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2014 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 2014 were stocked without PIT tags and like past years, relatively few Colorado Pikeminnow were encountered in the San Juan River after three years post-stocking. Total numbers of Colorado Pikeminnow individuals detected in 2014 declined compared with previous years. Abundance estimates for Colorado Pikeminnow by size class exhibited substantial temporal variation, but abundance of adults appeared to increase in recent years. The total number of Razorback Sucker individuals detected has generally increased since 2008, generally consistent with overall patterns in Razorback Sucker abundance estimates. Although the return rate of stocked Razorback Suckers has varied through time, numerous individuals were detected three or more years post-stocking in 2014. The proportion of Razorback Suckers captured in 2013 and 2014 without PIT tags was half that observed during 2010-2012, perhaps due to changes in PIT tagging protocol for fish stocked from the NAPI ponds. However, captures of 90 untagged Razorback Suckers in the San Juan River does not suggest widespread wild recruitment because of their large size. Patterns observed in PIT tag data were typically consistent with standardized monitoring efforts in terms of size distribution and population trends. 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 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 hatchery-reared endangered fishes, non-native fish removal, increased range expansion through removal of fish passage barriers, restoration of channel complexity, and managed releases of peak and base flows from Navajo Dam. Annual monitoring provides information on the fish community response to management actions. Endangered fishes are handled during management (non-native fish removal and PNM Fish Passage) and monitoring activities (larval, small-bodied, and large-bodied fish monitoring). Information on individual fish is gathered through the reading of uniquely identified passive integrated transponder (PIT) tags implanted in these individuals. In addition to the PIT tag number, river mile (RM) location, length, weight, breeding condition, and other observations are recorded for each endangered fish captured. Colorado Pikeminnow are currently stocked into the San Juan River at a size too small (~50 mm TL) to be implanted with a PIT tag (Furr 2014), but these fish are implanted with a PIT tag when they are recaptured ≥ 150 mm TL in the river. Age 1+ Colorado Pikeminnow were previously stocked into the San Juan River (Furr 2014) but this augmentation effort ceased in 2011 (Durst 2009). In 2010 no age 0 Colorado Pikeminnow were stocked due to a quarantine at Southwestern Native Aquatic Resources and Recovery Center (SNARRC; formerly Dexter National Fish Hatchery and Technology Center). These fish were held overwinter at SNARCC and stocked without PIT tags at age 1 in May 2011. SNARCC also fulfilled its 2011 age 0 Colorado Pikeminnow stocking obligations in November 2011. Razorback Suckers have typically been stocked into the San Juan River with a PIT tag (Furr 2014) but in 2006 and 2007 about 10,000 untagged fish were stocked as part of an effort to start a single cohort strategy at the Navajo Agricultural Production Industry (NAPI) Ponds (Ryden 2008). Recaptures of PIT tagged individuals across the Program's monitoring and management efforts form the basis of a database that I used to create encounter histories of each individual to produce the summaries and analyses presented herein.

The information that can be produced from this database includes summaries detailing the recapture rate of stocked individuals to inform the Program's adaptive management process, mark-recapture analyses to estimate annual survival of stocked individuals (Bestgen et al. 2009, Franssen and Durst *in review*), and population estimates that can be used to evaluate the Program's progress toward recovery for both species (Duran et al. 2011, Hines 2014). 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. The objectives of this report are to: (1) describe and summarize the recaptures of stocked Colorado Pikeminnow and Razorback Sucker, (2) investigate patterns in captures of Razorback Sucker without PIT tags, (3) use existing data to develop capture-recapture abundance estimates for Colorado Pikeminnow and Razorback Sucker, and (4) compare patterns observed for PIT tagged endangered fish across all sampling efforts to those observed in standardized monitoring efforts.

METHODS

Field methods

All management and monitoring efforts in the San Juan River that collect PIT tag data contributed to this report. Data were provided by SNARRC, Uvalde National Fish Hatchery (Uvalde), Horsethief Canyon Native Fish Facility (Horsethief), 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 other studies funded outside the Program. These activities primarily covered the San Juan River from upstream of the Animas River confluence (RM 180.2) to Clay Hills Crossing (RM 2.9), but also included data from the lower Animas River, the San Juan River arm of Lake Powell, and some tributaries of the San Juan River (Figure 1).

Colorado Pikeminnow stocked at age 0 were too small to be implanted with a PIT tag. All Colorado 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 recruitment of wild-produced individuals to juvenile and adult life-stages (Farrington et al. 2014). Colorado Pikeminnow and Razorback Sucker ≥ 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 in the PIT tag database, i.e., the initial encounter of a newly tagged individual). I did not include Colorado Pikeminnow < 150 mm TL in this study that were captured during management and monitoring efforts because they were too small to PIT tag.

Database methods

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 files for each species (Microsoft Office 2010; 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 must be 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 used for subsequent analyses.

Data analysis

I summarized the total number of individuals captured by year from particular stocking classes for Colorado Pikeminnow stocked with and without PIT tags and for Razorback Sucker stocked with PIT tags. Total numbers of individuals captured by year were not adjusted for annual sampling effort or numbers stocked in previous years. I compared numbers of Colorado Pikeminnow and Razorback Sucker individuals captured with unscaled catch per unit effort (CPUE; fish/hour) from the Adult Monitoring standardized sampling effort (Schleicher 2015). For Colorado Pikeminnow stocked without and with PIT tags, I reviewed recaptures from stocking classes since 2002 and 2003, respectively, and for Razorback Sucker, I summarized recaptures from stocking classes since 2000. I assigned Colorado Pikeminnow TAG records (when they were initially implanted with a PIT tag) a year class based on their length and the month when they were first encountered in the San Juan River (D. Ryden, personal communication; Table 1). This allowed me to assign individuals to a particular stocking year because untagged Colorado Pikeminnow were stocked at known ages (Table 2). However, Colorado Pikeminnow > 400 mm TL 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, but these cases were relatively rare (only 144 of 10,145 Colorado Pikeminnow TAG records through 2014 could not be assigned to a year class). Also for 2014, I compared the length-frequency of all PIT tagged Colorado Pikeminnow and all Colorado Pikeminnow collected during Adult Monitoring sampling (including fish that were too small to implant with PIT tags).

The capture of untagged Razorback Suckers could be an indicator of wild recruitment but it can be difficult to definitively distinguish among PIT tag loss, fish stocked without PIT tags, and wild recruitment based solely on PIT tag data. I examined the percentage of Razorback Sucker captured without PIT tags from 2004-2014 and the length-frequency histogram of untagged fish in 2014 to investigate potential wild recruitment. I did not continue the evaluation of Razorback Sucker return rates from the Program's hatchery and grow-out facilities in this report to avoid duplicating other Program integration work. A formal analysis of the Program's Razorback Sucker augmentation efforts was conducted by Franssen and Durst (*in review*) using Program MARK and presented to the Program's Biology Committee during February and May 2015 meetings.

Although the Program does not have a sampling regime in place (multiple river-wide passes in close temporal proximity) to specifically estimate abundance, I used all capture-recapture data to estimate annual abundance of Colorado Pikeminnow and Razorback Sucker for each year independently, 2008-2014. This ad hoc approach may not produce estimates as reliable as those that would be derived from an effort designed explicitly to conduct population estimates while meeting appropriate model assumptions. Nevertheless, this approach does not require a dedicated field study, it can produce trend estimates that could be compared to other monitoring efforts, it can be used to guide the Program when there is a need to conduct more formal estimates, and it can be used to inform the Program's progress toward recovery. In order to use all available data, I categorized captures during each year into four passes. Each year sampling typically spanned March-October, and each pass covered two months (i.e., captures from March and April were group into pass 1, May and June in pass 2, etc.). Each pass included sampling from the PNM Weir (RM 166.6) downstream to Clay Hills Crossing (RM 2.9). Thus encounter histories for each year were based on four occasions (i.e., the four passes). I used closed-capture models with full likelihood parameterization of p (probability of initial capture), c (probability of recapture), and N (abundance) (Otis et al. 1978) in Program MARK (White and Burnham 1999) to estimate the abundance of Colorado Pikeminnow and Razorback Sucker from 2008-2014. Because Colorado Pikeminnow are typically stocked without a PIT tag at ~50-70 mm TL, I grouped them into five size classes (< 200 mm TL, 200-299 mm TL, 300-399 mm TL, 400-449 mm TL, and ≥ 450 mm TL). Since Razorback Suckers are stocked into the San Juan River at nearly adult sizes, I grouped them into five groups based on years post-stocking (1-, 2-, 3-, 4-years post-stocking, and ≥ 5 years post-stocking). I modeled pass varying detection probability (M_t) and constant detection probability (M_0) for each year and species independently. I ranked models using Akaike's information criterion (Akaike 1973) adjusted for small sample size (AIC_c) following Burnham and Anderson (2002). I examined the difference in AIC_c scores (ΔAIC_c) to determine the relative support between the two models. For simplicity sake and because I was primarily interested in estimating abundance (N), in both M_t and M_0 models I constrained p = c.

All raw data were based on queries of the Colorado Pikeminnow and Razorback Sucker MS Access databases (Microsoft Office 2010). I used MS Excel (Microsoft Office 2010) to summarize data and create tables and all figures were produced in SigmaPlot 12 (Systat Software Inc. 2012).

RESULTS AND DISCUSSION

Following the 2014 data update, the Colorado Pikeminnow and Razorback Sucker PIT tag databases contained 56,452 and 155,962 records, respectively. The FIRST_ENC tables, containing both STOCK and TAG records, had a total of 50,952 Colorado Pikeminnow records and 143,296 Razorback Sucker records. The CAPTURE tables had 5,500 and 12,666 records for Colorado Pikeminnow and Razorback Sucker, respectively. Because I considered recaptures of individual PIT tagged Colorado Pikeminnow and Razorback Sucker in this report, the number of encounters presented here likely differs from other Program reports.

Recapture summaries

Across all management and monitoring efforts, a total of 496 individual Colorado Pikeminnow were captured in 2014 (Figure 2). Over 98% of these individuals were stocked without PIT tags (typically at age 0). Total numbers of individual Colorado Pikeminnow captured generally increased from 2003-2009, stabilized through 2011, and declined from 2012-2014. Total numbers of individuals captured in any year seems to be sensitive to sampling conditions, and spatial and temporal sampling effort, making it difficult to interpret these patterns. However, unscaled Colorado Pikeminnow CPUE from standardized Adult Monitoring sampling appears to show similar trends through time (Figure 2). It is important to note that Colorado Pikeminnow CPUE values reported in the Adult Monitoring report are scaled to the number of fish stocked in previous years. In contrast to the unscaled CPUE and total numbers of PIT tagged individuals captured presented herein, these scaled CPUE trends appear to show an increasing trend through time (Schleicher 2015). Observed recent declines in numbers of individual Colorado Pikeminnow captured and unscaled CPUE may be due to cessation of age 1+ stockings (see below) and increased stocking of age 0 fish upstream of PNM Weir (RM 166.6) in reaches of the San Juan River that are sampled less intensively than downstream reaches.

The size structure of PIT tagged Colorado Pikeminnow across all sampling closely resembles that of Adult Monitoring excluding fish < 150 mm TL (Figure 3). Colorado Pikeminnow < 150 mm TL are not typically PIT tagged but these smaller fish represented 49% of all Colorado Pikeminnow collected during Adult Monitoring sampling (Schleicher 2015). Although the PIT tag database includes a subset of Colorado Pikeminnow collected during Adult Monitoring, the similar length distribution of fish > 150 mm TL between the two datasets suggest the single-pass riverwide effort provide an accurate representation of the population’s size structure.

There were 488 individual Colorado Pikeminnow captured in 2014 that were stocked without PIT tags (Table 2). Most of these fish (81%) were assigned to the 2012 and 2013 year classes, i.e., age 1 and age 2. Note that the total number of individuals captured in 2014 included 21 Colorado Pikeminnow TAG records that could not reliably be assigned to a year class, but these were fish initially encountered at > 400 mm TL and thus represented individuals age 3+. The number of recaptured Colorado Pikeminnow that were stocked without PIT tags increased from 665 to 2,271 from 2008 to 2010 and decreased each year since 2010 with only 488 individuals detected in 2014. In 2012 approximately 7% and in 2013 about 12% of Colorado Pikeminnow stocked without PIT tags were age 3+ but these older age classes represented 21% of total captures in 2011 and 19% of total captures in 2014.

Only eight Colorado Pikeminnow stocked with PIT tags were recaptured in 2014 (Table 3). The low number of recaptures of Colorado Pikeminnow stocked with PIT tags is due to ending age 1+ stocking in 2011. From 2009-2011, > 83% of Colorado Pikeminnow stocked with PIT tags were only recaptured in the same year that they were stocked. Although several hundred Colorado Pikeminnow stocked at age 1+ were recaptured each year, the Program ceased production and stocking of age 1+ fish in 2011 based on the relatively higher cost and limited return rate compared with 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 but some adults from these stockings have continued to persist in the San Juan River.

A total of 1,464 Razorback Sucker individuals were captured in 2014 across all management and monitoring efforts (Figure 3). Over 86% of all Razorback Suckers captured in 2014 were assigned to a stocking record (i.e., they received and retained the PIT tag implanted prior to stocking; Table 4). Total numbers of Razorback Sucker individuals captured have generally increased since 2000. This pattern is consistent with unscaled Razorback Sucker CPUE data from Adult Monitoring. In contrast to Colorado Pikeminnow, unscaled and scaled CPUE for Razorback Sucker (Schleicher 2015) revealed similar temporal trends.

Of Razorback Suckers stocked with PIT tags, 65% of recaptures in 2014 were from the 2011-2013 stocking classes and 32% of recaptures were from stocking events prior to 2011 (Table 5). The pattern of Razorback Suckers regularly being captured from multiple stocking classes has been consistent for many years. Documented spawning over 15 consecutive years in the San Juan River (Farrington et al. 2014) indicates the presence of reproducing adult Razorback Suckers. This diverse age-structure of reproducing adults is an important step to establish a self-sustaining population of Razorback Suckers within the San Juan River Basin.

<u>Capture of Razorback Suckers without PIT tags</u>

Because almost all Razorback Suckers stocked prior to 2006 were implanted with PIT tags (Furr 2014), and because of limited evidence of natural recruitment (Golden et al. 2006, Farrington et al. 2014), untagged Razorback Suckers detected prior to 2006 were probably the result of tag loss. The high proportion (> 30%) of Razorback Suckers captured 2006-2008 without PIT tags was 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). The proportion of untagged Razorback Suckers declined and remained relatively constant from 2010-2012 as fewer untagged Razorback Suckers were available for capture from NAPI stocking events in 2006 and 2007 and PIT tag loss remained constant (Table 4). The percentage of Razorback Suckers captured without PIT tags from 2010-2012 declined by half in 2013 and remained stable in 2014, possibly due to a change in PIT tagging protocol for fish stocked from NAPI. Prior to 2013 SNARCC delivered Razorback Suckers to NAPI for grow-out in spring each year and these fish were PIT tagged during passive and active harvest just prior to being stocked into the San Juan River. In 2013 Razorback Suckers were PIT tagged at SNARCC prior to being delivered to NAPI for grow-out. PIT tagging under controlled hatchery conditions possibly resulted in improved PIT tag retention. Because > 90% of the 90 Razorback Suckers captured in 2014 without PIT tags were > 400 mm TL (Figure 5), it is unlikely that any of these fish recruited from wild-hatched fish. Efforts are currently underway to empirically determine the natal origin of untagged Razorback Suckers that have been captured in the San Juan River Basin (Clark-Barkalow Biology Committee presentation 20 February 2015).

Abundance estimates

Time varying detection probability models (M_t) typically received overwhelmingly greater support compared with constant detection probability models (M_0) for both Colorado Pikeminnow and Razorback Sucker abundance estimates for 2008-2014. The Colorado Pikeminnow estimate for 2013 was the only one in which the M_0 model received more support. The range of ΔAIC_c values between first and second ranked M_t and M_0 models were 136-5273, and $\Delta AIC_c > 20$ indicates essentially no support for the non-first-ranked model. Since the first-ranked models were overwhelmingly supported in all cases, parameter estimates were only based on the first-ranked model.

Annual Colorado Pikeminnow abundance estimates varied substantially and point estimates typically exhibited wide confidence intervals (Figure 6). Abundance of Colorado Pikeminnow < 300 mm TL was likely influenced by the short-term retention from recent stocking events as most Colorado Pikeminnow were only recaptured one or two years post-stocking. Trends in abundance estimates for recruiting sub-adults (400-449 mm TL) and adults (≥ 450 mm TL) over time were difficult to discern because of overlapping confidence intervals, likely due to limited numbers of within-year recaptures, but the abundance of adults from 2011-2014 appeared higher compared with 2008 and 2010.

Razorback Sucker abundance estimates varied substantially by year and there were wide confidence intervals around point estimates (Figure 7). The abundance of Razorback Suckers 1- and 2-years post stocking was likely influenced by short-term retention from recent stocking events. Razorback Suckers 1-year post-stocking were most abundant in 2011 and 2012, but the abundance for fish 2-years post-stocking in 2012 and 2013 was greater than 2008-2010 and 2014. Razorback Sucker were more abundant in 2013 and 2014 compared with 2008-2011 for fish 3-years post-stocking and 2008-2010 for fish 4-years post-stocking. The abundance of Razorback Suckers ≥ 5-years post-stocking was stable from 2008-2014. The lack of consistent abundance patterns across all Razorback Sucker age classes was possibly due to sampling inefficiency, low detection probability, limited within-year recaptures, substantial variation around point estimates, or lack of recruitment into older age classes.

The M_t models had most support for Colorado Pikeminnow for every year except 2013and M_t models were best supported in all years for Razorback Sucker. Thus, detection probability typically varied among the four passes for both species. For some passes there were no recaptures and overall there were relatively few within-year recaptures. The lack of standardized spatial and temporal sampling effort among passes likely resulted in high among-pass variation in detection probability each year. Detection probability by pass for different size classes of Colorado Pikeminnow for 2008-2012 and 2014 ranged from 0-0.56 (Table 6). In 2013 Colorado Pikeminnow detection probability for different size classes ranged from 0.021-0.113. Detection probability for Razorback Sucker from 1 to ≥ 5 years post stocking ranged from 0.0-0.34 from 2008 to 2014 (Table 7). In both M_t and M_0 models, initial capture probability (p) was set equal to recapture probability (c). I did not consider models evaluating p and c independently, but testing p and c independently would be important to determine if fish are more or less susceptible to recapture following their initial encounter and could possibly be used to infer behavioral avoidance to electrofishing (Grabowski et al. 2009).

MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

Colorado Pikeminnow population trends in the San Juan River were difficult to discern. Since 2010, the number of individual Colorado Pikeminnow captured has declined, consistent with unscaled CPUE from Program’s standardized Adult Monitoring project (Schleicher 2015). However, the number of captures is heavily influenced by spatial and temporal sampling effort and sampling conditions. Also, CPUE metrics do not account for detection probability. Although the Program does not have a dedicated capture-recapture population estimate effort, the river-wide sampling efforts produce equivalent data although it was not collected with the assumptions of a closed-capture population estimate in mind (White et al. 1982). These closed-capture models resulted in estimates with wide and overlapping confidence intervals due to limited within-year recaptures. Although these Colorado Pikeminnow abundance estimates were imprecise and their accuracy is unclear, they inform the Program’s progress toward recovery without an additional field effort. While temporal abundance trends for most Colorado Pikeminnow size classes were unclear, the abundance of adults appeared to have increased in recent years, hopefully establishing a persistent population of spawning adults. Adult and sub-adult Colorado Pikeminnow population abundance estimates have been calculated since 2010 based on numbers captured during Adult Monitoring and using a 0.05 detection probability determined from other analytic efforts (Schleicher 2015). However, I made no statistical comparisons between closed-capture estimates and Adult Monitoring estimates because they lack any variance measure.

The Razorback Sucker augmentation program has resulted in multiple adult age-classes in the San Juan River that have spawned for 15 consecutive years (Farrington et al. 2014). Captures of individual Razorback Suckers and unscaled CPUE data appeared to reveal consistent increasing temporal trends. Despite substantial annual variation and large errors around point estimates, summed closed-capture abundance estimates for all years post-stocking overlap Razorback Sucker recovery demographic criteria of 5,800 individuals in the San Juan River from 2011-2014. Although the Razorback Sucker adult population is apparently robust and regularly reproducing in the San Juan River, documentation of wild recruitment remains elusive despite the detection of some juvenile individuals (Farrington et al. 2014, Hines 2014). Adult and sub-adult Razorback Sucker population estimates have been calculated since 2010 based on numbers captured during Adult Monitoring and using a 0.04 detection probability determined from other analytic efforts (Schleicher 2015) but I did not compare these estimates with closed-capture estimates because the Adult Monitoring estimates do not have any variance measure.

Passive PIT tag readers or increased sampling effort may result in higher numbers of recaptures (or resights in the case of passive detection techniques). The Program has installed remote PIT tag readers in various locations within the San Juan River (PNM Weir, PNM Fish Passage, Hogback Fish Weir, Phase 2 restored secondary channel, and the mouth of McElmo Creek), in addition to using passive detection methods like a raft-mounted antenna and temporarily installed remote readers. These passive detection techniques should result in higher detection probabilities and more robust demographic parameter estimates for PIT-tagged individuals (Hewitt et al. 2010). Additionally, analytic and sampling efforts that more stringently follow assumptions of closed-capture models may result in more robust abundance estimates. This could possibly be accomplished with existing data by only using mark-recapture passes in close spatial and temporal proximity. Alternatively, a dedicated mark-recapture field effort to conduct estimates could be designed with appropriate model assumptions in mind. However, estimates from a dedicated field effort may also be imprecise if recaptures are limited. In the meantime, the available abundance estimates can serve as a benchmark to evaluate the Program's progress toward recovery. Given the underlying population bottlenecks such as lack of sufficient wild reproduction and recruitment for Colorado Pikeminnow and Razorback Sucker, the cost of a dedicated field effort to estimate abundance may not provide sufficient recovery benefit to be prudent at this time.

The Program's ability to assess the status of Colorado Pikeminnow and Razorback Sucker populations is hampered by movement of endangered fish and conducting management activities outside of areas that are regularly monitored. Colorado Pikeminnow and Razorback Sucker stocking has occurred in upstream reaches that are only infrequently monitored (Furr 2014, Schleicher 2015). It may be difficult to determine the success of these stocking events with the limited sampling that occurs in the San Juan River upstream of the PNM Weir and in the Animas River. Additionally, some endangered fish are lost from the San Juan River by passing over the waterfall into Lake Powell (Francis et al. 2013) making them unavailable for recapture in the San Juan River. The magnitude of fish lost to Lake Powell is unknown, but because the waterfall is only infrequently inundated these fish can rarely return to the San Juan River unless they are physically transported upstream of the waterfall (Francis et al. 2013). While the role Lake Powell plays in the recovery of Colorado Pikeminnow and Razorback Sucker is unclear, perhaps the Program should explore means to allow endangered fish access from the lake to the San Juan River.

Efforts are ongoing to evaluate the Program's Razorback Sucker augmentation efforts. Program MARK is being used to understand variation in Razorback Sucker survival and detection probability based on stocking season, stocking location, and total length based on fish stocked from NAPI, SNARRC, and Uvalde from 2000-2013 in order to guide augmentation efforts and improve the survival of hatchery-reared fish (Franssen and Durst *in review*). Efforts to reduce confounding interactions between stocking location and source, and evaluate the effect of hard versus soft release stocking protocols were implemented in 2014 (Cheek presentation 20

February 2015). Additionally, preliminary techniques to improve the post-stocking survival of Razorback Sucker from NAPI such as flow conditioning will be explored during the 2015 stocking season.

The change in PIT tagging protocol for NAPI Razorback Suckers appeared to improve PIT tag retention. Prior to 2013 when Razorback Suckers were PIT tagged at NAPI during passive and active harvest, processing and stocking these fish into the San Juan River as rapidly and efficiently as possible may have contributed to the capture of many untagged Razorback Suckers in the San Juan River because of PIT tag loss. Starting in 2013 Razorback Suckers were PIT tagged at SNARCC prior to delivery to NAPI. In addition to determining short-term (4-6 months) PIT tag retention while these fish grew-out in the NAPI ponds (Cheek 2014), it appears the reduced percentage of untagged Razorback Suckers captured in the San Juan River could be attributed to this revised protocol. Perhaps anesthetizing fish and tagging them under controlled hatchery conditions resulted in improved long-term (post six months) PIT tag retention for Razorback Suckers. Once wild recruitment becomes more widespread, a minimized rate of PIT tag loss will improve the Program's ability to distinguish between untagged fish resulting from wild recruitment and PIT tag loss. Reliable documentation of wild recruitment will be an important step in the recovery of Razorback Sucker in the San Juan River. Capturing smaller Razorback Sucker than are typically stocked, or the use of isotopic or elemental analysis to determine natal origin, will also be useful to document wild recruitment.

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 using 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. Increasing the spatial scope of monitoring activities could also document range expansion of PIT tagged individuals into upstream reaches of the San Juan and Animas Rivers or other San Juan River tributaries. Additionally, because the integrated PIT tag database details the capture history of individuals over time, it could be used to track growth and condition. Information on growth rates and condition may be useful to evaluate and revise the flow recommendations or assess the effect of temperature modification to Navajo Dam releases if particular management actions 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. Despite the lack of clarity provided by the current Colorado Pikeminnow abundance estimates, and the apparently robust Razorback Sucker population in the San Juan River, until wild recruitment replaces adult mortality, the long-term persistence of endangered fish is doubtful without continued stocking of hatchery-reared fish.

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TABLES

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

<table>
<tr><th></th><th colspan="12">Month of capture</th></tr>
<tr><th>Size at capture (TL)</th><th>Jan</th><th>Feb</th><th>Mar</th><th>April</th><th>May</th><th>June</th><th>Jul</th><th>Aug</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>150-190mm</td><td colspan="12">Age 1</td></tr>
<tr><td>191-240mm</td><td colspan="8">Age 2</td><td colspan="4">Age 1</td></tr>
<tr><td>241-300mm</td><td colspan="12">Age 2</td></tr>
<tr><td>301-350mm</td><td colspan="6">Age 3</td><td colspan="6">Age 2</td></tr>
<tr><td>351-400mm</td><td colspan="12">Age 3</td></tr>
</table>

Table 2. Number of Colorado Pikeminnow stocked at age 0 from 2002-2013 and recaptured from 2003-2014. The number of recaptures is based only on individuals large enough to be implanted with a PIT tag during their TAG record (≥ 150 mm TL). The total number of individuals recaptured may be less than the sum of the number of individuals recaptured by year because some individuals are recaptured in multiple years. The number of individuals from a particular stocking class can be examined looking across rows. The number of individuals captured by year from different stocking classes can be examined looking down 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.

				Individuals captured by year											
Year stocked	Year class	Number stocked	Total captured	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	UNKNOWN		112	3	1	2	15	7	4	12	19	27	19	22	21
2002	2002	210,418	211	73	132	11	0	1	0	0	0	0	0	1	0
2003	2003	175,928	446	-	190	233	33	2	0	0	0	0	0	0	0
2004	2004	280,000	341	-	-	155	183	22	5	4	2	0	2	1	1
2005	2005	302,270	547	-	-	-	393	138	37	11	1	4	1	0	3
2006	2006	313,854	507	-	-	-	-	270	224	80	7	3	1	0	4
2007	2007	475,970	872	-	-	-	-	1	395	476	76	20	6	5	3
2008	2008	270,234	2,108	-	-	-	-	-	-	899	1,124	353	8	3	2
2009	2009	468,000	1,949	-	-	-	-	-	-	-	1,042	962	48	6	3
2011	2010	214,720	1,033	-	-	-	-	-	-	-	-	555	456	74	7
2011	2011	426,588	1,032	-	-	-	-	-	-	-	-	-	667	371	47
2012	2012	395,640	598	-	-	-	-	-	-	-	-	-	-	420	200
2013	2013	439,264	197	-	-	-	-	-	-	-	-	-	-	-	197
Total individuals captured				76	323	401	624	441	665	1,482	2,271	1,924	1,212	903	488

Table 3. Number of Colorado Pikeminnow stocked as age 1+ and recaptured by year, 2003-2014. 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 SNARCC 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.

			Individuals captured by year											
Year stocked	Number stocked	Total captured	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
2003	1,002	3	3	0	0	0	0	0	0	0	0	0	0	0
2004	1,217	79	-	66	13	1	0	0	0	0	0	0	0	0
2005	4,119	89	-	-	84	5	0	0	0	0	0	0	0	0
2006	12,661	357	-	-	-	294	53	6	6	2	2	1	1	2
2007	3,250	233	-	-	-	-	141	79	16	1	3	0	0	1
2008	4,848	628	-	-	-	-	-	203	439	16	2	1	0	1
2009	8,942	565	-	-	-	-	-	-	470	108	14	4	1	3
2010	353	43	-	-	-	-	-	-	-	35	8	0	3	0
2011	3,724	295	-	-	-	-	-	-	-	-	269	25	1	1
Total individuals captured			11	68	99	300	194	288	931	162	298	31	6	8

Table 4. Number of individual Razorback Sucker captured with and without PIT tags, 2004-2014. Percent without PIT tags represents the percent of Razorback Sucker captured without PIT tags out of total number of Razorback Sucker individuals captured.

	Individuals captured				Percent without PIT tags
Year	Total	with PIT tags (STOCK)	with PIT tags (TAG)	without PIT tags	
2004	415	381	0	34	8.2
2005	343	305	4	34	9.9
2006	561	340	8	213	38.0
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	2,207	1,797	92	318	14.4
2013	1,878	1,617	125	136	7.2
2014	1,464	1,256	118	90	6.1

Table 5. Number of Razorback Sucker stocked and recaptured by year, 2000-2014. 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 down columns. The total number of individuals captured in any year also includes individuals stocked before 2000.

			Individuals captured by year														
Year stocked	Total stocked	Total captured	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
2000	1,044	62	0	26	7	9	8	12	7	7	5	7	5	4	2	1	3
2001	688	234	-	0	43	73	61	43	32	34	26	19	18	13	13	10	7
2002	140	36	-	-	5	13	12	3	6	2	3	2	3	4	1	2	1
2003	887	71	-	-	-	54	11	5	1	2	3	1	2	2	0	0	0
2004	2,979	592	-	-	-	-	288	173	114	65	48	56	33	55	46	26	22
2005	1,993	148	-	-	-	-	-	67	43	25	24	15	16	20	12	13	8
2006	13,764	256	-	-	-	-	-	-	133	72	38	38	24	33	28	15	15
2007	16,906	807	-	-	-	-	-	-	-	499	188	115	90	74	55	45	32
2008	4,424	243	-	-	-	-	-	-	-	-	46	144	46	31	29	16	17
2009	8,316	801	-	-	-	-	-	-	-	-	-	43	526	186	132	114	67
2010	28,419	1,527	-	-	-	-	-	-	-	-	-	-	108	862	479	373	230
2011	18,807	1,224	-	-	-	-	-	-	-	-	-	-	-	93	750	361	263
2012	15,822	647	-	-	-	-	-	-	-	-	-	-	-	-	248	368	113
2013	15,341	689	-	-	-	-	-	-	-	-	-	-	-	-	-	271	435
2014	6,545	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43
Total individuals recaptured			14	43	68	156	381	305	340	708	382	440	873	1,379	1,797	1,617	1,256

Table 6. Detection probability summarized by year for Colorado Pikeminnow by size class, 2008-2014. Detection probabilities for all years except 2013 are based on the M_t models. The 2013 detection probabilities are based on the M_0 model. M(t+1) represents the number of Colorado Pikeminnow captured in that year (by size class). The number of captures including recaptures by pass is represented by n(j1) for the first pass, n(j2) for the second pass, n(j3) for the third pass, and n(j4) for the fourth pass. Detection probability by pass is designated by p-j1 to p-j4. For 2013 the number of captures including recaptures and detection probability are for the entire year (across all passes).

Colorado Pikeminnow (TL)

	<200 mm TL					200-299 mm TL					300-399 m TL					400-449 mm TL					>=450 mm TL				
	M(t+1)	n(j1)	n(j2)	n(j3)	n(j4)	M(t+1)	n(j1)	n(j2)	n(j3)	n(j4)	M(t+1)	n(j1)	n(j2)	n(j3)	n(j4)	M(t+1)	n(j1)	n(j2)	n(j3)	n(j4)	M(t+1)	n(j1)	n(j2)	n(j3)	n(j4)
Year		p-j1	p-j2	p-j3	p-j4		p-j1	p-j2	p-j3	p-j4		p-j1	p-j2	p-j3	p-j4		p-j1	p-j2	p-j3	p-j4		p-j1	p-j2	p-j3	p-j4
2008	441	127	10	97	232	443	109	7	178	178	59	26	6	18	15	4	0	0	3	1	1	0	0	1	0
		0.05	0	0.04	0.09		0.04	0	0.07	0.07		0.11	0.03	0.08	0.06										
2009	824	101	15	246	490	1,162	604	3	374	286	297	70	0	113	131	13	0	0	11	2	5	1	0	5	0
		0.01	0	0.03	0.07		0.206	0.001	0.141	0.114		0.04	0	0.06	0.07							0.04	0	0.22	0
2010	1,082	279	136	196	561	1,069	328	135	314	410	252	59	18	55	140	22	5	2	7	12	8	0	1	3	6
		0.06	0.03	0.04	0.11		0.08	0.03	0.08	0.1		0.05	0.02	0.05	0.12		0.1	0.04	0.14	0.24		0	0.09	0.28	0.56
2011	544	201	41	136	206	860	264	88	446	182	647	71	21	514	98	41	5	1	33	3	26	3	2	14	8
		0.07	0.01	0.05	0.07		0.1	0.03	0.17	0.07		0.04	0.01	0.28	0.05		0.02	0	0.11	0.01		0.01	0.01	0.07	0.04
2012	622	106	78	216	244	430	59	68	182	142	88	14	21	30	27	10	1	4	4	3	30	5	14	8	7
		0.02	0.01	0.03	0.04		0.02	0.02	0.06	0.04		0.02	0.03	0.04	0.04		0.05	0.19	0.19	0.14		0.05	0.15	0.09	0.07
2013	375	387				343	366				128	137				14	16				28	33			
		0.02					0.04					0.05					0.1					0.11			
2014	221	74	8	58	87	163	43	36	73	31	50	12	3	30	9	13	2	2	7	3	40	2	9	21	14
		0.03	0	0.02	0.03		0.08	0.06	0.13	0.05		0.06	0.1	0.14	0.04		0.04	0.04	0.12	0.05		0.02	0.08	0.2	0.13

Table 7. Detection probability summarized by year for Razorback Sucker by years post-stocking, 2008-2014. Detection probabilities for all years are based on the M_t models. M(t+1) represents the number of Razorback Sucker captured in that year (by years post-stocking). The number of captures including recaptures by pass is represented by n(j1) for the first pass, n(j2) for the second pass, n(j3) for the third pass, and n(j4) for the fourth pass. Detection probability by pass is designated by p-j1 to p-j4.

Razorback Sucker (years post-stocking)

	1-year post-stocking					2-years post-stocking					3-years post-stocking					4-years post-stocking					>=5-years post-stocking				
	M(t+1)	n(j1)	n(j2)	n(j3)	n(j4)	M(t+1)	n(j1)	n(j2)	n(j3)	n(j4)	M(t+1)	n(j1)	n(j2)	n(j3)	n(j4)	M(t+1)	n(j1)	n(j2)	n(j3)	n(j4)	M(t+1)	n(j1)	n(j2)	n(j3)	n(j4)
Year		p-j1	p-j2	p-j3	p-j4		p-j1	p-j2	p-j3	p-j4		p-j1	p-j2	p-j3	p-j4		p-j1	p-j2	p-j3	p-j4		p - j1	p-j2	p - j3	p - j4
2008	188	111	4	45	48	37	12	0	18	9	22	11	1	6	7	45	20	0	20	17	37	17	3	13	6
		0.17	0.01	0.07	0.08		0.05	0	0.08	0.04		0.18	0.02	0.1	0.11		0.25	0	0.25	0.21		0.07	0.01	0.05	0.02
2009	144	109	2	22	31	115	65	0	33	31	38	16	0	14	16	15	5	0	6	7	85	31	1	32	28
		0.34	0.01	0.07	0.1		0.18	0	0.09	0.09		0.2	0	0.17	0.2		0.16	0	0.19	0.23		0.08	0	0.08	0.07
2010	531	265	69	142	1353	46	14	3	15	18	90	47	2	19	34	24	9	2	5	12	74	28	4	22	31
		0.17	0.05	0.09	0.09		0.07	0.01	0.07	0.09		0.18	0.01	0.07	0.13		0.15	0.03	0.08	0.2		0.13	0.02	0.1	0.15
2011	873	331	138	376	111	186	45	36	99	20	30	12	2	11	11	59	18	2	18	23	97	30	5	45	24
		0.09	0.04	0.1	0.03		0.05	0.04	0.11	0.02		0.18	0.03	0.16	0.16		0.03	0	0.03	0.04		0.06	0.01	0.09	0.05
2012	735	317	100	233	150	476	187	40	215	83	131	14	10	91	25	28	9	4	12	6	123	61	13	29	30
		0.09	0.03	0.07	0.04		0.1	0.02	0.12	0.05		0.03	0.02	0.16	0.04		0.09	0.04	0.11	0.06		0.11	0.02	0.05	0.05
2013	357	124	10	175	85	359	173	46	112	63	373	147	16	164	97	114	31	6	65	27	129	66	14	50	22
		0.09	0.01	0.13	0.06		0.12	0.03	0.08	0.04		0.13	0.01	0.14	0.09		0.09	0.02	0.19	0.08		0.21	0.04	0.16	0.07
2014	450	135	80	226	68	110	23	11	65	20	257	72	62	114	43	230	44	33	122	60	150	26	19	86	29
		0.09	0.06	0.16	0.05		0.05	0.02	0.14	0.04		0.09	0.07	0.13	0.05		0.06	0.04	0.16	0.08		0.03	0.02	0.11	0.04

FIGURES

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.

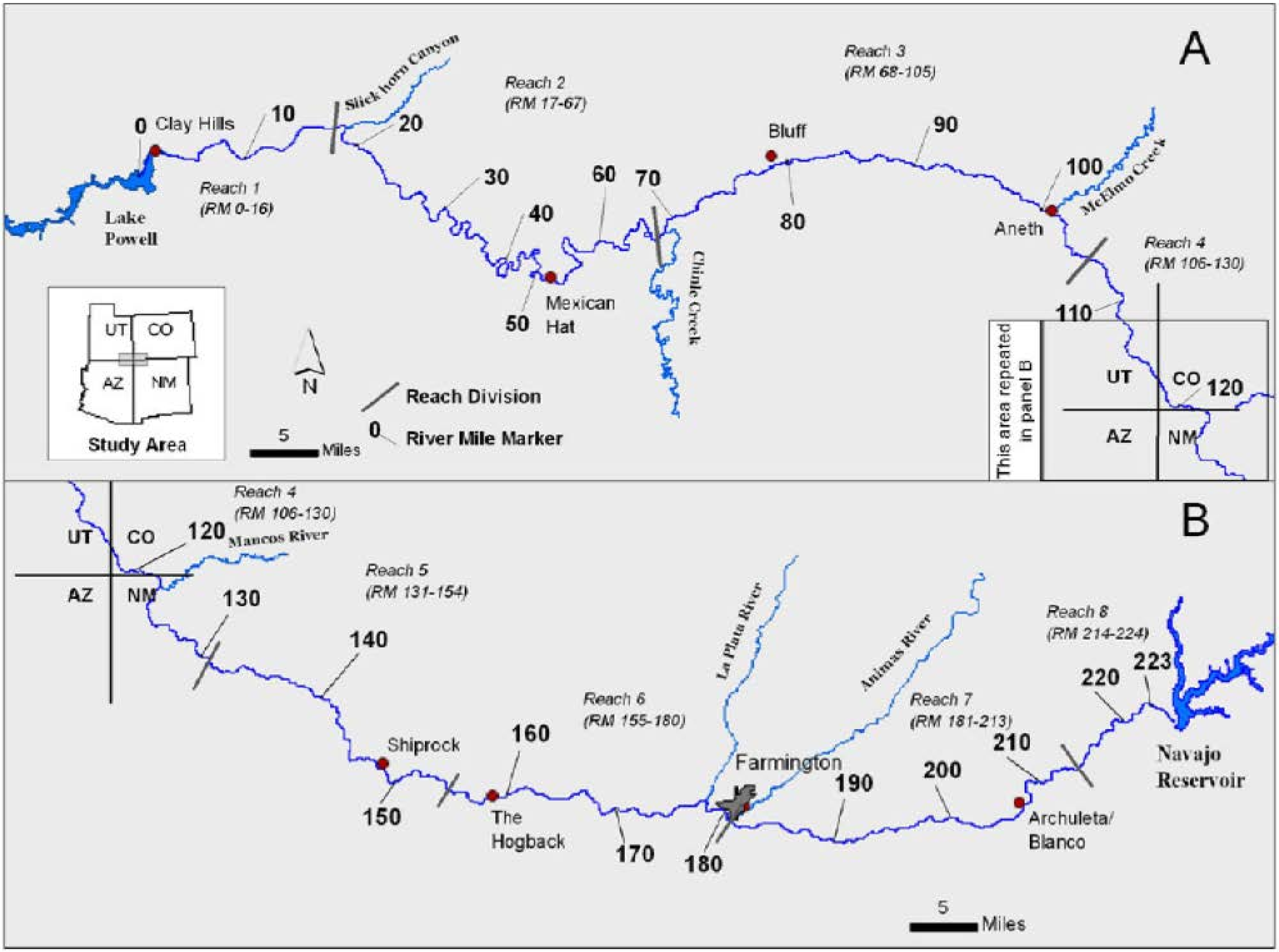


Figure 2. Total number of individual PIT tagged Colorado Pikeminnow captured by year across all Program projects and unscaled Colorado Pikeminnow catch per unit effort (CPUE; fish/hour) based on Adult Monitoring data. Error bars represent 95% confidence interval.

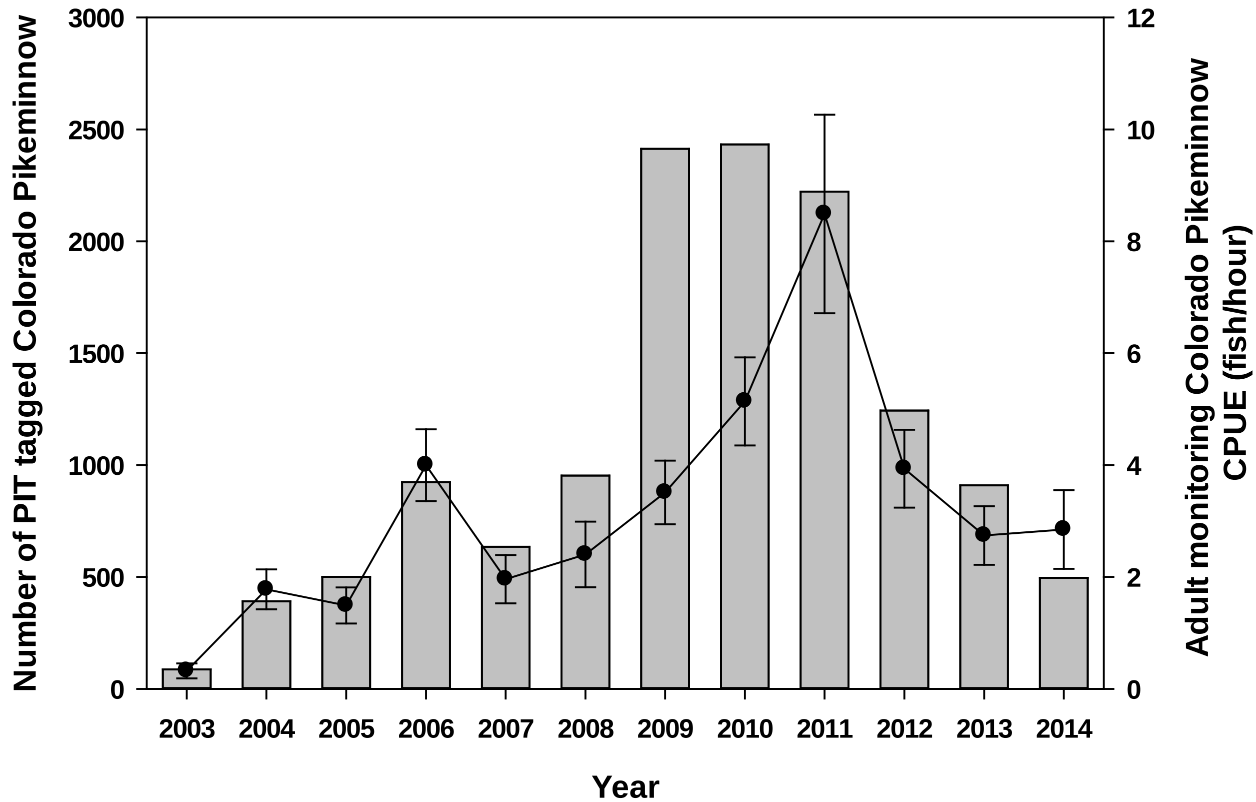


Figure 3. Length-frequency histogram of all PIT tagged Colorado Pikeminnow (across all projects) and Colorado Pikeminnow collected only during Adult Monitoring project (includes many Colorado Pikeminnow too small to PIT tag; Schleicher 2015). Colorado Pikeminnow ≥ 150 mm TL captured during Adult Monitoring are a subset of all tagged fish included in the PIT tag database.

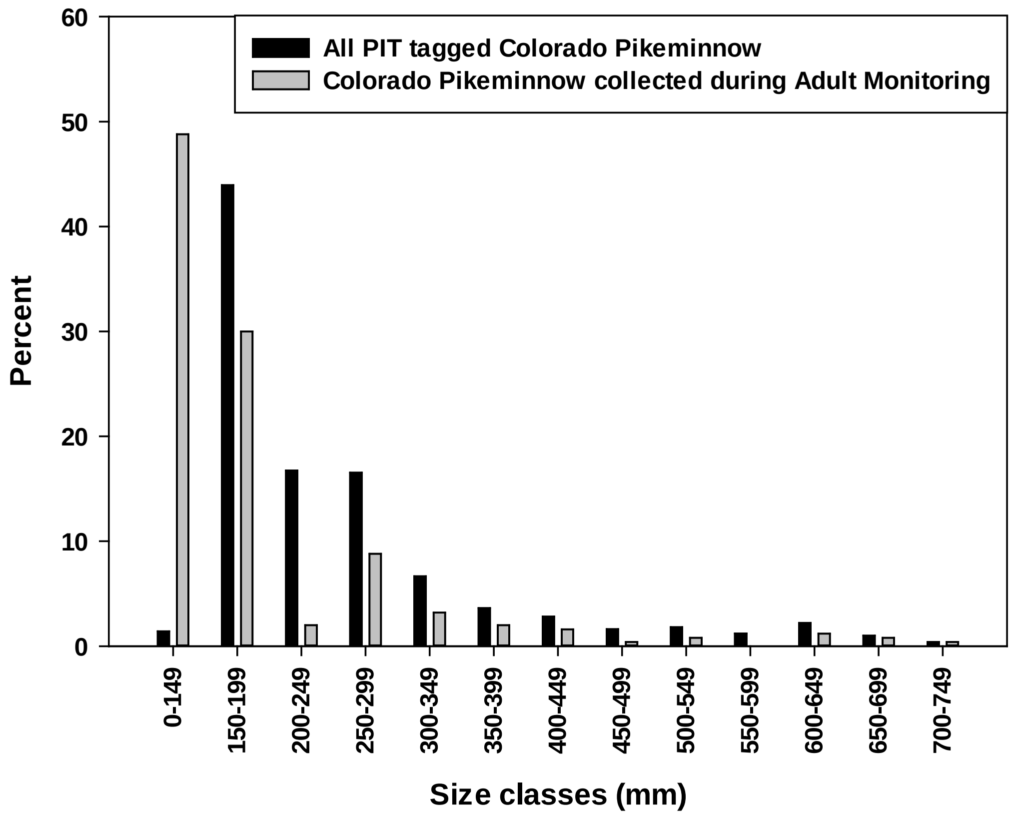


Figure 4. Total number of individual PIT tagged Razorback Sucker captured by year across all Program projects and unscaled Razorback Sucker catch per unit effort (CPUE; fish/hour) based on Adult Monitoring data. Error bars represent 95% confidence interval.

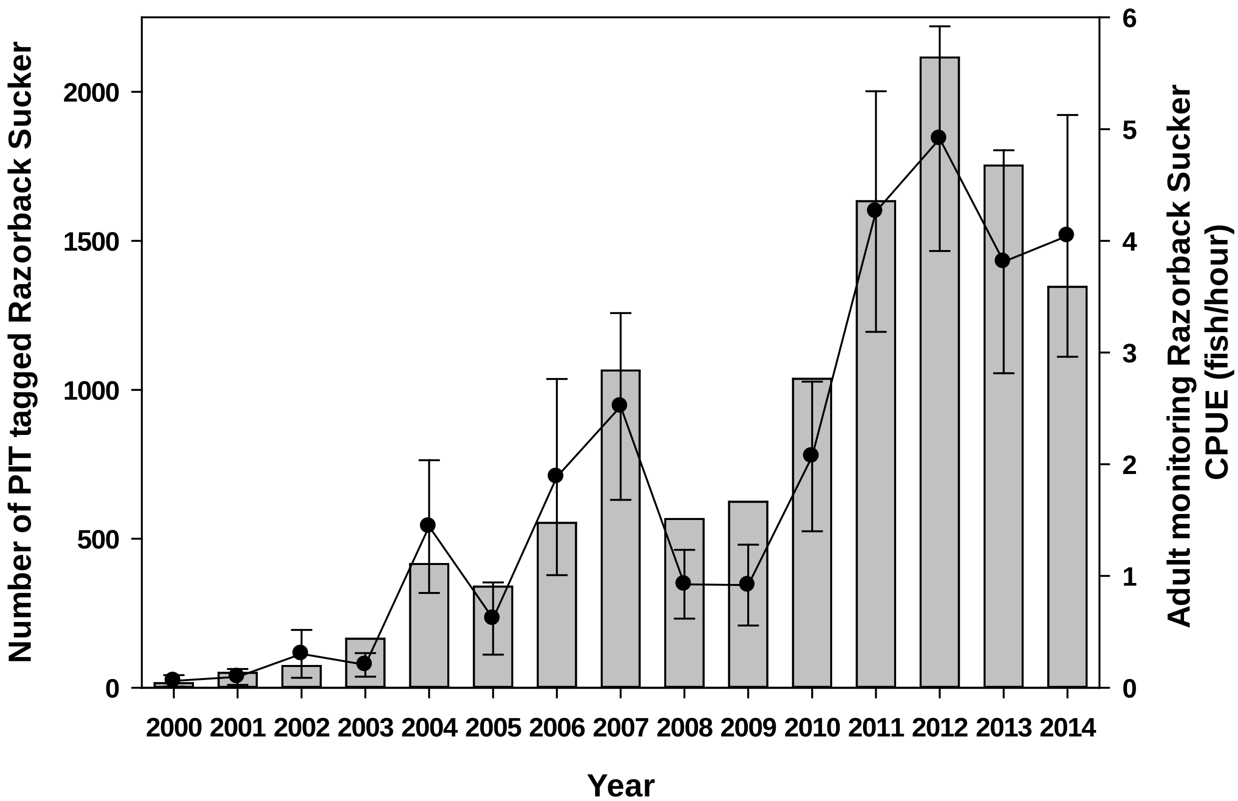


Figure 5. Length-frequency histogram of Razorback Suckers captured without PIT tags in 2014.

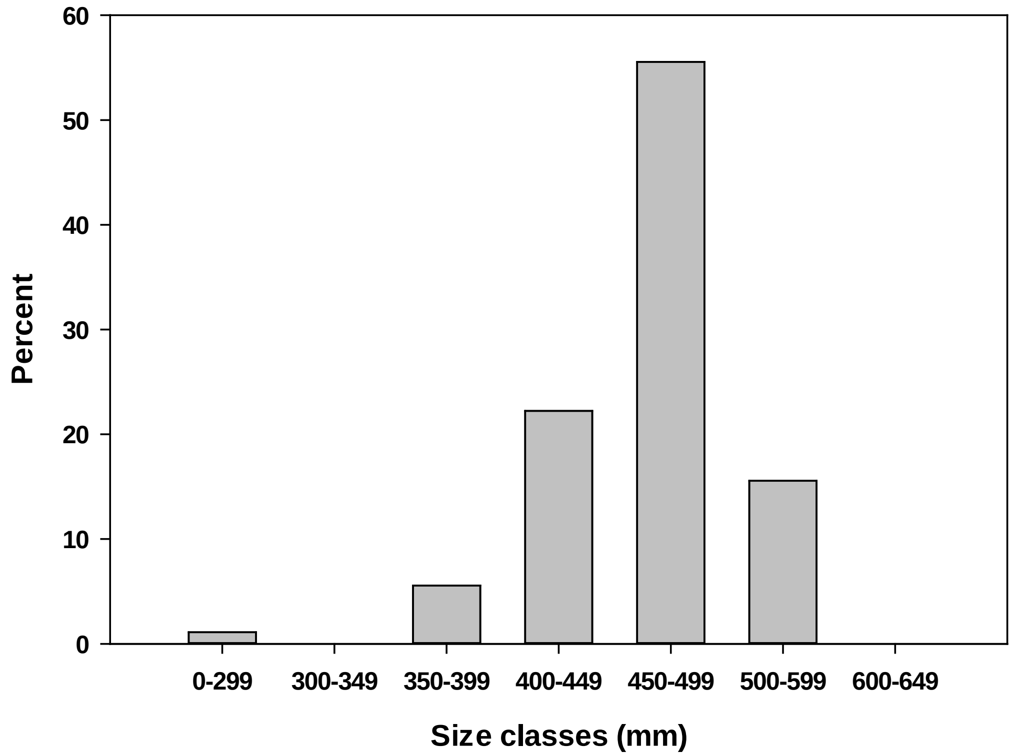


Figure 6. Closed capture abundance estimate of Colorado Pikeminnow based on first-ranked model each year. Each panel represents the abundance of Colorado Pikeminnow < 200 mm TL, 200-299 mm TL, 300-399 mm TL, 400-449 mm TL, and ≥ 450 mm TL by year 2008-2014. Error bars represent 95% confidence interval.

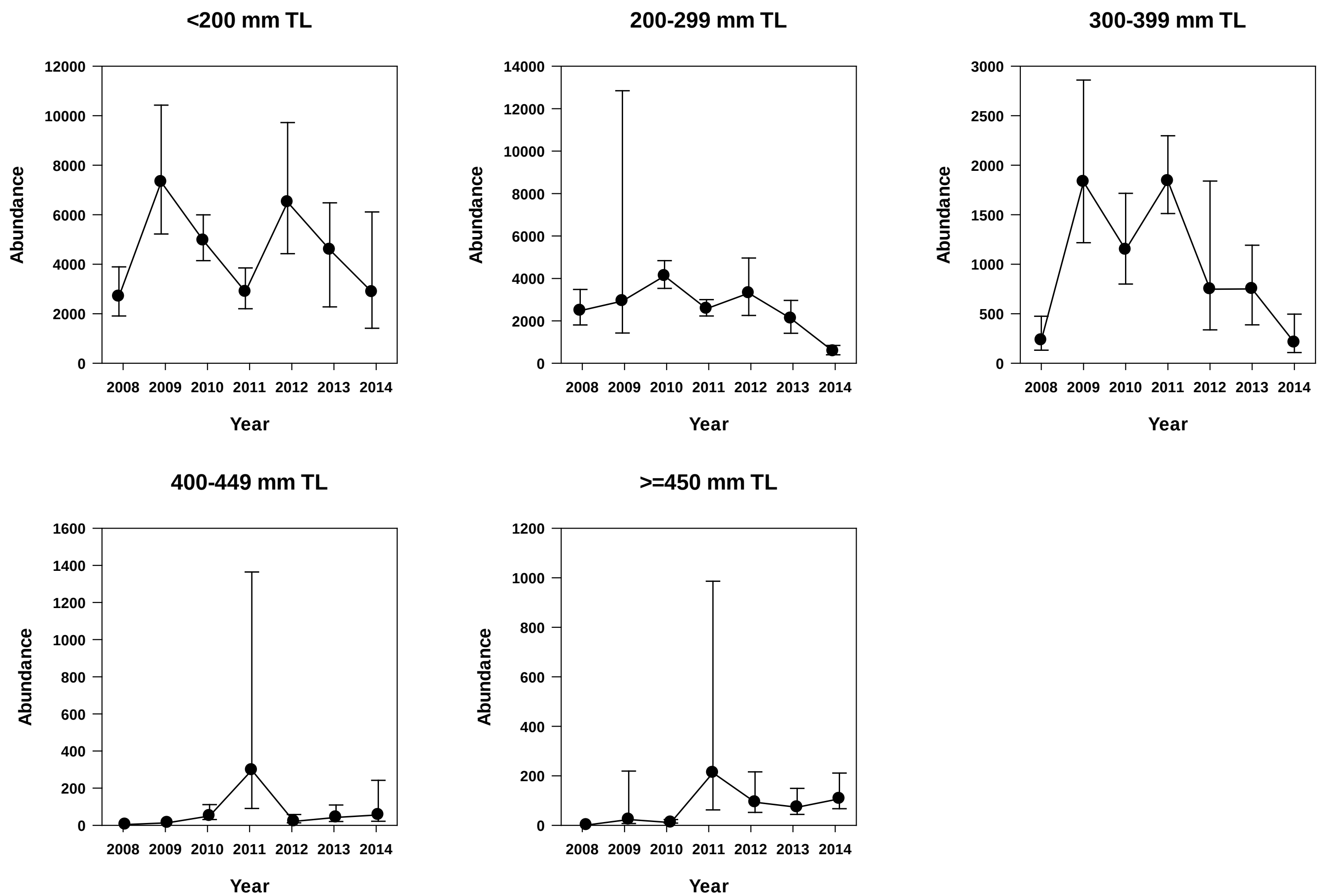
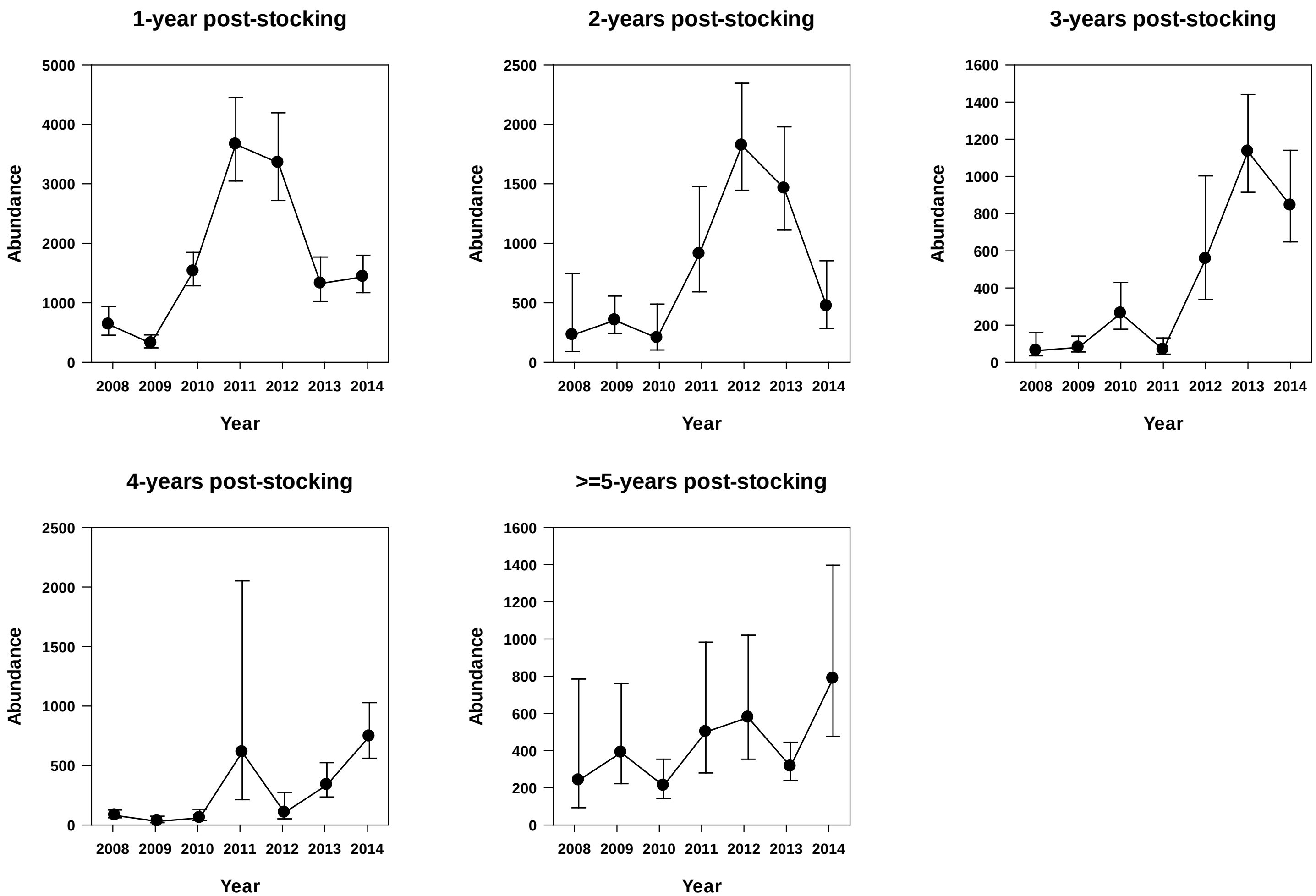


Figure 7. Closed capture abundance estimate of Razorback Sucker based on first-ranked model each year. Each panel represents the abundance of Razorback Sucker 1-year post stocking, 2-years post-stocking, 3-years post-stocking, 4-years post-stocking, and ≥ 5-years post-stocking by year 2008-2014. Error bars represent 95% confidence interval.



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 = Days 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.