LONG TERM MONITORING OF SUB-ADULT AND ADULT LARGE-BODIED FISHES IN THE SAN JUAN RIVER: 2016

Interim Progress Report

Final Report
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EXECUTIVE SUMMARY

General Information

- A total of 7,482 fishes were collected in the common sampled area (RM 180.0-77.0) during 2016 Adult Monitoring
    - Native fishes accounted for 88.9% of the total catch
    - 134 electrofishing samples
    - 57.89 hours of electrofishing

Native Species:

- Colorado Pikeminnow
    - Likely no wild Colorado Pikeminnow were collected
    - 142 stocked Colorado Pikeminnow were collected
        - Sixth most abundant species collected
        - CPUE of Colorado Pikeminnow in the river for 1+ overwinter periods post-stocking was significantly lower in 2016 than 3 of the previous 12 years
        - Sizes ranged from 100-690 mm TL (age-1 to age-10)
            - 4 adult fish (>450 mm TL) collected
            - 2 sub-adult fish (400-449 mm TL) collected
            - 20 large juvenile fish (300-399 mm TL) collected
        - Captures ranged from RM 180.0-77.0
            - 54 in Reach 6, 64 in Reach 5, 17 in Reach 4, and 7 in Reach 3
        - 102 (71.8%) of the 142 known-origin Colorado Pikeminnow were in the river $\leq$ 365 days post-stocking
            - All 142 Colorado Pikeminnow collected were in the river for at least one overwinter period
- Razorback Sucker
    - No wild Razorback Sucker were collected
    - 383 stocked Razorback Sucker were collected
        - Fourth most abundant species collected
        - Most Razorback Sucker ever collected during an Adult Monitoring in the common sampled area (RM 180.0-77.0)
        - CPUE of Razorback Sucker that had been in the river for 1+ overwinter periods was similar to previous 4 years
        - Sizes ranged from 352-557 mm TL (age-2 to age-16)
        - Captures ranged from RM 180.0-77.0
        - 181 were collected in Reach 6, 96 in Reach 5, 70 in Reach 4, and 36 in Reach 3.
        - Of 357 Razorback Sucker collected with PIT tags and known stocking

histories, 31 (8.7%) were in the river ≤ 365 days post-stocking
    - Two of those fish were in the river < 1 overwinter period when they were collected
    - The others were in the river from 1-15 overwinter periods
- Flannelmouth Sucker
    - Most abundant species in the common sampled area (RM 180.0-77.0)
        - Flannelmouth Sucker were the numerically dominant species in Adult Monitoring collections in the common sampled area in the last 18 years
        - Accounted for 61.7% of the total catch (n = 4,614 fish)
        - Had the widest distribution of any species, being collected all 134 electrofishing samples (RM 180.0-77.0)
- Bluehead Sucker
    - Among the three most-commonly collected species in each of the last 18 years in the common sampled area (RM 180.0-77.0)
    - Second most abundant species collected
        - Accounted for 16.0% of the total catch (n = 1,198 fish)
        - Collected in 90 of 134 (67.2%) electrofishing samples (RM 180.0-88.5)

Nonnative Species:

- Channel Catfish
    - Third most abundant species in the common sampled area (RM 180.0-77.0)
        - Accounted for 9.7% of the total catch (n = 722 fish)
        - Collected in 80.6% of electrofishing samples (RM 166.6-77.0)
        - The majority Channel Catfish were collected in the middle nonnative fish removal section (RM 147.9 – 93.0)
            - Numbers considerably reduced from PNM Weir downstream to Hogback diversion dam
            - Adult and juvenile CPUE show no significant increasing or decreasing trend from 1999-2016 (RM 180.0-77.0).
- Common Carp
    - Percent of total catch accounted for by this species had decreased steadily from 9.6% in 1999 to 0.20% in 2015 to 1.0% in 2016
        - Was the fourth most commonly-collected species in 1999
    - The seventh most commonly-collected species
        - 75 common carp collected from RM 180.0-77.0
            - 14 (18.7%) were adult fish (i.e., ≥ 250 mm TL)
            - 61 (81.3%) were juvenile fish (i.e., ≤ 250 mm TL)
        - Collected in 23.9% of electrofishing samples (RM 180.0-77.0)
        - Less abundant than both endangered Colorado Pikeminnow and Razorback Sucker during Adult Monitoring collections

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INTRODUCTION

Research performed from 1991 to 1997 led to the initiation of several major management actions by the San Juan River Basin Recovery Implementation Program (SJRIP) that are intended to have long-term positive impacts on the native fish community. These included development of flow recommendations for the reoperation of Navajo Reservoir, instituting the mechanical removal of nonnative fishes, modifying or removing three instream water diversion structures to provide fish passage and minimize entrainment, and augmentation efforts for both federally-listed endangered fish species (Colorado Pikeminnow, *Ptychocheilus lucius*, and Razorback Sucker, *Xyrauchen texanus*). To assess the effects of management actions on the fish community over the duration of the SJRIP, a long-term monitoring program was initiated in 1999 (Propst et al. 2000). These standardized long-term monitoring protocols have been updated twice since 1999 (Propst et al. 2006, SJRIP 2012). Data collection following these long-term monitoring protocols began in 1999 and is scheduled to continue throughout the life of the SJRIP.

One component of long-term monitoring, ***Sub-Adult And Adult Large-Bodied Fish Community Monitoring*** (referred to hereafter as Adult Monitoring) is the primary responsibility of the U. S. Fish and Wildlife Service (USFWS) Grand Junction Fish and Wildlife Conservation Office (GJFWCO) in Grand Junction, CO. However, other state and federal agencies supply personnel, equipment, and logistical support.

Objectives

The objectives of Adult Monitoring (as stated in the FY-2016 workplan) are:

1) Annually, during autumn, document fish community structure, species relative abundance (presented as catch/effort, CPUE) and distribution, and size structure among populations of both native and nonnative large-bodied fishes in San Juan River. Specific emphasis shall be placed upon monitoring the population parameters among the rare San Juan River fish species -- Colorado Pikeminnow, Razorback Sucker, and Roundtail Chub (both wild and stocked fish).

2) Obtain data that will aid in the evaluation of the responses (e.g., year-to-year survival, reproduction, recruitment, growth, and condition factor) of both native and nonnative large-bodied fishes to management actions.

3) Continue to perform activities that support other studies and recovery actions being implemented by the SJRIP. For example:
    a. Remove nonnative fish species which may prey upon or compete with native fish species in the San Juan River.

b. Collect tissue samples from various fish species for stable isotope, genetics, and contaminants studies.

c. Document hybridization of endangered fishes with native fishes.

d. When appropriate, document any observed parasites, lesions, or abnormalities on collected fishes. Make these data available to appropriate studies when they occur.

Relationship to the Recovery Program

Adult Monitoring provides data for or makes possible (at least in part) the following Tasks under element numbers 1-5 of the Long Range Plan (SJRIP 2016): 1.1.1.1, 1.1.1.2, 1.2.1.1, 1.2.1.2, 2.3.1.5, 2.3.1.6, 2.3.1.7, 2.3.2.1, 2.6.1.1, 2.6.1.2, 2.6.1.3, 3.1.1.1, 3.1.1.3, 3.1.1.4, 3.1.1.5, 3.1.1.6, 3.1.1.7, 3.2.3.1, 3.2.3.2, 3.2.3.5, 4.1.1.1, 4.1.1.2, 4.1.1.3, 4.1.2.3, 4.1.2.4, 4.1.2.6, 4.1.3.1, 4.1.4.2, 4.1.5.1, 4.1.6.1, 4.1.6.2, 4.1.6.3, 4.1.7.1, 4.1.7.2, 4.2.4.2, 4.2.4.3, 4.4.1.1, 4.4.2.1, 4.4.2.2, 4.4.2.3, 4.4.3.1, 4.4.3.2, 4.4.3.3, 4.4.3.4, 4.5.2.3, 5.2.2.2, 5.2.2.3, 5.2.2.4, and 5.2.2.5. The monitoring protocols discussed in the Methods section of this report reflect those that are currently included in the latest version of the revised SJRIP Monitoring Plan and Protocols (SJRIP 2012).

Study Area

In 2016, the study area for Adult Monitoring began just downstream of the Bloomfield boat landing (RM 196.0) and continued downstream to the Mexican Hat boat landing in Utah (RM 52.7). This study area encompassed six geomorphic reaches of the San Juan River between Navajo Reservoir and Lake Powell. These included the lower 15 miles of Reach 7, four complete reaches (Reaches 6 through 3) and 15.3 miles of Reach 2, as defined by Bliesner and Lamarra (2000). The seven geomorphic reaches in their entireties are: Reach 7 (RM 214.0-180.0); Reach 6 (RM 180.0-155.0); Reach 5 (RM 155.0-131.0); Reach 4 (RM 131.0-106.0); Reach 3 (RM 106.0-68.0); and Reach 2 (RM 68.0-17.0).

METHODS

Field Sampling

Sampling conducted in 2016 followed the protocols for long-term monitoring set forth in the latest version of the Monitoring Plan and Protocols (SJRIP 2012). These sampling protocols were first used during the fall 1999 Adult Monitoring trip. Similar data collected prior to the inception of these sampling protocols (i.e., 1991-1998) are not included in comparative analyses for this report.

Common Sampled Area versus Riverwide Sampling

From 1999 to 2010, Adult Monitoring sampled the large majority of geomorphic reaches 6-1 (RM 180.0-2.9). Although our study area ended 2.9 RM short of the end of Reach 1 (at Clay Hills boat landing) during those years, it was assumed during data analysis for those years that the data collected from the majority of Reach 1 (RM 17.0-2.9) were representative of the entirety of Reach 1 (RM 17.0-0.0). This approach to data analysis allowed year-to-year comparisons of data for the fish species we were interested in to be made on a "riverwide" basis (i.e., from RM 180.0-0.0).

However, as per modifications made to the long-term monitoring protocols in the latest version of the Monitoring Plan and Protocols (SJRIP 2012), the study area for Adult Monitoring was reduced to sample RM 180.0-77.0 in four out of five years, with the entirety of the previous study area (reaches 6-1) being sampled every fifth year. The entire study area from RM 180.0-2.9 was last sampled in the fall of 2015 and will be sampled again in 2020.

This change in sampling protocol for 2011 through 2014 and 2016 necessitated omitting data sets from Sand Island to Clay Hills from 2015 and previous sampling. Therefore, all data comparisons in this report will be for the common sampled area (RM180.0 – 77.0).

From 2012 to 2016 two river sections (totaling 15 RM) upstream of the confluence of the San Juan and Animas Rivers were sampled to see 1) if sampling in these areas of the river was feasible at this time of the year, and 2) to attempt to document range expansion of Colorado Pikeminnows and Razorback Suckers upstream of the Animas river confluence. Low water levels prevented sampling the lower several miles of the Animas River in 2012 and 2014, and flooding prevented sampling in 2013. In 2015, a spring trip was scheduled to sample two sections on the Animas (totaling 15RM) to avoid stochastic monsoonal flows, in 2016 a rapid increase in flows and limitation of scheduling prohibited sampling to occur in this 15 river mile section on the Animas.

With five years of data from the two upstream San Juan River sections, 2016 will only be compared to 2012 through 2015 data, and will not be used for comparative purposes in this report. A separate sub-section will be added at the end of the RESULTS section to describe the 2012 through 2016 finding on the upper reaches on the San Juan River above and confluence of the San Juan and Animas rivers. If sampling is continued in these upstream river sections, more year-to-year comparisons will be presented in future reports.

Data Analysis

Rare Native Fishes

Based on data collected in past years, essentially all of the endangered Colorado Pikeminnow and Razorback Sucker being collected during Adult Monitoring are fishes that have been stocked during augmentation efforts. Endangered fishes collected during Adult Monitoring were sorted by year of stocking as well as length of time (expressed in number of overwinter periods) that they had been in the river post-stocking. Additionally, since different age-classes of Colorado Pikeminnow were stocked in numerous years, they were further sorted by their age-class at stocking. Ages provided for fish were either determined using PIT tag information for known-age fish or were based on length frequency histograms and observed between-year growth rates. Emphasis in analyzing catch per unit effort (CPUE), as fish per hour of electrofishing, values was then placed on groups of fish that had been in the river for one or more overwinter periods post-stocking. Electrofishing data were pooled for all rafts to obtain total catch numbers by species for the entire sampling trip. Each fish is associated with a sampling event, and each sampling event has a unique amount of effort that each fish is related to. The number of Colorado Pikeminnow was divided by the number of seconds (converted to hours) fished to obtain a CPUE value for each sample, analysis of variance (ANOVA) was then used on all CPUE values to obtain a mean CPUE value and Tukey's Honestly Significant Difference (Tukey's HSD) multiple-comparison post-hoc tests was used to determine significance to previous years' CPUE with that of 2016.

Analysis of Razorback Sucker data was slightly different. Since all Razorback Sucker being stocked tended to be older fish (i.e., age-1 to age-3) and since there was only one target stocking size ($\geq$ 300 mm TL) for all Razorback Sucker, catch data for Razorback Sucker were pooled only by number of overwinter periods (i.e., regardless of age at stocking). CPUE for Razorback Sucker was calculated and analyzed (ANOVA, Tukey's HSD, $p < 0.10$) as described for Colorado Pikeminnow.

Common Large-Bodied Fishes

The four "common" large-bodied fishes encountered during Adult Monitoring sampling are Flannelmouth Sucker *Catostomus latipinnis*, Bluehead Sucker *Catostomus discobolus*, Channel Catfish *Ictalurus punctatus*, and Common Carp *Cyprinus carpio*. These were the only wild, large-bodied fish species present in the San Juan River in large enough numbers to yield sufficient sample sizes from which statistically valid conclusions could be drawn (based in the common sampled area, i.e., RM 180.0-77.0) across years. Electrofishing data were pooled for all rafts to obtain total catch by species for the entire sampling trip. Total catch for each species per sampling event was then divided by the number of seconds (converted to hours) fished by each raft to obtain CPUE values (i.e., number of fish per hour of electrofishing) for juvenile and adult life stages and for all life stages combined (i.e., juvenile + adult; referred to hereafter as "total CPUE"). CPUE values for each common large-bodied fish species were then compared to previous years' riverwide electrofishing data to evaluate long-term trends, ANOVA and Tukey's HSD multiple-comparison post-hoc were used similar to tests ran for Colorado Pikeminnow and Razorback Suckers to determine significant differences in CPUE values between years. Significance was determined at $p < 0.10$ (following Ryden 2000a). Linear regression analysis was used to determine if the long-term CPUE trends among common native species were increasing or decreasing and whether those increases or decreases were significant at $p < 0.10$ (following Ryden 2000a). Length data obtained from fish measured at designated miles (DMs) were used to develop riverwide length frequency histograms for wild populations of the four common large-bodied fish species.

RESULTS

The mean river flow (at the Shiprock USGS gage #09368000) during the 2016 Adult Monitoring trip was 762 CFS (Table 1). Overall, the mean river flow in the 18-year period (1999-2016) of Adult Monitoring riverwide sampling was 1053 CFS.

Fifteen fish species and hybrids were collected during the 2016 Adult Monitoring trip (Table 2). This included six native species, two native sucker X native sucker hybrids, one native sucker X nonnative sucker hybrids, and five nonnative species (Tables 2 and 3). Seven species (Flannelmouth Sucker, Bluehead Sucker, Channel Catfish, Razorback Sucker, Speckled Dace, Colorado Pikeminnow, and Common Carp) accounted for 99.5% (7,439 fish) of the total catch. The other five species and three hybrids contributed only 0.5% (43 fishes) to the total catch in 2016 (Table 3). Native fishes accounted for the majority (88.9%) of fishes collected in 2016 (Table 3). Native Flannelmouth Suckers were once again the most abundant species collected during Adult Monitoring, accounting for 61.7% of all fish collected riverwide.

In general fishes collected during Adult Monitoring appeared to be in good health. Any noticeable instances of abnormalities, parasites, or deformities were noted in the field notes, but the rate of occurrence was low. A total of 26 fish (1.07%) out of 2,436 that had length and

weights taken were noted to have some bite marks, sores, or deformities.

Table 1. Summary of dates, river miles (RM) sampled, and mean flow during riverwide Adult Monitoring trips in the San Juan River in New Mexico, Colorado, and Utah, 1999 to 2016.

Beginning Date Of Sampling	Ending Date Of Sampling	River Miles Sampled	Mean Trip Flow At The Shiprock, NM USGS Gage (#09368000) In CFS And (Cubic Meters/Second)
20 September 1999	7 October 1999	RM 180.0-2.9	2,177 CFS (61.6 m^3/sec)
18 September 2000	10 October 2000	RM 180.0-2.9	657 CFS (18.6 m^3/sec)
25 September 2001	19 October 2001	RM 180.0-2.9	611 CFS (17.3 m^3/sec)
20 September 2002	7 October 2002	RM 180.0-2.9	458 CFS (12.9 m^3/sec)
22 September 2003	14 October 2003	RM 180.0-2.9	450 CFS (12.7 m^3/sec)
20 September 2004	13 October 2004	RM 180.0-2.9	1,432 CFS (40.5 m^3/sec)
19 September 2005	12 October 2005	RM 180.0-2.9	1,072 CFS (30.3 m^3/sec)
18 September 2006	9 October 2006	RM 180.0-2.9	2,479 CFS (70.1 m^3/sec)
17 September 2007	11 October 2007	RM 180.0-2.9	1,262 CFS (35.7 m^3/sec)
22 September 2008	15 October 2008	RM 180.0-2.9	638 CFS (18.1 m^3/sec)
21 September 2009	14 October 2009	RM 180.0-2.9	532 CFS (15.0 m^3/sec)
20 September 2010	12 October 2010	RM 180.0-2.9	762 CFS (21.5 m^3/sec)
12 September 2011	29 September 2011	RM 180.0-52.9	615 CFS (17.4 m^3/sec)
10 September 2012	28 September 2012	RM 195.0-52.9	804 CFS (22.7 m^3/sec)
9 September 2013	27 September 2013	RM 195.0-52.9	2626 CFS (74.3 m^3/sec)
8 September 2014	26 September 2014	RM 195.0-52.9	789 CFS (22.4 m^3/sec)
7 September 2015	29 September 2015	RM 195.0-2.9	831 CFS (23.5 m^3/sec)
12 September 2016	30 September 2016	RM 195.0-52.9	762 CFS (21.6 m^3/sec)
18-year statistics: Mean = 1053 CFS (29.8 m^3/sec)			

Table 2. Scientific and common names (following Page et al. 2013), status, and database codes for fish species collected from the San Juan River during the 2016 Adult Monitoring trip.

Scientific Name	Common Name	Status	Database Code
Order Cypriniformes: Family Catostomidae – suckers			
Catostomus discobolus	Bluehead Sucker	Native	Catdis
Catostomus commersonii	White Sucker	Introduced	Catcom
Catostomus latipinnis	Flannelmouth Sucker	Native	Catlat
Xyrauchen texanus	Razorback Sucker	Native	Xyrtex
X. texanus X *C. latipinnis*	hybrid	Native	texXlat
C. latipinnis X *C. discobolus*	hybrid	Native	latXdis
C. commersonii X *C. latipinnis*	hybrid	Introduced	comXlat
Order Cypriniformes: Family Cyprinidae - carps and minnows			
Cyprinus carpio	Common Carp	Introduced	Cypcar
Gila robusta	Roundtail chub	Native	Gilrob
Ptychocheilus lucius	Colorado Pikeminnow	Native	Ptyluc
Rhinichthys osculus	Speckled Dace	Native	Rhiosc
Order Perciformes: Family Centrarchidae – sunfishes			
Micropterus salmoides	Largemouth Bass	Introduced	Micsal
Order Siluriformes: Family Ictaluridae - bullhead catfishes			
Ameiurus melas	Black Bullhead	Introduced	Amemel
Ameiurus natalis	Yellow Bullhead	Introduced	Amenat
Ictalurus punctatus	Channel Catfish	Introduced	Ictpun

Table 3. Total number of fishes collected during the 2016 Adult Monitoring trip in the common sampled area (RM 180.0-77.0).

Species (Status)[a]	Number Collected	Percent Of Total[b]	Number Of Samples Collected In
Flannelmouth Sucker (N)	4614	61.7	134
Bluehead Sucker (N)	1198	16.0	90
Channel Catfish (I)	722	9.7	108
Razorback Sucker (N)	380	5.1	99
Speckled Dace (N)	308	4.1	64
Colorado Pikeminnow (N)	142	1.9	59
Common Carp (I)	75	1.0	32
Largemouth Bass (I)	9	0.1	8
Black Bullhead (I)	8	0.1	7
Razorback Sucker X Flannelmouth Sucker (H, N)	7	0.1	6
White Sucker (I)	6	0.1	6
Flannelmouth Sucker X White Sucker (H, I)	5	0.1	5
Yellow Bullhead (I)	5	0.1	4
Flannelmouth Sucker X Bluehead Sucker (H, N)	2	-----	2
Roundtail Chub (N)	1	-----	1
GRAND TOTAL	7482		
Total Electrofishing Collections In 2016 = 134 Total Electrofishing Effort In 2016 = 57.89 Hours			
2016 Native Fishes = 6,652 (88.9% Of The Total Catch) 2016 Introduced Fishes = 830 (11.1% Of The Total Catch) 2016 Native To Introduced Fishes Ratio = 8.0:1			
a: (N) = Native species; (I) = Introduced species; (H, N) = A hybrid of two native fish species, considered to be a native fish; (H, I) = A hybrid of a native and a nonnative fish species, considered to be an introduced fish b: ----- = less than 0.1%			

Rare Native Fishes

Colorado Pikeminnow

In 2016, 142 Colorado Pikeminnows were captured from RM 180.0-77.0 (Table 3), all presumably stocked. This marked the 11th year since 2006 that >100 Colorado Pikeminnows were collected during an Adult Monitoring trip in the common sampled area. Colorado Pikeminnow captures ranged from 54 being collected in Reach 6, 64 in Reach 5, 17 in Reach 4, and 7 in Reach 3.

Forty-four (40.0%) Colorado Pikeminnows were collected upstream of the Hogback Diversion (RM 158.6) in 2016. Of these, four were collected above PNM Weir (RM 166.6) all of which were untagged Age-1 fish stocked at age-0. The other 40 fish were collected between PNM Weir and the Hogback Diversion, one adult fish that was tagged from the PNM fish passage in 2013, three age-2 fish stocked at age-0, and 35 fish that were age-1 stocked the previous winter at ago-0. Stocking locations for these fish would have been upstream at one of two locations Bloomfield (RM 196) or Berg Park (Animas RM 5.0) fish from downstream stocking locations would have been documented passing through the PNM fish ladder. Like many stocked fish, these fish showed a pattern of initial downstream displacement (Ryden 2000b), followed by upstream movements as they grew and matured (Osmundson et al., 1997a, 1998).

Table 4. General information on 142 known-origin stocked Colorado Pikeminnows collected in 2016.

Age At Capture & (Number Captured)	Size Range At Capture (TL in mm)	Range of Capture RM's	Days In River Post-Stocking (Number Of Overwinter Periods)	Stocking Dates	Age At Stocking & (Year-Class Of Fish)	Source[a]
Age-1 (102)	100-240	177.0-88.0	315-329 (1)	11/3/2015	Age-0 (2015)	SNARRC
Age-2 (28)	261-357	163.0-85.0	677-692 (2)	11/6/2014	Age-0 (2014)	SNARRC
Age-3 (4)	315-368	158.0-80.0	1050-1065 (3)	10/28/2013	Age-0 (2013)	SNARRC
Age-4 (4)	380-410	158.6-106.0	1409-1422 (4)	11/3/2012	Age-0 (2012)	SNARRC
Age-5 (1)	485	161.0	1777 (5)	11/2/2011	Age-0 (2011)	Dexter
Age-6 (1)	480	140	1954 (5)	5/18/2011	Age-1 (2010)	Dexter
Age-7 (1)	517	149	2500 (7)	11/9/2009	Age-0 (2009)	Dexter
Age-10 (1)	690	145	3613 (10)	11/2/2006	Age-0 (2006)	Dexter

a: Dexter = Southwestern Native Aquatic Resources & Recovery Center (SNARRC) formerly known as U. S. Fish & Wildlife Service, Dexter National Fish Hatchery & Technology Center, Dexter NM.

The majority (102 individuals; 71.8%) of the 142 known-origin Colorado Pikeminnows collected in 2016 were in the river ≤ 365 days post-stocking, but still had spent one overwinter period in the river (i.e., they were stocked in November 2015). The rest, 40 (28.2%) of the 142 known-origin Colorado Pikeminnows collected in 2016 were in the river for at least two overwinter periods. Of those 40 fish, all but one were stocked as age-0 fish (Table 4). In fall 2010, a Largemouth Bass Virus (LMBV) quarantine at Dexter National Fish Hatchery and Technology Center (NFH&TC) caused the hatchery to hold back approximately 214,000 age-0 Colorado Pikeminnows and 3,700 age-1 fish, that were scheduled to be stocked that fall. These fish were

instead stocked in May of 2011 as age-1 or age-2 fish after the hatchery cleared quarantine (Furr 2015). A single Colorado Pikeminnows collected in the fall 2016 Adult monitoring trip came from these stockings of age-1.

Numerous large Colorado Pikeminnows were collected during 2016 Adult Monitoring. These included 20 fish from 300-399 mm TL (age-2 to age-4 fish), 2 fish from 400-449 mm TL (age-4), and 4 fish ≥ 450 mm TL (age-5 to age-10). Thus, the Colorado Pikeminnow collected in 2016 did not meet the Recovery Goal demographic size criteria for Downlisting (USFWS 2002a). However, these larger size-class fish were likely all stocked fish. They were stocked at larger sizes than is normally expected for wild fish of the same age-class and are reaching the target size-class thresholds for both sub-adult and adult fish faster than would be true for wild fish (Osmundson et al. 1996, 1997b; D. Ryden, unpublished data). The use of the Recovery Goal demographic criteria for Downlisting in this context is simply a convenient way to judge progress of this species towards recovery (i.e., by comparing Adult Monitoring collections against a published target number or size). As a point of clarification:

Where stocked fish are involved, a self-sustaining population must consist of young produced in the wild and recruited to the adult population at the required rates; stocked fish are included in the count of adults ***after*** *their progeny are recruited to adults (USFWS 2002b).*

Comparisons of CPUE among groups of the Colorado Pikeminnow stocked as age-0 fish showed that at age-1, recapture rates were highly variable (indicating either highly variable survival or highly variable recapture probabilities) between years (Figure 1). Between 2003 and 2010, there was a general upward trend in CPUE for fish stocked at age-0 and recaptured at age-1. The observed CPUE in 2016 in the common sampled area, was significantly lower than 2009 through 2012, but similar to 2004 to 2008 and 2013 to 2015. For age-2 catch rate in 2016, CPUE was lower than 2010, 2011, and 2013 in the common sampled area but similar to all other years from 2004 to 2009 along with 2014 and 2015 (Figure 1). Stocked at age-0 CPUE continued to show no change in age-3, age-4, and age-5 fish. No age-6 fish stocked as age-0 fish were captured in 2016 due to the quarantine for the LMBV at Dexter NFH&TC in 2010. Older Colorado Pikeminnows stocked at age-0 were once again present in 2016, this marks the fifth consecutive year that age-6+ fish were present for this analysis when Adult Monitoring sampled the common sampled area (Figure1).

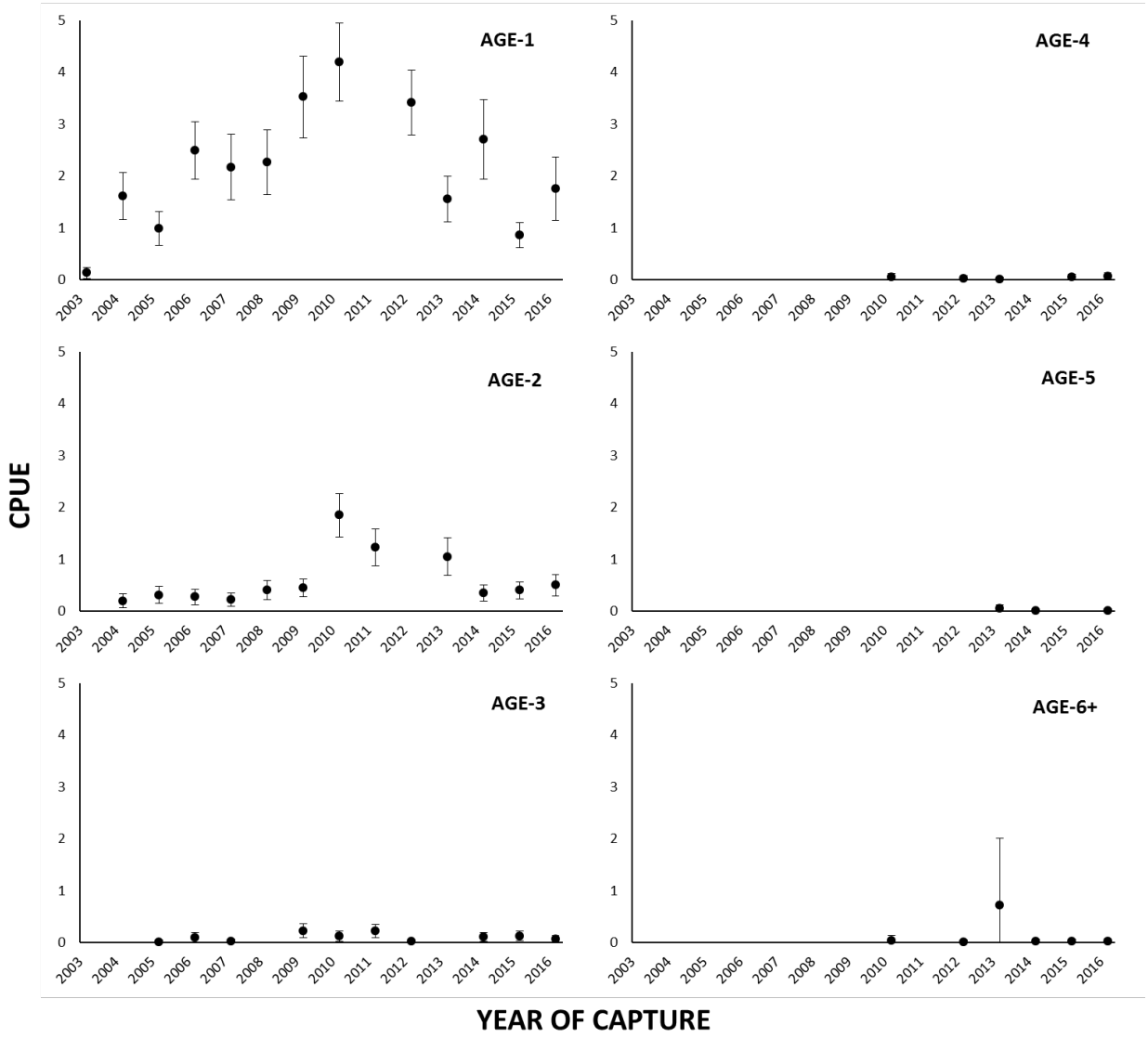

Figure 1. A comparison of CPUE (fish/hr) at age among groups of Colorado Pikeminnow stocked as age-0 fish and captured during subsequent Adult Monitoring trips, 2003 to 2016, riverwide (RM 180.0-77.0). The mark shows the mean CPUE values for each year-class of fish during a given calendar year. The error bars are 95% CI.

Of the 142 known-origin Colorado Pikeminnows collected in 2016, only one fish that was stocked as age-1+ fish (Table 4). This fish has been handled four times since stocking twice by non-native removal crew and twice by Adult Monitoring crews.

Between-year comparisons of CPUE for all Colorado Pikeminnow that were in the river 1+ overwinter periods showed an increasing trend of CPUE from 2003 to 2010 (Figure 2). In 2010, significantly higher numbers of age-2 fish (stocked at age-0 in fall 2008) combined with large numbers of age-1 fish (stocked at age-0 in fall 2009) helped drive the significant increase observed (Figure 1). The large numbers of age-1 and age-2 fish were not present in 2013

through 2016 (Table 4, Figure 1), which consequently lowered the catch rate significantly (Figure 2). In 2011, there was a significant decline is CPUE for Colorado Pikeminnow, since in most years the magnitude of this metric is driven by (i.e., reflective of) fish stocked at age-0 and captured the following year of age-1 (Figure 1), there were no fish stocked in the fall of 2010 due to the Largemouth Bass Virus quarantine in Dexter. The observed catch rate in 2016 was similar to 2004 through 2015 with the exception of being lower than those in 2009, 2010, and 2012. (Figure 2)

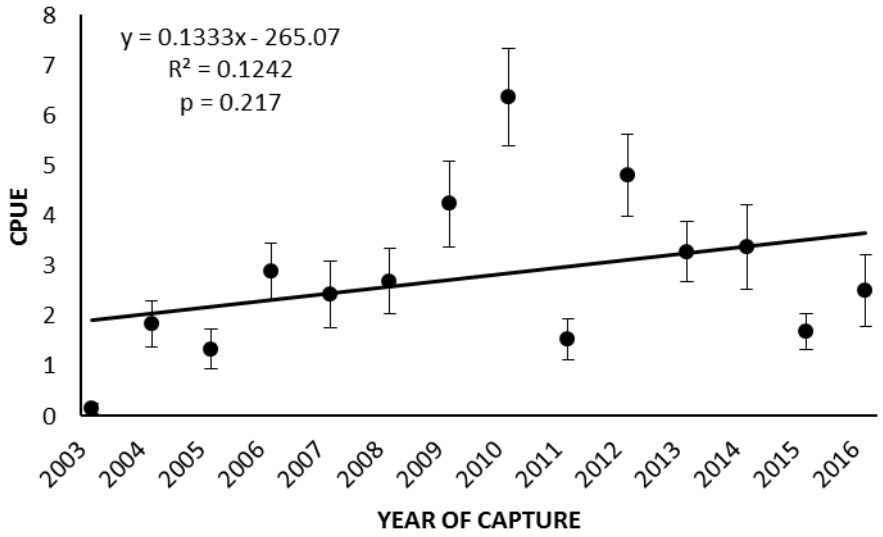

Figure 2. Year-to-year comparison CPUE for all Colorado Pikeminnow collected on Adult Monitoring trips in the common sampled area (RM 180.0-77.0) from 2003 to 2016 that were in the river for one or more overwinter periods following stocking (regardless of age). The markers show the mean CPUE values for each year, the error bars are 95% CI, and the solid line shows a linear regression between years.

Table 5. Information on stocked Colorado Pikeminnow collected from 2003 to 2016 that had been in the river for 1+ overwinter periods.

Information For Fish Collected During Adult Monitoring Trips (RM 180-77):			Information For Fish That Were In The River For 1+ Overwinter Periods At Time Of Capture:		
Year	Effort (Total Hours Electrofished)	Total Number Collected	Number Of Fish Collected That Were In River 1+ Overwinter Periods	Oldest Year-Class Captured	Number Of Overwinter Periods
2003	51.98	8	8	2002	1
2004	50.25	102	91	2002	1-2
2005	47.31	84	62	2002	1-3
2006	51.19	250	146	2002	1-4
2007	50.64	140	117	2004	1-3
2008	58.77	197	162	2006	1-2
2009	58.34	300	257	2006	1-3
2010	54.96	371	351	1996	1-14
2011	48.68	386	75	2006	1-5
2012	54.51	272	272	2006	1-6
2013	43.95	149	149	2004	1-9
2014	60.73	218	218	2006	1-8
2015	65.62	108	108	2006	1-7
2016	57.89	142	142	2006	1-10

Razorback Sucker

A total of 383 Razorback Suckers were collected in 2016, all of which were assumed to be stocked fish (Table 6). This was the highest number ever collected during an Adult Monitoring trip in the common sampled area. Razorback Sucker captures ranged from RM 179.0-77.0 (Table 6), with 181 being collected in Reach 6, 96 in Reach 5, 70 in Reach 4, and 36 in the portion of Reach 3 that was sampled.

Twenty three Razorback Suckers (6.0%) were collected upstream of the PNM Weir and fish passage facility (RM 166.6). In contrast, there were no collections of Razorback Sucker upstream of PNM Weir during our 2010 sampling. However, the majority (246 individuals; 64.2%) of Razorback Sucker collections in 2016 still occurred downstream of Hogback Diversion (RM 158.6).

A total of 26 Razorback Suckers were collected for which either the stocking history or the exact length of the time the fish had been in the river could not be determined (Table 6). Personnel recording error led to an unusable PIT tag for one Razorback Sucker. Sixteen Razorback Suckers had been collected without a PIT tag on previous sampling trips; these fish were PIT tagged prior to being released. Nine Razorback Suckers had no detectable PIT tag upon capture during the 2016 Adult monitoring trip, these fish (most likely a product of tag loss) were implanted with a new 134 kHz PIT tag prior to being released.

Of the 357 Razorback Sucker recaptured with PIT tags and known stocking histories in 2016, 31 (8.7%) were in the river $\leq$ 365 days post-stocking none of which were in the river < 1 overwinter period when they were collected. The other 326 (91.3%) were in the river > 365 days post-stocking and had been in the river from 1-15 overwinter periods (Table 6).

Table 6. General information on stocked Razorback Suckers collected in 2016.

Days In River Post-Stocking (Number Of Overwinter Periods)	Age At Capture & (Number Captured)	Size Range At Capture (TL in mm)	Range of Capture RM's	Stocking Year	Age At Stocking & (Year-Class Of Fish)
Information on the 357 Razorback Sucker with known stocking histories:					
307-368 (1)	Age-2 & Age-3 (72)	352-496	178.0-77.0	2015	Age-1 & Age-2 (2013& 2014)
677-749 (2)	Age-3 – Age-5 (97)	389-520	179.0-77.0	2014	Age-1 & Age-3 (2011-2013)
1056-1097 (3)	Age-5 - Age-7 (48)	403-525	179.0-107.0	2013	Age-1 - Age-4 (2009 - 2012)
1410-1641 (4)	Age-7 & Age-8 (21)	436-540	180.0-119.0	2012	Age-3 & Age-4 (2008 & 2009)
1784-1848 (5)	Age-7 (48)	419-594	180.0-80.0	2011	Age-2 (2009)
2139-2181 (6)	Age-7 & Age-8 (27)	442-557	165.0-92.0	2010	Age-1 & Age-2 (2008 & 2009)
2499-2565 (7)	Age-7 (16)	435-545	165.0-109.0	2009	Age-2 (2007)
2861-2896 (8)	Age-8 (2)	466-483	154.0	2008	Age-2 (2006)
3413-3448 (9)	Age-9 (3)	496-550	135.0-82.0	2007	Age-1 (2006)
3669-3675 (10)	Age-11 & Age-15 (2)	482 & 563	162.0-160.0	2006	Age-1 & Age-5 (2001 & 2005)
4403-4445 (12)	Age-15 (4)	415 - 525	161.0-119.0	2004	Age-3 (2001)
5443 (15)	Age-16 (1)	470	119.0	2001	Age-1 (2000)
Information on the 16 Razorback Sucker captured without known stocking histories:					
Unknown	Unknown (16)	444-557	165.0-106.0	Unknown	Unknown

Comparisons of capture data for Razorback Sucker that were in the river for 1+ overwinter periods and collected during Adult Monitoring trips changed little from 2003 to 2009 (range = 17-36; Table 7). However, in 2010, this number rose to 70 fish, double the value observed in any previous year. There has been a steady increase in the number captured that have been in the river for 1+ overwinter period from 2011 to 2016. For comparison, the number captured in 2010 is five times less than that in 2016 (Table 7). Razorback Suckers collected after 1+ overwinter periods continue to demonstrate a much longer post-stocking persistence (up to 15 overwinter periods or 5,448 days post-stocking) than Colorado Pikeminnows (Table 7). On every Adult Monitoring trip since 2003, Razorback Suckers were collected that had been in river for at least six overwinter periods post-stocking (Table 7).

Table 7. Information on stocked Razorback Sucker collected from 2003 to 2016 that had been in the river for 1+ overwinter periods.

Information For Fish Collected During Adult Monitoring Trips (RM 180-77):			Information For Fish That Were In The River For 1+ Overwinter Periods At Time Of Capture:		
Year	Effort (Total Hours Electrofished)	Total Number Collected	Number Of Fish Collected That Were In River 1+ Overwinter Periods	Oldest Year-Class Captured	Number Of Overwinter Periods
2003	51.98	17	17	1992 (1 wild juvenile collected)	1-9 (wild fish; 249 mm TL = age-1 or age--2)
2004	50.25	108	18	1992	1-10
2005	47.31	46	30	1998	1-6
2006	51.19	121	23	1997	1-8
2007	50.64	171	22	1992	1-12
2008	58.77	73	36	2000	1-7
2009	58.34	77	35	1999	1-9
2010	54.96	149	70	1992	1-15
2011	48.68	197	118	1999	1-11
2012	54.51	321	231	1992	1-18
2013	43.95	196	175	2000	1-12
2014	60.73	268	225	1999	1-14
2015	65.62	308	278	1999	1-15
2016	57.89	383	357	2000	1-15

The 2016 CPUE value for Razorback Suckers that were in the river 1+ overwinter periods was similar to that of the previous three years in the common sampled area (Figure 3). There has been a significant increase in CPUE from 2001 to 2016 (Figure 3), which could be a function of these fish persisting in the river for long periods of time post stocking (Table 7).

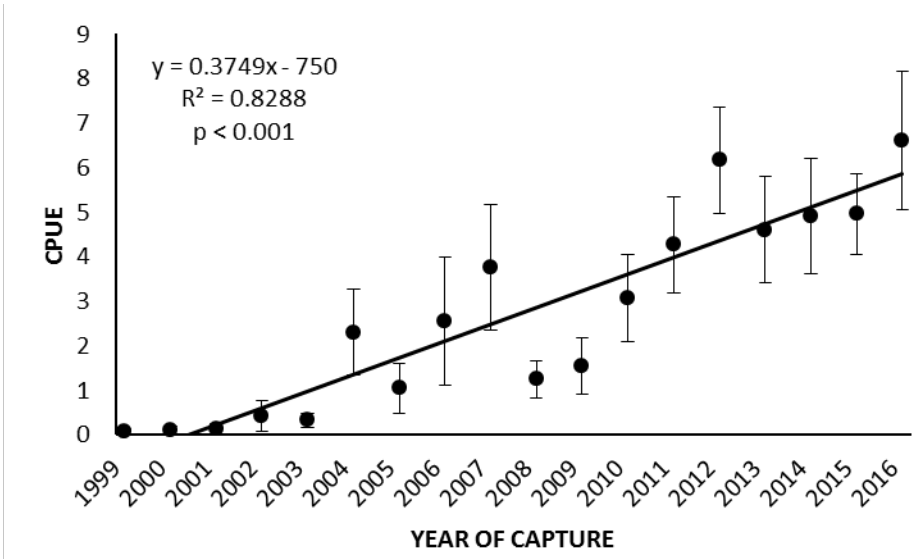

Figure 3. Year-to-year comparison of CPUE for all Razorback Sucker collected on Adult Monitoring trips riverwide (RM 180.0-77.0) from 1999 to 2016 that were in the river for one or more overwinter periods following stocking (regardless of age). The markers indicate the mean CPUE values for each year, the error bars are 95% CI, and the solid line shows a linear regression between years of capture.

Source of origin could be determined for 341 Razorback Sucker that had been in the river for 1+ overwinter period. Of these, 218 (63.9%) were reared in the Navajo Agricultural Products Industry (NAPI) grow-out ponds, southwest of Farmington, NM. One hundred and one (29.6%) were reared in Ouray Nation Fish Hatchery – Grand Valley Unit, Grand Junction, CO. Thirteen (3.8%) were reared at the USFWS' Uvalde National Fish Hatchery, in Uvalde, TX. Nine (2.6%) were reared at the USFWS' Dexter NFH&TC, near Roswell, NM. Of the 208 fish reared at the NAPI ponds, 80 were from Hidden Pond, 64 from East Avocet Pond, 72 from West Avocet Pond, and 2 from the now-defunct 6-Pack Ponds.

Common Native Fishes

Flannelmouth Sucker

Catch Information

The Flannelmouth Sucker was once again the most common large-bodied fish species collected in the common sampled area (Table 3, Figure 4), being collected in 134 (100%) electrofishing samples (Table 3, Figure 4). With the exception of one sample in 2008, Flannelmouth Suckers have been captured in every single sample from 1999 to 2016 in the common sampled area (Figure 4). These fish also comprised 61.7% of the total catch for 2016 (Figure 4).

The combined adult and juvenile CPUE for Flannelmouth Sucker showed no significant change since 1999 (Figure 5). The 2016 combined CPUE was statistically similar to 13 of the last 17 years; lower than one of the last 17 years, and higher than 3 of the last 17 years as well (Figure 5) that sampling has occurred in the common sampled area. A comparatively high degree of variation in the year-to-year juvenile CPUE values has been observed from 1999 to 2016 (Figure 5); however the long-term trend indicated no significant change. In the adult CPUE there has been a significant decline since 1999, largely driven by the CPUE value in 1999 and 2000. The 2016 adult CPUE value was significantly lower than 6 of the previous 17 years.

Length Information

Flannelmouth Sucker sampled in 2016 ranged in size from 75-573 mm TL (mean TL = 351 mm). The 2016 length-frequency histogram was left skewed, with the peak centered on a cohort of fish (426-450mm), similar to that of 2015, that had just recruited into adulthood (Figure 6).

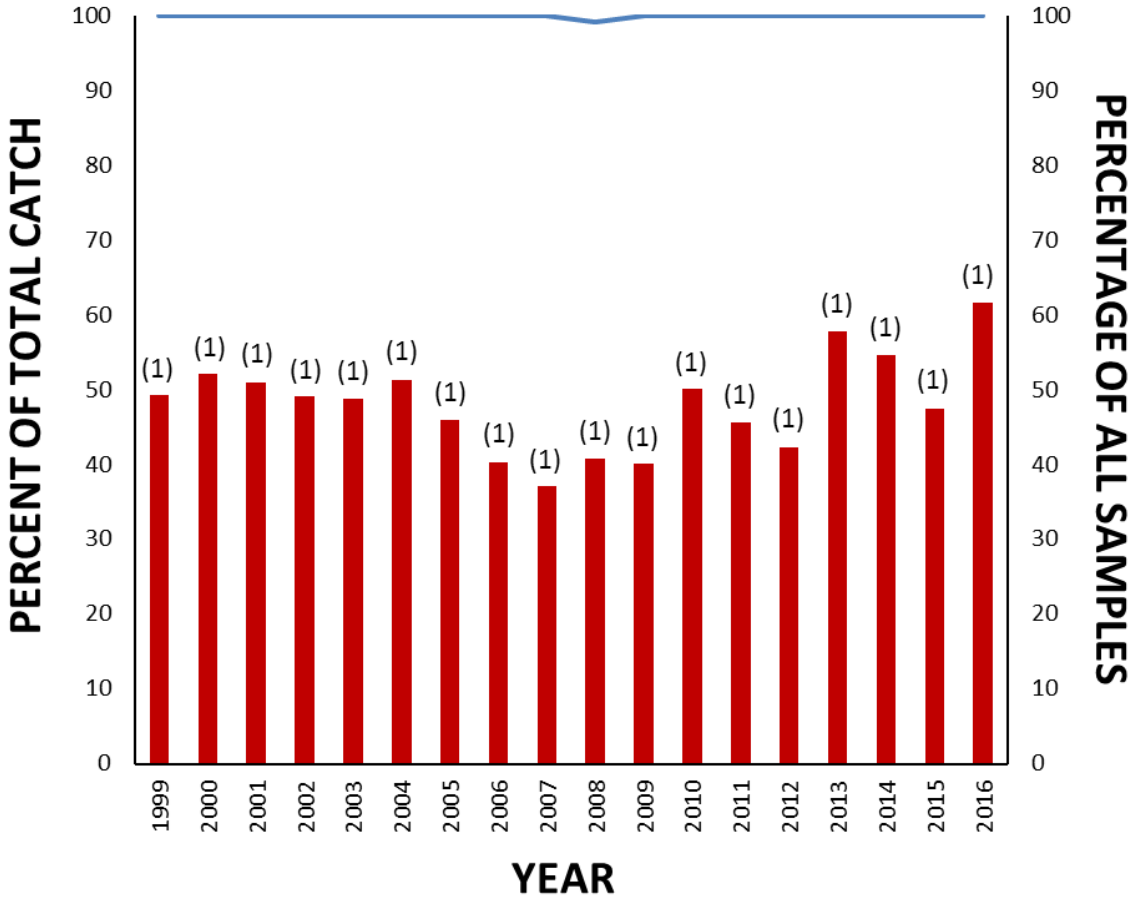

Figure 4. A summary of Flannelmouth Sucker relative abundance in Adult Monitoring collections, 1999 to 2016. The solid blue line at the top of the graph represents the percentage of all electrofishing samples on a given Adult Monitoring trip in which this species occurred (i.e., percent occurrence). The solid red bars represent the percent of the total catch that this species composed in a given year. Numbers in parentheses indicate the numeric rank for this species in a given year relative to all other fish species collected riverwide (RM 180.0-77.0).

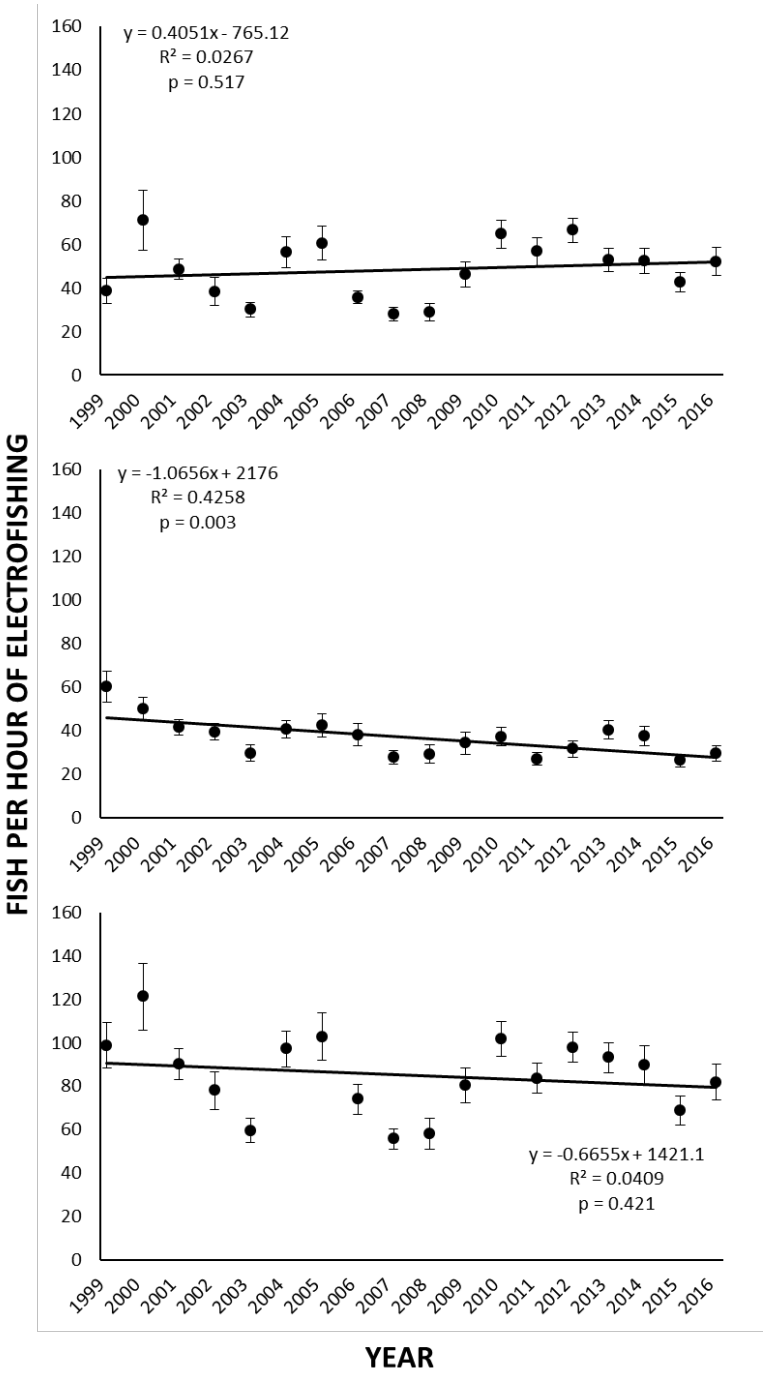

Figure 5. Flannelmouth Sucker CPUE in the common sampling area (RM 180.0-77.0) on fall Adult Monitoring trips, for juvenile fish (< 410 mm TL; top), adult fish (≥ 410 mm TL; middle), and for all life stages combined (juveniles + adults; bottom). Error bars are 95% CI. The solid, black sloping line is a linear regression analysis of the mean CPUE values. The statistics are for these regression lines.

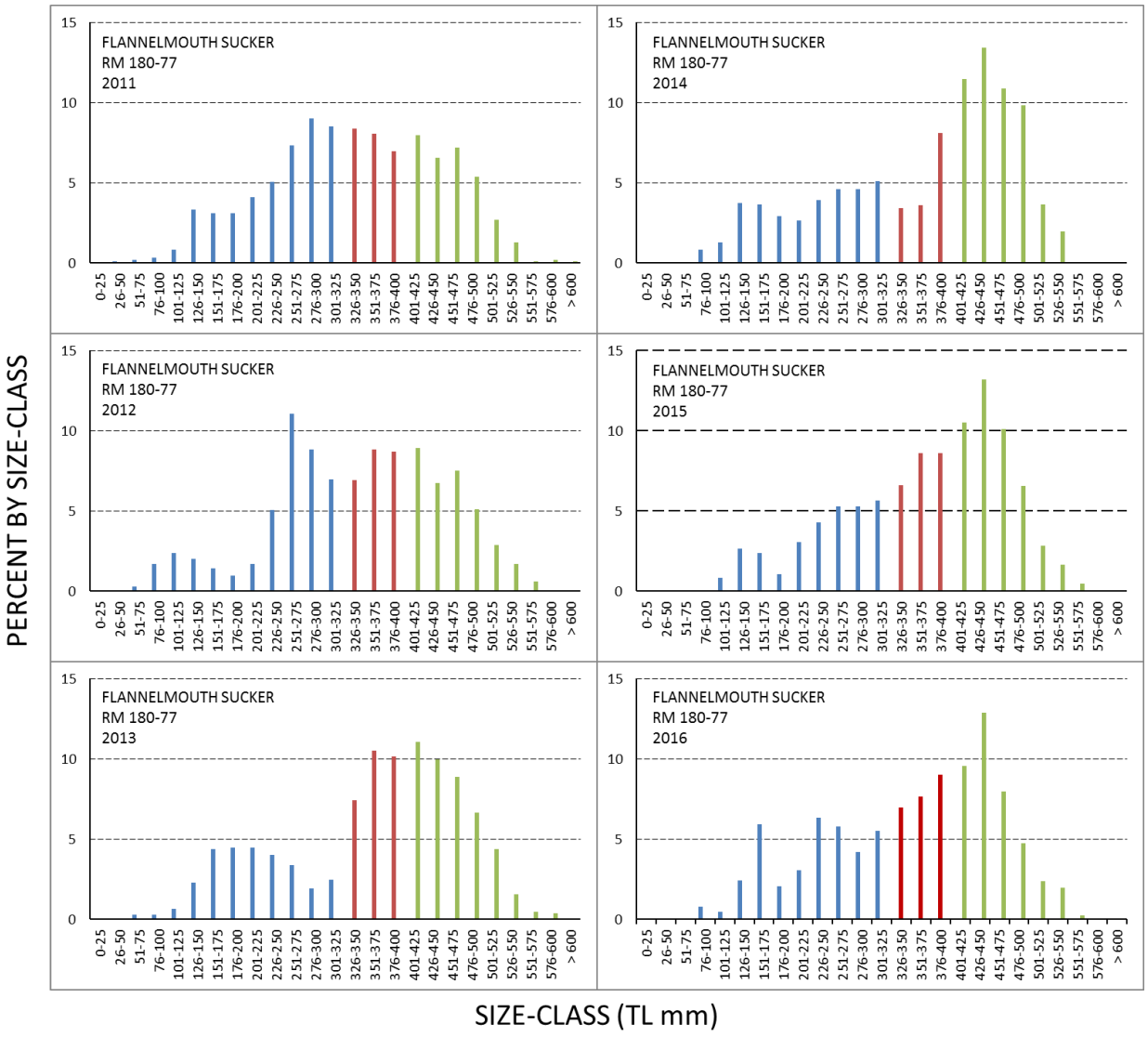

Figure 6. Length-frequency histograms showing the size-class distribution of Flannelmouth Sucker in the common sample area (RM 180.0-77.0) on fall Adult Monitoring trips in the San Juan River, 2011 to 2016. Solid blue bars represent juvenile fish, solid red bars represent recruiting sub-adult fish, and solid green represent adult fish.

Bluehead Sucker

Catch Information

Bluehead Sucker was the second most commonly-collected large-bodied fish species during 2016 Adult Monitoring (Table 3, Figure 7). The percentage of the total catch composed of Bluehead Sucker (16.0%) was within 2% of the average catch value observed for this species over the last 17 years in the common sampled area (Figure 7). Bluehead Suckers were collected in Reaches 6-3 in 2016 (from RM 180.0-88.5) with the highest catch from RM 180-155 (Reach 6), and were collected in 67.2% of the samples (Figure 7).

Long-term trends for Bluehead Sucker adult CPUE have shown no significant changes in abundance indices over the last 17 years in the common sampled area (Figure 8), whereas Bluehead Sucker juvenile and combined age classes have shown a decrease. The 2016 Bluehead Sucker adult CPUE value was significantly lower than 4 of the previous 17 years (Figure 8). Bluehead Sucker juvenile CPUE value for 2015 was significantly lower than 5 of the previous 17 years sampled and similar to the other 12 (Figure 8). The 2015 Bluehead Sucker total CPUE value which mimics the juvenile catch is lower than 7 of the previous 17 years and similar to the other 10.

Length Information

Bluehead Suckers ranging from 83 – 445mm TL (mean TL = 279 mm) were collected during 2016 Adult Monitoring. The Bluehead Sucker length-frequency histogram showed a bimodal distribution with peaks around 167-200mm TL (sub-adult) and 376-400mm TL (adult) size classes (Figure 9).

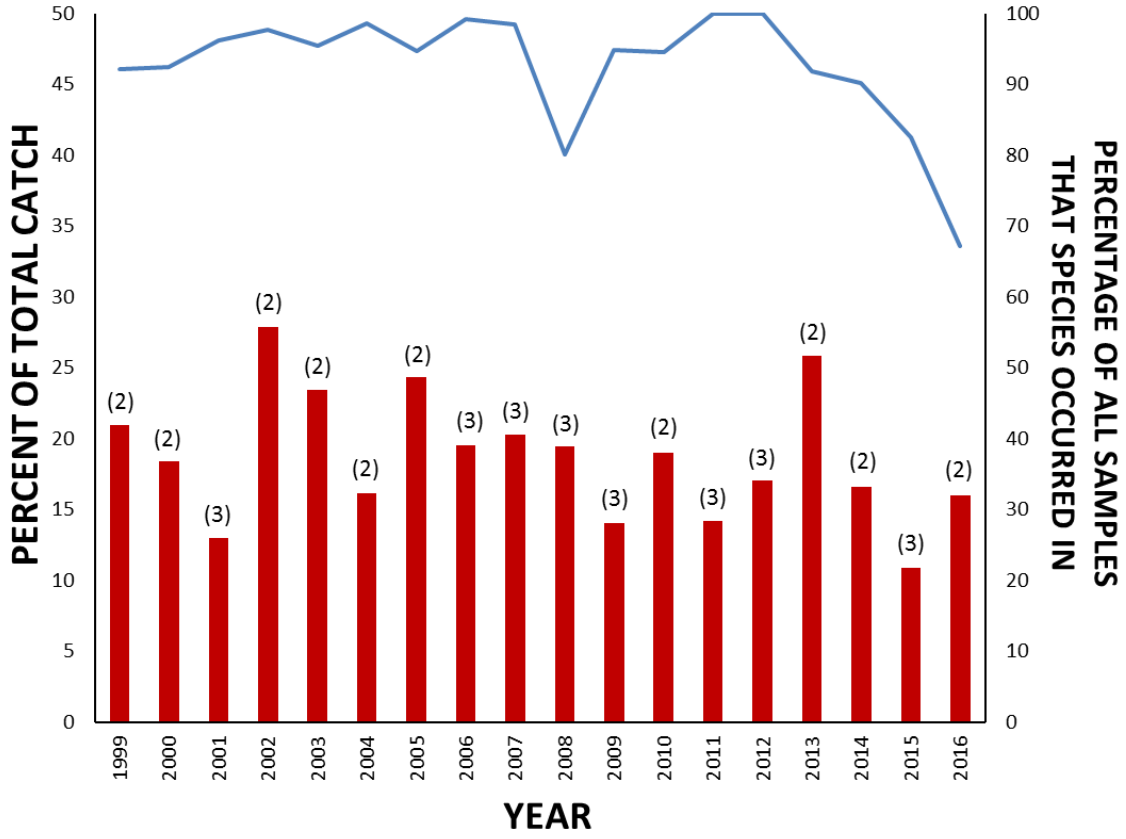

Figure 7. A summary of Bluehead Sucker relative abundance in Adult Monitoring collections, 1999 to 2016. The solid blue line at the top of the graph represents the percentage of all electrofishing samples on a given Adult Monitoring trip in which this species occurred (i.e., percent occurrence). The solid red bars represent the percent of the total catch that this species composed in a given year. Numbers in parentheses indicate the numeric rank for this species in a given year relative to all other fish species collected in the common sampled area (RM 180.0-77.0).

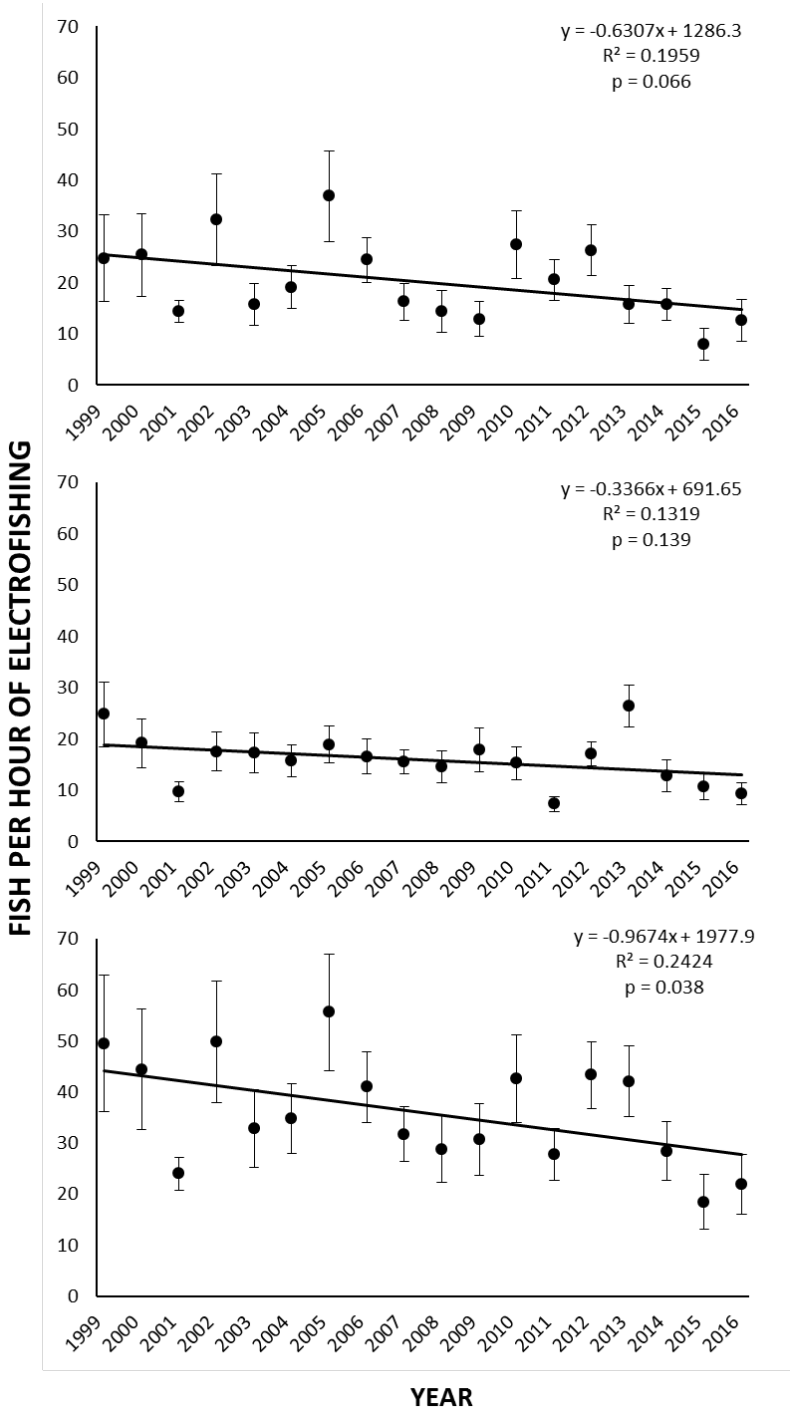

Figure 8. Bluehead Sucker CPUE in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips, for juvenile fish (< 300 mm TL; top), adult fish (≥300 mm TL; middle), and for all life stages combined (juveniles + adults; bottom). Error bars are 95% CI. The solid, black sloping line is a linear regression analysis of the mean CPUE values. The statistics are for these regression lines.

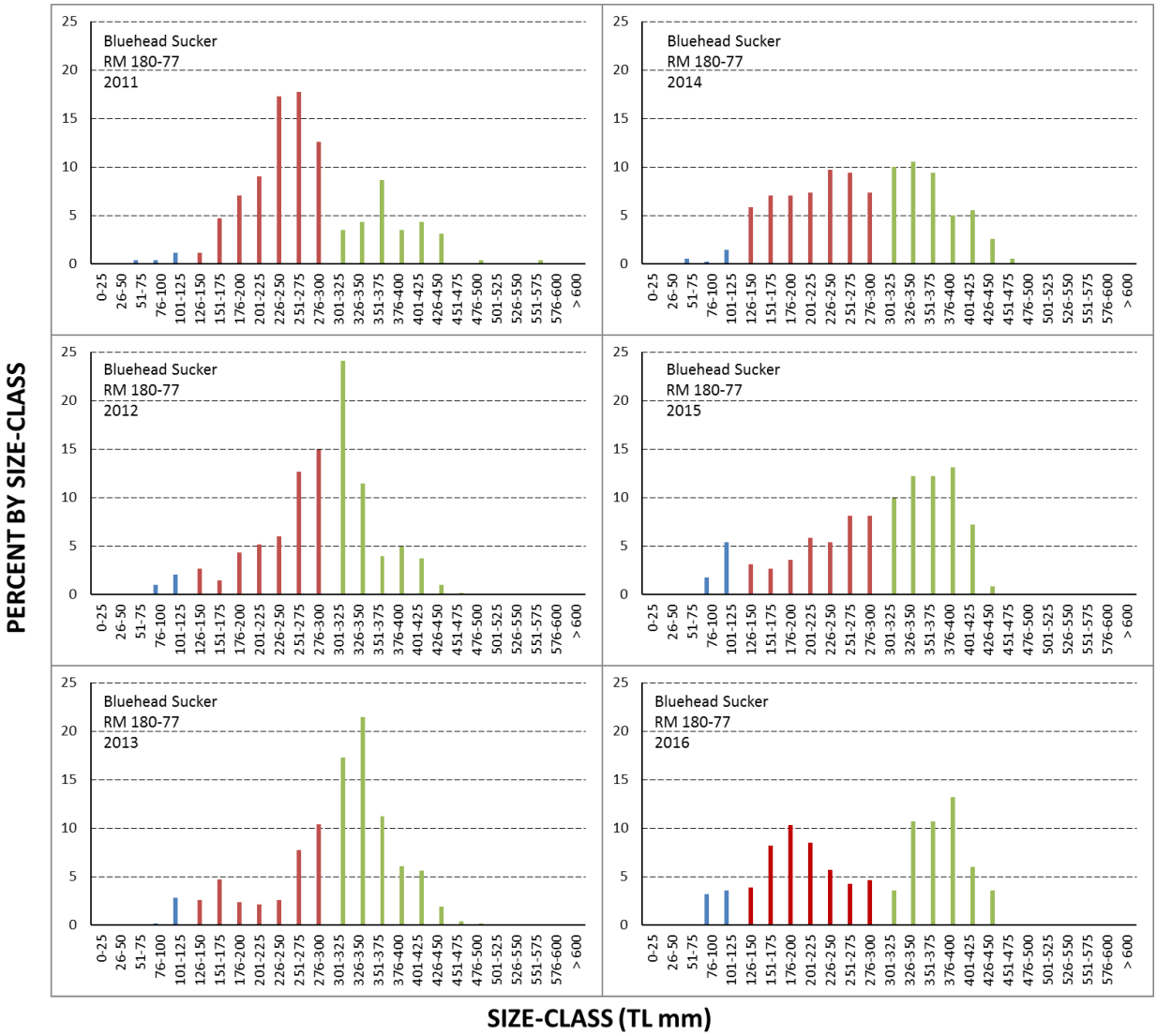

Figure 9. Length-frequency histograms showing the size-class distribution of Bluehead Sucker in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips in the San Juan River, 2011 to 2016. Solid blue bars vertical lines are juvenile fish. Solid red bars represent recruiting sub-adult fish. Solid green bars represent adult fish.

Common Nonnative Fishes

Channel Catfish

Catch Information

In 2016, Channel Catfish was the third most abundant species, making up 9.7% of the total catch (Table 3, Figure 10). This was the second lowest total catch value in the common sampled area since 1999. Channel Catfish were collected in 80.6% of all electrofishing samples occurred in five geomorphic reaches (from RM 166.6-53; Figure 10).

There has been no significant change in the common sampled area in the juvenile Channel Catfish CPUE from 1999 to 2016 shown by the trend line with a p-value of 0.69 (Figure 11). The catch rate in 2016 was similar to 6 of the previous 17 years, lower than 11 of the previous 17 year, and not significantly higher than any of the previous 17 years (Figure 11). There has been no significant change in the long term adult Channel Catfish CPUE trend since 1999. Similarly, the total CPUE trend has not shown any significant increase or decrease since 1999; total CPUE for 2016 was similar to 7 of the past 17 years, lower than 10 of the past 17, and not significantly higher than any year since 1999 (Figure 11). Each year since 2008 has also been significantly different than the year prior and the next year showing high variation in CPUE among recent years.

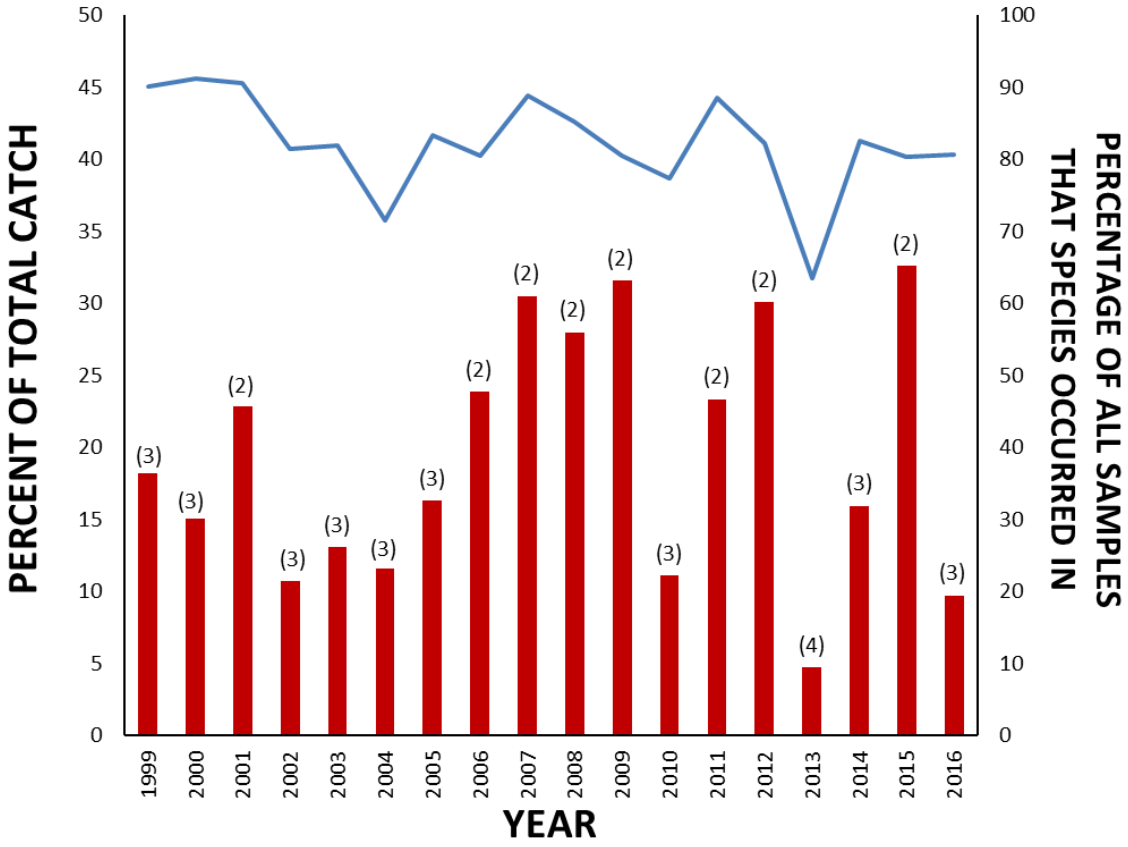

Figure 10. A summary of Channel Catfish relative abundance in Adult Monitoring collections, 1999 to 2016. The solid blue line at the top of the graph represents the percentage of all electrofishing samples on a given Adult Monitoring trip in which this species occurred (i.e., percent occurrence). The solid red bars represent the percent of the total catch that this species composed in a given year. Numbers in parentheses indicate the numeric rank for this species in a given year relative to all other fish species collected in the common sampled area (RM 180.0-77.0).

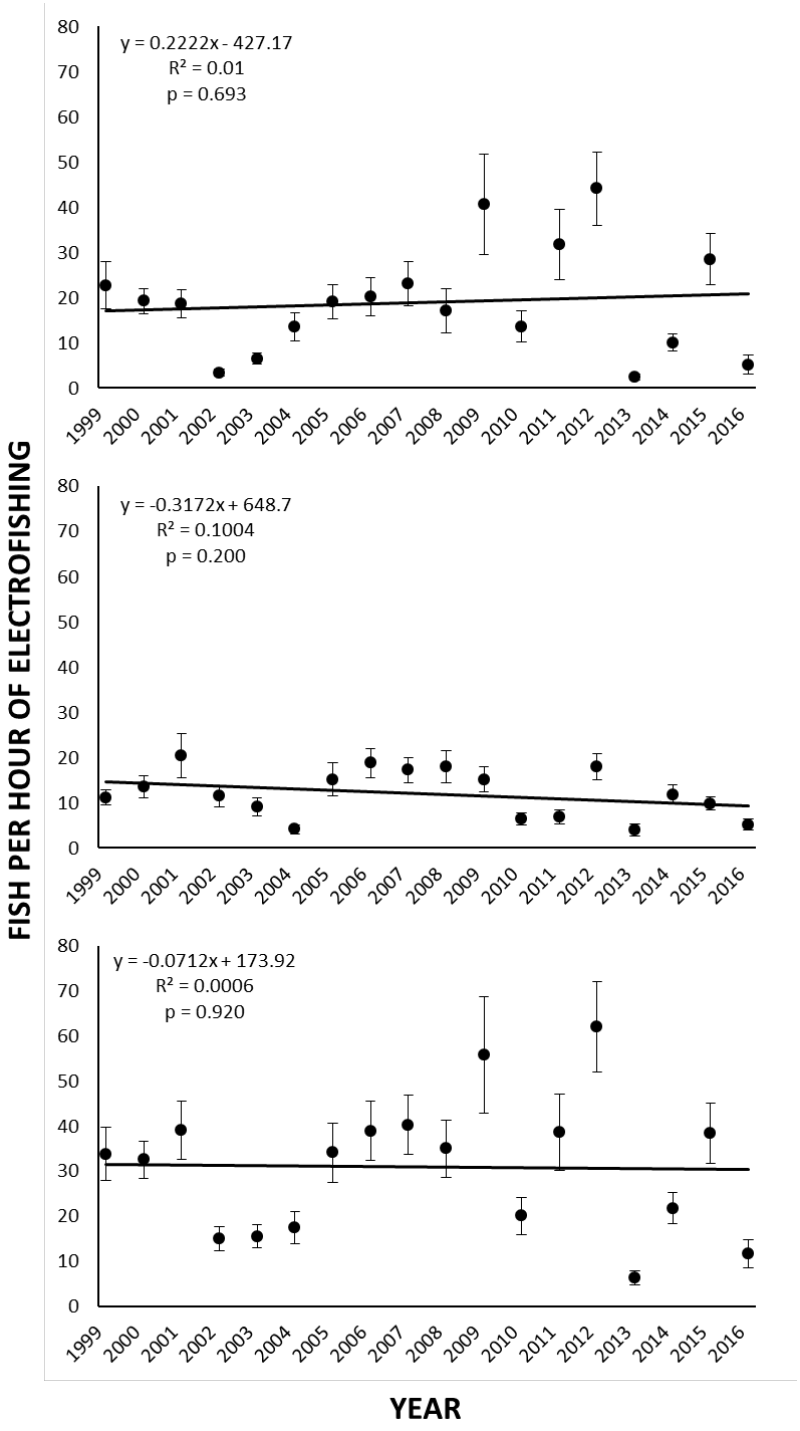

Figure 11. Channel Catfish CPUE in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips, for juvenile fish (< 300 mm TL; top), adult fish (≥ 300 mm TL; middle), and for all life stages combined (juveniles + adults; bottom). Error bars are 95% CI. The solid, black sloping line is a linear regression analysis of the mean CPUE values. The statistics are for these regression lines.

In 2016, the peak of Channel Catfish CPUE was centered on river miles 90-77, just downstream of Montezuma Creek to Sand Island, this was twice the catch rate than then next highest from RM 150-140. No Channel Catfish were caputred above PNM (RM 166.6) and only 24 were captured above Hogback Diversion (RM 158.6) (Figure 12).

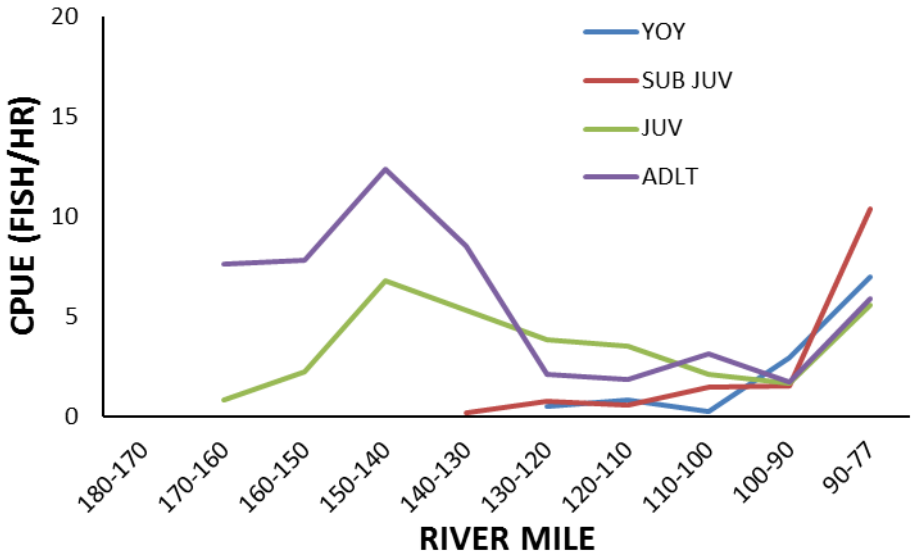

Figure 12. A comparison of the longitudinal distribution by 10-RM sections of the various life-stages of Channel Catfish (expressed as total CPUE) compared to one another in the common sampled area (RM 180.0-77.0) in 2015. YOY = young-of-the-year (< 60 mm TL); SUBJUV = sub-juvenile fish (61-199 mm TL); JUV = juvenile fish (200-299 mm TL); ADULT = adult fish (≥ 300 mm TL).

A longitudinal comparison of catch rates for life-history of Channel Catfish shows that the two larger size classes peaked just below Shiprock, NM (Figure 12). The two smaller size classes were not picked up until the four corners area and they increased along with the larger size classes after Montezuma Creek (Figure 12).

Length Information

Channel Catfish ranged from 42-637 mm TL (mean TL = 341 mm) in 2016 Adult Monitoring collections. In the 2015 length-frequency histogram, the largest 25mm size group was fish 276-300 mm TL, likely larger age-2 and smaller age-3 (Figure 13). These distinct influxes of younger cohorts of Channel Catfish continue to be very pronounced in length-frequency histograms over the years.

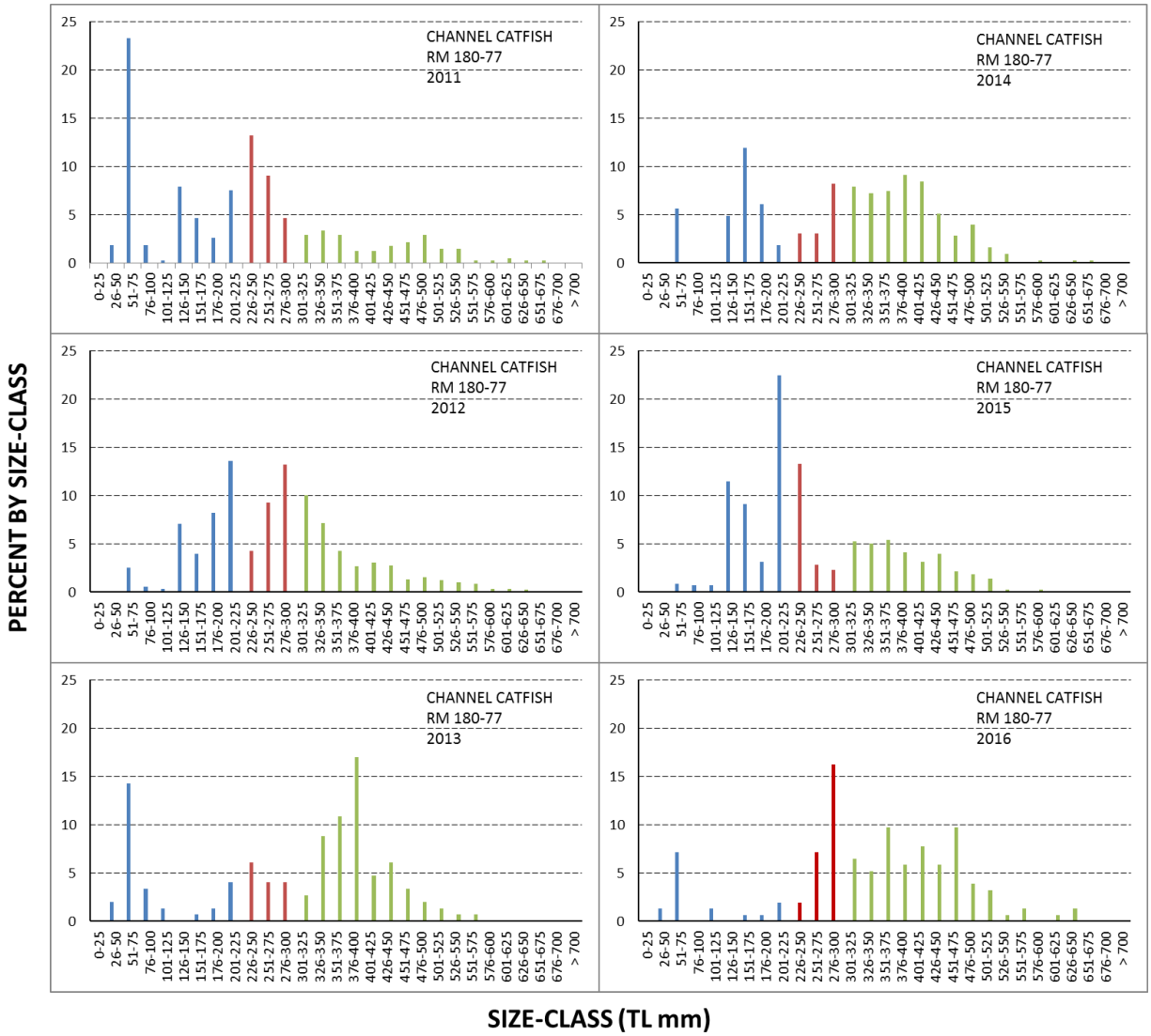

Figure 13. Length-frequency histograms showing the size-class distribution of Channel Catfish in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips in the San Juan River, 2011 to 2016. Solid blue bars represent juvenile fish. Solid red bars represent recruiting sub-adult fish. Solid green bars represent adult fish.

Common Carp

Catch Information

Common Carp were the seventh most commonly-collected fish during 2016 Adult Monitoring (Table 3, Figure 14). This marks the 13th consecutive year the species has not been among the four most commonly-collected fish species when sampling occurred riverwide (Figure 14). A total of 75 Common Carp were collected in the common sampled area (Table 3) of which, 61 were juveniles (≤ 250mm TL) and 14 were adults (≥ 250 mm TL). Common Carp were collected from Reaches 6-3 (from RM 180.0-77.0), with 51 being collected from Reach 6, 8 from Reach 5, 3 from Reach 4, and 13 from Reach 3.

In 2016, Common Carp accounted for only 1.0% of the total catch and were collected in 23.9% (n = 32) of electrofishing samples (Table 3, Figure 14). Of the 32 electrofishing samples that had Common Carp, half contained a single fish and nine samples had 2 fish. Common Carp adult CPUE hasn't changed significantly since 2007 and has continued to remain significantly lower than the 1999-2006 period (Figure 15). Juvenile Common Carp have not significantly changed since 2005, whereas 2004 was a higher catch (Figure 14).

Length Information

Common Carp ranging from 100-162 mm TL (mean TL = 125 mm) were collected during 2016 Adult Monitoring (Figure 16). As protocol of sampling, two out of every three river miles are sampled and every fourth river mile sampled all fish are measured and weighed, so adult Common Carp were captured, however not in the river miles where lengths were taken.

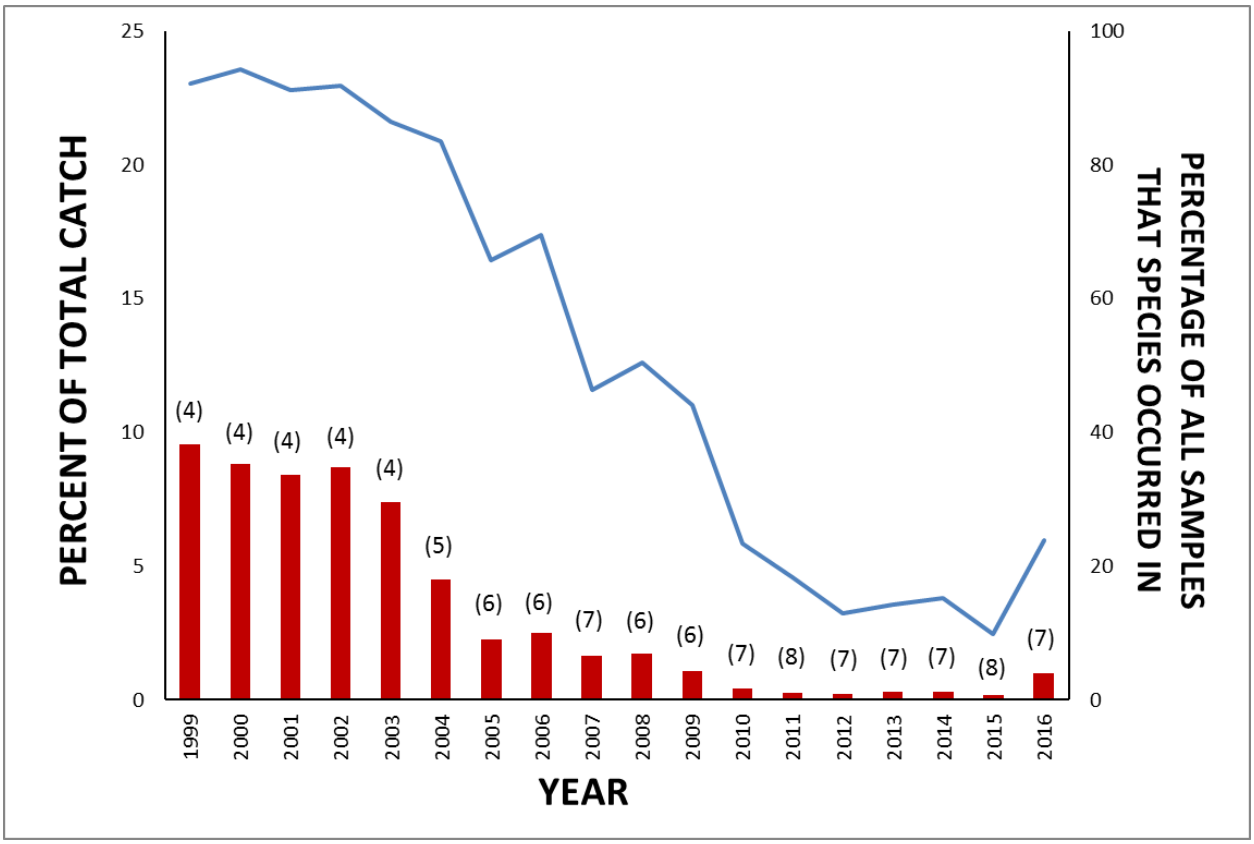

Figure 14. A summary of Common Carp relative abundance in Adult Monitoring collections, 1999 to 2016. The solid blue line at the top of the graph represents the percentage of all electrofishing samples on a given Adult Monitoring trip in which this species occurred (i.e., percent occurrence). The solid red bars represent the percent of the total catch that this species composed in a given year. Numbers in parentheses indicate the numeric rank for this species in a given year relative to all other fish species collected in the common sampled area (RM 180.0-77.0).

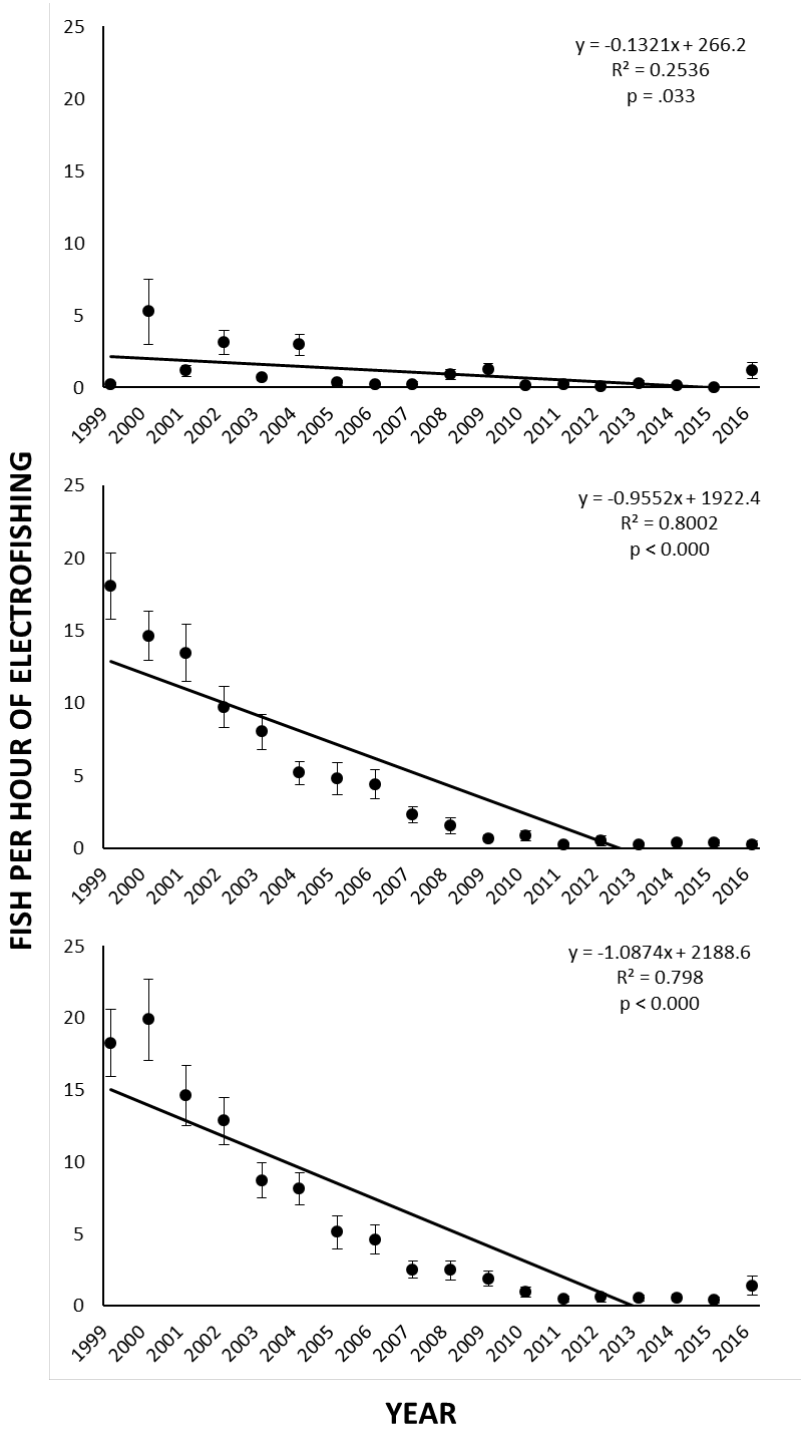

Figure 15. Common Carp CPUE in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips, for juvenile fish (< 50mm TL; top), adult fish (≥ 250 mm TL; middle), and for all life stages combined (juveniles + adults; bottom). Error bars are 95% CI. The solid, black sloping line is a linear regression analysis of the mean CPUE values. The statistics are for these regression lines.

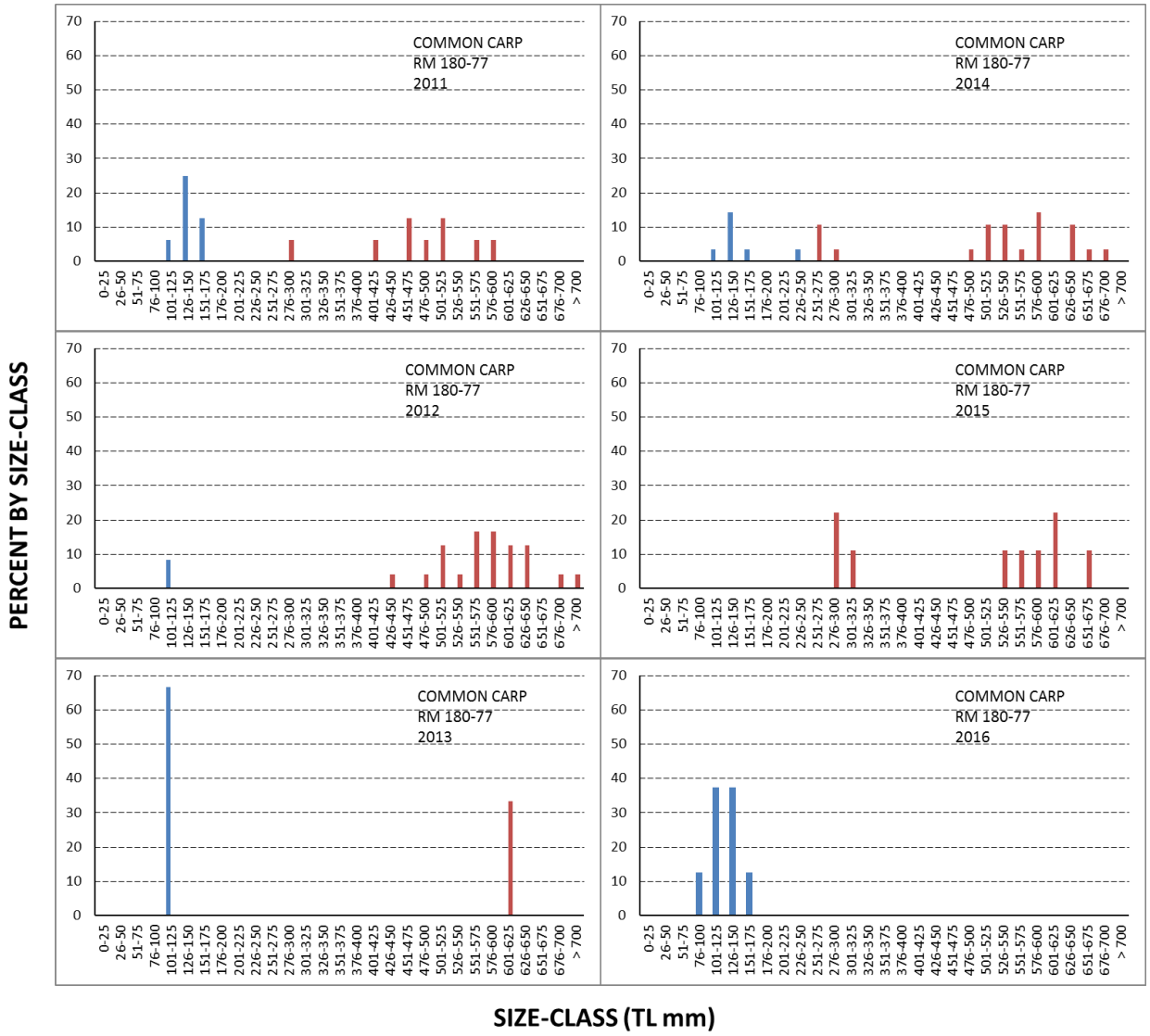

Figure 16. Length-frequency histograms showing the size-class distribution of Common Carp in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips in the San Juan River, 2011 to 2016. Solid blue bars represent juvenile fish. Solid red bars represent adult fish.

Fall Sampling in the San Juan River upstream of the Animas River Confluence

On 15 and 16 September 2016, a 15-RM section of the San Juan River upstream of the Animas River confluence was sampled. The purpose of this sampling was to expand Adult Monitoring upstream to document possible range expansion by Colorado Pikeminnow and Razorback Sucker into these upstream areas, as well as documenting the overall makeup of the fish community.

Eleven fish species (848 total fishes) were collected during upstream sampling. This included five native and four nonnative species. The five native species in descending order of abundance were Flannelmouth Sucker (545 fish), Bluehead Sucker (202 fish), Speckled Dace (41 fish), Razorback Sucker (7 fish), and Colorado Pikeminnow (3 fish). The five native species (798 total fishes) accounted for 94.1% of the total catch during upstream sampling. The four nonnative species in descending order of abundance were Common Carp (38 fish), White Sucker (3 fish), Fathead Minnow (2 fish), and Brown Trout (1 fish). The non-native species accounted for only 5.2% of the total catch. Two different hybrid crosses in suckers were observed as well, three total Flannelmouth Sucker X Bluehead Sucker (native X native) and three Flannelmouth Sucker X White Sucker (native X introduced).

Table 8. Total number of fishes collected during sampling in the San Juan River upstream of the confluence with the Animas River on the 2016 Adult Monitoring trip.

Species (Status)[a]	Number Collected	Percent Of Total	Number Of Samples Collected In
Flannelmouth Sucker (N)	545	64.27	18
Bluehead Sucker (N)	202	23.82	18
Speckled Dace (N)	41	4.83	11
Common Carp (I)	38	4.48	12
Razorback Sucker (N)	7	0.83	5
Colorado Pikeminnow (N)	3	0.35	3
Flannelmouth Sucker X Bluehead Sucker (H,N)	3	0.35	3
Flannelmouth Sucker X White Sucker (H,I)	3	0.35	3
White Sucker (I)	3	0.35	3
Fathead Minnow (I)	2	0.24	1
Brown Trout (I)	1	0.12	1
GRAND TOTAL	848		
Total Electrofishing Collections In 2016 = 18 Total Electrofishing Effort In 2016 = 7.37 Hours			
2016 Native Fishes = 801 (94.5% Of The Total Catch) 2016 Introduced Fishes = 47 (5.5% Of The Total Catch) 2016 Native To Introduced Fishes Ratio = 17.0:1			
a: (N) = Native species; (I) = Introduced species; (H, N) = A hybrid of two native fish species, considered to be a native fish; (H, I) = A hybrid of a native and a nonnative fish species, considered to be an introduced fish			

Native Fishes

Sampling has occurred upstream of the Animas River since 2012, the presence of Razorback Suckers has been documented every year and as far upstream as RM 194.0 (2016). Seven individual Razorback Suckers were collected during upstream sampling in 2016, these fish ranged in size from 383-443 mm TL and were collected from RM 194-181. Five of the fish were stocked in the fall of 2015; four of the five were stocked at Bloomfield (RM 196.0) the other was stocked at Berg Park (Animas RM 5.0). The Razorback Sucker stocked in the Animas and four of the other five fish were from NAPI, the other was from Ouray NFH- GVU. The other two of the seven fish captured upstream of the Animas confluence were both stocked in the fall of 2014 and were both from Ouray NFH-GVU and were stocked at Bloomfield. Razorback Sucker accounted for considerably less of the total catch upstream of the Animas (0.83%) when compared to the riverwide sampling that occurred downstream (5.1%) (Table 3, Table 8).

As in the common sampled area (RM 180.0-77.0) downstream, native Flannelmouth Sucker were the most abundant large-bodied fish species collected (Tables 3, Table 8). They accounted for 64.3% of the total catch upstream of the Animas and San Juan confluence, and 61.7% downstream. However, their total CPUE was higher in the downstream area (82.0 fish/hr) than it was upstream (75.6 fish/hr). Adult Flannelmouth Suckers were more abundant upstream of the Animas River (48.1% of all Flannelmouth Sucker collected) than downstream (36.8% of all Flannelmouth Sucker collected).

Native Bluehead Suckers were the second most abundant large-bodied species collected in upstream sampling (Table 8). They accounted for a higher percentage of the total catch upstream of the Animas (23.8%) compared to the downstream common sampled area (16.0%) (Tables 3, Table 8). Their total CPUE was higher upstream as well, with 29.1 fish/hr in the upstream section and 21.9 fish/hr in the downstream riverwide area. The Bluehead Sucker age class structure was different above the Animas River confluence than below. Above the confluence, 30.7% of the Bluehead Suckers caught were adult and 69.3% were juvenile, while below the confluence the age class structure was more evenly divided 44.6% adult and 55.4% juvenile.

Speckled Dace was the third most abundant species caught above the confluence in 2016, making up 4.83% of the number of fish caught (Table 8). Speckled Dace were present in 11 of the 18 (61.1%) samples upstream of the confluence but were only present in 64 of the 134 (47.8%) downstream (Table 3, Table 8). CPUE of Speckled Dace was almost identical upstream to downstream samples (5.4 fish/hr and 5.7fish/hr, respectively).

Nonnative Fishes

Common Carp accounted for 4.5% of the total catch in upstream sampling, versus 1.0% in the common sampled area downstream (Tables 3, Table 8). Common Carp total CPUE was substantially higher in the upstream section (5.3 fish/hr of electrofishing) in 2016, than in 2014 and 2015 (1.5 fish/hr each year). Downstream in the riverwide area the catch rate was 1.4 fish/hr in 2016. All other non-native fishes collected upstream of the Animas on the San Juan River collectively were 1.1% of the total catch (White Sucker X Flannelmouth Sucker, White Sucker, Fathead Minnow, and Brown Trout) (Table 8).

DISCUSSION

Data Integration

Adult Monitoring gives the San Juan River Basin Recovery Implementation Program a once-a-year snapshot of the entire large-bodied fish community prior to overwintering. This study provides a long-term, statistically-powerful data set that allows assessment of the success or failure of several ongoing management actions, including retention, survival, and growth of stocked endangered fishes, attempts to increase occupied range by endangered fishes, and the effects of nonnative fish removal on the large-bodied fish community. Adult Monitoring also contributes data to assess the issue of PIT tag retention/loss and how that affects the SJRIP's determination of recruitment and overall population size among endangered fish species. It also provides information on recaptured FLOY tagged and PIT tagged fish movement from other studies as well as fin clips from both common and endangered fishes for stable isotope analysis (diet overlap) work.

Adult Monitoring has been used to help assess progress towards recovery by making comparisons between numbers of endangered fishes actually being collected during fall monitoring and numbers of these same species that would be expected if the SJRIP were at or near the numbers specified in the Recovery Goals. This relative status of the two endangered fish species in the San Juan River can be used to make comparisons to the status of these same species in other sections of the upper Colorado River basin.

From 1996 to 2010, Adult Monitoring was able to provide a "riverwide" (Reaches 6-1) look at population trends and concentrations among not only the endangered fishes, but also wild Roundtail Chub, and the common large-bodied fish species (Flannelmouth Sucker, Bluehead Sucker, Channel Catfish, and Common Carp). The truncating of Adult Monitoring, in 2011, to sampling just RM 180.0-77.0 has limited our ability to make "riverwide" statements about the trends among various fish species. Sampling riverwide will occur once every five years to include the lower canyon, the next will be in 2020. It is obvious that the lower San Juan River still plays a vital role in telling the story of certain fish species populations (particularly Channel Catfish) and their interactions with one another. Unfortunately with the adoption of this restriction in sampling, we no longer have population data for common native fish species in this section of the river (RM 77.0-0.0) or comparative population data for Channel Catfish and Common Carp at the time of year we are using Adult Monitoring to "measure" the success or failure of our management actions. In addition, Adult Monitoring data have been used to bolster other data sets and to undertake independent analyses, such as those done for the 1999 Flow recommendations for the San Juan River (Holden 1999), contributing data to the population model, providing data to help determine the effects of nonnative fish removal of native fish populations (Franssen et al. 2014), and nonnative fish populations (Duran et al. 2013).

Rare Native Fishes

Colorado Pikeminnow

Wild Colorado Pikeminnow likely continue to be absent from our fall Adult Monitoring collections. However, over the last several years, it has become relatively common to collect over a hundred stocked Colorado Pikeminnow of varying size-classes during Adult Monitoring. While the 142 stocked Colorado Pikeminnow collected during 2016 were not the most Colorado Pikeminnow ever collected, 2016 marked the 11th consecutive year that > 100 Colorado Pikeminnow were collected in the common sampled area.

The collection of four adult fish (> 450 mm TL) and two fish in the recruiting sub-adult size-class (400-449 mm TL) proves that recruitment into the adult population from younger stocked fish is indeed taking place. In all, more individual adult Colorado Pikeminnow were collected during all 2016 sampling (n = 25 individuals), than were collected in the period from June 1991 to October 1994 (n = 17 individuals) when wild adult Colorado Pikeminnow were still present and being collected via electrofishing (S. Durst pers. comm., Ryden and Ahlm 1996). The Colorado Pikeminnow collected on the San Juan River during Adult Monitoring at $\geq$ 300 mm TL (including sub-adult and adult size-class categories as defined in USFWS 2002a) tended to be larger than wild fish would have been at these same ages (Osmundson et al. 1997b).

Once again in 2016, the large majority of the 142 known-origin Colorado Pikeminnow collections (99.3%) were fish that had been stocked as age-0 fish. The CPUE for age-1 fish was similar to the previous three years (2013-2015). With the exception of age-2 fish in 2010, 2011, and 2013 CPUE for these fish was not different than any previous year. The lack of an increase or decrease in CPUE is present in age-3 fish as well. However, despite this lack of an observable significant increase in CPUE from age-1 to age-3, numbers of both recruiting sub-adult and adult size Colorado Pikeminnow fish seem to be slowly increasing, not only in Adult Monitoring collections, but also in collections for other studies (e.g., Duran 2015). Colorado Pikeminnow larger than 100 mm TL feed primarily on fishes (Vanicek and Kramer 1969; Franssen and Durst 2013), so the absence of larger fish might be related to the lack of suitable prey. An isotopic study of dietary compositions and shifts in San Juan River fishes suggested that there may be a food source missing from the basin that was there prior to the listing of this species (Franssen 2014).

Colorado Pikeminnows were collected throughout the common sampled area (RM 180.0-77.0) in 2016 with the largest number being collected in Reach 5. Adult fish (four individuals) were only captured from RM 162.0 to 140.0, all of which having a PIT tag prior to being captured. These adult fish have shown a strong affinity to these upper, more complex, reaches. All four of the adult fish have never been captured below RM 125 with the oldest capture being from 11 August 2009. Three of these four fish have passed through the PNM fish ladder only to be recaptured

downstream again, which indicates that stocked Pikeminnow are at least visiting the far upper reaches of river above PNM Weir (RM 166.6). Expanding the range of Colorado Pikeminnow to sections of the San Juan River upstream of PNM Weir was identified as being important to recovery for this species (U. S. Bureau of Reclamation 2001). To date, this range expansion has been accomplished by stocking hatchery-reared fish directly into this river section to account for large downstream movements that have been present after past stocking events, as well as providing upstream passage of fish at the PNM Fish Passage (e.g., Furr 2015). Short-term results seem to indicate that this approach has helped stocked Colorado Pikeminnows retain in higher numbers upstream of PNM Weir.

Adult Monitoring data, combined with data from other San Juan studies, indicate that range expansion appears to be occurring in other areas of the San Juan River Basin as well. Eleven Colorado Pikeminnow were collected from Yellowjacket Canyon, a tributary of McElmo Creek from 2007-2010 (Fresques 2007, 2008, 2009, and 2010). Ten of these fish (ranging from 168-307 mm TL) collected from the Yellowjacket Canyon site were untagged and believed to have been stocked into the San Juan River that had moved up McElmo Creek to Yellowjacket Canyon. In April 2011, a Colorado Division of Wildlife crew sampling McElmo Creek about a mile upstream of the Yellowjacket Canyon confluence recaptured one of the Colorado Pikeminnow (298 mm TL) that had been captured and tagged in Yellowjacket Canyon on 29 September 2010 (296 mm TL: J. White, pers. comm.). In the spring and summer of 2011, 24 individual Colorado Pikeminnows (range = 225-519 mm TL) were collected from the San Juan River arm of Lake Powell (Francis et al. 2013). One additional individual was collected in the summer 2012 (Francis et al. 2017).

From 2003 to 2010 there had been an increasing trend in age-1 catch rates for fish that were stocked at age-0 (Figure 1). Since 2010, larger size classes of Colorado Pikeminnow have been present in the Fall Monitoring catch, however not in large numbers, but it is encouraging to see these adult fish and multiple ages. An overall look at all Colorado Pikeminnow captured in Adult Monitoring from year to year had shown a significant increasing trend since 2003 to 2010 but a significant decrease in the last four years, mimicking the age-0 graph in Figure 1.

On the down side, we know that Colorado Pikeminnows can be lost from the San Juan system in a number of ways. Stocked Colorado Pikeminnows have been documented becoming entrained in two different canals (Trammell 2000, Renfro et al. 2006). In the case of the Hogback canal, 201 Colorado Pikeminnows were documented as being entrained in 2004 (n = 140) and 2005 (n = 61). A fish screen with remote PIT tag antennas has been installed in the Hogback Diversion to divert fish back into the San Juan and detect any fish with PIT tags that would be entrained. Colorado Pikeminnows have been documented in the San Juan River arm of Lake Powell (Francis et al. 2013). However, a large (approximately 10 meter high) waterfall prevents their moving back upstream and into the San Juan River, unless inundated in which case Razorback Sucker have been documented moving past the waterfall upstream (Francis et al. 2013). In addition, in April of 2007 a Colorado Pikeminnow was captured by the UDWR-Moab crew below the water fall at RM -0.5 and released above the water fall, this fish has been recaptured

five times since then (Schleicher 2013). This method may be labor intensive but does provide passage over the water fall for native fishes. Lastly, a number of studies in the San Juan River have documented negative interactions between Colorado Pikeminnow and nonnative Channel Catfish. These include both predation upon stocked Colorado Pikeminnow by Channel Catfish (e.g., Jackson 2005) as well as Colorado Pikeminnow choking on Channel Catfish and Black Bullhead after attempting to ingest them (e.g., Ryden and Smith 2002, A. Lapahie unpublished data).

Despite various sources of loss, a wide spectrum of size-classes of Colorado Pikeminnows were collected in 2016, up to and including sub-adult and adult fish. Documented reproduction of Colorado Pikeminnow in 6 of the last 10 years indicates that stocked fish that have recruited into adulthood are now successfully spawning. In addition, Colorado Pikeminnows have been documented using areas of the San Juan River basin where they were previously absent. Caution must be taken when interpreting these data, because the San Juan River Colorado Pikeminnow population is essentially still a population of stocked fish. However, given that just 10 years ago, Colorado Pikeminnow were all but nonexistent in Adult Monitoring collections, their current status (i.e., potentially having thousands of these fish in the river) is encouraging.

Razorback Sucker

No definitive wild Razorback Suckers were collected in 2016. The 383 stocked Razorback Suckers collected in 2016 was the highest number ever collected during Adult Monitoring, 93.2% of the Razorback Suckers caught on the trip had been in the river for one or more overwinter periods. Increased numbers of Razorback Suckers collected in Adult Monitoring coincides with the start of an eight year stocking effort, where more Razorback Suckers were stocked and better handling techniques were used when releasing fish. Unlike the Colorado Pikeminnow, some Razorback Suckers are retaining in the San Juan River for as long as 18 overwinter periods post-stocking (Schleicher et. al 2013). In addition, larval Razorback Sucker were collected for the 19th consecutive year (M. Farrington, pers. comm). The continued collection of larval Razorback Sucker, paired with the presence of older fish indicates that stocked Razorback Suckers are able to spawn successfully in the wild. The presence of a few small untagged Razorback Suckers collected by various studies in 2003 and 2004, when no fish of that size were being stocked indicates that at least some of these larvae had recruited to the age-1 and age-2 year-classes during those particular years (e.g., Jackson 2004, Ryden 2004, Golden and Holden 2005, Jackson 2005). In February 2014, investigators from UDWR-Moab reported capturing and releasing a small (224 mm TL) untagged Razorback sucker during a non-native removal trip from Mexican Hat, UT to Clay Hills boat landing (B. Hines, pers. comm).

Razorback Suckers were collected throughout riverwide sampling in 2016 (RM 180.0-77.0) with the highest number collected in Reach 6 (RM 180-155). Like the Colorado Pikeminnow, Razorback Suckers appear to be expanding their range upstream beyond PNM Weir, both via stocking and upstream passage through the PNM Fish Passage facility. A total of 138 Razorback

Suckers were collected above Hogback Diversion in 2016, 23 of which were collected upstream of PNM Weir. Razorback Sucker from the NAPI grow-out ponds and ONFH-GVU were stocked using hard and soft release methods in three different locations; Boyd Park on the Animas River (A-RM 5.0), PNM Weir (RM 166.6), and Montezuma Creek (RM 93.0) in the falls of 2013-2015 to see if these fish will stay higher in the system where they are stocked. The collections of seven Razorback Suckers upstream of the Animas River confluence on the San Juan in fall 2016, one in 2015, three in 2014, five in 2013, and two in 2012, with an additional 10 fish captured in the Animas River during a spring collection in 2015, have been very encouraging in regards to attempting to retain these fish higher in the system.

Seventy-five Razorback Suckers were collected in the San Juan river arm of Lake Powell in 2011 and another 72 in 2012 (Francis et al. 2012, Francis et al. 2017). Six of these fish are known to have moved upstream (from 147-144 RM) when the waterfall at the old Piute Farms Marina almost disappeared due to rising lake levels in late July 2011 (Francis et al. 2013). In addition, database searches have indicated that at least four Razorback Suckers stocked into the San Juan River in 2004 (n = 1; 360 mm TL) and 2006 (n = 2; 167 and 253 mm TL) moved downstream out of the San Juan River, through Lake Powel and back upstream into the Colorado River and Green River, a distance of 477 RM in the most extreme case (T. Francis, pers. comm.). A Razorback Sucker in 2015 was captured on 10 September during Adult Monitoring at RM 95 on the San Juan that was stocked into the Green River at RM 255.4. This fish would have had to pass over the water fall on the San Juan River in the summer of 2011 to gain access to the river without being detected. Two Razorback Suckers with sonic tags were detected by two submersible ultrasonic receivers (SURs) placed in Lake Powell, one fish had moved down the San Juan arm and continued down lake past the confluence of the San Juan and Colorado arms of the lake, the other moved down the San Juan arm and headed up the Colorado arm. Additionally, Razorback Suckers have been detected over remote PIT tag antennas in upstream locations of both Chaco Wash (RM 153.0) and McElmo Creek (RM 100.5). Thus like the Colorado Pikeminnow, the Razorback Sucker seems to be moving into and exploiting more habitats peripheral to the mainstem San Juan River. The detection of fish moving between river basins also shows that habitats once thought to be a barrier to this species may indeed be acting more like a highway.

Between 2006 and 2015 there were 17 capture events with Razorback Sucker X Flannelmouth Sucker hybrids during Adult Monitoring in the common sampled area, in 2016 there were 7 additional fish captured. These fish were collected from near the APS Weir, downstream to just below Recapture Wash (RM 163.0-83.0). Seven of these captures were juvenile fish (225-392 mm TL). The other 17 captures were adult fish (410-515 mm TL). In addition, two Razorback Sucker X Flannelmouth Sucker hybrids were collected in the San Juan River arm of Lake Powell in 2011 (Francis et al. 2013). The presence of these juvenile and adult fish over numerous years points to a low level of successful spawning, survival, retention, and recruitment among this hybrid form. If these Razorback Sucker X Flannelmouth Sucker hybrids are surviving, retaining, and recruiting to adulthood in numbers large enough to document via Adult Monitoring, why then aren't pure Razorback Sucker able to do the same? Every year Razorback Suckers are

collected in the river that do not possess a PIT tag. These fish were once considered to be fish that dropped their tag after being stocked or tagged in the river. Fin clips have been taken from these untagged fish and have been given to ASIR to determine the natal origin of these fish through laser ablation and use of stable isotopes.

I assume that it will take the consistent collection of small, unmarked Razorback Sucker by an intensive, seining-based study such as the small-bodied fish monitoring study to demonstrate that recruitment of wild-produced Razorback Sucker is indeed taking place. It has long been known among Colorado River basin endangered fish researchers that it is extremely difficult to collect early life-stage Razorback Suckers in any of the Upper Colorado rivers, not just in the San Juan River.

However, in spring 2013, at least 32 age-1 and age-2 Razorback Suckers (<200 mm TL) were collected in the Colorado River around and downstream of Moab, UT (T. Francis, pers. comm.). Unlike the fall 2012 captures on the San Juan, these fish were all collected with boat-mounted electrofishing units performing shoreline electrofishing – essentially identical to the sampling done during Adult Monitoring. These young Razorback Suckers were collected across a range of flows (from low to high water), mostly from slack water habitats along shorelines, although some were collected over low-velocity point sand bars. They also seemed to be associated with instream structure (brush piles, tamarisk root wads, and boulders/rocks). In many cases, these young Razorback Suckers were collected in groups and often those groups were in the same places where young Colorado Pikeminnows were also being collected. In most cases, these young Razorback Suckers were described as being "easy to recognize" as they came into the electrofishing field. The Principal Investigator described it as these fish just reacting "differently" to the electrofishing field than did Flannelmouth or Bluehead sucker, swimming vigorously towards the electrofishing boat once they were in the electrofishing field, just like larger Razorback Suckers do, and were easy to identify because of that fact (T. Francis, pers. comm.). The Principal Investigator who has sampled these areas for years (as well as performing Adult Monitoring in the San Juan River) felt sure that his crews were not doing anything different or special to collect these fish this year. He also stated that he felt Adult Monitoring is sampling in an effective manner to document the presence of these fish in the San Juan River, if and when they are present in large enough numbers to be documented.

On the down side, we know that the Razorback Sucker, like the Colorado Pikeminnow can be lost from the San Juan system in a couple of ways. To date, stocked Razorback Suckers have not been documented being entrained in canals -- although data from two canals in Grand Junction, CO indicate that they do become entrained in upper basin canals (D. Ryden, pers. obs.). However, Razorback Suckers have moved into and now occupy the San Juan River arm of Lake Powell. Until summer 2011 it was assumed that the presence of the waterfall prevented any movement of Razorback Sucker back upstream and into the San Juan River. We now know that at least some of these fish will return upstream if the opportunity presents itself. Lastly, a number of studies in the San Juan River have documented predation upon stocked Razorback Sucker by Channel Catfish (e.g., Jackson 2005).

Despite various sources of loss, and the far lesser numbers of fish that have been stocked over the years in comparison to Colorado Pikeminnow (Furr 2015), Razorback Sucker continue to persist and spawn in the San Juan River, producing greater numbers of larval fish annually than do Colorado Pikeminnow (Farrington et al. 2015). As with Colorado Pikeminnow, caution must be taken when interpreting these data, because the San Juan River Razorback Sucker population is essentially still a population of stocked fish. Like Colorado Pikeminnow, Razorback Sucker were all but nonexistent in Adult Monitoring collections just 18 years ago. Looking at these data through that lens, their current status (i.e., having numbers of adult fish that we know are consistently reproducing) is encouraging.

Common Native Fishes

Flannelmouth Sucker

The Flannelmouth Sucker remains the most abundant species collected riverwide, captured in 100% of samples, and represented 61.7% of the total catch. In addition, Flannelmouth Suckers of all life stages continue to be collected with regularity, showing that reproduction and recruitment are occurring. The long-term trend line for juvenile Flannelmouth Sucker CPUE riverwide has shown great fluctuations, but no significant long-term change since 1999. The long-term trend line for adult Flannelmouth Sucker CPUE riverwide has significantly declined in the last 18 years that riverwide sampling occurred. The CPUE in 2016 was statistically similar to 11 of the previous 17 years and lower than the rest. The exact reason for the marked decline in adult Flannelmouth Sucker CPUE is unknown. There has been some speculation that the stocking of large numbers of large juvenile and adult Razorback Sucker (a potential competitor of Flannelmouth Sucker) could be the reason. However, a small number of Razorback Sucker were stocked prior to 1999 (only 5,100 of the 143,672 stocked to date = 3.55%) when the downward trend began, and most of those were relatively small fish, which PIT tag data shows were not recaptured in high numbers (Furr 2016, Durst 2015). However, this trend does bear close examination in future years. As a whole (juvenile and adult fish combined), the San Juan River Flannelmouth Sucker population has remained relatively stable and widespread in the common sampled area over the last 18 years. This is the case despite: 1) the stocking of over > 4.8 million Colorado Pikeminnow (potential predators) from 2002 to 2015 and 143,672 Razorback Sucker (potential competitors) from 1994-2015; and, 2) repeated intensive electrofishing efforts that are ongoing in the San Juan River.

There are populations of Flannelmouth Suckers in the San Juan River upstream of the Adult Monitoring study area, in the Animas River, Chaco Wash, the Mancos River, and in McElmo Creek and its tributaries (including Yellowjacket Canyon). Flannelmouth Suckers have also been documented in the San Juan River arm of Lake Powell in both 2011 and 2012 (Francis et al.

2013, Francis et al. In Prep.). Based on recaptures of Flannelmouth Sucker FLOY-tagged in the mid-1990s (SJRIP database), we know that Flannelmouth Sucker move upstream at least into the Animas River from the San Juan River. This exchange of fish probably also occurs between the mainstem San Juan and the other tributary streams mentioned above. It could be that mainstem San Juan population is just the downstream end of a larger functional unit and that the fluctuating trends in CPUE (especially juvenile CPUE, but possibly also the long-term decline in adult CPUE values) that we've observed over time are reflective of changes within this larger metapopulation.

Bluehead Sucker

Bluehead Sucker were the second most common large-bodied fish species collected in the common sampled area in the 15 RM upstream of the Animas River confluence in 2016. Bluehead Suckers were collected in over half of electrofishing samples (67.2%) in the common sampled area and in all of the samples upstream of the Animas confluence. The Bluehead Sucker population is strongly associated with cobble-dominated habitats in upstream reaches of the San Juan River (i.e., upstream of Reach 4) where 96.2% of captured Bluehead Suckers where found. Over the past 18 years the Bluehead Sucker population has remained relatively stable. The long-term trend line for juvenile Bluehead Sucker CPUE has shown that there has been a significant decrease in this abundance index over the last 18 years. The highest CPUE data points for adult Bluehead Suckers were in 1999 and 2013, and, unlike Flannelmouth Sucker, the long-term trend line for adult Bluehead Sucker CPUE riverwide has shown no significant change over the last 18 years. To date, the San Juan River Bluehead Sucker population has remained relatively stable and widespread in the common sampled area. This is the case despite: 1) the stocking of over > 4.8 million Colorado Pikeminnow (potential predators) from 2002 to 2015 and > 143,672 Razorback Sucker (potential competitors) from 1994 to 2015; and, 2) repeated intensive electrofishing efforts that are ongoing in the San Juan River.

Like Flannelmouth Sucker, there are also populations of Bluehead Sucker in the San Juan River upstream of the Adult Monitoring study area, in the Animas River, Chaco Wash, the Mancos River, and in McElmo Creek and its tributaries (including Yellowjacket Canyon). Bluehead Sucker have also been documented in Lake Powell, as far downstream as Neskahi Canyon (Francis et al. 2017). Recaptures of Bluehead Sucker FLOY-tagged in the mid-1990s (SJRIP database), showed that at least some of these fish had moved upstream into the Animas River from the San Juan River. An exchange of fish probably also occurs between the mainstem San Juan and the other tributary stream populations of Bluehead Sucker, as mentioned above. It could be that mainstem San Juan population of Bluehead Sucker is just the downstream end of a larger functional unit and that the fluctuating trends in CPUE that we've observed over time are reflective of changes within this larger metapopulation.

Common Nonnative Fishes

Channel Catfish

Channel Catfish were the third most abundant species collected in 2016 in the common sampled area (RM 180.0-77.0). Channel Catfish were collected between RM 166.6 to 77.0, being present in 80.6% of samples. Discouragingly, numbers of adult and juvenile Channel Catfish have shown no significant long-term decline in the face of intensive nonnative fish removal efforts by multiple agencies.

In 2001 (the year intensive nonnative fish removal efforts began), the largest numbers of Channel Catfish were collected in the upper nonnative fish removal section, from RM 166.6-147.9 (Ryden 2012). In 2016, the Channel Catfish population was most abundant in the portion of the middle nonnative fish removal section (RM 147.9-77.0) that we sampled. Larger numbers of both adult and juvenile size class fish were found more upstream near Shiprock where-as sub-juvenile and young of year Channel Catfish were more common further downstream below Montezuma Creek, UT.

Strong year-classes of young Channel Catfish continue to be observed in length-frequency histograms in the common sampled area. This alludes to the resilience of the Channel Catfish population in the San Juan River. Channel Catfish have demonstrated an impressive capacity for reproduction and recolonization that has, so far, managed to offset many of the impacts made by intensive nonnative fish removal efforts in both the middle and lower nonnative fish removal sections.

While the population trends would seem to indicate that nonnative fish removal efforts are ineffective in reducing numbers of this species in the common sampled area, it should be remembered that in the upper nonnative fish removal sections it took several years of hard work in a much shorter area of river to bring numbers of Channel Catfish down significantly. It is anticipated that with the repetition of multiple-pass, intensive nonnative fish removal efforts being applied in all sections of the San Juan River (i.e., enough pressure over a long enough period of time), will make it possible to effectively reduce the number of Channel Catfish in the section of river from Shiprock, NM downstream to Mexican Hat, UT. Removal efforts in 2016 had been changed to test the efficacy of this sample design on a smaller scale to be able to increase effort in each river mile. There was a significant decrease in the CPUE of both adult and juvenile size class Channel Catfish when compared to CPUE values from 2015 in similar miles. More years of this sampling design will be needed to see a longer term effect of the catfish population.

Common Carp

Common Carp were the seventh most commonly-collected species during 2016 Adult Monitoring, with 75 fish collected in 134 electrofishing samples. Over the last 18 years, Common Carp numbers have been greatly reduced. While the exact causes of the large-scale decline of Common Carp are unknown (N. Franssen, pers. comm.), nonnative fish removal is a contributing factor. Common Carp were numerically less abundant in 2016 than both endangered Colorado Pikeminnow and Razorback Sucker. Common Carp accounted for only 1.0% of the total catch and were collected in only 23.9% of all electrofishing samples in the common sampled area. While there were more Common Carp captured this year than that of 2015 when the whole river was sampled (19 total fish, all adult), it is important to put things into prospective, during 1998 Adult Monitoring, 77 adult Common Carp were collected in just one electrofishing sample (RM 163-162). The increase in numbers this year were in the juvenile size class which these fish could have been washed into the river from on off river ponds during extremely high flows or there could have been a strong year class brought on by the additional habitat that was available during high flows. Regardless of the juvenile increase in catch this year, if there has been a success story associated with the nonnative removal efforts in the San Juan River to date, it would be the marked reduction in numbers of Common Carp in the common sampled area.

Sampling Upstream of the Animas River Confluence

Sampling occurred upstream of the Animas and San Juan River confluence (RM 195-181) for the fifth consecutive year in 2016. In all five years the two most abundant species were native fishes (Flannelmouth Suckers and Bluehead Suckers). In the last four years, the top three most abundant species were native, with Speckled Dace being the third most abundant fish species.

Every year Razorback Suckers have been captured in this section. In 2016, seven Razorback Suckers were collected that had been in the river for one overwinter period, which is the most that has been collected in this section of river. That also coincided with our first captures of Colorado Pikeminnow in this section of river as well. Three Colorado Pikeminnow were captured that were stocked into the river in the fall of 2015. Overall catch in this section of river was higher than the previous year but similar to 2012-2014, suggesting fish were not affected or moved by the large spring release this year from Navajo Reservoir.

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