 166.6 | 2613 | 56 | |
| | Hidden Pond | 10,11 | 166.6 | 2435 | 10 | |

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.

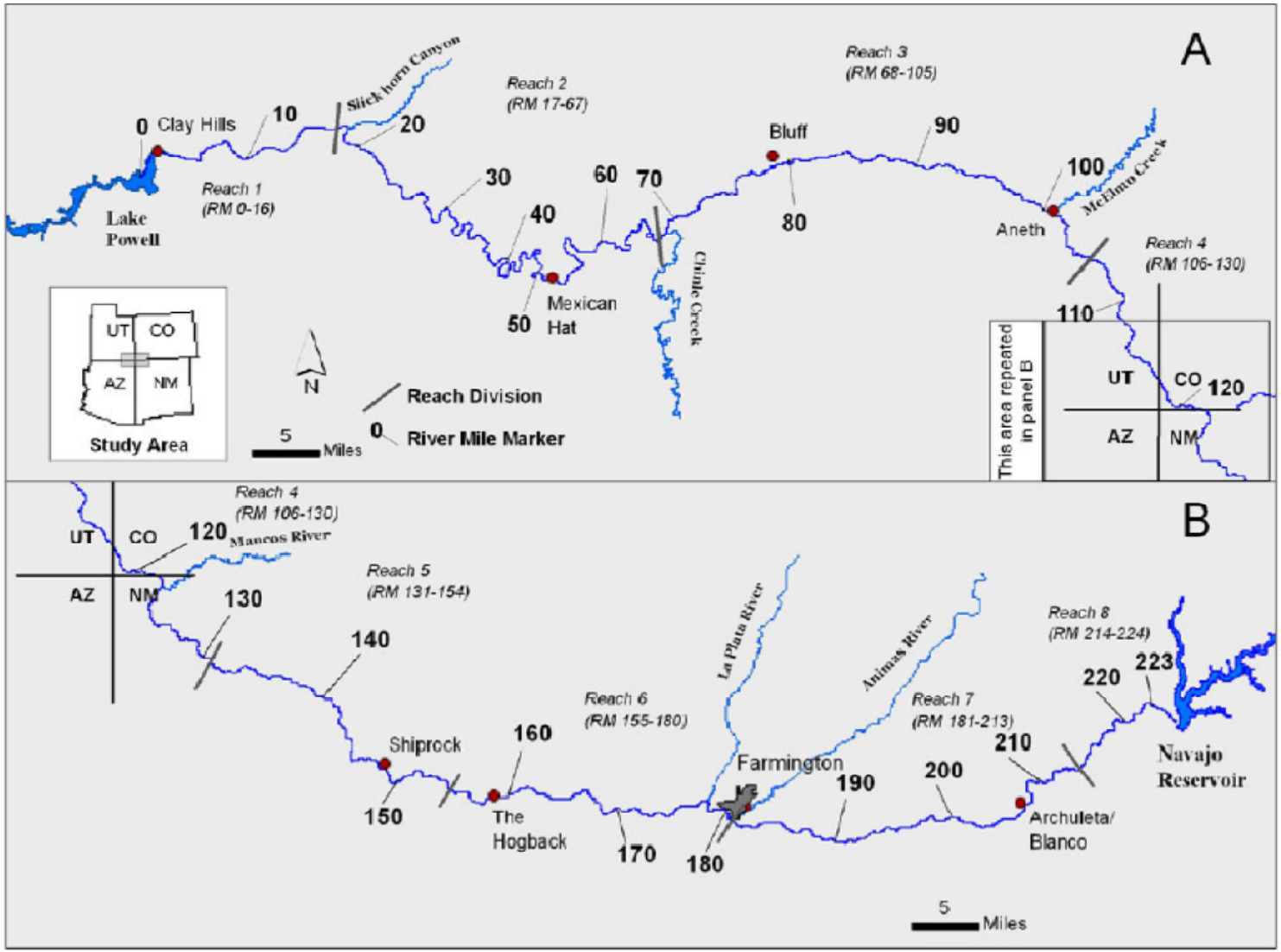


Figure 2. Total Colorado pikeminnow encounters by the CONTACT_TYPE (STOCK versus TAG; all STOCK records have a PIT tag when they are stocked in to the San Juan River, all TAG records are stocked into the San Juan River without PIT tags and they are implanted with a PIT tag when they are first encountered in the San Juan River) of the first encounter record and year of the first encounter record in 2010. The sum of all values represents the total number of pikeminnow encounters in 2010. The TAG encounters for 2010 includes both pikeminnow that were first implanted with a PIT tag upon capture in 2010 and additional recaptures of these fish in 2010. There were only 9 encounters of pikeminnow in 2010 that were first encountered in 2005, 2006, and 2007.

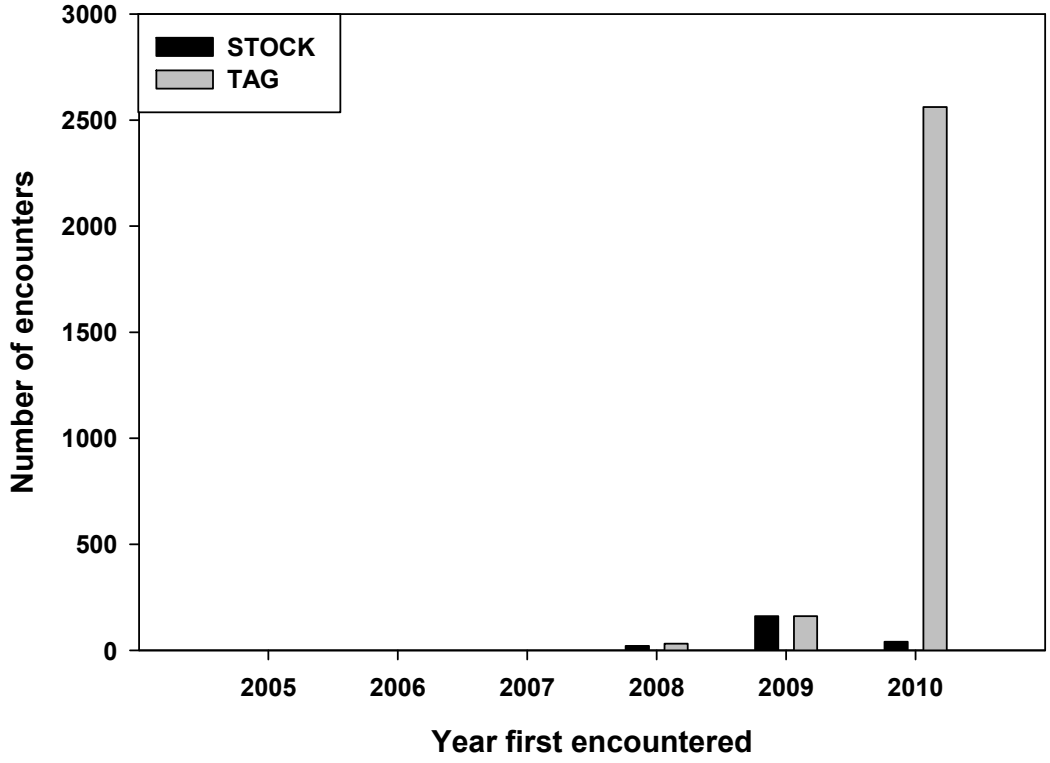


Figure 3. Total razorback sucker encounters by the CONTACT_TYPE (STOCK versus TAG; all STOCK records have a PIT tag when they are stocked in to the San Juan River, all TAG records are stocked into the San Juan River without PIT tags and they are implanted with a PIT tag when they are first encountered in the San Juan River) of the first encounter record and year of the first encounter record in 2010. The sum of all values represents the total number of razorback sucker encounters in 2010. Most razorback suckers encountered in 2010 were 2007 year class fish that were stocked in 2009. There were 104 razorback sucker encounters in 2010 of fish that were first encountered 1995-2005. There were a total of 183 TAG encounters of razorback sucker first encountered in 2010, 164 of these were newly captured fish that were implanted with PIT tags. Capturing fish of the appropriate size without PIT tags will be an indication of wild-spawned fish recruiting into adult size classes. There is no indication that these 164 fish represent a class of recruiting razorback sucker.

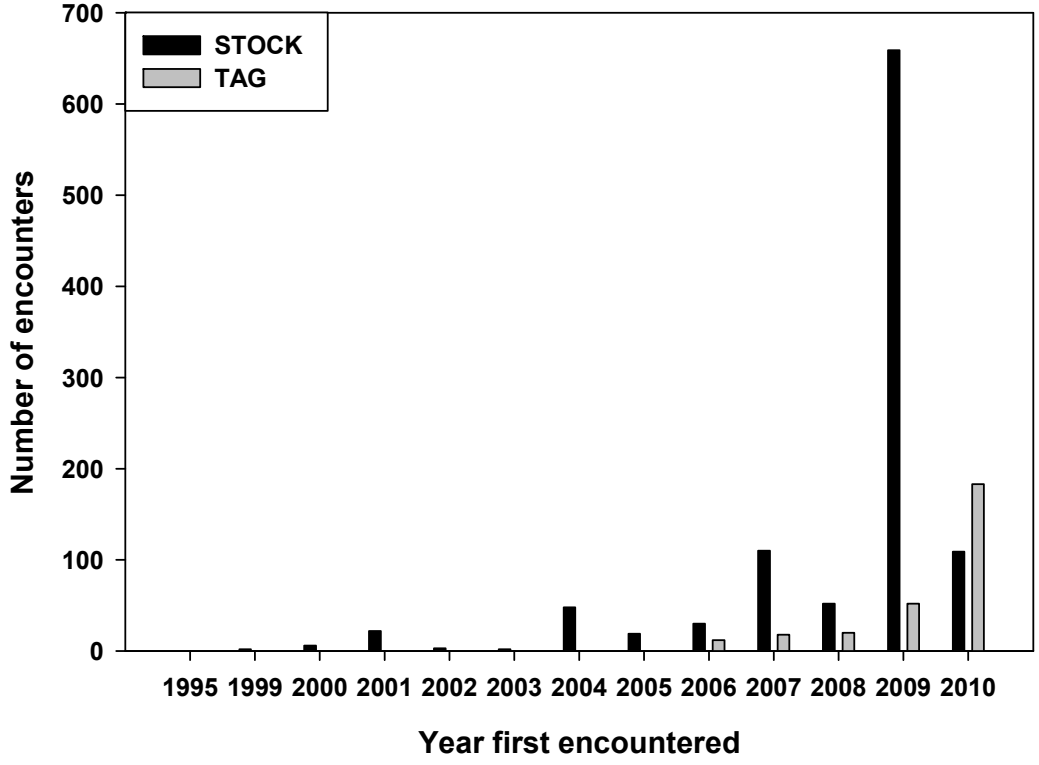
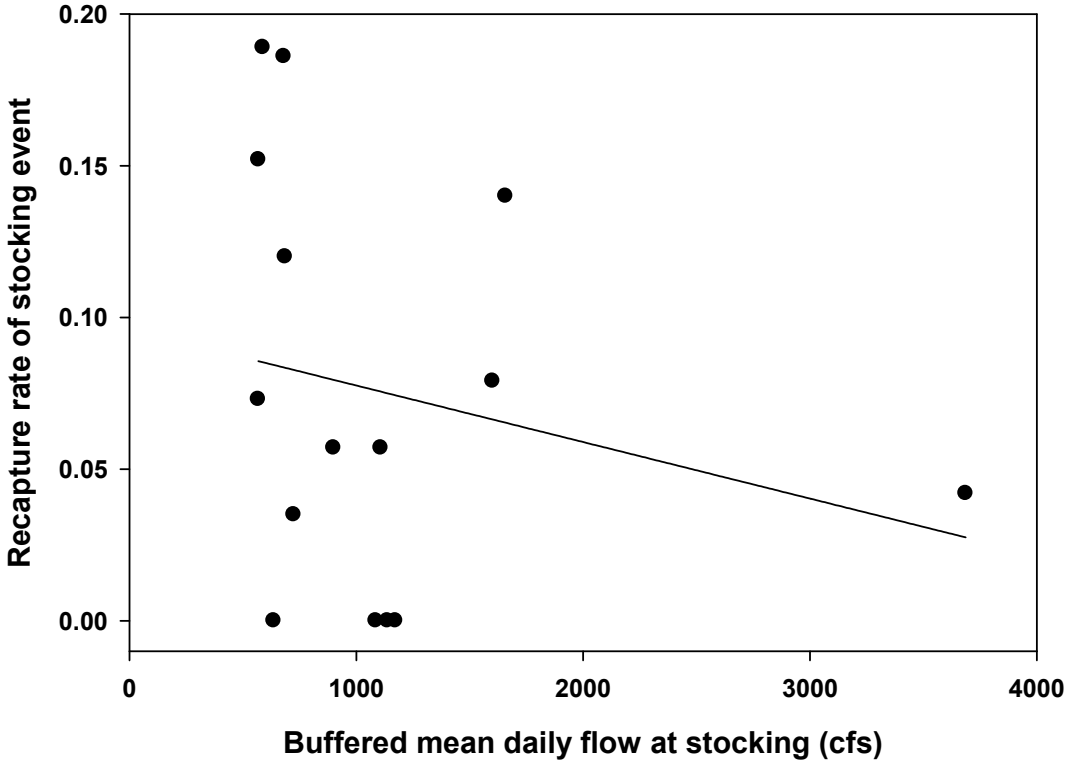


Figure 4. Razorback sucker recapture rate by flow conditions of stocking event. Each point represents the razorback sucker recapture rate from a particular stocking events and the buffered mean daily flow of that stocking event (the buffered mean daily flow is the mean daily flow at the Bluff gauge of a week prior to the event's first stocking day, the range of stocking dates, and the week following the week after the event's last stocking day). Equation of linear regression: $Y = 0.096\text{-}1.86\text{x}10^{-5}X$ ($R^2 = 0.048$, $p = 0.43$).



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 | |
| 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)).

**RM** = River Mile – River 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