LONG TERM MONITORING OF SUB-ADULT AND ADULT LARGE-BODIED FISHES IN THE SAN JUAN RIVER: 2014

Interim Progress Report

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EXECUTIVE SUMMARY

General Information

- A total of 9,508 fishes were collected during 2014 Adult Monitoring
    - Native fishes accounted for 83.4% of the total catch

Native Species:

- Colorado Pikeminnow
    - No wild Colorado Pikeminnow were collected
    - 218 stocked Colorado Pikeminnow were collected
        - Sixth most abundant species collected
        - Scaled CPUE of Colorado Pikeminnow in the river for 1+ overwinter periods post-stocking was significantly higher in 2014 than 6 of the previous 11 years
        - Sizes ranged from 108-701 mm TL (age-1 to age-8+)
            - 9 adult fish (>450 mm TL) collected
            - 4 sub-adult fish (400-449 mm TL) collected
            - 12 large juvenile fish (300-399 mm TL) collected
        - Captures ranged from RM 180.0-79.1
            - 18 in Reach 6, 111 in Reach 5, 73 in Reach 4, and 16 in Reach 3
        - 178 (82.8%) of the 215 known-origin Colorado Pikeminnow were in the river ≤ 365 days post-stocking
            - All 218 Colorado Pikeminnow collected were in the river for at least one overwinter period
- Razorback Sucker
    - No wild Razorback Sucker were collected
    - 268 stocked Razorback Sucker were collected
        - Fifth most abundant species collected
        - Second most Razorback Sucker ever collected during an Adult Monitoring trip in the common sampled area (RM 180.0-77.0)
        - Scaled CPUE of Razorback Sucker that had been in the river for 1+ overwinter periods was significantly higher than 7 of the previous 11 years
        - Sizes ranged from 300-554 mm TL (age-2 to age-15)
        - Captures ranged from RM 179.0-77.0
        - 106 were collected in Reach 6, 105 in Reach 5, 45 in Reach 4, and 12 in Reach 3
        - Of 224 Razorback Sucker collected with PIT tags and known stocking histories, 79 (35.3%) were in the river ≤ 365 days post-stocking
            - Seventeen of those fish were in the river < 1 overwinter period when they were collected
            - The others were in the river from 1-14 overwinter periods
    - Razorback Sucker that have been in the river > 10 overwinter periods have been collected every year since 2010
- 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 all of the last 16 years
        - Accounted for only 54.6% of the total catch (n = 5,191 fish)

        - Had the widest distribution of any species, being collected in all 132 electrofishing samples (RM 180.0-77.0)
- Bluehead Sucker
    - Among the three most-commonly collected species in each of the last 16 years in the common sampled area (RM 180.0-77.0)
    - Second most abundant species collected in the common sampled area
        - Accounted for 16.6% of the total catch (n = 1,576 fish)
        - Collected in 119 of 132 (90.2%) electrofishing samples (RM 180.0-77.0)

Nonnative Species:

- Channel Catfish
    - Third most abundant species in the common sampled area (RM 180.0-77.0)
        - Accounted for 15.9% of the total catch (n = 1,512 fish)
        - Collected in 82.6% of electrofishing samples (RM 180.0-77.0)
        - The majority channel catfish were collected in the middle nonnative fish removal section
            - Numbers considerably reduced from PNM Weir downstream to Hogback diversion dam
            - Adult and juvenile CPUE show no increasing or decreasing trend in the common sampled area (RM 180.0-77.0) from 1999-2014
            - Juvenile CPUE from 2008 to 2013 showed significant variation from year to year
- Common Carp
    - Percent of total catch accounted for by this species has decreased steadily over the last 16 years (to 0.3% in 2014) in the common sampled area (RM 180.0-77.0)
        - Was the fourth most commonly-collected species in 1999
    - The seventh most commonly-collected species
        - Only 29 common carp collected from RM 180.0-77.0
            - 21 (72.4%) were adult fish (i.e., ≥ 250 mm TL)
            - 8 (27.6%) were juvenile fish (i.e., ≤ 249 mm TL)
        - Collected in 15.2% 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 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) Colorado River Fishery Project (CRFP) office 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-2014 workplan) are:

1) Annually, during autumn, document fish community structure, species 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 prey upon and may 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 2014): 1.1.1.1, 1.1.1.2, 1.2.1.1, 1.2.1.2, 1.2.2.1, 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, 3.1.1.7, 4.1.1.1, 4.1.1.2, 4.1.1.3, 4.1.2.3, 4.1.2.4, 4.1.2.5, 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 4.3.1.1, 4.4.1.1, 4.4.2.1, 4.4.2.2, 4.4.2.3, 4.4.4.1, 4.4.4.2, 4.4.4.3, 5.2.1.1, 5.2.1.2, 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 2014, the study area for Adult Monitoring began just downstream of the Bloomfield boat landing (RM 195) and continued downstream to the Sand Island boat landing, near Bluff, UT (RM 77.0). This study area encompassed five geomorphic reaches of the San Juan River between Navajo Reservoir and Lake Powell. These included the lower 15 miles of Reach 7, three complete reaches (Reaches 6, 5, and 4) and the majority of Reach 3, 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); Reach 2 (RM 68.0-17.0); and Reach 1 (RM 17.0-0.0).

METHODS

Field Sampling

Sampling conducted in 2014 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 just RM 180.0-77.0 in four out of five years, with the entirety of the previous study area (reaches 6-1) being sampled only every fifth year. The entire study area from RM 180.0-2.9 isn't scheduled to be sampled again until fall 2015.

This change in sampling protocol for 2011 through 2014 necessitated a cropping of 1999 to 2010 data sets to a common sampled area (RM 180.0-77.0). Therefore, all data comparisons in this report will be just for this common sampled area and will not include any data from the downstream, mostly canyon-bound areas of the San Juan River (RM 77.0-2.9) reported in 1999 to 2010 reports.

From 2012 to 2014 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 Pikeminnow and Razorback Sucker 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.

With three years of data from the two upstream San Juan River sections, 2014 will only be compared to 2012 and 2013 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 2014 findings. 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 over the last several years, it appears that essentially all of the endangered Colorado Pikeminnow and Razorback Sucker being collected during Adult Monitoring are fishes that have been stocked during augmentation efforts. Large disparities exist in numbers of fish stocked between various calendar years, making year-to-year comparisons of CPUE problematic. To deal with this problem, 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 CPUE 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. Total catch numbers for endangered fishes were then scaled to account for the differences in numbers of fishes stocked between years (Golden and Holden 2005, Robertson and Holden 2007, R. Ryel pers. comm.).

The number of Colorado Pikeminnow collected during Adult Monitoring from any given stocking year and age-class at stocking was transformed to a theoretical annual stocking of 300,000 Colorado Pikeminnow. The transformation for Colorado Pikeminnow followed the formula:

$$SCPM = (300{,}000/N)CPM$$

where SCPM = the scaled number of Colorado Pikeminnow, N = the total number of Colorado Pikeminnow of a given age-class stocked in a particular calendar year, and CPM = the number of Colorado Pikeminnow of that same age-class from that particular stocking year that were collected during Adult Monitoring. The scaled number of Colorado Pikeminnow was then divided by the number of seconds (converted to hours) fished by all rafts combined to obtain a scaled CPUE value (i.e., the scaled number of fish per hour of electrofishing). Scaled CPUE values were then log-transformed (i.e., ln{scaled CPUE + 1}) prior to all analyses (Golden and Holden 2005, Robertson and Holden 2007, R. Ryel pers. comm.).

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 also scaled, to a theoretical annual stocking of 11,400 individuals. The transformation for Razorback Sucker followed the formula:

$$SCRZ = (11{,}400/N)RZ$$

where SCRZ = the scaled number of Razorback Sucker, N = the total number of Razorback Sucker stocked in a particular calendar year, and RZ = the number of Razorback Sucker from that particular stocking year that were collected during Adult Monitoring. Scaled CPUE for Razorback Sucker was calculated, transformed, 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 (on a common sampled area basis, 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 was then divided by the number of seconds (converted to hours) fished by all rafts combined 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' common sampled area electrofishing data to evaluate long-term trends. Analysis of variance (ANOVA) using Tukey's Honestly Significant Difference (Tukey's HSD) multiple-comparison post-hoc tests was then used to determine whether significant differences in CPUE values occurred 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 common sampled area 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 2014 Adult Monitoring trip was 789 CFS (Table 1). Overall, the mean river flow during the entire 15-year period (1999-2014) of Adult Monitoring sampling was 1082 CFS.

Seventeen fish species and hybrids were collected during the 2014 Adult Monitoring trip (Table 2). This included 6 native species, 2 native sucker X native sucker hybrids, 1 native sucker X nonnative sucker hybrid, and 8 nonnative species (Tables 2 and 3). Seven species (Flannelmouth Sucker, Bluehead Sucker, Channel Catfish, Speckled Dace, Razorback Sucker, Colorado Pikeminnow, and Common Carp) accounted for 99.5% (9,243 fish) of the total catch. The other seven species and three hybrids contributed only 0.5% (47 fishes) to the total catch in 2014 (Table 3). Native fishes accounted for the majority (83.4%) of fishes collected in 2014 (Table 3). Native Flannelmouth Sucker were once again the most abundant species collected during Adult Monitoring, accounting for 54.6% of all fish collected in our common sampled area.

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. Currently there are no studies being conducted to explore these phenomena, but the data are available to the program if a study is initiated.

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 2014.

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 ($22.4\ m^3/sec$)
16-year statistics: Mean = 1082 CFS ($30.7\ m^3/sec$)			

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 2014 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. commersoni X *C. latipinnis*	hybrid	Introduced	comXlat
Order Cypriniformes: Family Cyprinidae - carps and minnows			
Cyprinella lutrensis	Red Shiner	Introduced	Cyplut
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 Salmoniformes: Family Salmonidae – trouts			
Oncorhynchus mykiss	Rainbow Trout	Introduced	Oncmyk
Salmo trutta	Brown Trout	Introduced	Saltru
Order Siluriformes: Family Ictaluridae - bullhead catfishes			
Ameiurus melas	Black Bullhead	Introduced	Amemel
Ictalurus punctatus	Channel Catfish	Introduced	Ictpun

Table 3. Total number of fishes collected during the 2014 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)	5191	54.6	132
Bluehead Sucker (N)	1576	16.6	119
Channel Catfish (I)	1512	15.9	109
Speckled Dace (N)	667	7.0	102
Razorback Sucker (N)	268	2.8	78
Colorado Pikeminnow (N)	218	2.3	74
Common Carp (I)	29	0.3	20
Black Bullhead (I)	16	-----	12
White Sucker (I)	8	-----	7
Flannelmouth Sucker X Bluehead Sucker (H, N)	6	-----	6
Flannelmouth Sucker X White Sucker (H, I)	5	-----	4
Roundtail Chub (N)	4	-----	3
Red Shiner (I)	3	-----	2
Largemouth Bass (I)	2	-----	2
Brown Trout (I)	1	-----	1
Rainbow Trout (I)	1	-----	1
Razorback Sucker X Flannelmouth Sucker (H, N)	1	-----	1
GRAND TOTAL	9508		
Total Electrofishing Collections In 2014 = 132 Total Electrofishing Effort In 2014 = 60.16 Hours			
2014 Native Fishes = 7,931 (83.4% Of The Total Catch) 2014 Introduced Fishes = 1,577 (16.6% Of The Total Catch) 2014 Native To Introduced Fishes Ratio = 5:1			
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 2014, 218 Colorado Pikeminnow were captured from RM 180-77 (Table 3), all presumably stocked. All but three could be traced back to a stocking event. This marked the ninth consecutive year that > 100 Colorado Pikeminnow were collected during an Adult Monitoring trip from this common sampled area. Colorado Pikeminnow captures ranged from RM 180.0-79.1 (Table 4), with 18 being collected in Reach 6, 111 in Reach 5, 73 in Reach 4, and 16 being collected in the portion of Reach 3 (RM 106-77) that was sampled in 2014

Thirteen (6.0%) Colorado Pikeminnow were collected upstream of the Hogback Diversion (RM 158.6) in 2014. Six of these collections occurred upstream of PNM Weir (RM 166.6), and 3 of the 13 had PIT tags. Two of these fish were stocked as age-1 fish in the spring of 2011 at RM 166.6, just downstream of the PNM Weir, or at Boyd Park (Animas RM 1.0). Of the two, one was tagged in the river in June 2012 at the PNM fish ladder and the other in July 2013 at RM 159.4 during a non-native removal trip. The third PIT-tagged fish was stocked as an age-0 fish in the fall of 2012 at RM 196.1 or at Boyd Park (Animas RM 1.0), and tagged in the PNM fish ladder in July 2014. 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).

Three Colorado Pikeminnow without PIT tags were also collected upstream of PNM Weir. Of these, two (142 & 171 mm TL) were age-1 fish, assumed to have been stocked as age-0 fish in November 2013 (Furr 2014). The other Colorado Pikeminnow captured without a PIT tag was an age-2 fish stocked at age-0 in November 2012 (Furr 2014).

Table 4. General information on 215 known-origin stocked Colorado Pikeminnow collected in 2014.

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 (178)	108-216	176.0-91.0	315-329 (1)	10/28/2013	Age-0 (2013)	Dexter
Age-2 (22)	260-354	173.0-79.1	664-679 (2)	11/13/2012	Age-0 (2012)	Dexter
Age-3 (7)	301-411	152.0-116.0	1041-1053 (3)	11/2/2011	Age-0 (2011)	Dexter
Age-4 (3)	404-525	180.0-154.0	1210-1212 (3)	5/17/2011	Age-1 (2010)	Dexter
Age-5 (1)	624	151.0	1764 (5)	11/9/2009	Age-0 (2009)	Dexter
Age-7 (1)	684	133.0	2501 (7)	11/14/2007	Age-0 (2007)	Dexter
Age-8 (1)	516	154.0	2336 (6)	4/16/2008	Age-2 (2006)	Dexter
Age-8 (2)	655-701	152.0-133.0	2867-2878 (8)	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.

Stocking history (and length of time in the river) could not be determined for three Colorado Pikeminnow in 2014. These three fish (635, 610, 475 and mm TL), collected from RM 152-109, were large, adult sized fish when captured and tagged for the first time in the river. This left 215 Colorado Pikeminnow of known origin (Table 4).

The majority (n = 178; 82.8%) of the 215 known-origin Colorado Pikeminnow collected in 2014 were in the river $\leq$ 365 days post-stocking, but still had one overwinter period in the river (i.e., they were stocked in November 2013). The rest, 37 (17.2%) of the 215 known-origin Colorado Pikeminnow collected in 2014 were in the river for at least two overwinter periods. Of those 37 fish, 33 (89.2%) were stocked as age-0 fish. 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 Pikeminnow 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 2014). Three of the Colorado Pikeminnow collected on the fall 2014 Adult monitoring trip came from these stockings of age-1 and age-2 fish.

Numerous large Colorado Pikeminnow were collected during 2014 Adult Monitoring. These included 12 fish from 300-399 mm TL (age-2 to age-3 fish), 4 fish from 400-449 mm TL (age-3 and age-4 fish), and 9 fish $\geq$ 450 mm TL (age-4+). Thus, the Colorado Pikeminnow collected in 2014 met the Recovery Goal demographic size criteria, not age, for Downlisting (USFWS 2002a). However, these larger size-class fish were likely all stocked fish. They were stocked at larger sizes than is normal 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 scaled CPUE among groups of 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). However, between 2003 and 2014, there was a general upward trend in scaled CPUE for fish stocked at age-0 and recaptured at age-1. Data collected from 2004 to 2014 showed an increasing trend for age-2 fish. This increase in CPUE is largely driven by the years from 2010 to 2014 (Figure 1). Data collected from 2004 to 2009 indicated that by age-2, differences in scaled CPUE among stocking years tended to essentially disappear, with few significant differences being present (Figure 1). Age-2 fish collected in 2010 through 2013 were an exception to this trend, with scaled CPUE for age-2 fish in 2010, 2011 and 2013 being significantly higher than the previous six years values (Figure 1); however, in 2014 age-2 Colorado Pikeminnow scaled CPUE was similar once again to that of 2004 to 2009. Age-3 fish stocked at age-0 continued to show no change since 2005. No age-4 fish stocked as age-0 fish were captured in 2014 due to the quarantine for the LMBV at Dexter NFH&TC in 2010. Older Colorado Pikeminnow stocked at age-0 were once again present in 2014, this marks the second consecutive year that age-5 fish were present for this analysis, and the fourth year out of the last five that fish six or older were caught (Figure1).

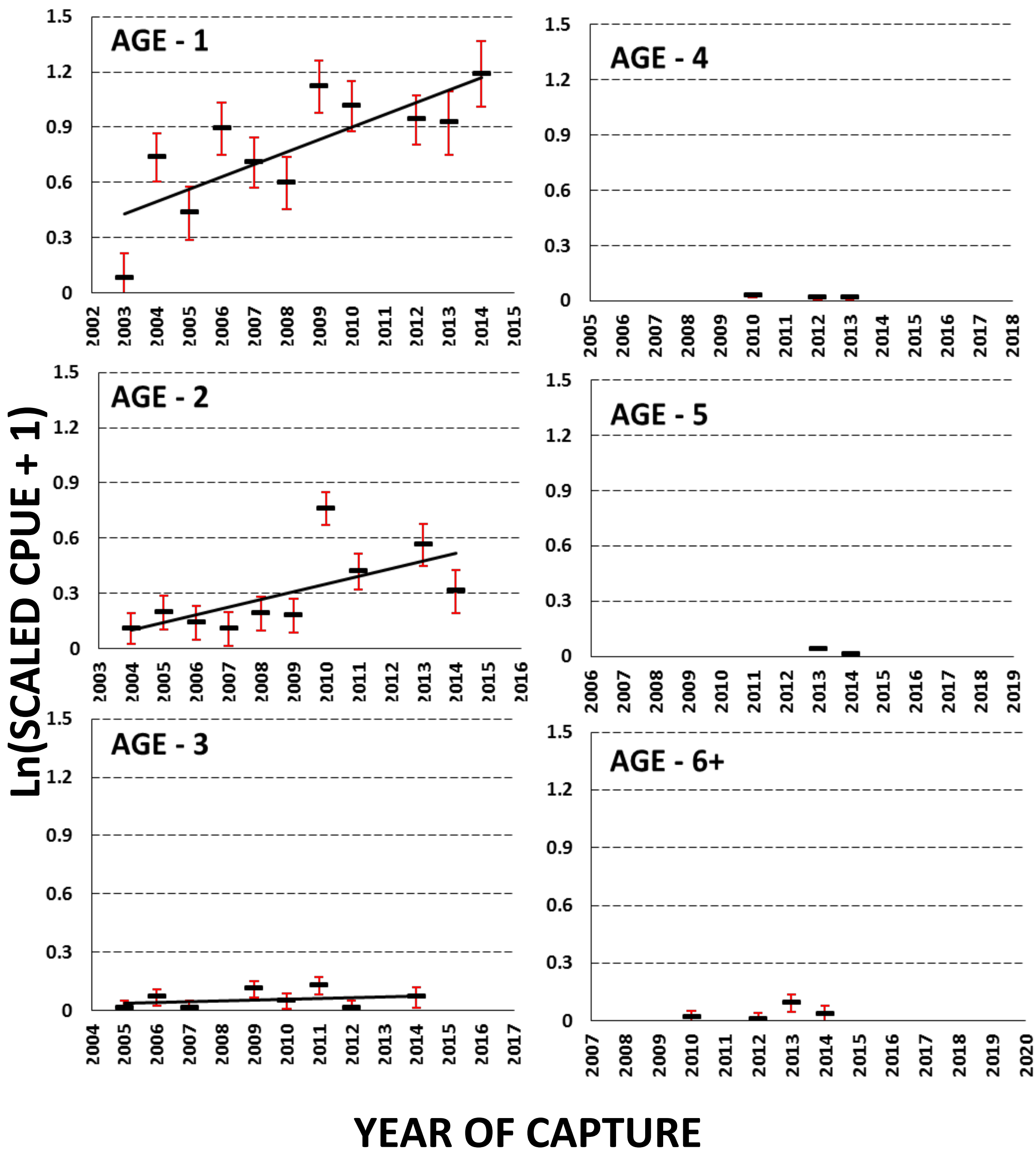

Figure 1. A comparison of scaled CPUE at age among groups of Colorado Pikeminnow stocked as age-0 fish and captured during subsequent Adult Monitoring trips, 2003 to 2014, in the common sampled area (RM 180.0-77.0). The black dashed line shows the mean scaled CPUE values for each year-class of fish during a given calendar year. Red error bars are +/- 2 SE. The black lines show a linear regression from year to year for each year-class.

There were three years (2010, 2012, and 2013) in which an age-4 Colorado Pikeminnow that had been stocked as an age-0 fish were collected from RM 180.0-77.0 (Figure 1). There were no age-0 fish stocked in the fall of 2010 so there would be no age-4 fish for this analysis. One Colorado Pikeminnow stocked as an age-0 fish was collected in 2014 at age-5 during Adult Monitoring. This marked only the second year that an age-5 fish stocked at age-0 was collected during Adult Monitoring. One age-7 and two age-8 Colorado Pikeminnow stocked as an age-0 fish were captured in 2014.

Of the 215 known-origin Colorado Pikeminnow collected in 2014, three (1.4%) were fish stocked as age-1+ fish and one was stocked at age-2 (Table 4). All four fish stocked at age-1+ were recaptured after three or more overwinter periods post-stocking (Table 4).

Between-year comparisons of scaled CPUE for all Colorado Pikeminnow that were in the river 1+ overwinter periods showed an increasing trend of scaled CPUE from 2003 to 2014 (Figure 2). The last six years (2009 to 2014) have not changed significantly in CPUE with the exception of 2011 (Figure 2). A LMBV quarantine in Dexter NFH &TC in 2010 prevented any stocking into the San Juan river until spring of 2011. 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). Those fish were not present after an overwinter period in 2011. While a large number were collected, few were in the river for more than an overwinter period (Table 5). 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 in 2010 (Figure 1). In 2011, scaled CPUE for fish stocked at age-0 that survived into their age-2 year-class was once again higher than observed from 2004 to 2009, although not as high as in 2010 (Figure 1). However, there were no age-0 Colorado Pikeminnow stocked in fall 2010 (Furr 2014), thus there were no age-1 fish available to be recaptured as age-1 fish during the fall 2011 Adult Monitoring trip. Thus, the decrease observed between 2010 and 2011 in scaled CPUE for all Colorado Pikeminnow that were in the river 1+ overwinter periods (Figure 2) was really driven by (i.e., reflective of) this lack of age-1 fish in the system. These 2010 and 2009 year-class fish were present in the 2014 Adult Monitoring catch as both age-4 and age-5 fish (Table 4).

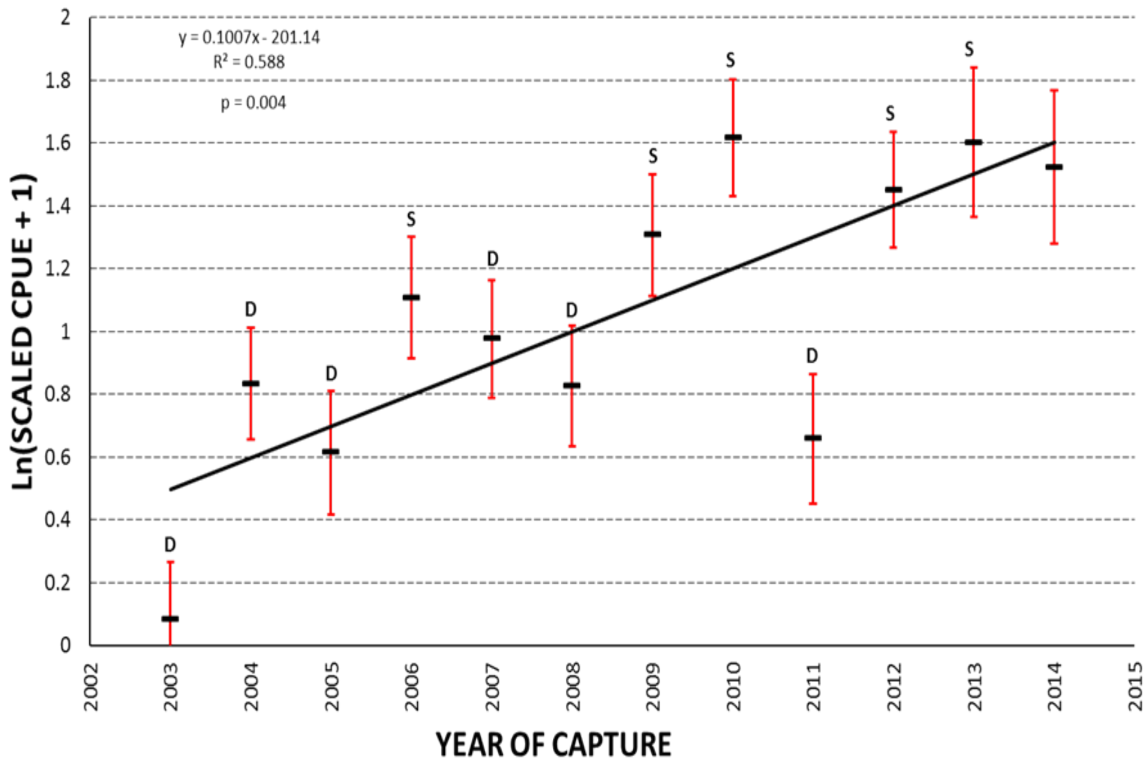

Figure 2. Year-to-year comparison of scaled CPUE for all Colorado Pikeminnow collected on Adult Monitoring trips in the common sampled area (RM 180.0-77.0) that were in the river for one or more overwinter periods following stocking (regardless of age). The black bars show the mean scaled CPUE values for each year. Red error bars are +/- 2 SE. The solid black line shows a linear regression between years. Letters are between-year comparisons using Tukey's HSD post-hoc test). The letter S is significantly similar to 2014 and the letter D is significantly different.

Table 5. Information on stocked Colorado Pikeminnow collected from 2003 to 2014 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

Razorback Sucker

A total of 268 Razorback Sucker were collected in 2014, all of which were assumed to be stocked fish (Table 6). This marks the fifth consecutive year during which > 100 Razorback Sucker were collected during an Adult Monitoring trip from this common sampled area (2010 = 149; 2011 = 197; 2012 = 321; 2013 = 196). Razorback Sucker captures ranged from RM 179.0-77.0 (Table 6), with 106 being collected in Reach 6, 105 in Reach 5, 45 in Reach 4, and 12 from the portion of Reach 3 (RM 106-77) that was sampled in 2014.

Thirteen Razorback Sucker (4.9%) 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 large majority (n= 213; 79.5%) of Razorback Sucker collections in 2014 still occurred downstream of Hogback Diversion (RM 158.6).

A total of 44 Razorback Sucker 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 error (e.g., not recording the correct number or recapture/not recapture) led to unusable PIT tag numbers for five Razorback Sucker. Twenty two Razorback Suckers were fish that had been collected without a PIT tag on previous sampling trips; these fish were PIT tagged prior to being released. Ten Razorback Sucker had no detectable PIT tag upon capture during the 2014 Adult monitoring trip, these fish (likely from the 2006 to 2007 clean-out of the NAPI grow-out ponds) were implanted with a new 134 kHz PIT tag prior to being released.

Of the 224 Razorback Sucker recaptured with PIT tags and known stocking histories in 2014, 79 (35.3%) were in the river ≤ 365 days post-stocking and 17 were in the river < 1 overwinter period when they were collected. The other 145 (64.3%) were in the river > 365 days post-stocking and had been in the river from 1-14 overwinter periods (Table 6).

Table 6. General information on stocked Razorback Suckers collected in 2014.

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 224 Razorback Sucker with known stocking histories:					
2-14 (0)	Age-3 (17)	300-432	166-122	2014	Age-3 (2011)
321-362 (1)	Age-2 - Age-5 (62)	342-545	179.0-77.0	2013	Age-1 - Age-4 (2009- 2012)
692-905 (2)	Age-6 (20)	375-489	167.0-121.0	2012	Age-4 (2008)
1047-1301 (3)	Age-5 & Age-7 (43)	399-525	179.0-95.0	2011	Age-2 & Age-4 (2007 & 2009)
1403-1474 (4)	Age-5 & Age-6 (57)	419-524	166.7-85.0	2010	Age-2 & Age-3 (2008 & 2009)
1763-1800 (5)	Age-7 (12)	432-531	161.0-109.0	2009	Age-2 (2007)
2128 (6)	Age-8 (1)	474	160.0	2008	Age-2 (2006)
2933-2950 (8)	Age-9 – Age-11 (5)	468-527	155.0-92.0	2006	Age-1 - Age-3 (2003 - 2005)
3326 (9)	Age-12 (1)	467	124	2005	Age-3 (2002)
3668-3811 (10)	Age-13 (3)	476-541	151.0-122.0	2004	Age-3 (2001)
4695 (13)	Age-14 (1)	462	157.0	2001	Age-1 (2000)
5072-5073 (14)	Age-15 (2)	514-525	155.0-151.0	2000	Age-1 (1999)
Information on the 44 Razorback Sucker captured without known stocking histories:					
Unknown	Unknown (44)	429-554	166.0-109.0	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 = 18-36; Table 7). However, in 2010, this number rose to 70 fish, double the value observed in any previous year. In 2011, this number rose again to 118 fish, and in 2012 nearly doubled again with 231. In 2014, 225 Razorback Sucker were captured that had been in the river for 1+ overwinter periods, the second highest observed in Adult Monitoring (Table 7). Razorback Sucker collected after 1+ overwinter periods continue to demonstrate a much longer post-stocking persistence (up to 18 overwinter periods or 6,520 days post-stocking) than Colorado Pikeminnow (Table 7). On every Adult Monitoring trip since 2003, Razorback Sucker were collected that had been in river for at least six overwinter periods post-stocking (Table 7). The 2014 scaled CPUE value for Razorback Suckers that were in the river 1+ overwinter periods was not significantly higher than the previous four years; however, it was significantly higher than any year previous to 2010 (Figure 3).

Table 7. Information on stocked Razorback Sucker collected from 2003 to 2014 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

Source of origin could be determined for 207 Razorback Sucker that had been in the river for 1+ overwinter period. Of these, 167 (74.6%) were reared in the Navajo Agricultural Products Industry (NAPI) grow-out ponds, southwest of Farmington, NM. Nineteen (8.5%) were reared at the USFWS' Uvalde National Fish Hatchery, in Uvalde, TX. Fourteen (6.3%) were reared in Ouray Nation Fish Hatchery – Grand Valley Unit, Grand Junction, CO. Seven (3.1%) were reared at the USFWS' Dexter NFH&TC, near Roswell, NM. Of the 167 fish reared at the NAPI ponds, 77 were from Hidden Pond, 45 from East Avocet Pond, 43 from West Avocet Pond, and 2 from the now-defunct 6-Pack Ponds.

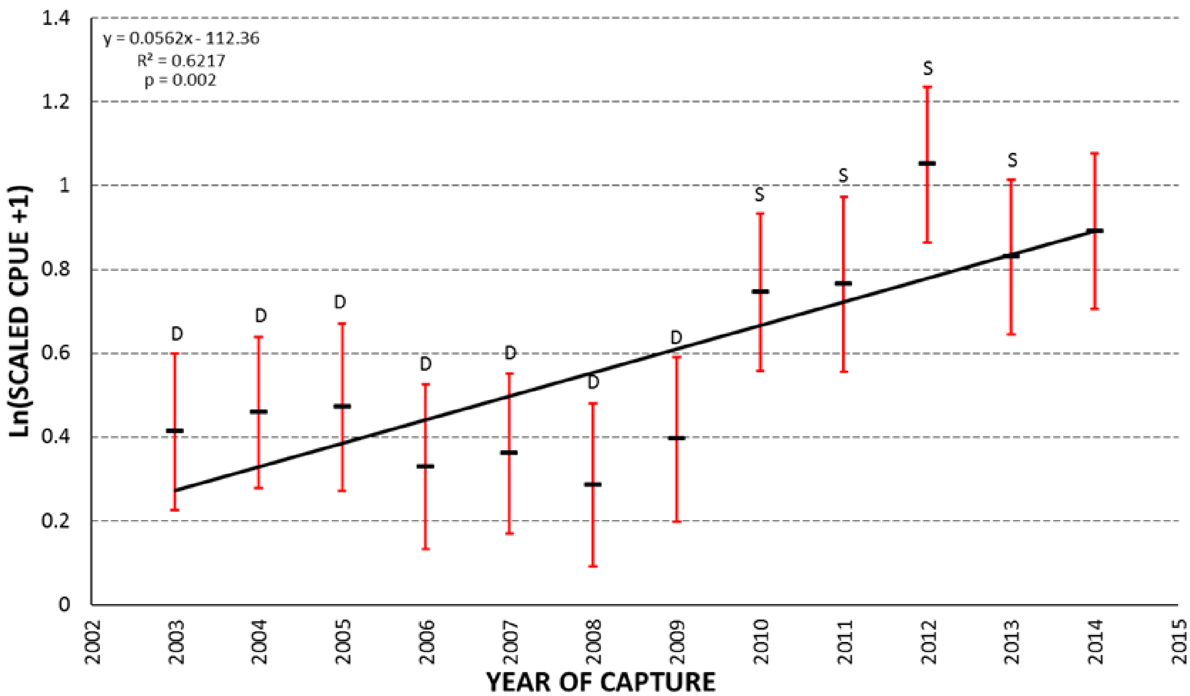

Figure 3. Year-to-year comparison of scaled CPUE for all Razorback Sucker collected on Adult Monitoring trips in the common sampled area (RM 180.0-77.0) that were in the river for one or more overwinter periods following stocking (regardless of age). The black dash marks the mean scaled CPUE values for each year. Red error bars are +/- 2 SE. The solid black line shows a linear regression between years of capture. Letters are between-year comparisons using Tukey's HSD post-hoc test). The letter S is significantly similar to 2014 and the letter D is significantly different.

Common Native Fishes

Flannelmouth Sucker

Catch Information

Flannelmouth Sucker was once again the most common large-bodied fish species collected in the common sampled area during the 2014 Adult Monitoring trip (Table 3, Figure 4), being collected in all 132 electrofishing samples (Table 3, Figure 4).

The combined adult and juvenile CPUE for Flannelmouth Sucker showed no significant change over the last 16 years (Figure 5). The 2014 combined CPUE was statistically similar to 11 of the last 16 years and only lower than that of 2000 (Figure 5). A comparatively high degree of variation in the year-to-year juvenile CPUE values has been observed from 1999 to 2014 (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 values in 1999 and 2000. However, the 2014 adult CPUE value was not significantly lower than any of the previous 13 years.

Length Information

Flannelmouth Sucker sampled in 2014 ranged in size from 71-580 mm TL (mean TL = 366 mm). The 2014 length-frequency histogram was left skewed, with the peak centered around a cohort of fish (426-450mm) that have just recruited into adulthood (Figure 6).

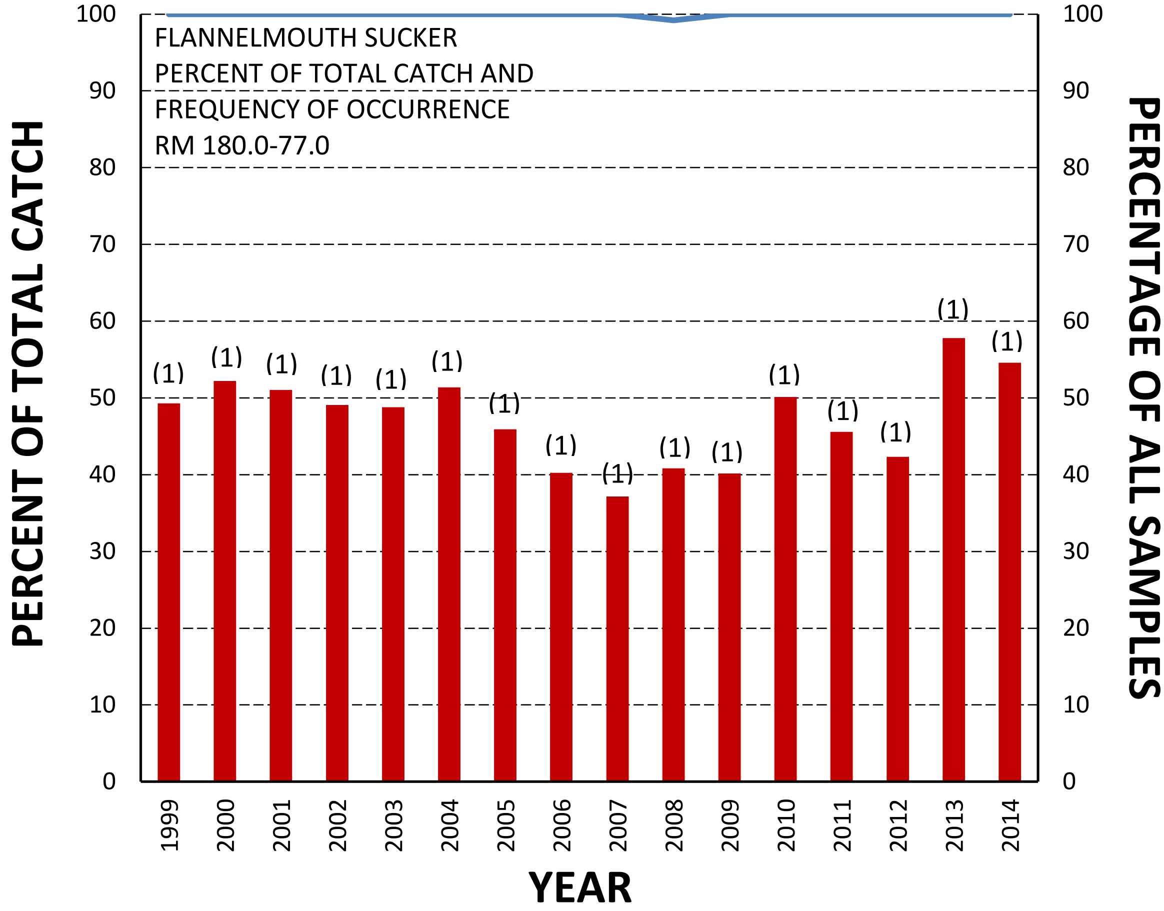

Figure 4. A summary of Flannelmouth Sucker relative abundance in Adult Monitoring collections, 1999 to 2014. The solid blue line at the top of the graph represents the percentage of all electrofishing samples on a given Adult Monitoring trip in which this species occurred (i.e., percent occurrence). 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).

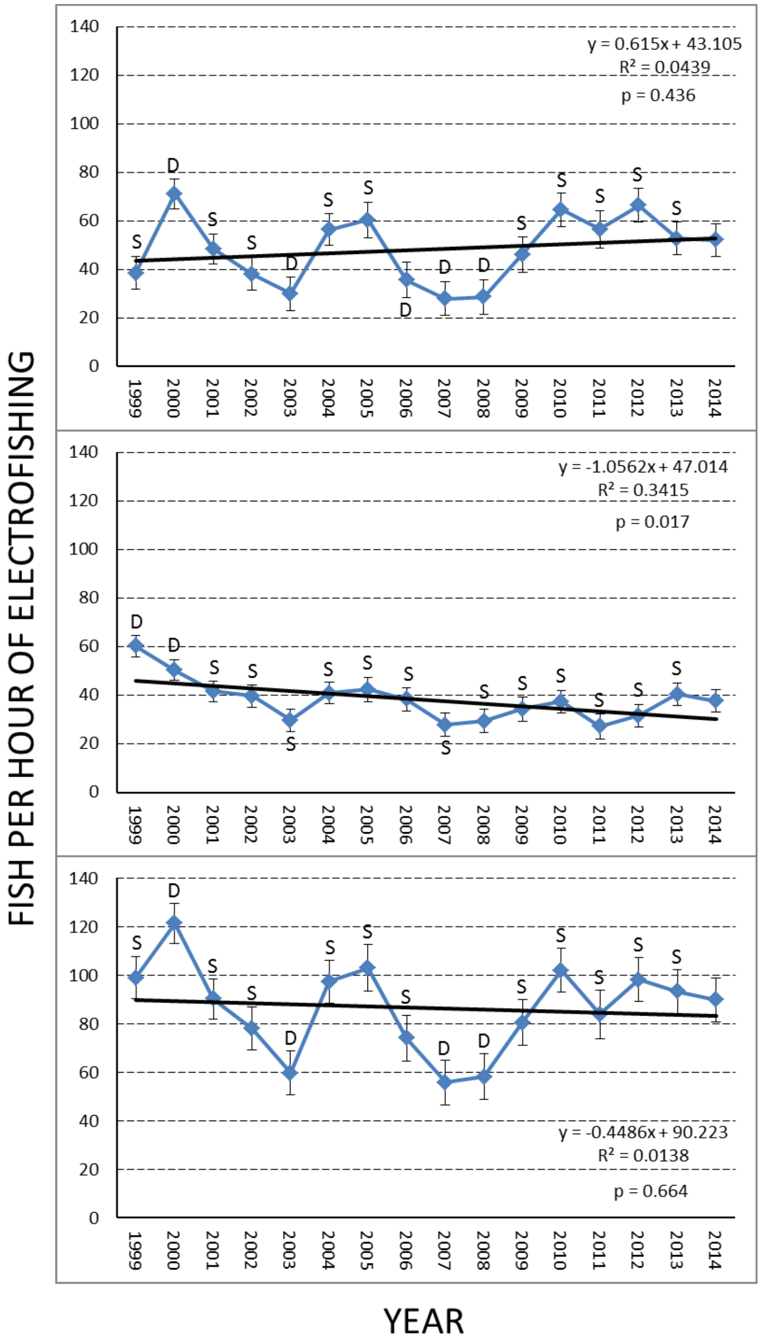

Figure 5. Flannelmouth Sucker CPUE (blue line) in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips, for juvenile fish (< 410 mm TL; top), adult fish (≥ 410 mm TL; middle), and for all life stages combined (juveniles + adults; bottom). Error bars are +/- 2 SE. Bold black letters are between-year comparisons. The letter "**S**" means the value is not significantly different from the 2014 value. The letter "**D**" means the value is significantly different from the 2014 value. The solid, black sloping line is a linear regression analysis of the mean CPUE values. The statistics are for these regression lines.

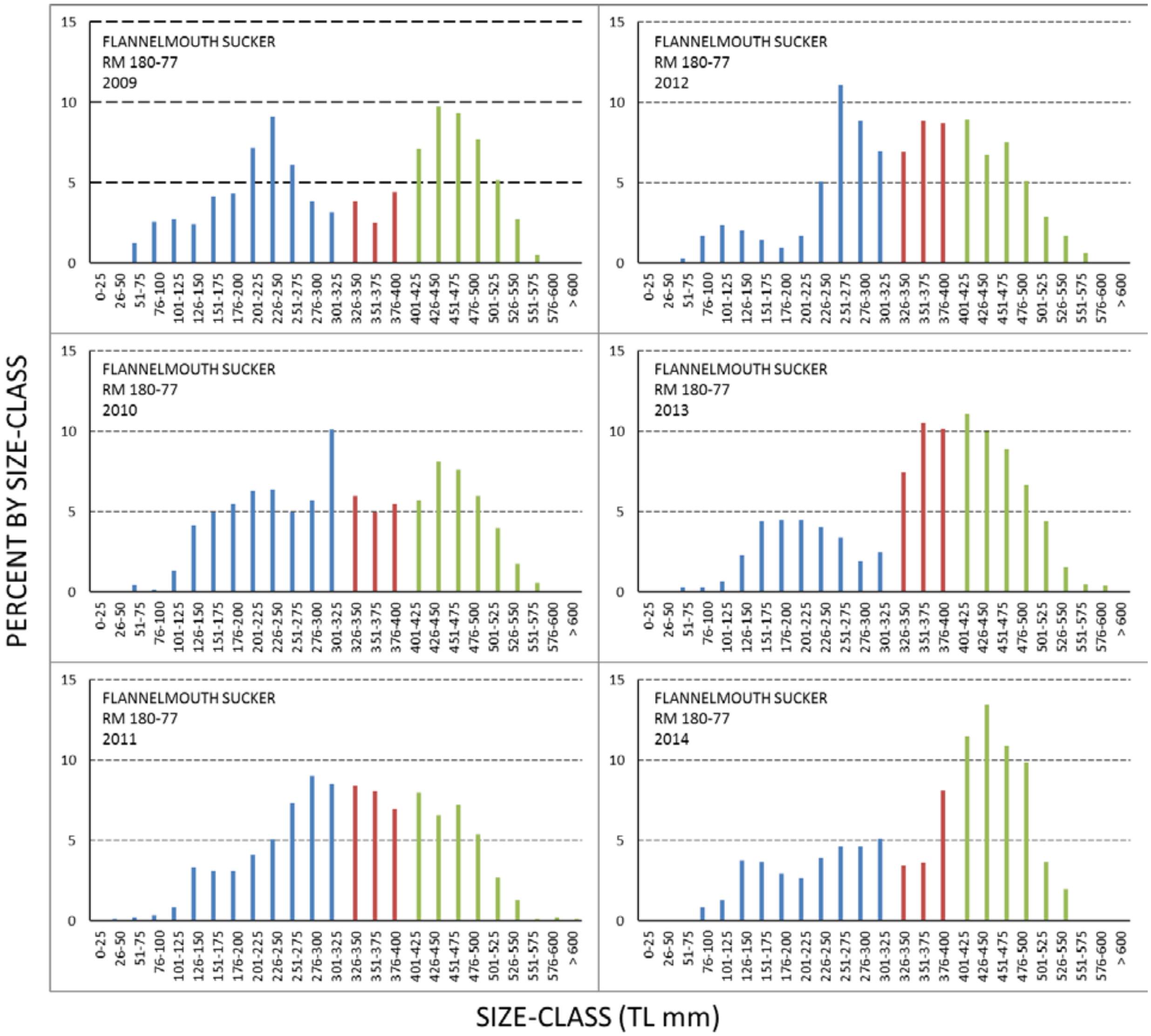

Figure 6. Length-frequency histograms showing the size-class distribution of Flannelmouth Sucker in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips in the San Juan River, 2009 to 2014. Solid blue bars represent juvenile fish. Solid red bars represent recruiting sub-adult fish. Solid green represent adult fish.

Bluehead Sucker

Catch Information

Bluehead Sucker were the second most commonly-collected large-bodied fish species during 2014 Adult Monitoring (Table 3, Figure 7). The percentage of the total catch composed of Bluehead Sucker in 2014 (16.6%) was the fifth lowest catch rate values observed for this species over the last 16 years (Figure 7). Bluehead Sucker were collected in Reaches 6-3 in 2014 (from RM 180.0-79.1) and were collected in 90.15% of the samples (Figure 7).

Long-term trends for Bluehead Sucker juvenile, adult, and total CPUE riverwide have shown no significant change in abundance indices over the last 16 years (Figure 8). The 2014 Bluehead Sucker adult CPUE value was significantly lower than only 2 of the previous 15 years (Figure 8). Despite what looks like marked year-to-year fluctuations, the 2013 Bluehead Sucker juvenile CPUE value was significantly different from only two of the previous 15 years (Figure 8).). The 2014 Bluehead Sucker total CPUE value was lower that only three of the previous 15 years.

Length Information

Bluehead Sucker ranging from 64-461 mm TL (mean TL = 278 mm) were collected during 2014 Adult Monitoring. The Bluehead Sucker length-frequency histogram showed more of an even distribution within the size classes of recruiting sub-adult and adult fish (Figure 9).

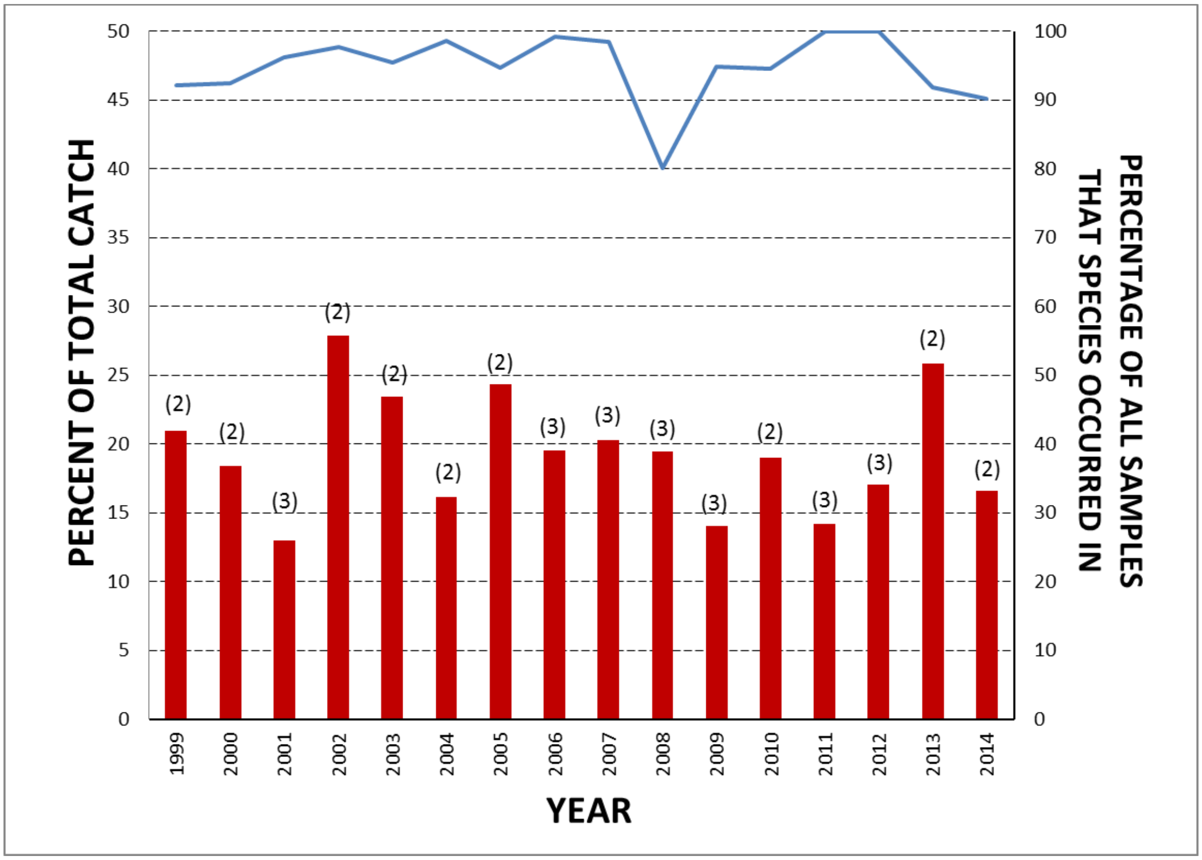

Figure 7. A summary of Bluehead Sucker relative abundance in Adult Monitoring collections, 1999 to 2014. The solid blue line at the top of the graph represents the percentage of all electrofishing samples on a given Adult Monitoring trip in which this species occurred (i.e., percent occurrence). The 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).

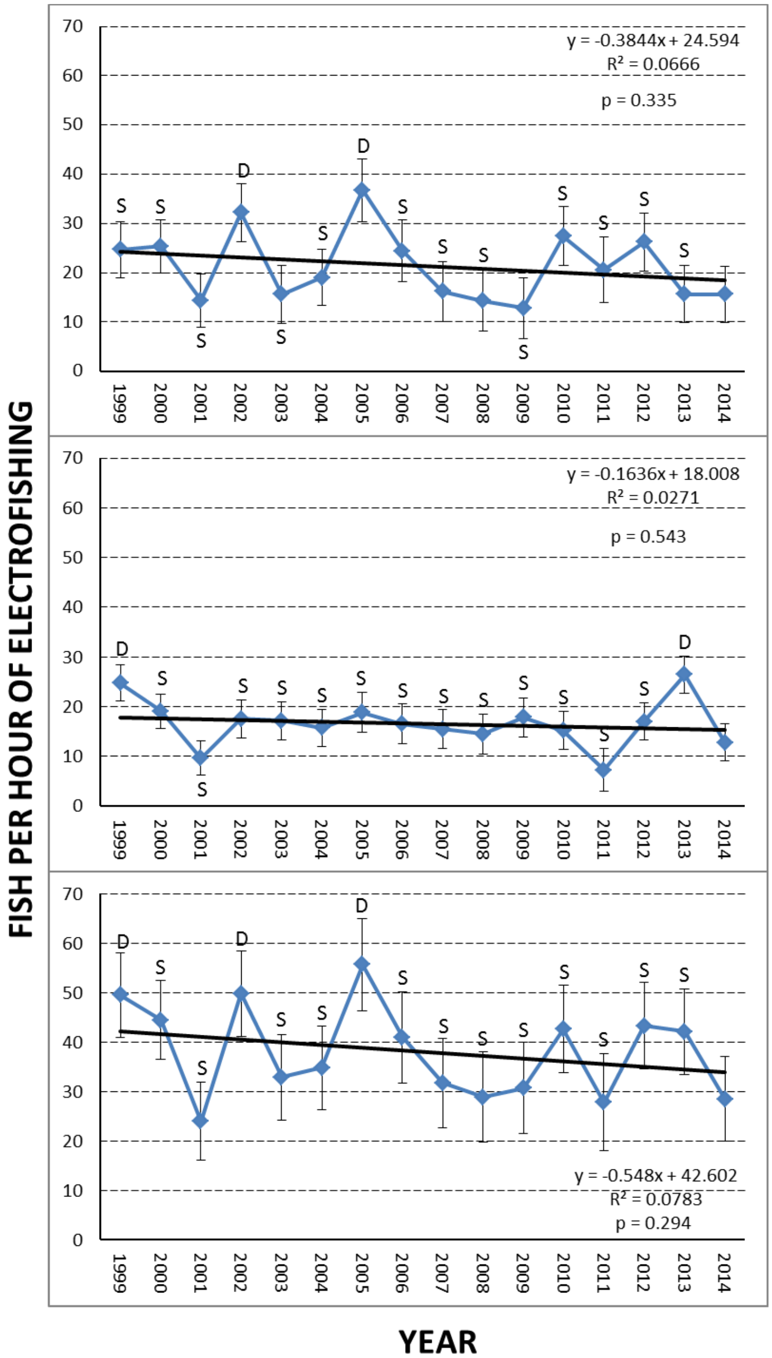

Figure 8. Bluehead Sucker CPUE (blue line) in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips, for juvenile fish (< 300 mm TL; top), adult fish (≥300 mm TL; middle), and for all life stages combined (juveniles + adults; bottom). Error bars are +/- 2 SE. Bold black letters are between-year comparisons. The letter "S" means the value is not significantly different from the 2014 value. The letter "D" means the value is significantly different from the 2014 value. The solid, black sloping line is a linear regression analysis of the mean CPUE values. The statistics are for these regression lines.

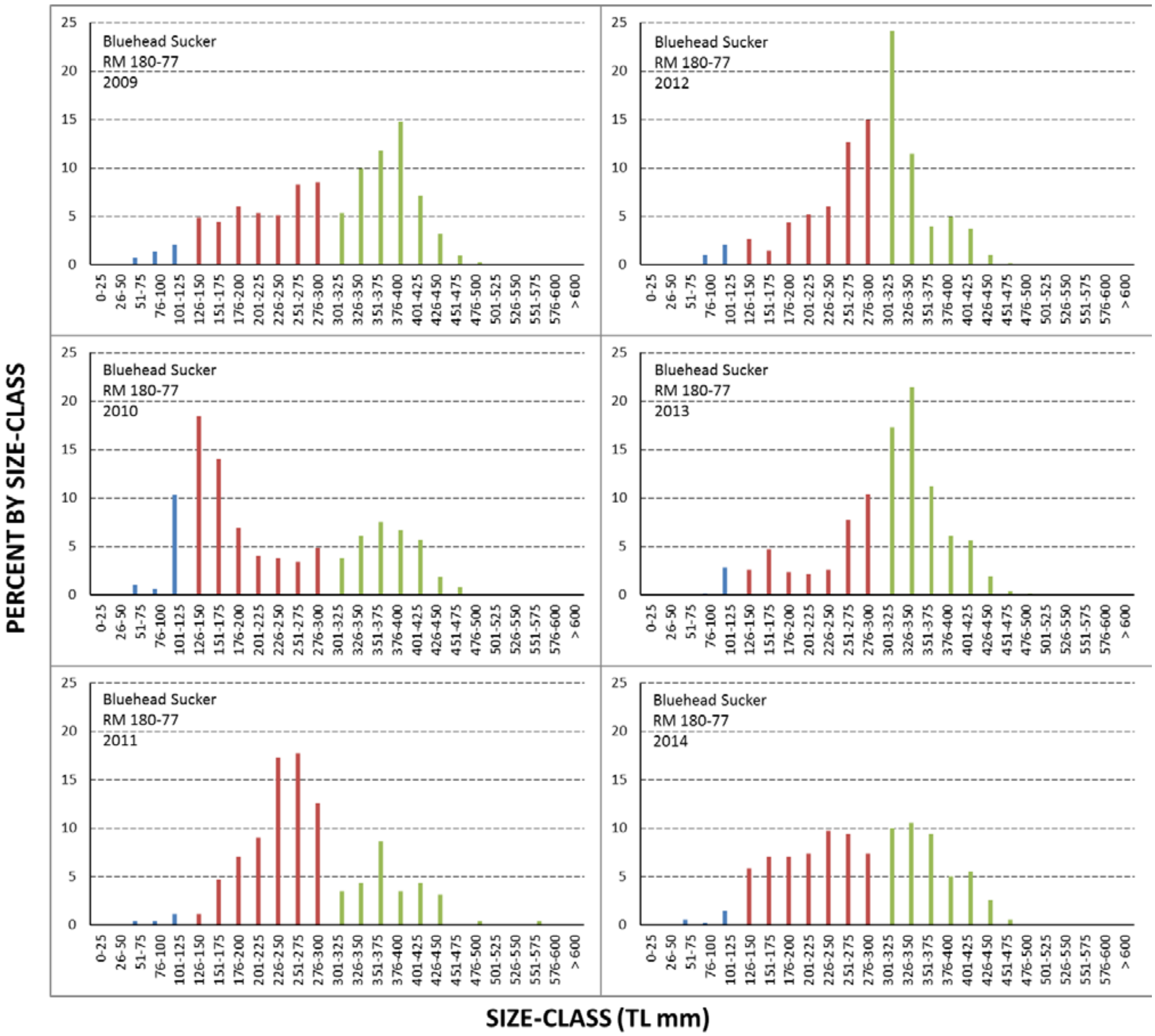

Figure 9. Length-frequency histograms showing the size-class distribution of Bluehead Sucker in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips in the San Juan River, 2009 to 2014. Solid blue bars vertical lines are juvenile fish. Solid red bars represent recruiting sub-adult fish. Solid green bars represent adult fish.

Common Nonnative Fishes

Channel Catfish

Catch Information

In 2014, Channel Catfish were the third most abundant species, making up 15.9% of the total catch (Table 3, Figure 10). This was the seventh lowest total catch value in the common sampled area since 1999. Channel Catfish were collected in 82.58% of all electrofishing samples in 2014 and occurred in all four geomorphic reaches (from RM 166.6-79.1; Figure 10).

There has been no change overall in the juvenile Channel Catfish CPUE value in the common sampled area (RM 180.0-77.0) from 1999 to 2014 shown by the trend line with a p-value of 0.495 (Figure 11). Prior to 2009, the riverwide CPUE value for juvenile Channel Catfish had not changed significantly for five years (2004 to 2008). Since 2009, every year has been significantly different than the year before and the year after, until this year. In 2014, the juvenile CPUE value was not significantly different than the lowest CPUE recorded in the last 16 years, which was in 2013 (Figure 11).

There has been no significant change in the long term adult Channel Catfish CPUE trend since 1999. However in the past four years the CPUE has changed significantly from year to year. Similarly, the total CPUE trend has not shown and increase or decrease in since 1999; however, year to year fluctuations have been significant from 2008 to 2014 (Figure 11).

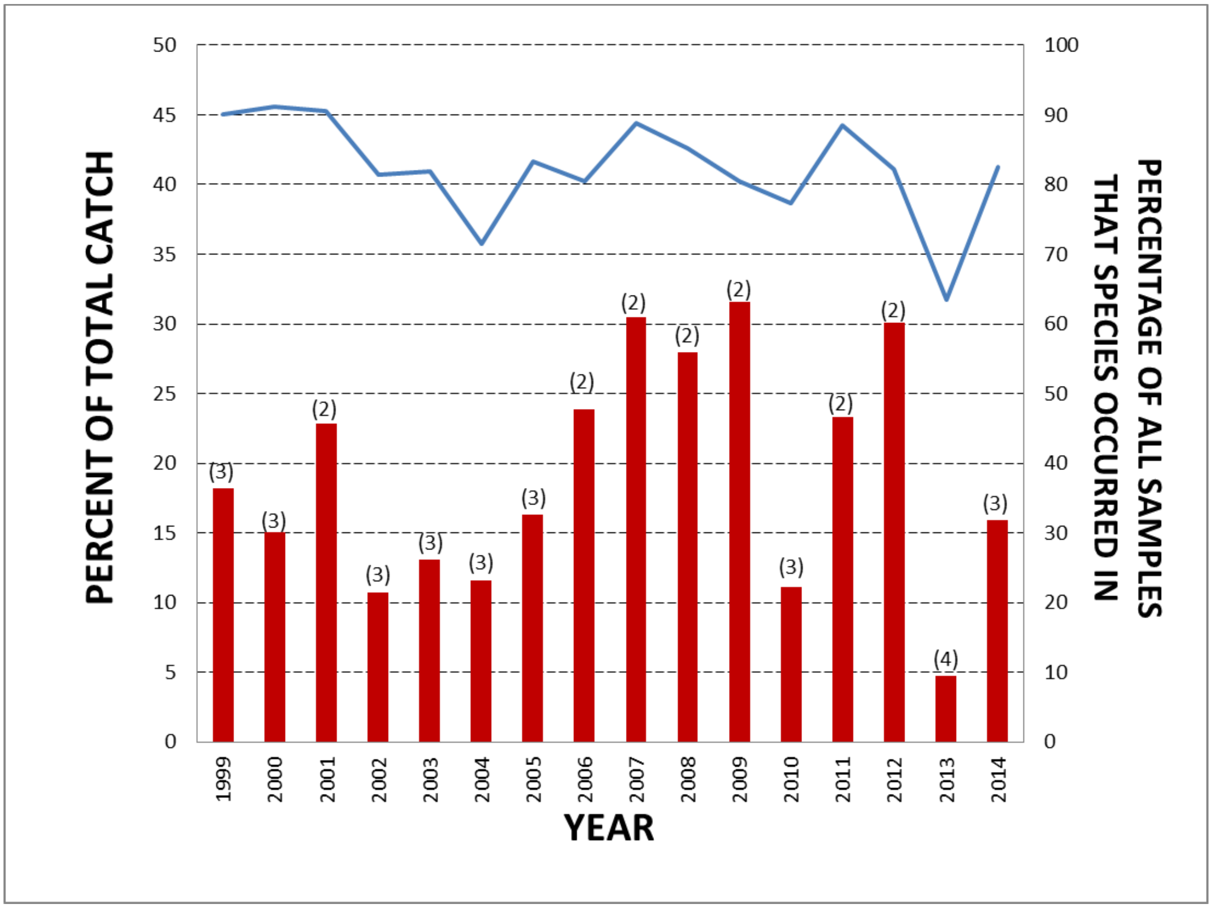

Figure 10. A summary of Channel Catfish relative abundance in Adult Monitoring collections, 1999 to 2014. The solid blue line at the top of the graph represents the percentage of all electrofishing samples on a given Adult Monitoring trip in which this species occurred (i.e., percent occurrence). The 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).

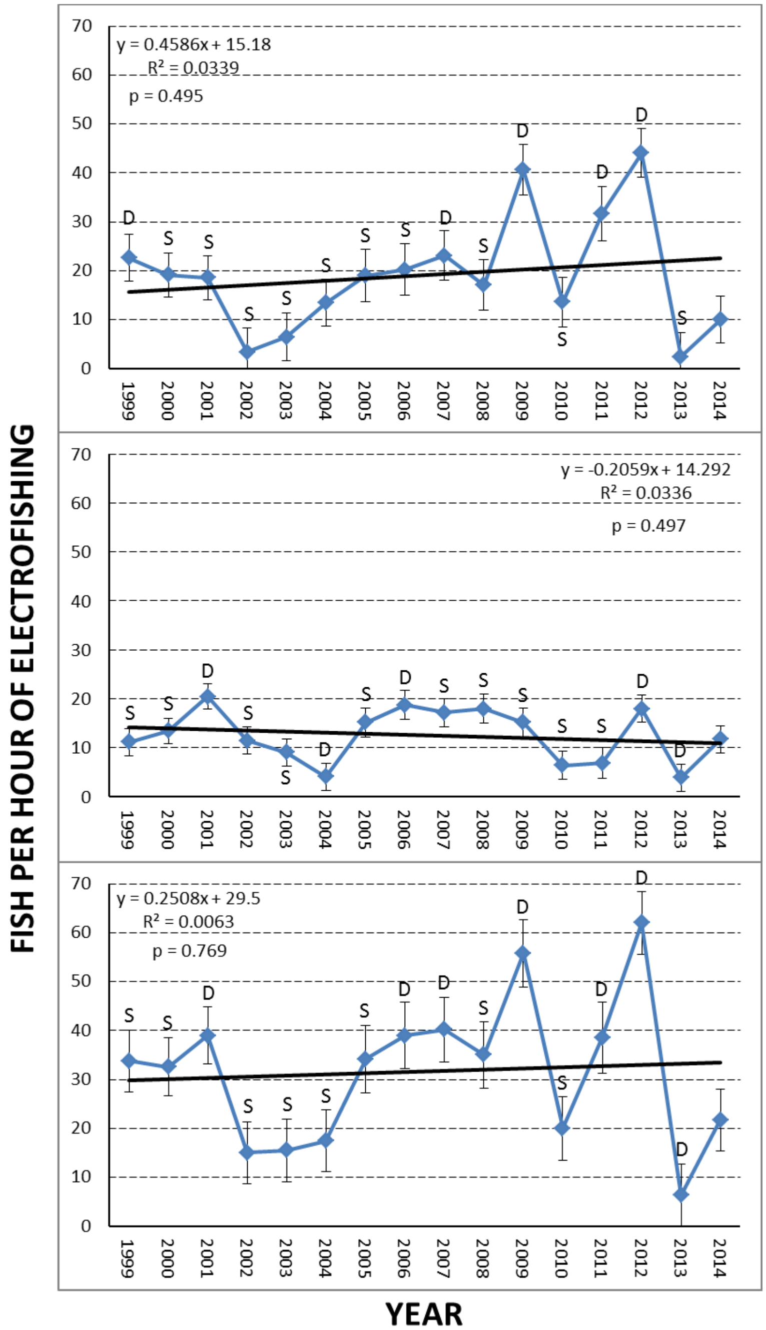

Figure 11. Channel Catfish CPUE (blue line) in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips, for juvenile fish (< 300 mm TL; top), adult fish (≥ 300 mm TL; middle), and for all life stages combined (juveniles + adults; bottom). Error bars are +/- 2 SE. Bold black letters are between-year comparisons. The letter "S" means the value is not significantly different from the 2014 value. The letter "D" means the value is significantly different from the 2014 value. The solid, black sloping line is a linear regression analysis of the mean CPUE values. The statistics are for these regression lines.

In 2014, the peak of Channel Catfish CPUE was centered around river miles 140.0 to 130.0, just downstream of Shiprock, NM, the catch rate slowly decreased below there. No Channel Catfish were seen above PNM (RM 166.6) and only eight about Hogback Diversion (RM 158.6) (Figure 12).

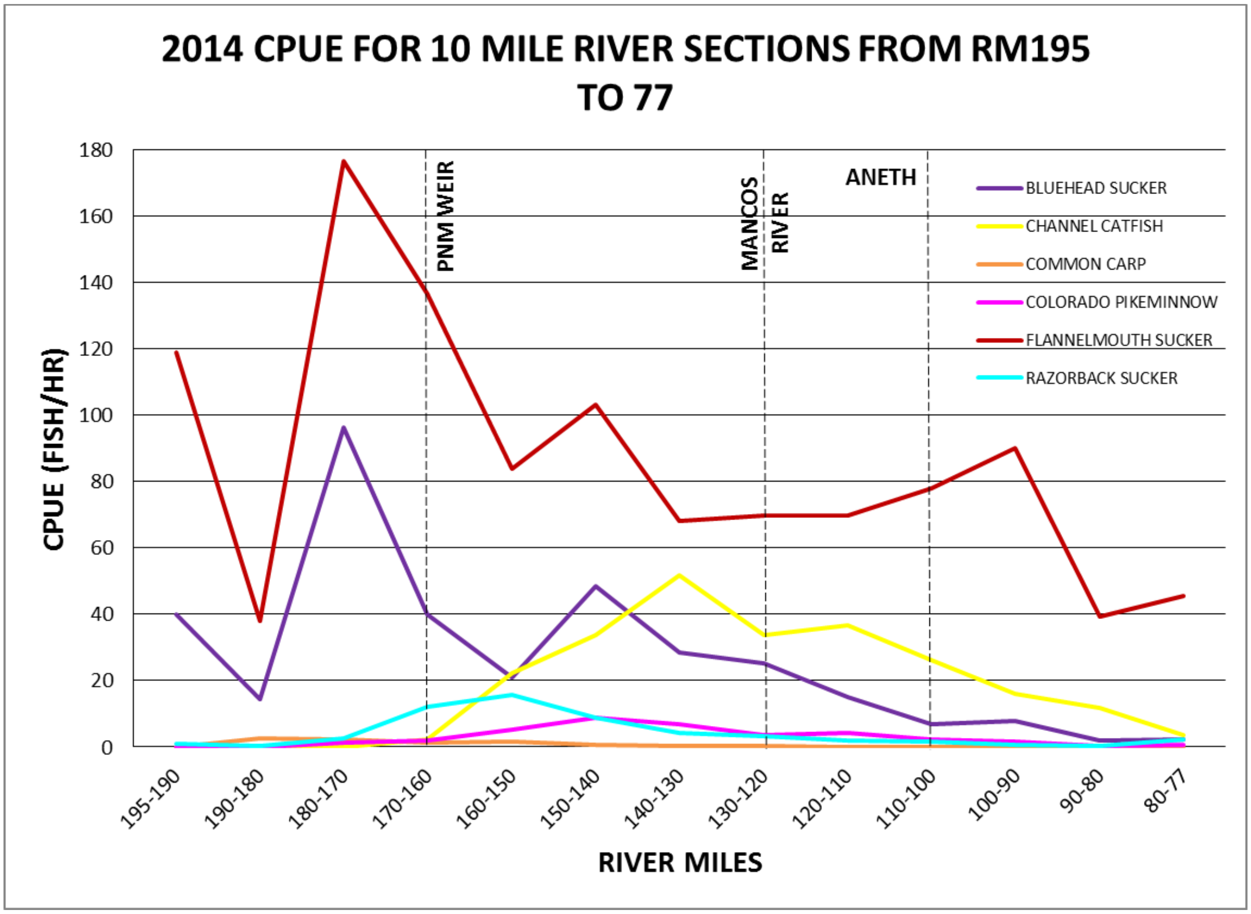

Figure 12. A comparison of the longitudinal distribution by 10-RM section of Channel Catfish (expressed as total CPUE) compared to the other rare and common species collected in the common sampled area (RM 195.0-77.0) in 2014.

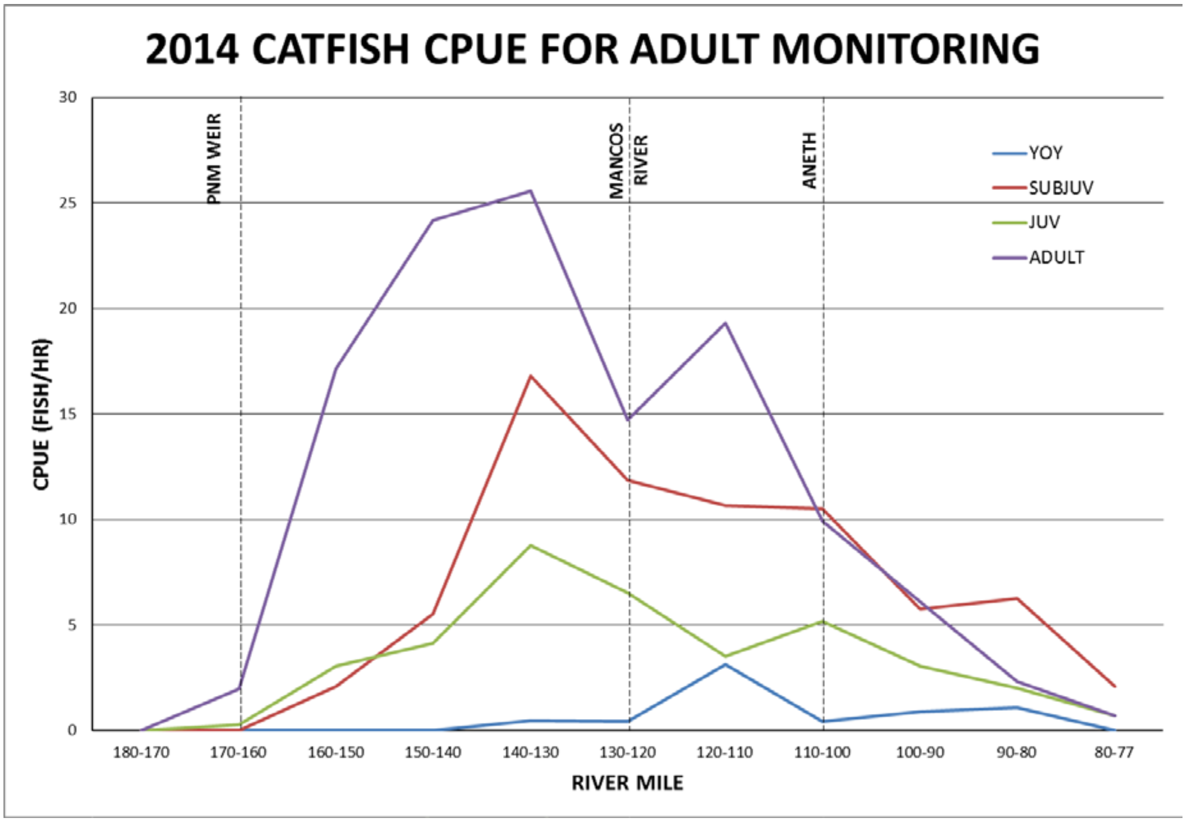

Figure 13. A comparison of the longitudinal distribution by 10-RM sections of the various life-stages of Channel Catfish (expressed as total CPUE) compared to one another in the common sampled area (RM 180.0-77.0) in 2014. YOY = young-of-the-year (< 60 mm TL); SUBJUV = sub-juvenile fish (61-199 mm TL); JUV = juvenile fish (200-299 mm TL); ADULT = adult fish (≥ 300 mm TL).

A longitudinal comparison of distribution of various life-stages of Channel Catfish shows that adult Channel Catfish catch rates peaked below Shiprock, NM, more specifically within the 17 river miles below Shiprock Bridge, with another small peak between river miles 120.0 and 110.0 (Figure 13). Juvenile and sub juvenile Channel Catfish were most abundant in the same section as the adults, with both having peaks between river miles 140.0 – 130.0. After the peak, both age classes gradually decreased down to Sand Island (RM 77.0) (Figure 13). Young-of-year Channel Catfish had a peak between river miles 120.0 and 110.0; however, this age class' CPUE was consistently lower than the other three age classes (Figure 13).

With the discontinuation of Adult Monitoring sampling at RM 77.0 since 2011, the ability to use the Adult Monitoring data set to measure the effectiveness of nonnative fish removal efforts downstream of this point has been limited to once every five years.

Length Information

Channel Catfish ranged from 51-656 mm TL (mean TL = 303 mm) in 2014 Adult Monitoring collections. In the 2014 length-frequency histogram, the largest 25mm size group was fish 151-175 mm TL, likely age-1 (Figure 14). These distinct influxes of young cohorts of Channel Catfish continue to be very pronounced in length-frequency histograms over the years.

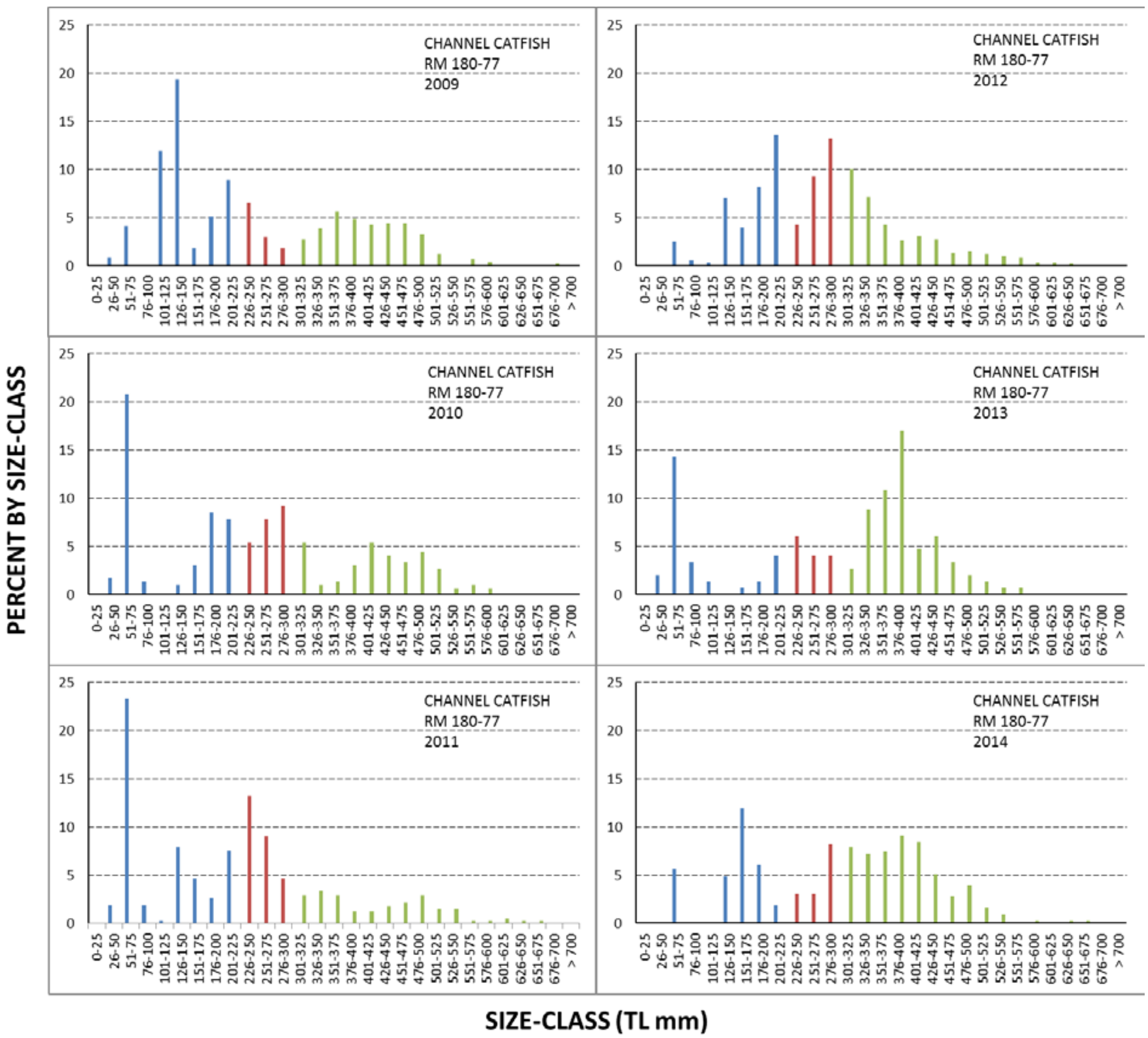

Figure 14. Length-frequency histograms showing the size-class distribution of channel catfish in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips in the San Juan River, 2009 to 2014. Solid blue bars represent juvenile fish. Solid red bars represent recruiting sub-adult fish. Solid green bars represent adult fish.

Common Carp

Catch Information

Common Carp were the seventh most commonly-collected fish during 2014 Adult Monitoring (Table 3, Figure 15). This marks the tenth consecutive year the species has not been among the four most commonly-collected fish species (Figure 15). Only 29 Common Carp were collected in the common sampled area in 2014 (Table 3), of which 21 (72.4%) were adults (i.e., $\geq$ 250 mm TL) and 8 (27.6%) were juveniles. Common Carp were collected from Reaches 6-4 in 2014 (from RM 180.0-122.0), with 15 being collected from Reach 6, 13 from Reach 5, and 1 from Reach 4.

In 2014, Common Carp accounted for only 0.3% of the total catch and were collected in just 15.2% (n = 20) of electrofishing samples in the common sampled area (Table 3, Figure 15). Of the 20 electrofishing samples that had Common Carp, 15 contained a single fish, 3 had two fish, 1 had three fish, and 1 sample had 5 fish. Common Carp juvenile CPUE was not significantly different than 12 of the previous 15 years and was significantly lower than the pulses of juvenile Common Carp observed in 2000, 2002, and 2004 (Figure 16). These pulses of juvenile fish didn't last more than one year and didn't ultimately increase numbers of adult fish in the river. Common Carp adult CPUE hasn't changed significantly over the last eight years and has continued to remain significantly lower than the 1999-2006 period (Figure 16).

Length Information

Common Carp ranging from 124-687 mm TL (mean TL = 427 mm) were collected during 2014 Adult Monitoring. The numerically dominant cohorts of juvenile Common Carp observed in 2011, and 2013 were evident in the 2014 length-frequency histogram (Figure 17).

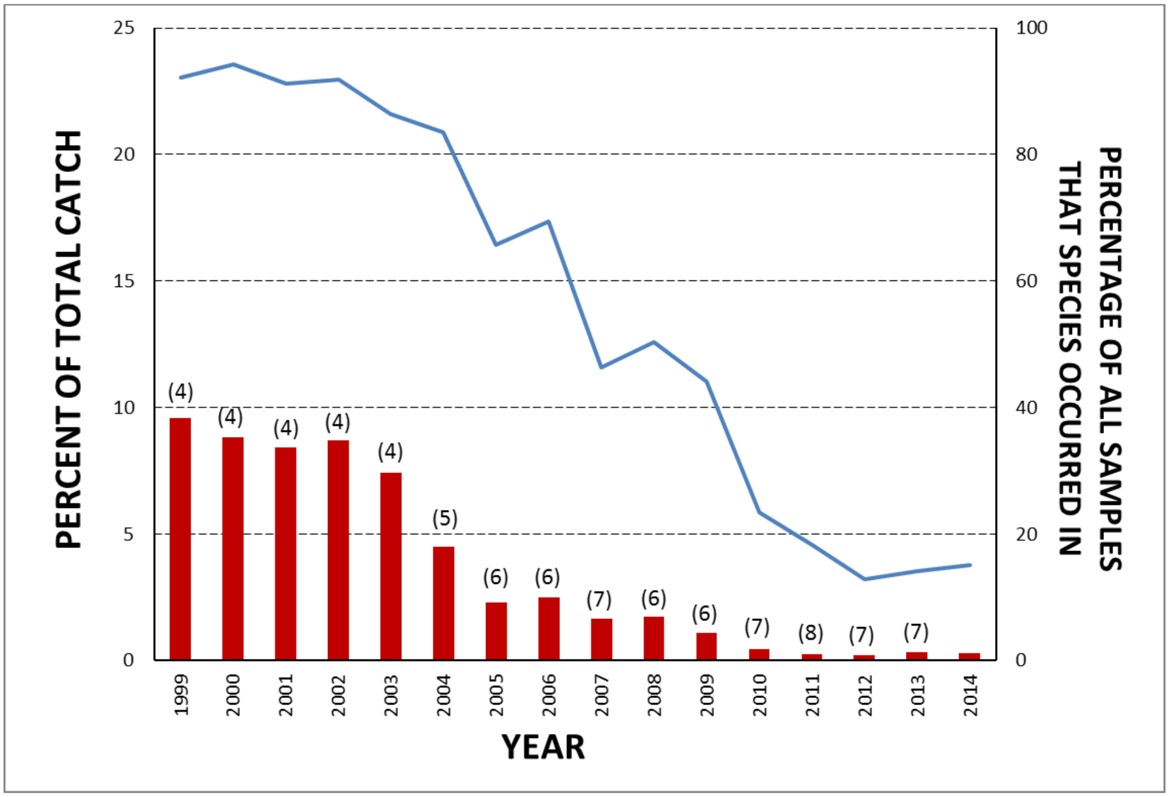

Figure 15. A summary of Common Carp relative abundance in Adult Monitoring collections, 1999 to 2014. The solid blue line at the top of the graph represents the percentage of all electrofishing samples on a given Adult Monitoring trip in which this species occurred (i.e., percent occurrence). The solid 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).

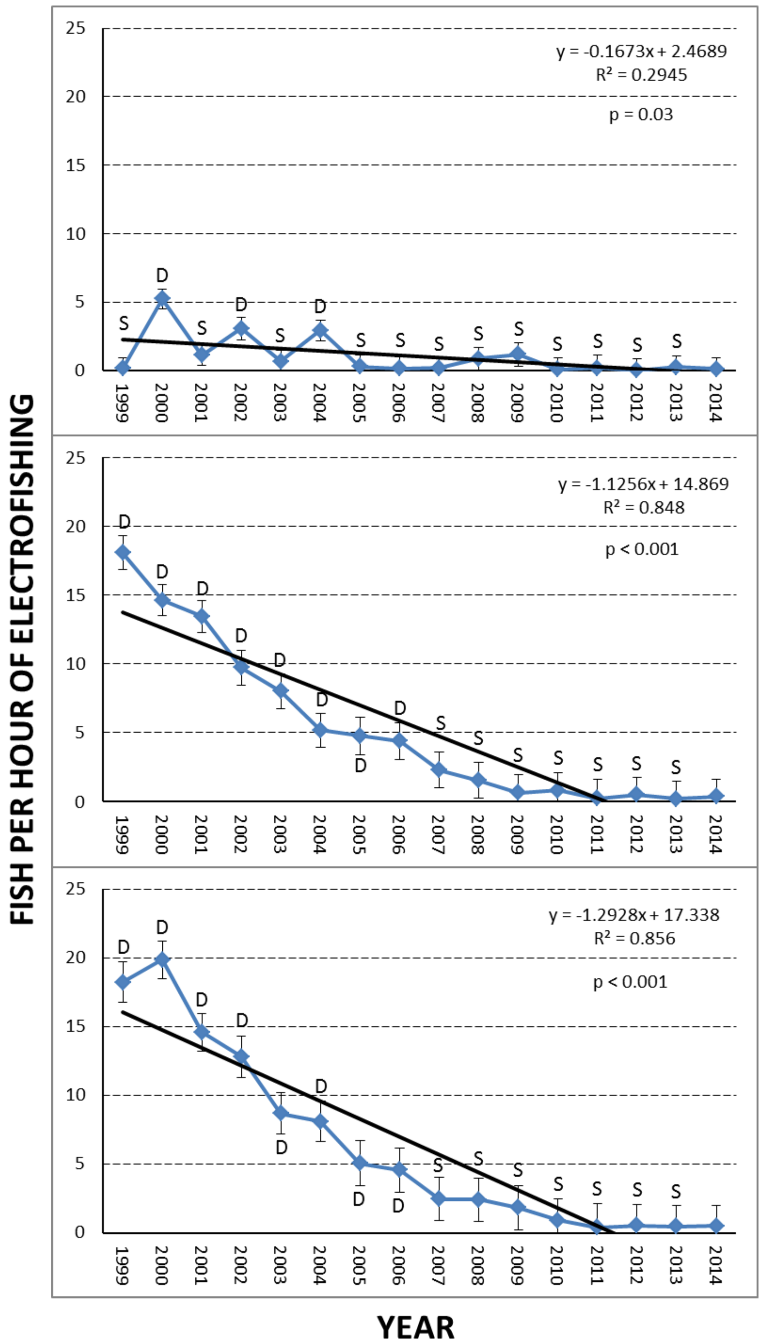

Figure 16. Common Carp CPUE (blue line) in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips, for juvenile fish (< 250 mm TL; top), adult fish (≥ 250 mm TL; middle), and for all life stages combined (juveniles + adults; bottom). Error bars are +/- 2 SE. Bold black letters are between-year comparisons. The letter "S" means the value is not significantly different from the 2014 value. The letter "D" means the value is significantly different from the 2014 value. The solid, black sloping line is a linear regression analysis of the mean CPUE values. The statistics are for these regression lines.

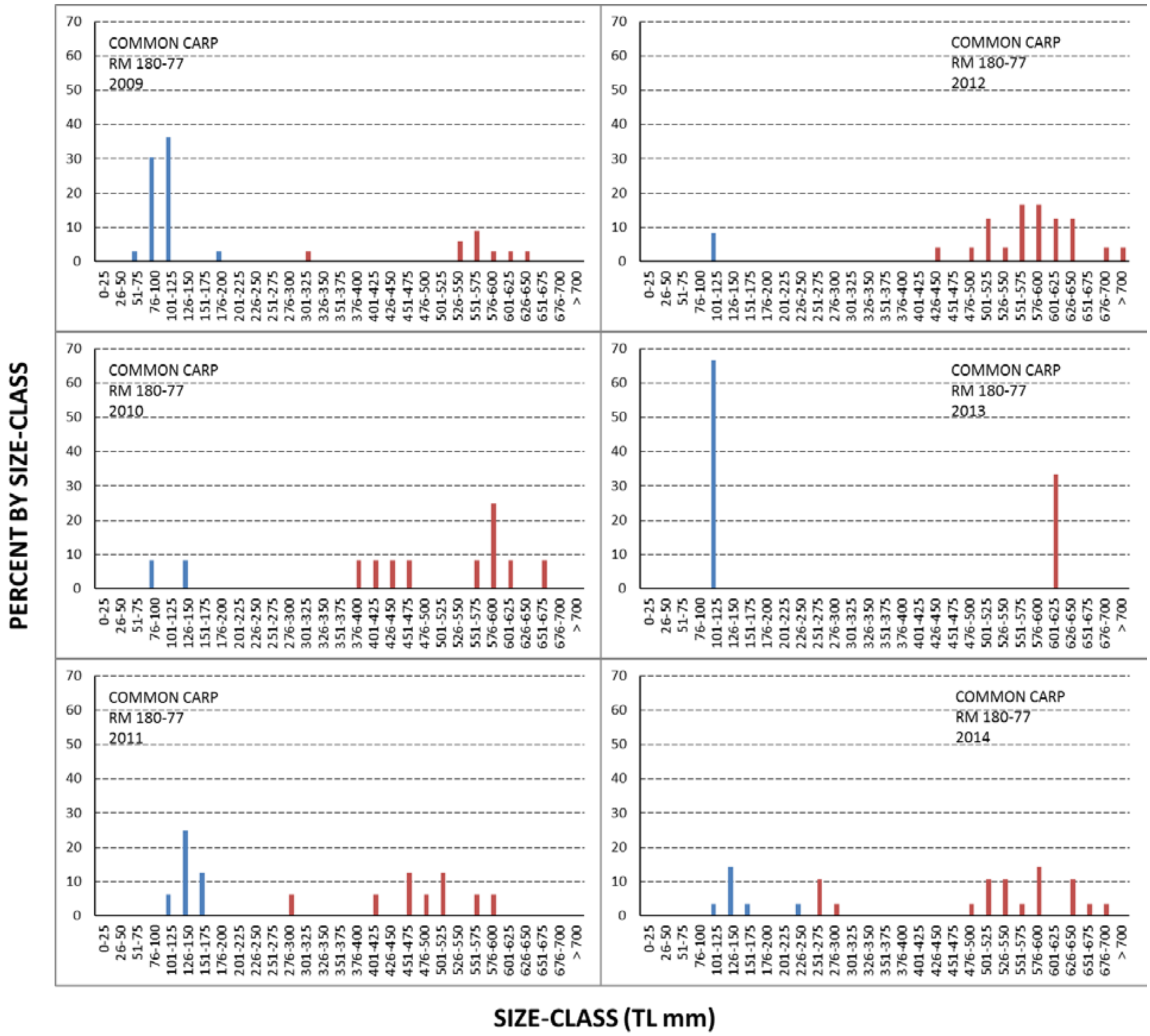

Figure 17. Length-frequency histograms showing the size-class distribution of Common Carp in the common sampled area (RM 180.0-77.0) on fall Adult Monitoring trips in the San Juan River, 2009 to 2014. Solid blue bars represent juvenile fish. Solid red bars represent adult fish.

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

On 10 and 12 September 2014, 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. The lower 7-10 miles of the Animas River were also scheduled to be sampled on this trip. However, low and inconsistent flows prevented sampling from occurring.

Nine fish species (658 total fish) were collected during upstream sampling. This included four native and five nonnative species. The four native species in descending order of abundance were Flannelmouth Sucker (421 fish), Bluehead Sucker (146 fish), Speckled Dace (70 fish), and Razorback Sucker (3 fish). No Colorado Pikeminnow were collected. The four native species (782 total fish) accounted for 97.3% of the total catch during upstream sampling. The five nonnative species in descending order of abundance were Common Carp (8 fish), Brown Trout (6 fish), Black Bullhead (2 fish), Yellow Bullhead (1 fish), and White Sucker (1 fish). The non-native species accounted for only 2.7% of total catch.

Table 8. Total number of fishes collected during sampling in the San Juan River upstream of the confluence with the Animas River on the 2014 Adult Monitoring trip.

Species (Status)[a]	Number Collected	Percent Of Total	Number Of Samples Collected In
Flannelmouth Sucker (N)	421	63.98	18
Bluehead Sucker (N)	146	22.19	17
Speckled Dace (N)	70	10.64	16
Common Carp (I)	8	1.22	3
Brown Trout (I)	6	0.91	4
Razorback Sucker (N)	3	0.46	3
Black Bullhead (I)	2	0.30	2
White Sucker (I)	1	0.15	1
Yellow Bullhead (I)	1	0.15	1
GRAND TOTAL	658		
Total Electrofishing Collections In 2014 = 18 Total Electrofishing Effort In 2014 = 5.70 Hours			
2014 Native Fishes = 640 (97.3% Of The Total Catch) 2014 Introduced Fishes = 18 (2.7% Of The Total Catch) 2014 Native To Introduced Fishes Ratio = 35.6:1			
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 upstream of the Animas River confluence documented the presence of Razorback Sucker as far upstream as RM 191.0 (approximately 10.4 RM upstream of the Animas River confluence). Three individual Razorback Sucker were collected during upstream sampling. The first fish (465 mm TL) was collected from RM 192.0-191.0 on 12 September. It was a 2009 year-class from Uvalde National Fish Hatchery and stocked on 17 October 2012 at San Juan RM 196.1 (408 mm TL). The second fish (363 mm TL) was collected from RM 191.0-190.0 on 12 September. It was a 2010 year-class fish harvested from Avocet West (NAPI ponds) and stocked on 25 September 2013 at San Juan RM 196.0 (330 mm TL). The third fish (476 mm TL) was collected on 10 September from RM 186.0-185.0, it was from Uvalde National Fish Hatchery 2009 year class (421 mm TL), and stocked on 17 October 2012 at San Juan RM 196.0. Razorback Sucker accounted for considerably less of the total catch upstream of the Animas (0.46%) when compared to the common sampled area downstream (2.8%) (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 63.98% of the total catch upstream of the Animas, and 54.6% downstream. However, their total CPUE was higher in the downstream area (85.4 fish/hr) than it was upstream (73.9 fish/hr). Adult Flannelmouth Sucker were more abundant (53.7% of all Flannelmouth Sucker collected) upstream of the Animas River than adult Flannelmouth Sucker (42.9% of all Flannelmouth Sucker collected) downstream.

Native Bluehead Sucker 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 (22.9%) compared to the downstream common sampled area (16.6%) (Tables 3, Table 8). However, their total CPUE was essentially identical (26 fish/hr) in both the downstream common sampled area and the upstream area. The Bluehead Sucker age class structure was different above the Animas River confluence than below. Above the confluence, 52.7% of the Bluehead Suckers we caught were adult and 47.3% were juvenile, while below the confluence juvenile fish predominated (56.3%).

Speckled Dace was the third most abundant species caught above the confluence in 2014, making up 10.64% of the number of fish caught (Table 8). This percentage is essentially similar to 2013, but more than doubled when compared to 4.1% in 2012. Speckled Dace were present in 16 of the 18 (88.9%) samples upstream of the confluence but were only present in 102 of the 132 (77.3%) downstream (Table 3, Table 8). CPUEs of Speckled Dace in the upstream and downstream areas were similar (12 fish/hr and 11fish/hr, respectively).

Nonnative Fishes

Common Carp accounted for 1.22% of the total catch in upstream sampling, versus 0.3% in the common sampled area downstream (Tables 3 and 8). Common Carp total CPUE was substantially higher in the upstream section (7.78 fish/hr of electrofishing) in 2013, than in 2014 (1.4 fish/hr).

Brown Trout became much more abundant upstream of the Animas river confluence. A total of 6 fish (0.91 fish/hr) were collected, making them the fifth most abundant species collected (Table 8). In contrast, only one Brown Trout was collected in the common sampled area from RM 180.0-77.0 (Table 3).

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 fish, 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 starting in 2015. 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 (N. Franssen et al. 2014), and nonnative fish populations (Duran et al. 2013), to name a few.

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 218 stocked Colorado Pikeminnow collected during 2014 were not the most Colorado Pikeminnow ever collected, 2014 marked the ninth consecutive year that > 100 Colorado Pikeminnow were collected during our study.

The collection of 25 Colorado Pikeminnow ≥ 300 mm TL, suggests that there may be roughly 1,000 fish of this size riverwide (see Appendix A for details). The 1,000 number is the Demographic Delist Criteria for Colorado Pikeminnow in the San Juan River (USFWS 2002a). The collection of nine adult fish (> 450 mm TL) and four 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 2014 sampling (n = 43 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 we collected during Adult Monitoring at ≥ 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 2014, the large majority of the 215 known-origin Colorado Pikeminnow collections (212 of 215 = 98.6%) were fish that had been stocke,d as age-0 fish. In the past 4-5 years, it appears that better handling, transport, tempering, and acclimation protocols have helped increase scaled CPUE (i.e., post-stocking survival) of young Colorado Pikeminnow through the age-2 year-class. This still hasn’t translated into a significant increase of young fish into the age-3 year-class. However, despite this lack of an observable significant increase in scaled CPUE at 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 et al. 2013). This begs the question, since Colorado Pikeminnow are a top predator, is this bottleneck at around age-3 a natural phenomenon? In other words, can the San

Juan River only support a certain number of fish passing into adulthood in a given period of time, with the others dying off for some unknown reason (e.g., competition, lack of forage at a certain size-class)? Based on the number of adult Speckled Dace and juvenile native suckers encountered during sampling, it would not seem intuitive that this is a bottleneck based on lack of forage at this size-class. However, there may be other factors that are not as evident that are causing such a bottleneck to occur. If such a bottleneck does exist, would stocking more young Colorado Pikeminnow make any difference when it comes to trying to increase the rate of recruitment? Perhaps exploring this issue further with the use of the population model will help provide new insight into this issue.

Colorado Pikeminnow were collected throughout the common sampled area (RM 180.0-79.1) in 2014 with the largest number being collected in Reach 5. During 2014 Adult Monitoring, a small percentage of Colorado Pikeminnow collections (6.0%, n = 13) occurred upstream of Hogback Diversion (RM 158.6). Six of those collections occurred between RM 180.0 and the PNM Weir (RM 166.6). These fish (142-525 mm TL) had all been in the river at least 11 months prior to our sampling, which indicates that stocked Colorado Pikeminnow are now retaining in, or at least revisiting, the river upstream of that barrier. 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, as well as providing upstream passage of fish at the PNM Fish Passage. Long-term (multi-year) retention of stocked Colorado Pikeminnow between PNM Weir and the Animas River confluence (RM 180.6) has not been documented yet. In past years, large downstream displacements have been documented among stocked Colorado Pikeminnow of all age-classes, often within the first few days to first two weeks post-stocking. To offset this, recent stockings have been moved to more upstream locations and have used longer tempering and holding times to help acclimate fish to the river prior to release (e.g., Furr 2014). Short-term results seem to indicate that this approach has helped stocked Colorado Pikeminnow 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). McElmo Creek enters the San Juan River at RM 100.5. Only one of these fish (425 mm TL) was documented to have a PIT tag upon capture. This individual had been stocked with a PIT tag at RM 134.9 on 16 April 2008 and recaptured at RM 125.0 on 4 September 2008 (250 mm TL). The other 10 fish (ranging from 168-307 mm TL) collected from the Yellowjacket Canyon site were almost certainly fish that were 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 Pikeminnow (range = 225-519 mm TL) were collected from the San Juan River arm of Lake Powell, from the waterfall at Piute Farms boat launch to Neskahi Canyon

(Francis et al. 2013). One additional individual was collected in the summer 2012 (Francis et al. 2014 In Prep.).

In 2014, the number of larval Colorado Pikeminnow collected increased dramatically, 312 larval fish were collected in 74 unique collections (M. Farrington, pers. comm). This increase was strongly weighted to Adult Monitoring catch rates for adult Colorado Pikeminnow when ran through a mixture-model. Although these larvae could have been produced by some heretofore uncollected extant wild fish, it is likely that these larvae are the progeny of stocked Colorado Pikeminnow. Despite low numbers of larval Colorado Pikeminnow being collected in five of the last seven years (2007-2013) and then this past year (2014) with a large number of larval Colorado Pikeminnow, there has been no detectable recruitment of these young fish to adulthood. However, it may be extremely hard to detect young, wild-produced Colorado Pikeminnow in the presence of hundreds of thousands of stocked fish. One way to get at that, which has been undertaken by the American Southwest Ichthyological Researchers (ASIR) for Razorback Suckers already, is to collect fin rays from untagged adult Colorado Pikeminnow for analysis using laser oblation to determine natal origin. The only other way we may ever be able to tell for sure if natural reproduction and recruitment is occurring with this species is stop stocking altogether for some period of time. However, we would not advise this course of action until numbers of both adult and wild-produced larval fish have increased greatly over the numbers now being observed.

Scaled catch rates since 2003 there has been an increasing trend for age-1 and age-2 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. An overall look at all Colorado Pikeminnow captured in Adult Monitoring from year to year has shown a significant increasing trend since 2003 with no change in the catch rate in five of the last six years.

On the down side, we know that Colorado Pikeminnow can be lost from the San Juan system in a number of ways. Stocked Colorado Pikeminnow have been documented becoming entrained in two different canals (Trammell 2000, Renfro et al. 2006). In the case of the Hogback canal, 201 Colorado Pikeminnow 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 Pikeminnow have moved into and now occupy 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 April of 2007 a 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 fish. 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 Pikeminnow were collected in 2014, up to and including sub-adult and adult fish. Documented reproduction of Colorado Pikeminnow in six of the last eight years indicates that stocked fish that have recruited into adulthood are now successfully spawning. In addition, Colorado Pikeminnow have been documented using areas of the San Juan River basin where they have never before been seen. 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 ten years ago, Colorado Pikeminnow were all but nonexistent in Adult Monitoring collections, their current status (i.e., having thousands of these fish in the river) is encouraging.

Razorback Sucker

We believe that no wild Razorback Sucker were collected in 2014. The 268 stocked Razorback Sucker collected in 2014 marked the fifth consecutive year during which > 100 Razorback Sucker were collected during an Adult Monitoring trip and the second highest amount collected, 84% of the Razorback Suckers caught on the 2014 trip had been in the river for one or more overwinter periods. Increased numbers of Razorback Sucker collected in Adult Monitoring coincides with the start of an eight year stocking effort, where more Razorback Sucker were stocked and better handling techniques were used when releasing fish. Unlike Colorado Pikeminnow, some Razorback Sucker are retaining in the San Juan River for as long as 18 overwinter periods post-stocking (Schleicher et. all 2013). In addition, larval Razorback Sucker were collected for the 17th consecutive year (M. Farrington, pers. comm). The continued collection of larval Razorback Sucker, paired with the presence of older fish indicates that stocked Razorback Sucker are able to retain, find one another, and spawn successfully in the wild. The presence of a few small untagged Razorback Sucker 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). Recently, 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 Sucker were collected throughout the common sampled area in 2014 (RM 179.0-77.0). However, most of those were collected in Reaches 6 and 5. Like Colorado Pikeminnow, Razorback Sucker appear to be expanding their range upstream beyond PNM Weir, both via stocking and upstream passage through the PNM Fish Passage facility. Fifty five Razorback Sucker were collected in the common sampled area above Hogback Diversion in 2014, thirteen of which were collected upstream of PNM Weir. Razorback Sucker from the NAPI grow-out ponds were stocked both immediately downstream, as well as upstream of the PNM Weir in 2013 (Furr 2014), which explains the presence of most of the collections of this species between the Animas River confluence and Hogback Diversion. The collections of three additional adult Razorback Sucker upstream of the Animas River confluence in fall 2014, five in 2013, and two in 2012, have been very encouraging.

Seventy-five Razorback Sucker 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. In Prep.). Five 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 three Razorback Sucker 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, a movement of 477 RM in the most extreme case (T. Francis, pers. comm.). 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 Sucker 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 Colorado Pikeminnow, Razorback Sucker seem 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 2001 and 2014 there were 24 capture events with Razorback Sucker X Flannelmouth Sucker hybrids during Adult Monitoring trips. These fish were collected from near the APS Weir, downstream to just above Lake Powell (RM 163.0-13.0). Four of these captures were juvenile fish (240-360 mm TL). The other 20 captures were adult fish (410-510 mm TL). One was captured in 2001, 2 in 2003, 1 in 2004, 1 in 2005, 6 in 2006, 1 in 2007, 1 in 2008, 4 in 2009, 3 in 2010, 2 in 2011, 1 in 2012, and 1 in 2014. 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?

It has been assumed 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 prove 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 Sucker in any of the Upper Colorado rivers, not just the San Juan River.

However, in spring 2013, at least 32 age-1 and age-2 Razorback Sucker (<200 mm TL) have been 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 Sucker 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 Sucker were collected in groups and often those groups were in the same places where young Colorado Pikeminnow were also being collected. In most cases, these young Razorback Sucker 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 Sucker or Bluehead Sucker, swimming vigorously towards the electrofishing boat once they were in the electrofishing field, just like larger Razorback Sucker do and were easy to recognize as being razorbacks 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 Razorback Sucker, like Colorado Pikeminnow can be lost from the San Juan system in a couple of ways. To date, stocked Razorback Sucker have not been documented being entrained in canals -- although data from two canals in Grand Junction, CO indicates that they do become entrained in canals (D. Ryden, pers. obs.). However, Razorback Sucker 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 2014), 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. 2014). Population estimates indicate that several thousand of the fish now occupy the San Juan River, mostly upstream of the canyon-bound reaches, which begin at RM 68.0. 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 16 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

Flannelmouth Sucker remain the most abundant species collected in the common sampled area, as well as in the 15 RM upstream of the Animas River confluence. Flannelmouth Sucker were the only species to be collected in every single electrofishing sample in 2014. Flannelmouth Sucker are ubiquitous, occupying a multitude of habitat types. In addition, Flannelmouth Sucker of all life stages continue to be collected with regularity, showing that reproduction and recruitment are still occurring. The long-term trend line for juvenile Flannelmouth Sucker CPUE riverwide has shown great fluctuations, but no significant long-term change over the last 16 years. The long-term trend line for adult Flannelmouth Sucker CPUE riverwide has shown a significant decline in this abundance index over the last 16 years. However, the first three data points on that line (1999 to 2001) are the three that drive that relationship. In fact, those three data points are the two highest CPUE values for adult Flannelmouth Sucker seen since 1996, when CPUE values for adult Flannelmouth Sucker were about the same as what they were in 2012 (Ryden 2004). The CPUE in 2012 was statistically similar to that of 2014. If those three data points are excluded, the long-term trend line for adult Flannelmouth Sucker CPUE is flat over the last 13 years. The exact reason for the marked decline in adult Flannelmouth Sucker CPUE from 1999 to 2001 is unknown. There has been some speculation that the stocking of large numbers of large juvenile and adult Razorback Sucker (a competitor of Flannelmouth Sucker) could be to blame. However, a small number of Razorback Sucker were stocked prior to 1999 (only 5,100 of the 136,666 stocked to date = 3.73%) 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 2014, Durst 2013). 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 16 years. This is the case despite: 1) the stocking of over > 4 million Colorado Pikeminnow (potential predators) from 2002 to 2013 and > 136,666 Razorback Sucker (potential competitors) from 1994-2013; and, 2) repeated intensive electrofishing efforts that are ongoing in the San Juan River.

There are populations of Flannelmouth 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). Flannelmouth Sucker 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 and the second most abundant in the 15 RM upstream of the Animas River confluence in 2014. Bluehead Sucker were collected in almost every electrofishing sample (90.2%) in the common sampled area and in all but one of the samples upstream of the Animas. 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). Riverwide, the Bluehead Sucker population has remained relatively stable over the last 16 years. The long-term trend line for juvenile Bluehead Sucker CPUE riverwide has shown that despite some relatively large year-to-year fluctuations, there has been no significant change in this abundance index over the last 16 years. The two highest CPUE data points for adult Bluehead Sucker were in 1999 and 2013. Unlike Flannelmouth Sucker, the long-term trend line for adult Bluehead Sucker CPUE riverwide has shown no significant change over the last 16 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 million Colorado Pikeminnow (potential predators) from 2002 to 2013 and > 136,666 Razorback Sucker (potential competitors) from 1994 to 2013; 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. In Prep.). 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 2014 in the common sampled area (RM 180.0-77.0). Channel Catfish were collected between RM 166.6 to 79.1, being present in 82.6% of all electrofishing samples in the common sampled area. Discouragingly, numbers of adult and juvenile Channel Catfish have shown no significant long-term decline in the face of intensive nonnative fish removal efforts in the common sampled area.

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 2014, 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. Large numbers of both juvenile and young adult Channel Catfish were common in samples downstream of Shiprock, NM.

Strong year-classes of young Channel Catfish continue to be observed in length-frequency histograms in the common sampled area. This points 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. Additional effort will be allocated to this section of river in 2015 for non-native removal.

Common Carp

Common Carp were the seventh most commonly-collected species during 2014 Adult Monitoring. A total of only 29 Common Carp were collected in 132 electrofishing samples in the common sampled area in 2014. Over the last 16 years, Common Carp numbers have been reduced. While the exact causes of the large-scale decline of Common Carp are unknown (N. Franssen, pers. comm.), nonnative fish removal could be a heavily contributing factor. Common Carp were numerically less abundant in 2014 than both endangered Colorado Pikeminnow and Razorback Sucker. Common Carp accounted for only 0.3% of the total catch and were collected in only 15.2% of all electrofishing samples of the common sampled areas in 2014. Of the 29 Common Carp collected this year, 22 were adult and 7 were juvenile. In comparison, during 1998 Adult Monitoring, 77 adult Common Carp were collected in just one electrofishing sample (RM 163-162). 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 third consecutive year in 2014. In all three years the two most abundant species were native fishes (Flannelmouth Suckers and Bluehead Suckers). In 2013 and 2014, the top three most abundant species were native, with Speckled Dace being the third most abundant fish species.

In all three years (2012 to 2014), Razorback Sucker were caught in this section. In 2014 two of the three Razorback Sucker were adult size fish that had been in the river for two over winter periods. Additionally, one of the three Razorback Sucker had been in the river for one over winter period, stocked in the San Juan River at RM 196.1 in September of 2013, the other two were stocked in the San Juan River at RM 196.1 in October of 2012. Unfortunately no Colorado Pikeminnow were collected in this river section, although we know they have been stocked both up and downstream of here (Furr 2014).

A total of 53 Common Carp were captured in this 15 river miles section in 2013. High water spikes could have led to escapement of Common Carp from ponds within the flood plain. In 2014, Common Carp numbers (n=8) were down even lower than what was observed in 2012, maybe indicating that infested ponds were the case to the higher numbers in 2013. If this is the case, these ponds could be a continual source of Common Carp in the entire river.

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APPENDIX A

How many Colorado Pikeminnow and Razorback Sucker need to be collected during a fall Adult Monitoring trip to indicate that numbers in the river are at or near the downlist and/or delist criteria for these two species as specified in their respective Recovery Goals documents?

INTRODUCTION

During spring 2009, a series of three workshops were held in Albuquerque, NM to assess the various monitoring studies that the SJRIP currently uses to monitor both fish populations (large-bodied, small-bodied, and larval fishes) and riverine habitats. During these workshops, it was noted that when populations of the two endangered fishes increased to certain levels, it would be appropriate to switch from doing relative abundance oriented studies (such as Adult Monitoring) which use CPUE as their main abundance index, to doing multiple-pass, mark-recapture population estimate studies to obtain precise point estimates. These precise point estimates (and associated confidence intervals) could then be used to tell when the SJRIP had reached the downlist and/or delist criteria specified in the Recovery Goals documents for these two species (USFWS 2002a, 2002b).

The question we were trying to answer was; at what point does the SJRIP make that switch? This topic was the subject of several slides presented during the Adult Monitoring data presentations at those workshops. The focus of those portions of the Adult Monitoring presentations was to identify how many adult and recruiting sub-adult Colorado Pikeminnow and Razorback Sucker would need to be collected on a standardized fall Adult Monitoring trip (sampling from RM 180.0-2.9 and sampling 2 of every 3 RM) to indicate that populations were at or near the downlist or delist criteria for these two species, as specified in their respective Recovery Goals documents (USFWS 2002a, 2002b).

Our analysis used the age-class and size-class breakdowns specified in the Recovery Goals documents for the two endangered fishes. The original analysis, done in spring 2009 for the workshops, used a 20% capture probability for both Colorado Pikeminnow and Razorback Sucker. This 20% capture probability came from a rule of thumb (generated by Bill Miller and Vince Lamarra) that stated that during the first electrofishing pass through a given RM, sampling crews will collect an average of 20% of all of the fish (regardless of species) that are actually present in that RM. This rule of thumb had been used for several years, when trying to relate relative abundance data to actual population numbers.

In 2009 and 2010, endangered fish capture data from several different nonnative fish removal trips that, as a group, sampled the entirety of the San Juan River in fairly close temporal proximity to one another was used to make preliminary riverwide population estimates for the two endangered fish species (Davis et al. 2010, Duran et al. 2011). The results of these preliminary riverwide population estimates indicated that the capture probability for Colorado Pikeminnow on any given electrofishing pass was 5% and for Razorback Sucker it was 4%. Thus, the calculations presented here use these newer (and likely more accurate) capture probabilities to answer the question of when do we switch from one study to another.

METHODS

An example, for Colorado Pikeminnow, to reach the delist criteria (USFWS 2002a):

To predict if there are 800 naturally-produced adult Colorado Pikeminnow in the San Juan River using our current Adult Monitoring sampling protocols, I used the following calculations.

- Recovery Goal = 800 adult Colorado Pikeminnow (> 450 mm TL; age-7+) riverwide (i.e., from Animas confluence to Lake Powell = 180 RM) to delist

{FYI: Downlist criteria = 1,000 fish > 300 mm TL; age -5+}

- Using a 5% capture probability (J. E. Davis, pers. comm.), if 800 adult Colorado Pikeminnow are present in 180 RM, then Adult Monitoring sampling (i.e. shoreline, raft-borne electrofishing) should catch 40 of them, if we sample every single RM

5% = 0.05
800 fish X 0.05 = 40 fish collected per 180 RM sampled
40 adult fish collected in 180 RM sampled = 0.222 adult fish per RM

- But, right now we only sample from the Animas confluence to just upstream of the Sand Island Boat Landing (103.0 total RM) and we only sample two out of every three of those RM

RM 180.0-77.0 = 103.0 total RM
2/3 = 0.667
103.0 RM X 0.667 = 68.7 RM sampled

- Therefore, with our current sampling regime, we would have to collect 15 adult Colorado Pikeminnow during a fall Adult monitoring trip to be reasonably sure that there were about 800 adult Colorado Pikeminnow riverwide

68.7 RM sampled X 0.222 fish per mile = 15.25 adult Colorado Pikeminnow

Also, the mean estimated recruitment of age-6 (400–449 mm TL) naturally-produced Colorado would need to equal or exceed the average annual adult mortality (estimated at 15% on page 21 of the Colorado Pikeminnow Recovery Goals document; USFWS 2002a).

15% of 800 = 120 naturally-produced age-6 fish (400-449 mm TL) each year in 180 RM.

- 120 age-6 Colorado Pikeminnow (400-449 mm TL) riverwide (i.e., from Animas confluence to Lake Powell = 180 RM)

- Using a 5% capture probability (J. E. Davis 2009), if 120 age-6 Colorado Pikeminnow are present in 180 RM, then Adult Monitoring sampling (i.e. shoreline, raft-borne electrofishing) should catch 6 of them, if we sample every single RM

5% = 0.05
120 fish X 0.05 = 6 fish collected per 180 RM sampled
6 age-6 fish collected in 180 RM sampled = 0.033 age-6 fish per RM

But, right now we only sample from the Animas confluence to just upstream of the Sand Island Boat Landing (103.0 total RM) and we only sample two out of every three of those RM

RM 180.0-77.0 = 103.0 total RM
2/3 = 0.667
103.0 RM X 0.667 = 68.7 RM sampled

- Therefore, with our current sampling regime, we would have to collect 2 age-6 (400-449 mm TL) Colorado Pikeminnow during a fall Adult monitoring trip to be reasonably sure that there were about 120 age-6 Colorado Pikeminnow riverwide

68.7 RM sampled X 0.033 fish per mile = 2.26 age-6 Colorado Pikeminnow

RESULTS

Performing these calculations for Colorado Pikeminnow (using a 5% capture probability) and for Razorback Sucker (using a 4% capture probability), for both the downlist and delist criteria, indicates that the following numbers of fish would need to be collected on a typical September Adult Monitoring trip (i.e., sampling 2 of every 3 river miles from RM 180.0-2.9):

For Colorado Pikeminnow:

To Downlist (Demographic Criteria only): Collecting 19 Colorado Pikeminnow (> 300 mm TL; age-5+) would indicate that there were close to 1,000 fish > 300 mm TL riverwide.

To Delist (Demographic Criteria only): Collecting 15 adult Colorado Pikeminnow (> 450 mm TL; age-7+) and 2 sub-adult Colorado Pikeminnow (400-449 mm TL; age-6) would indicate that there were close to 800 fish > 450 mm TL, with a 15% recruitment rate.

For Razorback Sucker:

To Downlist (Demographic Criteria only): Collecting 88 adult Razorback Sucker (> 400 mm TL; age-4+) and 26 sub-adult Razorback Sucker (300-399 mm TL; age-3) would indicate that there were close to 5,800 fish > 400 mm TL, with a 30% recruitment rate. This would need to occur over a consecutive 5-year period.

To Delist (Demographic Criteria only): Collecting 88 adult Razorback Sucker (> 400 mm TL; age-4+) and 26 sub-adult Razorback Sucker (300-399 mm TL; age-3) would indicate that there were close to 5,800 fish > 400 mm TL, with a 30% recruitment rate. This would need to occur over a consecutive 3-year period beyond downlisting.

Discussion

When should the SJRIP should begin a formal (riverwide, repeated-pass sampling) population estimates for the two endangered fishes has surfaced a few times, which is a tough one to address. In the upper Colorado River basin, specific studies to obtain population estimates (repeated periodically over an extended period of time) are being performed for both Colorado Pikeminnow and Humpback Chub. However, populations of both of these species are made up entirely of wild fish that are known to fulfill all aspects of their life cycle (natural reproduction through recruitment into adulthood) at some level in the wild. Preliminary efforts to generate population estimates for Razorback Sucker (populations that consist of both wild and stocked fish) in the upper basin are also underway. However, data for that effort is not being collected via a separate study, but rather being collected opportunistically during several other studies.

Switching to a population estimate approach in the San Juan River would help provide the SJRIP more precise numbers of fish by species and size-class. This information could be used in the population model to help make future management decisions. Additionally, at some point, the SJRIP will need to switch to the population estimate approach to provide the kind of data specified in the Recovery Goals (e.g., USFWS 2002a). The population estimate approach may help provide a better understanding of the size-structure of endangered fish populations, thus helping inform whether or not the SJRIP needs to stock more or less fish than what our current augmentation program is doing. Lastly, if the same approach is used in the SJRIP as is being used in the upper basin (three years of sampling, followed by two years off -- five years total for a cycle), then the SJRIP could anticipate doing slightly less than two full cycles of population estimates before the Recovery Program is scheduled to end in 2023.

On the down side, population estimate studies (as they are being performed in the upper basin) are really intended to be performed on populations of fish that are completing all aspects of their life cycle. Current research tells us that there are still “holes” in the life cycles of both Colorado Pikeminnow and Razorback Sucker in the San Juan River. For Colorado Pikeminnow, the hole occurs with producing large enough numbers of wild larvae every year that can then recruit into and through the juvenile life stages and back into adulthood. This may be a problem of not enough adult fish, or it may be a problem of survival of enough larvae post-spawning (e.g., egg viability, etc.). Current studies show that if enough age-0 Colorado Pikeminnow are present in the fall of the year during every year (i.e., as with our current stocking regime), some of them will eventually recruit to adulthood, although maybe not as quickly and in as large of numbers as we would like or anticipate. For Razorback Sucker, the hole occurs between early life stages and adulthood as well. Wild-produced, larval Razorback Sucker have been collected every year since 1998 and the numbers of larvae being collected appear to be increasing over time. We also know that some stocked Razorback Sucker are retaining and surviving in the river for long periods of time post-stocking and are contributing to the production of larval fish. There have even been occasional collections of age-1 and age-2 Razorback Sucker in the San Juan River.

However, it doesn't appear that enough fish are surviving from age-0 through adulthood to fill in behind the larger juvenile and adult fish that are being stocked. So, if these life cycles aren't being completed, population estimate studies are just giving a more precise way of measuring groups of stocked fish.

The second consideration is that population estimate studies are very expensive to do and they are very resource intensive. In order to do accommodate population estimate studies like those being done in the upper basin (during which sampling occurs literally every day for three straight months – April through June), the SJRIP would need to do a major reorganization of not only how it spends its funding, but also how its available manpower and equipment are allocated. This could lead to the modification or elimination of numerous current study and management efforts, due to budgetary considerations and overlapping timing of sampling. While we feel that it still may be premature to expect population estimate studies to yield all of the information the SJRIP needs, beginning the process of developing workplans, sampling regimes, and a strategy whereby the SJRIP can fund such a large undertaking could be advantageous to the SJRIP in the long-term.