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2012 INTEGRATED PIT TAG DATABASE SUMMARY OF COLORADO PIKEMINNOW AND RAZORBACK SUCKER IN THE SAN JUAN RIVER

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To Bureau of Reclamation

From

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ABSTRACT

I integrated and summarized the PIT tag data for endangered Colorado pikeminnow and razorback sucker from all of the San Juan River Basin Recovery Implementation Program's management and monitoring efforts. Most Colorado pikeminnow encountered in 2012 were stocked at age-0 and like past years, relatively few pikeminnow were encountered in the San Juan River after three years post-stocking. While the total numbers of Colorado pikeminnow individuals detected in 2012 declined compared to previous years, this appears to be due to sampling artifacts rather than a reduction in the pikeminnow population. While most Colorado pikeminnow encounters are clustered between RM 20-50 and RM 140-170, within year movements were typically minimal or in an upstream direction but between year movements were evenly distributed upstream and downstream. The total number of razorback sucker individuals detected has increased every year since 2008. Although the return rate of stocked razorback suckers has varied through time, numerous individuals were detected three or more years post-stocking in 2012. Following a downstream post-stocking movement, razorback suckers typically remain stationary. The proportion of razorback suckers captured each year without PIT tags has been declining since 2006 and 2007 when razorback suckers were stocked without PIT tags from the NAPI ponds. However, the total number of razorback suckers captured without PIT tags has been increasing in part due to the collection of untagged razorback suckers in Lake Powell. 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*) and razorback sucker (*Xyrauchen texanus*). 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), to population estimates that can be used to evaluate the Program's progress toward recovery for both species (Duran et al. 2011, Gerig 2013). 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.

METHODS

All management and monitoring efforts in the San Juan River that collect PIT tag data contributed to this report. Data were provided by the Southwestern Native Aquatic Resources and Recovery Center (SNARRC; formerly Dexter National Fish Hatchery and Technology Center), 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; the fish passage at PNM Weir; and studies by Colorado Parks and Wildlife and Kansas State University in San Juan River's tributaries. These activities primarily covered the San Juan River from the Animas River confluence (RM 180.2) to Clay Hills Crossing (RM 2.9) but also included data from the San Juan River arm of Lake Powell and some tributaries of the San Juan River (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. Records in source files with duplicate or

inappropriate PIT tag numbers 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 unique 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 corresponding 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 et al. 2012). Only those pikeminnow ≥ 150 mm TL captured in the San Juan River are typically implanted with a PIT tag (and entered in to the FIRST_ENC table as TAG records).   The numerous pikeminnow < 150 mm that are captured without PIT tags 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.   Typically, 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 (only 93 of 8,882 Colorado pikeminnow TAG records through 2012 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 Colorado pikeminnow stocked without and with PIT tags, I reviewed stocking classes since 2002 and 2003, respectively. For razorback sucker, I summarized stocking classes since 2000. To explore Colorado pikeminnow within-year movement patterns I examined individuals with at least two encounters in the same year from 2009-2011. For Colorado pikeminnow between-year movements, I examined initial encounters in 2009-2011 and subsequent recaptures one or more years after the initial encounter. I summarized Colorado pikeminnow distribution before and after movement events and examined the proportion of individuals that move upstream, downstream, or remained in the same location they were initially encountered. I explored razorback sucker distribution and movement patterns by summarizing the recapture locations of stocked individuals and calculated the mean distance moved between successive recapture locations. I examined recapture rate of individuals stocked from different sources from 2006-2011. Since the recapture of untagged razorback suckers could be an indication of wild recruitment, I examined the number and proportion of razorback sucker captured without PIT tags from 2004-2012 and sought to provide the most reasonable explanation for razorback suckers being encountered without PIT tags in the San Juan River.

RESULTS AND DISCUSSION

Following the 2012 update, the Colorado pikeminnow and razorback sucker PIT tag databases contained 54,302 and 130,017 records, respectively. The FIRST_ENC tables, containing both STOCK and TAG records, had a total of 49,217 Colorado pikeminnow records and 121,184 razorback sucker records. The CAPTURE tables had 5,085 and 8,833 records for Colorado pikeminnow and razorback sucker, respectively. Because I consider recaptures of individual PIT tagged Colorado pikeminnow and razorback sucker in this report, the number of encounters presented here likely 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 1,225 individual Colorado pikeminnow were captured in 2012 (Tables 2 and 3). Almost 98% of these individuals were originally stocked at age-0 (i.e. without PIT tags). Stocking of what I defined as "age-0" in 2011 actually included two age classes of fish stocked without PIT tags. In May 2011, 214,720 age-1 Colorado pikeminnow were stocked into the San Juan without PIT tags (Table 2). These fish were 2010 year class pikeminnow held at SNARRC through 2010 due to quarantine issues at the hatchery. Since these fish were stocked without PIT tags, I considered them stocked as age-0 for analysis purposes. This stocking class was available for recapture through summer and fall 2011 in addition to the entirety of 2012. Additionally, SNARCC fulfilled its Colorado pikeminnow age-0 stocking obligations in 2011 with 426,588 untagged fish stocked in November 2011. The first opportunity to recapture the age-0 Colorado pikeminnow from that stocking class was 2012. There were 1,195 individual Colorado pikeminnow captured in 2012 that were stocked as age-0 fish (i.e., without PIT tags; Table 2). Most of these fish were stocked in 2011 and assigned to the 2010 and 2011 year classes, but almost 7% of individuals were from 2009 or earlier stocking classes (Table 2). Note that the total number of individuals captured in 2012 includes 17 Colorado pikeminnow TAG records that could not reliably be assigned to a year class (Table 2).

The number of recaptured Colorado pikeminnow that were stocked at age-0 increased from 662 in 2008; to 2,271 in 2010; and declined to 1,195 in 2012 (Table 2). The most reasonable explanation for the decline in the total number of Colorado pikeminnow stocked as age-0 in 2012 compared to 2011 was reduced sampling effort because the PNM fish passage was not operated in 2012. In 2011 there were 495 individual Colorado pikeminnow collected at the PNM fish passage that were stocked as age-0 fish. Concomitant with the decline in the total number of pikeminnow captured, approximately 21% of Colorado pikeminnow stocked as age-0 captured in 2011 were age-3+ but in 2012 fish in these older age classes represented only 7% of the total captured. The lack of sampling at PNM in 2012 does not explain the disproportionate decline of older Colorado pikeminnow compared to 2011. The abundant age-3+ Colorado pikeminnow documented in 2011 may have been the result of unidentified environmental conditions unique to that year since that high proportion of older pikeminnow has not been observed in other years.

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, some individuals from stocking classes as old as 2004 continue to persist in the San Juan River, suggesting that these stocked individuals could form a group of reproducing adult Colorado pikeminnow.

Only 30 Colorado pikeminnow stocked as age-1+ were recaptured in 2012 (Table 3). This was 10% of the number recaptured in 2011 stocked as age-1+. The decline in the number of recaptures of Colorado pikeminnow stocked as age-1+ is primarily due to ending age-1+ stocking in 2011. From 2009-2011, at least 83% of Colorado pikeminnow stocked as age-1+ were only recaptured in the same year that they were stocked. 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 more time passes between the age-1+ Colorado pikeminnow stocking events and future monitoring efforts, fewer fish from these stockings should be detected.

From 2009-2011, a total of 1,004 Colorado pikeminnow were recaptured in the river at least twice within the same year. The majority of Colorado pikeminnow initial encounters that exhibited within-year movements were found between RM 20-50 (54%) or RM 140-170 (18%; Figure 2). I observed most subsequent encounters of within-year movement in the same locations (43% from RM 20-50 and 29% from RM140-170; Figure 2). However, although the majority of pikeminnow within-year encounters were distributed in the lower and upper reaches of the San Juan River, 28% of individuals moved upstream, only 2% moved downstream, and 69% were found in approximately the same location. There were 455 Colorado pikeminnow encountered in the river from 2009-2011 that were subsequently recaptured at least one year later (2010-2012). Colorado pikeminnow that exhibited between-year movements were more evenly distributed throughout the San Juan River but were clustered in the same reaches as pikeminnow making within-year movements; 19% and 29% of pikeminnow that exhibited between-year movements were initially encountered in RM 20-50 or RM 140-170, respectively (Figure 3). Those same reaches accounted for 27% and 38% of subsequent encounters following between-year movements, respectively (Figure 3). Individual between-year movements were also relatively evenly distributed among upstream (29%), downstream (36%), and detections in the

same approximate location (34%). These within and between-year movement patterns may suggest areas in the San Juan River that could be important to different life stages of Colorado pikeminnow across different periods of their annual life history. Identifying the environmental conditions of these reaches may warrant further investigation.

Summary of razorback sucker stockings, recaptures, and distribution

A total of 2,192 individual razorback sucker were captured in 2012 across all management and monitoring efforts (Tables 4 and 5). While 41% of razorback suckers stocked with PIT tags that were recaptured in 2012 were from the 2006, 2007, and 2009 year classes stocked in 2011; 45% of razorback suckers recaptured in 2012 were distributed among stocking events from 2000-2010 (Table 4). The persistence of razorback suckers in the San Juan River from multiple stocking classes has resulted in a variety of adult age classes that have been spawning for 14 consecutive years (Brandenburg et al. 2012). This diverse age-structure of reproducing adults is among the first steps necessary to establish a self-sustaining population of razorback suckers within the San Juan River Basin. Note that because 6,655 razorback suckers were stocked following the majority of fish management and monitoring efforts in the San Juan River in 2012, the recapture rate of the 244 razorbacks captured in 2012 should be based on only 9,167 stocked individuals.

In the entire razorback sucker PIT tag database, there were 5,409 initial recaptures with location data for both the stocking and recapture record. Most razorback sucker first recaptures were detected between RM 150-160 (45%; Figure 4) and all first recaptures were on average approximately 24 river miles downstream from the majority (90%) of razorback stocking locations between RM 150-170 . Following the initial downstream post-stocking movement, subsequent recaptures of individual razorback suckers tended to remain within two river miles of the initial recapture location. Although razorback suckers make long distance movements as evidenced by the detection of razorback suckers downstream of Mexican Hat, UT (RM 52.9) and the four instances of razorback suckers moving from Lake Powell back to the San Juan River (Francis et al. 2013), in general razorback sucker tended to remain relatively stationary following initial post-stocking displacement.

From 2006-2011 razorback suckers were stocked into the San Juan River from SNARCC, Uvalde, and NAPI Ponds (Table 6). I did not include 2012 stocking data in this summary because monitoring efforts that produce recapture data for that stocking class had ended prior to most razorback sucker stockings. I calculated return rates based on recaptures occurring through 2012, so fish stocked in earlier years have been subject to more sampling effort than those stocked in later years. There were four stocking events that to date have yielded < 0.5% recapture rates; Uvalde 2006, Uvalde 2007, Uvalde 2009, and Uvalde 2010 (Table 6). Alternatively, some stocking events have yielded relatively high return rates; Dexter 2007 (24%), NAPI 2009 (17%), and NAPI 2010 (15%). 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). In 2011 Uvalde revised management actions, primarily hauling fish in smaller batches, in an effort to improve return rates. Based on recaptures through 2012, it appears that these efforts have increased the return rate of razorback suckers stocked from Uvalde in 2011; however, the 2.6% return rate of the 11,391 razorback suckers stocked from Uvalde in 2011 is still lower than typical return rates of razorback suckers stocked from other sources (Table 6). If return rates of razorback sucker stocked from Uvalde matched those from NAPI Ponds, approximately 4,500 additional razorback suckers would have been detected in the San Juan River since 2007. The Program should continue to explore methods of increasing return rates to the level observed at NAPI Ponds including investigating additional sources of razorback suckers.

Because almost all razorback sucker stocked prior to 2006 were implanted with PIT tags (Furr 2011), and because of limited evidence of natural recruitment (Golden et al. 2006, Brandenburg et al. 2012), I suggest that untagged razorback suckers observed in 2004 and 2005 (8-10%) represented baseline PIT tag loss rate of razorback suckers in the San Juan River. The high proportion (> 30%) of razorback suckers 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 fewer untagged razorback suckers were available for capture from those stocking events from NAPI (Table 5). Since 2010 the percent of razorback suckers captured without PIT

tags has remained relatively constant while the absolute number of fish captured without PIT tags has continued to increase along with the increased total number of individuals captured (Table 5). Since the pool of untagged razorback sucker stocked from NAPI in 2006 and 2007 should decline through time, the most plausible explanations for the increase in the total number of razorback suckers captured without PIT tags since 2010 are:

(1) the persistence of background levels of tag loss of 8-10% that was observed prior to the release of many thousands of razorback sucker without PIT tags in 2006 and 2007 has likely remained constant and accounts for the majority of these untagged fish.

(2) Recapture of untagged razorback suckers during survey efforts in Lake Powell in 2011 and 2012. A total of 55 razorback suckers (37% of the total captured in Lake Powell) were captured in Lake Powell without PIT tags (T. Francis unpublished data). If one assumes a PIT tag loss rate of 10%, then of the 572 razorback suckers captured without PIT tags in 2011 and 2012, only 181 would be attributed to other causes. Thus the survey effort in Lake Powell and the collection of 55 untagged individuals accounts for over 30% of these unexplained untagged fish.

(3) When the waterfall separating Lake Powell from the San Juan River was temporarily inundated for approximately two week in July 2011, four razorback suckers encountered in Lake Powell in 2011 were subsequently encountered in the San Juan River (Francis et al. 2013). Given the higher proportion of untagged razorback sucker detected in Lake Powell, it seems likely that untagged razorback suckers also moved from Lake Powell to the San Juan River although it was not possible to document that movement due to the lack of a PIT when they were captured in the San Juan River.

(4) Given the large size of razorback suckers captured without PIT tags in 2012, untagged razorback suckers have possibly persisted from the NAPI stocking in 2006 and 2007 when many thousands of untagged razorback suckers were stocked into the San Juan River (Figure 5).

(5) Finally, although razorback sucker recruitment has not been widely demonstrated in the San Juan River, the capture of some small untagged individuals (< 300 mm) could indicate isolated cases of wild recruitment.

I suspect the large number of razorback sucker captured without PIT tags over the past three years is due to a combination of these factors. 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

Observed declines in the total number of individual Colorado pikeminnow captured in 2012 should not be interpreted as declines in Colorado pikeminnow populations in the San Juan River Basin. The number of individual Colorado pikeminnow captured in any given year is sensitive to the overall sampling effort in that year and efficiency of any particular sampling trip within that year. Since the PNM fish passage was not operated in 2012, it is not surprising that fewer pikeminnow were detected in 2012 compared to 2011, especially since 495 Colorado pikeminnow stocked at age-0 were handled there in 2011. Additionally, the steep decline in the numbers of recaptures of Colorado pikeminnow stocked as age-1+ was expected given the previously observed pattern that the majority of fish from these stocking events were only detected in the same year that they were stocked. Also no age-1+ Colorado pikeminnow were stocked in 2011. Given the infrequent detections of Colorado pikeminnow in adult age classes, it appears that the Colorado pikeminnow augmentation program is necessary to sustain and enhance their populations in the San Juan River Basin. However, the infrequent encounters of adult Colorado pikeminnow could in part be related to their low detection probability (5-10%) observed in preliminary population estimates (Duran et al. 2011, Gerig 2013). Detection of PIT tagged individuals could be enhanced by the planned installation of remote PIT tag readers in the San Juan River at the PNM Weir (RM 166.6) and just upstream of Mexican Hat (RM 52.9).   The passive detection of PIT tagged individuals should result in more detections and lead to higher detection probabilities and more robust demographic parameter estimates (Hewitt et al. 2010).

The Colorado pikeminnow pre and post-movement distribution patterns need additional investigation to explore the mechanisms underlying these patterns. Colorado pikeminnow movements could be tracking prey densities or favorable temperature regimes. Alternatively, Colorado pikeminnow could segregate longitudinally to avoid intraspecific competition or predation. Hopefully further investigation of existing data will be able to tease apart these factors. It is possible that further refining our understanding of these movement and distribution patterns will highlight important areas of the river and inform site selection for future habitat restoration efforts for different Colorado pikeminnow age classes.

The numerous razorback suckers captured from older stocking classes combined with the increasing number of larvae detected (Brandenburg et al. 2012) indicates that a substantial cohort of adult razorback suckers has formed in the San Juan River. Because razorback suckers can persist many years post-stocking and their tendency to remain stationary following downstream post-stocking displacement, razorback suckers have become particularly abundant between RM 130-170. While these trends are positive indicators for razorback sucker recovery in the San Juan River, perhaps stocking should be extended both up and downstream of current locations in order to expand the range of razorback suckers within the San Juan River and alleviate the high densities near current stocking locations (Figure 4).

Recent efforts to increase the recapture rate of razorback suckers stocked from Uvalde have apparently been successful as evidenced by recapture rates increasing from < 0.5% in any year prior to 2011 to 2.6% for the 2011 stocking class. However, current recapture rates from Uvalde remain lower than recapture rates from razorback sucker stocked concurrently and historically from NAPI Ponds. The continued low recaptures rates of razorback suckers stocked from Uvalde indicates the Program should consider exploring alternative stocking sources for razorback suckers. Increasing the mean recapture rate of razorback suckers would likely result in more razorback suckers retaining in the San Juan River that would potentially contribute to the existing adult spawning population. If hauling time and distance were the primary reasons that razorback suckers stocked from Uvalde are only rarely recaptured, perhaps sources in closer

proximity to the San Juan River should be highlighted to increase the overall recapture rate of stocked razorback suckers.

Detection of untagged razorback suckers within the San Juan River Basin is most likely due to a combination of (1) tag loss, (2) fish originating from 2006/2007 NAPI harvest, and (3) natural recruitment. Efforts to address tag loss include PIT tagging all razorback suckers under controlled hatchery conditions prior to delivery to NAPI. The increasing number of untagged razorback suckers captured in 2012 can also in part be attributed to the collection of untagged individuals from Lake Powell. Razorback suckers in Lake Powell exhibited a higher proportion of untagged individuals compared to the San Juan River, likely due to the limited sampling that has occurred in the lake prior to 2011. Additionally, immigration of razorback suckers from Lake Powell to the San Juan River while the waterfall separating the river from the lake was inundated in 2011 possibly contributed to the detection of greater numbers of untagged fish in the San Juan River. While all of these factors have likely contributed to the persistence of untagged razorback suckers, it is currently not possible to determine each factor's relative contribution. However, the Program has funded a scope-of-work to determine the natal origin of untagged razorback suckers (Platania et al. 2013) that hopefully will provide additional details to elucidate this issue in the near future.

It is important to periodically summarize and analyze the Program's monitoring data to determine the biological response to management actions and inform adaptive management decisions. Analyses utilizing the integrated PIT tag database could be informative in refining and revising Colorado pikeminnow and razorback sucker demographic parameters like abundance and survival that would be beneficial to the Program's adaptive management process and ultimately, species recovery. Additionally, because the integrated PIT tag database details the capture history of individuals over time, it could be utilized to track growth and condition. Information on growth rates and condition may be useful in evaluating and revising the flow recommendation if particular flow regimes can be tied to growth, condition, and survival of endangered fishes. Maintenance of this integrated PIT tag database will be essential to evaluate the Program's progress toward recovery in reaching Colorado pikeminnow and razorback sucker demographic criteria in the San Juan River Basin for downlisting and delisting.

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TABLES AND FIGURES

Table 1. Age matrix for untagged Colorado pikeminnow based on size of fish and month 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 D. Ryden.

Size at capture (TL)	Month of capture											
	Jan	Feb	Mar	April	May	June	Jul	Aug	Sept	Oct	Nov	Dec
150-190mm	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 2003-2012. The number of recaptures is based only on individuals large enough to be implanted with a PIT tag during their TAG record ($\geq$ 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 without PIT tags 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.

Year stocked	Year class	Number stocked	Total captured	Individuals captured by year									
				2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	UNKNOWN		90	3	1	2	15	7	4	12	19	27	17
2002	2002	210,418	211	73	132	11	0	1	0	0	0	0	0
2003	2003	175,928	446	-	190	233	33	2	0	0	0	0	0
2004	2004	280,000	341	-	-	155	183	22	5	4	2	0	2
2005	2005	302,270	547	-	-	-	393	138	37	11	1	4	1
2006	2006	313,854	507	-	-	-	-	270	224	80	7	3	1
2007	2007	475,970	872	-	-	-	-	1	395	476	76	20	6
2008	2008	270,234	2,108	-	-	-	-	-	-	899	1,124	353	8
2009	2009	468,000	1,921	-	-	-	-	-	-	-	1,042	962	44
2011	2010	214,720	985	-	-	-	-	-	-	-	-	555	450
2011	2011	426,588	666	-	-	-	-	-	-	-	-	-	666
Total individuals captured				76	323	401	624	441	662	1,482	2,271	1,924	1,195

Table 3. Number of Colorado pikeminnow stocked as age-1+ and recaptured by year, 2003-2012. 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. Also, 2011 was the last year that age-1+ Colorado pikeminnow were stocked into the San Juan River.

Year stocked	Number stocked	Total captured	Individuals captured by year									
			2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
2003	1,002	3	3	0	0	0	0	0	0	0	0	0
2004	1,217	79	-	66	13	1	0	0	0	0	0	0
2005	4,119	89	-	-	84	5	0	0	0	0	0	0
2006	12,661	357	-	-	-	294	53	6	6	2	2	1
2007	3,250	232	-	-	-	-	141	79	16	1	3	0
2008	4,848	628	-	-	-	-	-	203	439	16	2	1
2009	8,942	565	-	-	-	-	-	-	469	108	14	4
2010	353	41	-	-	-	-	-	-	-	35	8	0
2011	3,724	292	-	-	-	-	-	-	-	-	269	24
Total individuals captured			11	68	99	300	194	228	930	162	298	30

Table 4. Number of razorback sucker stocked and recaptured by year, 2000-2012. 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 6,655 razorback suckers were stocked in 2012 after fish management and monitoring activities, they were not available for recapture. Thus the 244 recaptures of the 2012 stocking class should be based on 9,167 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.

Year stocked	Total stocked	Total captured	Individuals captured by year												
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
2000	1,044	61	0	26	7	9	8	12	7	7	5	7	5	4	2
2001	688	232	-	0	43	73	61	43	32	34	26	19	18	13	13
2002	140	36	-	-	5	13	12	3	6	2	3	2	3	4	1
2003	887	71	-	-	-	54	11	5	1	2	3	1	2	2	0
2004	2,979	586	-	-	-	-	288	174	113	65	48	56	33	55	47
2005	1,993	144	-	-	-	-	-	68	42	25	24	15	16	20	12
2006	13,764	247	-	-	-	-	-	-	133	72	38	38	24	33	28
2007	16,906	788	-	-	-	-	-	-	-	499	188	115	90	74	55
2008	4,424	237	-	-	-	-	-	-	-	-	46	144	46	31	29
2009	8,316	746	-	-	-	-	-	-	-	-	-	43	526	186	131
2010	28,419	1,298	-	-	-	-	-	-	-	-	-	-	108	862	479
2011	18,807	826	-	-	-	-	-	-	-	-	-	-	-	93	736
2012	15,822	244	-	-	-	-	-	-	-	-	-	-	-	-	244
Total individuals recaptured			14	43	68	156	381	307	338	708	382	440	873	1,379	1,779

Table 5. Number of individual razorback sucker captured with and without PIT tags, 2004-2012. Percent without PIT tags represents the percent of razorback sucker captured without PIT tags out of total number of razorback sucker individuals captured.

Year	Total	Individuals captured with PIT tags (STOCK)	with PIT tags (TAG)	without PIT tags	Percent without PIT tags
2004	415	381	0	34	8.2
2005	345	307	4	34	9.9
2006	559	338	8	213	38.1
2007	1,105	708	40	357	32.3
2008	605	382	39	184	30.4
2009	699	440	75	184	26.3
2010	1,117	873	80	164	14.7
2011	1,717	1,379	84	254	14.8
2012	2,192	1,779	95	318	14.5

Table 6. Razorback sucker recaptures by stocking year and source from 2006-2011. Return rate and recapture number are based on fish collected through the 2012 monitoring effort, thus there have been more opportunities to sample the fish stocked in earlier years.

Year	Source	Stock Number	Recapture Number	Percent
2006	Dexter	1,129	0	0.0
	NAPI	12,635	247	2.0
2007	Dexter	1,344	329	24.5
	NAPI	10,717	459	4.3
	Uvalde	4,845	0	0.0
2008	Dexter	2,051	76	3.7
	NAPI	2,373	161	6.8
2009	NAPI	4,350	745	17.1
	Uvalde	3,966	1	0.0
2010	NAPI	8,170	1,254	15.3
	Uvalde	20,249	44	0.2
2011	NAPI	7,416	526	7.1
	Uvalde	11,391	300	2.6

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.
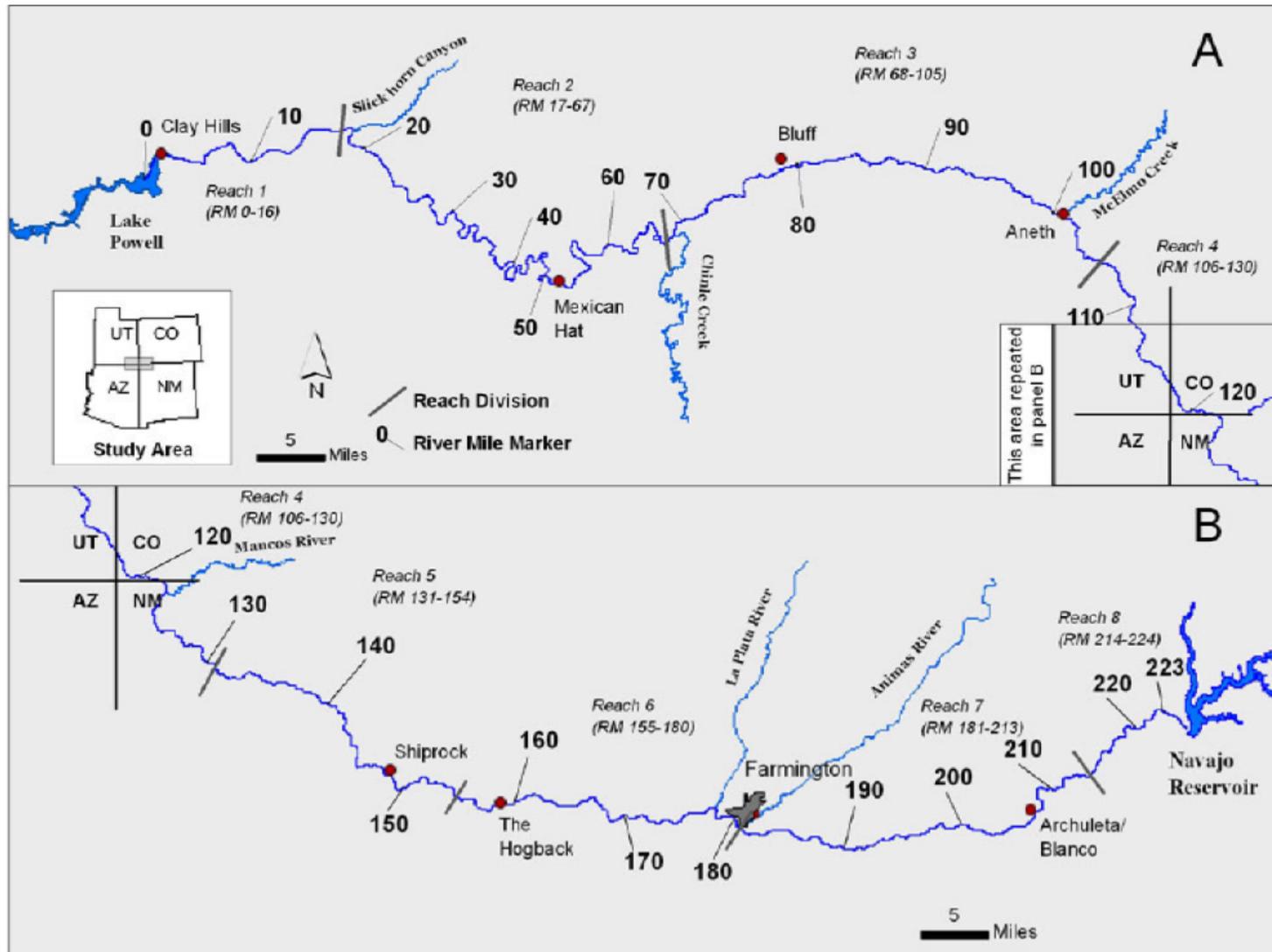
Figure 2. Distribution of 1,004 Colorado pikeminnow captured multiple times within the same year, 2009-2011. The black bar represents the distribution of those 1,004 Colorado pikeminnow prior to the within-year movement and the grey bar represents the distribution of those same 1,004 pikeminnow following a within-year movement.
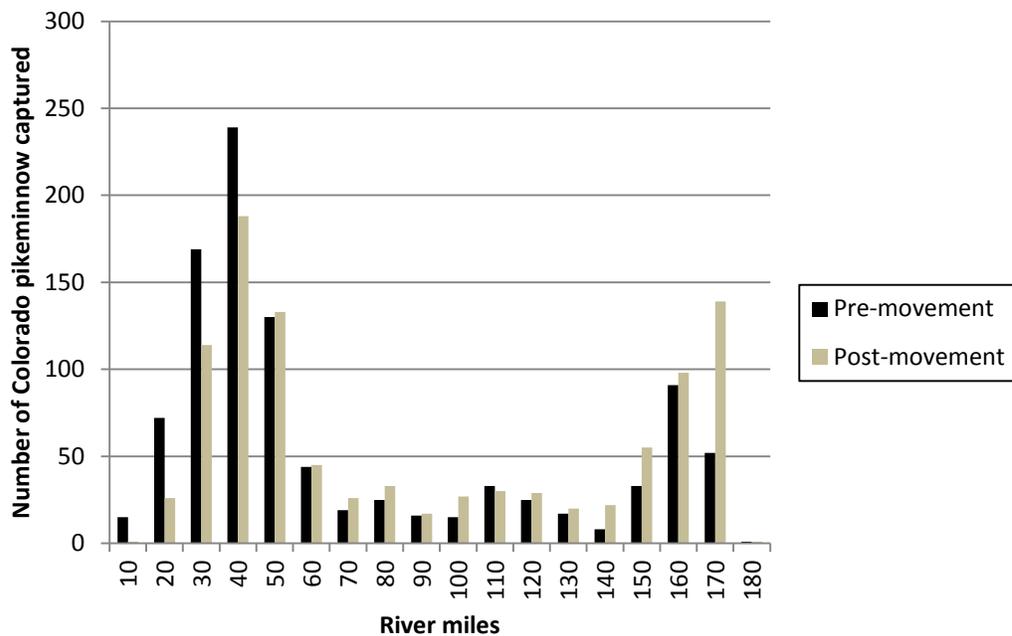
Figure 3. Distribution of 455 Colorado pikeminnow captured in 2009-2011 and recaptured in one or more subsequent year. The black bar represents the distribution of those 455 Colorado pikeminnow prior to the between-year movement and the grey bar represents the distribution of those same 455 pikeminnow following a between-year movement.
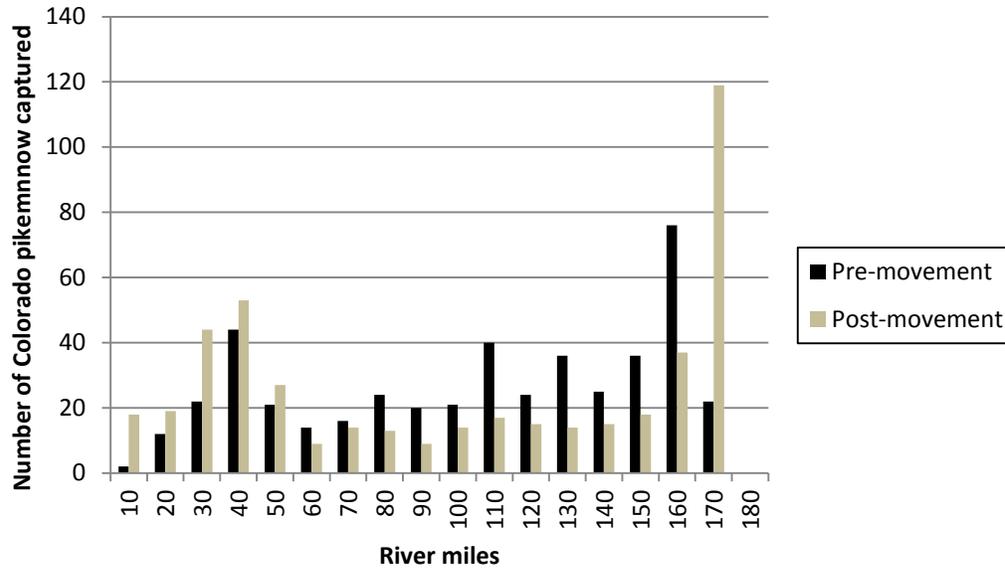
Figure 4. Distribution of razorback sucker first, second, third, and forth recaptures by river mile. Most razorback suckers (90%) were stocked between RM 150-170.
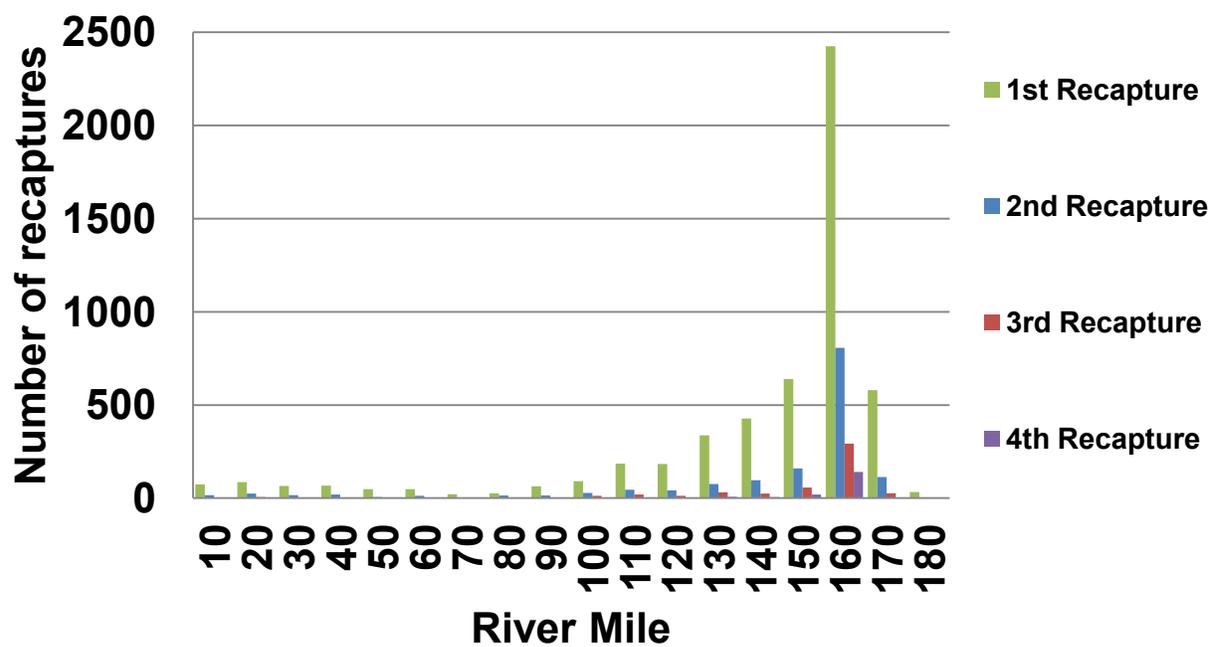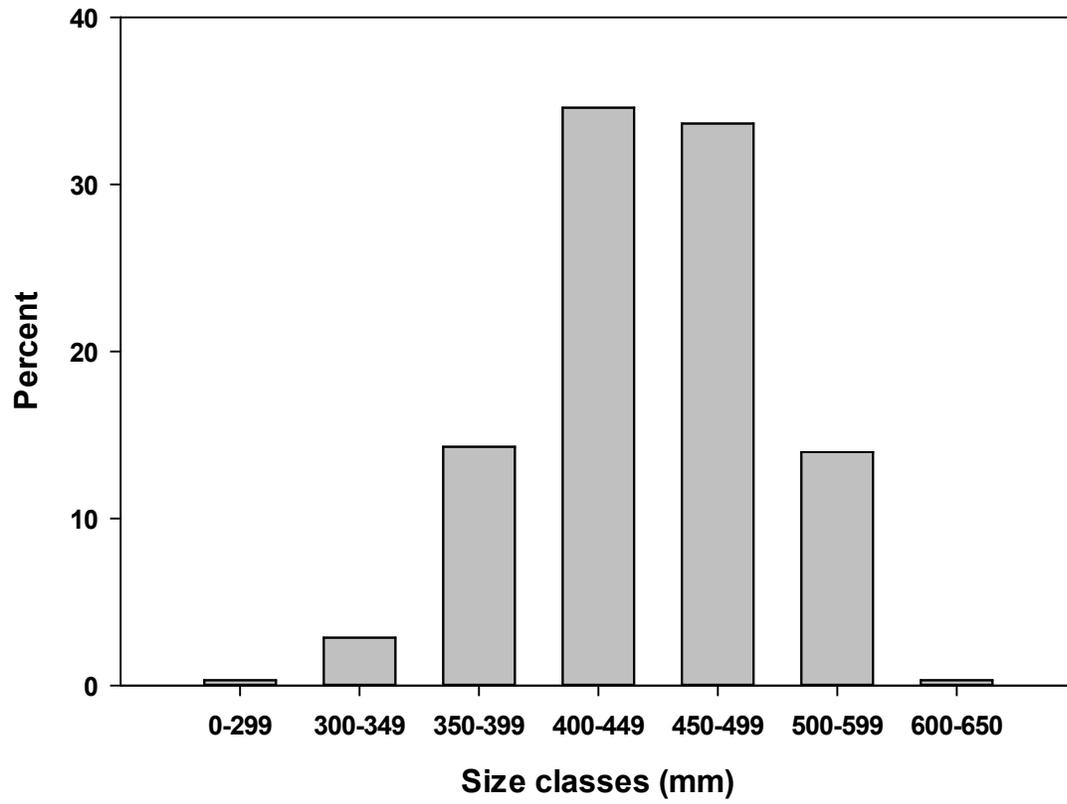
Figure 5. Length-frequency histogram of razorback suckers captured without PIT tags in 2012.

Appendix 1. The following 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 encountered this fish .

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 used to encounter fish.

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 grow-out 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 grow-out ponds.

Comments = Comments – Any notes related to fish encounter