LONG TERM MONITORING OF SUB-ADULT AND ADULT LARGE-BODIED FISHES IN THE SAN JUAN RIVER: 2007

Interim Progress Report

(Final Report)

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EXECUTIVE SUMMARY

General Information

- A total of 9,111 fish were collected during 2007 Adult Monitoring
    - Native fishes accounted for 63.6% of the total catch in 2007

Native Species:

- Colorado pikeminnow
    - No wild Colorado pikeminnow were collected in 2007
    - 167 stocked Colorado pikeminnow were collected in 2007
        - Sixth most abundant species collected
        - Scaled CPUE of Colorado pikeminnow that had been in the river for 1+ overwinter periods post-stocking has not changed significantly over the last four years
        - Sizes collected in 2007 ranged from 86-405 mm TL (age-0 to age-3)
        - Captures ranged from RM 176.0-19.0
            - 32 were collected in Reach 6, 31 in Reach 5, 46 in Reach 4, 35 in Reach 3, 23 in Reach 2, and 0 in Reach 1
        - 141 (84.4%) of these had been in the river < 365 days post-stocking
            - However, all but 21 (12.6%) of these fish had been in the river for at least one overwinter period
        - After about four overwinter periods, Colorado pikeminnow stocked as age-0 fish are no longer being collected during adult monitoring
            - After about two overwinter periods, Colorado pikeminnow stocked at age-1 or older are no longer being collected during adult monitoring
- Razorback sucker
    - No wild razorback sucker were collected in 2007
    - 207 stocked razorback sucker were collected in 2007
        - Fifth most abundant species collected
        - Scaled CPUE of razorback sucker that had been in the river for 1+ overwinter periods post-stocking has not changed significantly over the last five years
        - Sizes ranged from 221-516 mm TL (age-1 through age-1 and age-15)
        - Captures ranged from RM 170.0-7.0
            - 50 were collected in Reach 6, 55 in Reach 5, 39 in Reach 4, 33 in Reach 3, 24 in Reach 2, and 6 in Reach 1
        - Of 127 razorback sucker captured with PIT tags in 2007, 105 (82.7%) were in the river < 365 days post-stocking
            - All 105 of these fish were in the river < 1 overwinter period when they were collected
        - Razorback sucker that have been in the river for 6 or more overwinter periods have been collected every year since 2001
- Roundtail chub
    - No roundtail chub were collected in 2007

- Flannelmouth sucker
    - The most abundant species collected in each of the last nine years
        - Accounted for 36.1% of the total catch (n = 3,288 fish)
        - Collected in 96.4% of all electrofishing samples from RM 180.0-2.9
        - The long-term trend for flannelmouth sucker total CPUE riverwide over the last nine years is essentially flat
        - Was collected throughout all six river reaches
- Bluehead sucker
    - Among the three most-commonly collected species in each of the last nine years
    - The third most common species collected in 2007
        - Accounted for 18.7% of the total catch (n = 1,703 fish)
        - Collected in 81.5% of all electrofishing samples from RM 180.0-2.9
        - The long-term trend for bluehead sucker total CPUE riverwide over the last nine years is essentially flat
        - Collected regularly in Reaches 6-2
        - Was collected in Reach 1 for fourth time in the last five years
            - Prior to 2003, bluehead sucker had never been collected in Reach 1

Nonnative Species:

- Channel catfish
    - Among the three most commonly-collected species in each of the last nine years
    - The second most abundant species collected in 2007
        - Accounted for 34.4% of the total catch (n = 3,137 fish)
        - Collected in 89.1% of all electrofishing samples from RM 180.0-2.9
        - Was collected in all six river reaches
            - Very rare upstream of RM 166.6 (PNM Weir) in Reach 6
        - However, distribution was centered in the middle portion of our study area (i.e., from RM 119.2-52.9) with numbers being considerably reduced both up- and downstream of that area
            - Channel catfish numbers from RM 158.6-119.2 and RM 52.9-2.9 were significantly lower than those observed in 2001 (i.e., when intensive nonnative fish removal began)
- Common carp
    - Percent of total catch accounted for by this species has decreased steadily over the last nine years (from 9.8% in 1999 to 1.5% in 2007)
        - Was the fourth most commonly-collected species in 1999
    - The seventh most commonly-collected species in 2007
        - Only 138 common carp were collected from RM 180.0-2.9 in 2007
        - Collected in 30.8% of all electrofishing samples from RM 180.0-2.9
        - Was collected in all six river reaches
        - Riverwide CPUE among adult common carp declined significantly from 1999-2007
        - Common carp were less "common" than both of the endangered species (Colorado pikeminnow and razorback sucker) during 2007 Adult Monitoring collections

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INTRODUCTION

Research performed from 1991-1997 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, modification or removal of 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 over the duration of the SJRIP, a long-term monitoring program (Propst et al. 2000) was initiated. Standardized data collection following long-term monitoring protocols began in 1999 and is scheduled to continue throughout 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's (USFWS) Colorado River Fishery Project (CRFP) office in Grand Junction, CO. However, other state and federal agencies supply personnel, equipment, and logistical support.

The objectives of Adult Monitoring (as stated in the FY-2007 workplan) are:

1) Monitor the San Juan River's fish community, specifically the large-bodied fish species, to identify shifts in fish community structure, species relative abundance and distribution, and length/weight frequencies that are occurring over time. Determine whether these shifts in fish community parameters correspond to management actions that are being implemented by the SJRIP. These include (but may not be limited to) the following:
    a) Reoperation of water releases from Navajo Reservoir
    b) Mechanical removal of nonnative fishes
    c) Modification or removal of instream water diversion structures
    d) Augmentation efforts for both federally-listed endangered fish species – Colorado pikeminnow and razorback sucker

2) Monitor population trends (e.g., distribution and abundance) of the rare San Juan River fish species -- Colorado pikeminnow, razorback sucker, and roundtail chub (both wild and stocked fish).

3) Remove nonnative fish species which prey upon and may potentially compete with native fish species in the San Juan River.

The study area for Adult Monitoring begins just downstream of the Animas River confluence (at river mile {RM} 180.0) and continues downstream to Clay Hills boat landing (RM 2.9) just upstream of Lake Powell. This study area encompasses six of the eight major geomorphic reaches identified in the San Juan River between Navajo Reservoir and Lake Powell (Bliesner and Lamarra 2000). The six geomorphic reaches in our study area are: 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). Although our study area ends 2.9 RM short of the end of Reach 1, it is assumed herein that the data collected from RM 17.0-2.9 are representative of the entirety of Reach 1.

METHODS

Field Sampling

Sampling conducted in 2007 followed the protocols for long-term monitoring set forth in Propst et al. (2000). 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) will not be included in comparative analyses for this report.

Data Analysis

Rare Native Fishes

Based on data collected over the last several years, essentially all of the endangered Colorado pikeminnow and razorback sucker being collected during Adult Monitoring were fish stocked during augmentation efforts. Large disparities existed in numbers of fish stocked annually. This made comparing year-to-year catch per unit effort (CPUE) values for these two species problematic, since large numbers of fish being stocked in any particular year tended to lead to artificially-inflated CPUE values in that year's Adult Monitoring data set. To deal with this problem, endangered fish collected during Adult Monitoring were sorted by year of stocking as well as the length of time (i.e., expressed in number of overwinter periods) they had been in the river post-stocking. Since different age-classes of Colorado pikeminnow were stocked within and among years, they were also sorted by age-class at stocking. Ages were determined using PIT tag information for known-age fish or were estimated approximately from 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 fish were then scaled to account for the differences in numbers of fish 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 scaled to what it theoretically would have been had 300,000 Colorado pikeminnow of that age-class been stocked in that particular calendar year. 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 were then divided by the number of seconds (converted to hours) fished by all rafts combined to obtain scaled CPUE values (i.e., the scaled number of fish per hour of electrofishing). Scaled CPUE values were then log-transformed (i.e., ln{scaled CPUE + 1}) for analysis (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 (i.e., age-1 to age-3) fish 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 were also scaled, but in their case they were scaled to what it theoretically would have been had 11,400 razorback sucker been stocked in that particular calendar year. 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. The scaled number of razorback sucker were then divided by the number of seconds (converted to hours) fished by all rafts combined to obtain scaled CPUE values (i.e., the scaled number of fish per hour of electrofishing). Scaled CPUE were then log-transformed (i.e., ln{scaled CPUE + 1}) for analysis (Golden and Holden 2005, Robertson and Holden 2007, R. Ryel pers. comm.).

Using log-transformed, scaled CPUE values made data more comparable between age-classes and stocking years despite the differences in numbers of fish stocked between years. Analysis of variance (ANOVA) utilizing Tukey's Honestly Significant Difference (Tukey's HSD) multiple-comparison post hoc tests, were then used to determine if significant differences in CPUE values occurred between years. Significance was determined at $p < 0.10$ (following Ryden 2000a).

Common Large-Bodied Fishes

The four common large-bodied fishes 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 riverwide {i.e., Reaches 6-1 -- RM 180.0-0.0} basis) across years.

Electrofishing data were pooled for all rafts to obtain total catch numbers, by species, for the entire sampling trip. Total catch numbers for each species were 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 of the six large-bodied fish species were then compared to 1999-2006 riverwide electrofishing data to evaluate long-term trends. Analysis of variance (ANOVA) utilizing Tukey's Honestly Significant Difference (Tukey's HSD) multiple-comparison post hoc tests, were then used to determine whether significant differences in CPUE values occurred between years. Significance was determined at $p < 0.10$ (following Ryden 2000a).

Length data obtained from fish measured at designated miles (DMs) were used to develop riverwide length frequency histograms for wild populations of the four common large-bodied fish species, from 1999-2007.

RESULTS

The mean river flow (at the Shiprock USGS gage #09368000) during the 2007 Adult Monitoring trip was 1,262 CFS (Table 1). This was very near both the mean and median values for sampling flows encountered over the last nine years of Adult Monitoring.

Eighteen fish species and hybrids were collected during the 2007 Adult Monitoring trip (Table 2). This included five native species and two native sucker hybrids, as well as nine nonnative species and two native- nonnative sucker hybrids (Tables 2 and 3). Seven species (flannelmouth sucker, channel catfish, bluehead sucker, speckled dace, Colorado pikeminnow, common carp, razorback sucker, and red shiner) accounted for 99.4% (9,053 fish) of the total catch during the 2007 Adult Monitoring trip. The other seven species and four hybrids contributed only 0.6% (58 fish) to the total catch in 2007 (Table 3). Native fishes dominated the total catch in 2007 (Table 3). For the fourth consecutive year common carp were not among the four most commonly-collected fish species.

Table 1. Summary of dates, river miles sampled, and mean flow during riverwide Adult Monitoring trips in the San Juan River in New Mexico, Colorado, and Utah, 1999-2007.

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 ($35.7\ m^3/sec$)
9-year statistics: Mean = 1,178 CFS ($33.3\ m^3/sec$) Median = 1,072 CFS ($30.3\ m^3/sec$)			

Table 2. Scientific and common names (following Nelson et al. 2004), status, and database codes for fish species collected from the San Juan River during the 2007 Adult Monitoring trip.

Scientific Name	Common Name	Status	Database Code
Order Cypriniformes: Family Catostomidae – suckers			
Catostomus discobolus	bluehead sucker	Native	Catdis
Catostomus commersoni	white sucker	Introduced	Catcom
C.commersoni X C.discobolus	Hybrid	Introduced	comXdis
C.commersoni X C.latipinnis	Hybrid	Introduced	comXlat
Catostomus latipinnis	flannelmouth sucker	Native	Catlat
C.latipinnis X C.discobolus	Hybrid	Native	latXdis
Xyrauchen texanus	razorback sucker	Native	Xyrtex
X.texanus X C.latipinnis	Hybrid	Native	texXlat
Order Cypriniformes: Family Cyprinidae - carps and minnows			
Cyprinella lutrensis	red shiner	Introduced	Cyplut
Cyprinus carpio	common carp	Introduced	Cypcar
Pimephales promelas	fathead minnow	Introduced	Pimpro
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 fish collected during the 2007 Adult Monitoring trip.

Species (Status)[a]	Number Collected	Percent Of Total[b]	Number Of Samples Collected In
flannelmouth sucker (N)	3,288	36.1	213
channel catfish (I)	3,137	34.4	197
bluehead sucker (N)	1,703	18.7	180
speckled dace (N)	413	4.5	100
razorback sucker (N)	207	2.3	88
Colorado pikeminnow (N)	167	1.9	95
common carp (I)	138	1.5	68
bluehead sucker X flannelmouth sucker (H, N)	19	0.2	16
brown trout (I)	9	-----	8
largemouth bass (I)	8	-----	7
white sucker X flannelmouth sucker (H, I)	6	-----	5
white sucker (I)	4	-----	4
fathead minnow (I)	4	-----	3
red shiner (I)	3	-----	2
white sucker X bluehead sucker (H, I)	2	-----	1
razorback sucker X flannelmouth sucker (H, N)	1	-----	1
black bullhead (I)	1	-----	1
rainbow trout (I)	1	-----	1
GRAND TOTAL	9,111		
Total Electrofishing Collections In 2007 = 221 Total Electrofishing Effort In 2007 = 90.95 Hours			
2007 Native Fishes = 5,798 (63.64% Of The Total Catch) 2007 Introduced Fishes = 3,313 (36.36% Of The Total Catch) 2007 Native To Introduced Fishes Ratio = 1.75:1			
a: (N) = Native species; (I) = Introduced species; (H, N) = A hybrid of two species, considered to be a native fish; (H, I) = A hybrid of two species, considered to be an introduced fish b: ----- = less than 0.1%			

Rare Native Fishes

Colorado Pikeminnow

No wild adult Colorado pikeminnow were collected in 2007. A total of 167 stocked Colorado pikeminnow were collected in 2007 (Table 3). This marked the fourth consecutive year that > 100 Colorado pikeminnow were collected during an Adult Monitoring trip (2004 = 159; 2005 = 127; 2006 = 323).

Colorado pikeminnow captures ranged from RM 176.0-19.0 (Table 4). The majority (n = 144; 86.2%) occurred upstream of the canyon-bound reaches (RM 68.0-0.0) of the river. In addition, 29 (17.4%) of these collections occurred upstream of the Hogback Diversion (RM 158.6). Thirty-two Colorado pikeminnow were collected in Reach 6, 31 in Reach 5, 46 in Reach 4, 35 in Reach 3, 23 in Reach 2, and 0 in Reach 1.

Table 4. General information on stocked Colorado pikeminnow collected in 2007.

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-0 (1)	86	50	4 (0)	10/03/2007	Age-0 (2007)	Dexter
Age-1 (115)	127-225	176.0-34.0	319-340 (1)	10/19/2006 & 11/02/2006	Age-0 (2006)	Dexter
Age-1 (20)	160-309	175.0-19.0	1-168 (0)	04/18/2007 & 10/03/2007	Age-1 (2006)	Dexter
Age-2 (20)	241-321	160.0-31.0	683-705 (2)	10/20/2005 & 11/03/2005	Age-0 (2005)	Dexter
Age-2 (6)	204-301	115.0-31.0	364-371 (1)	10/03/2006	Age-1 (2005)	Dexter
Age-3 (2)	374-405	139.0-71.0	1,055-1,073 (3)	10/21/2004 & 10/28/2004	Age-0 (2004)	Dexter
Age-3 (3)	280-315	122.0-38.0	426-452 (1)	07/13/2006 & 07/20/2006	Age-2 (2004)	Mumma

a: Dexter = U.S. Fish and Wildlife Service, Dexter National Fish Hatchery and Technology Center, Dexter NM; Mumma = Colorado Division of Wildlife, Mumma Native Species Hatchery, Alamosa, CO.

Most (n = 141; 84.4%) of the Colorado pikeminnow collected in 2007 were in the river $\leq$ 365 days post-stocking. However, all but 21 (12.6%) of these fish had been in the river for at least one overwinter period (Table 4). Only 26 (15.6%) were in the river > 365 days post-stocking and, of those, 22 were stocked as age-0 fish. Likewise, the only two Colorado pikeminnow collected in 2007 that were in the river > 730 days (two years) post-stocking had been stocked as age-0 fish.

Mean scaled CPUE among groups of age-0 stocked fish showed significantly different scaled CPUE at age-1. Recapture rates for the 2003 and 2005 year-classes were higher at age-1 than other years (Figure 1). Recapture rates among 2002 year-class fish captured at age-1 in fall 2003 were significantly lower than among comparable groups of age-1 fish during three of the next four years (Figure 1). In 2002, Colorado pikeminnow stocked as age-0 fish in the fall had considerably shorter tempering times and none of these fish were acclimated prior to stocking. Beginning in 2003, protocols to reduce handling stress at the hatchery and during transport were implemented. In addition, longer tempering times were implemented and at least 20,000 age-0 fish per year were acclimated prior to release.

By age-2, no clear differences in scaled CPUE among year-classes are apparent, and no relationship to age-1 CPUE emerges (Figure 1). By age-3 and age-4, scaled CPUE is greatly diminished and no differences were detected among age-classes. The 2002 year-class of Colorado pikeminnow was the only group stocked as age-0 fish that were available to be collected as age-5 fish in 2007. However, no age-5 fish were collected during 2007 Adult Monitoring (Figure 1).

In summary, Colorado pikeminnow stocked as age-0 fish in the fall of the year are being collected in Adult Monitoring collections through about age-4. After age-4 these fish have, so far, been absent from Adult Monitoring collections. It is unknown whether these age-4+ fish die, move out of the mainstem river (either into lake Powell or into tributaries), or their numbers diminish to the point that single-pass electrofishing efforts, such as Adult Monitoring, are unable to detect their presence.

Comparisons of scaled CPUE among nine different groups of Colorado pikeminnow stocked as age-1 or older fish (Figure 3) showed that during the calendar year in which they were stocked, these fish were collected in very high proportions compared to the low numbers at which they were stocked (Ryden 2008a details the numbers and age-classes of Colorado pikeminnow stocked from 2002-2007). However, after their first overwinter period, few if any were collected (Figure 3). After two overwinter periods, no fish from any of these stocking of age-1+ fish were present in Adult Monitoring collections. Once again, it is unknown whether these older stocked fish became extirpated from the river, moved out of the mainstem river (either into lake Powell or into tributaries), or whether their numbers just diminished to the point where single-pass electrofishing efforts, such as Adult Monitoring, were unable to detect their presence.

Scaled CPUE for all Colorado pikeminnow that were in the river 1+ overwinter periods showed no differences from 2004-2007, but all four years were significantly higher than 2003 (Figure 4).

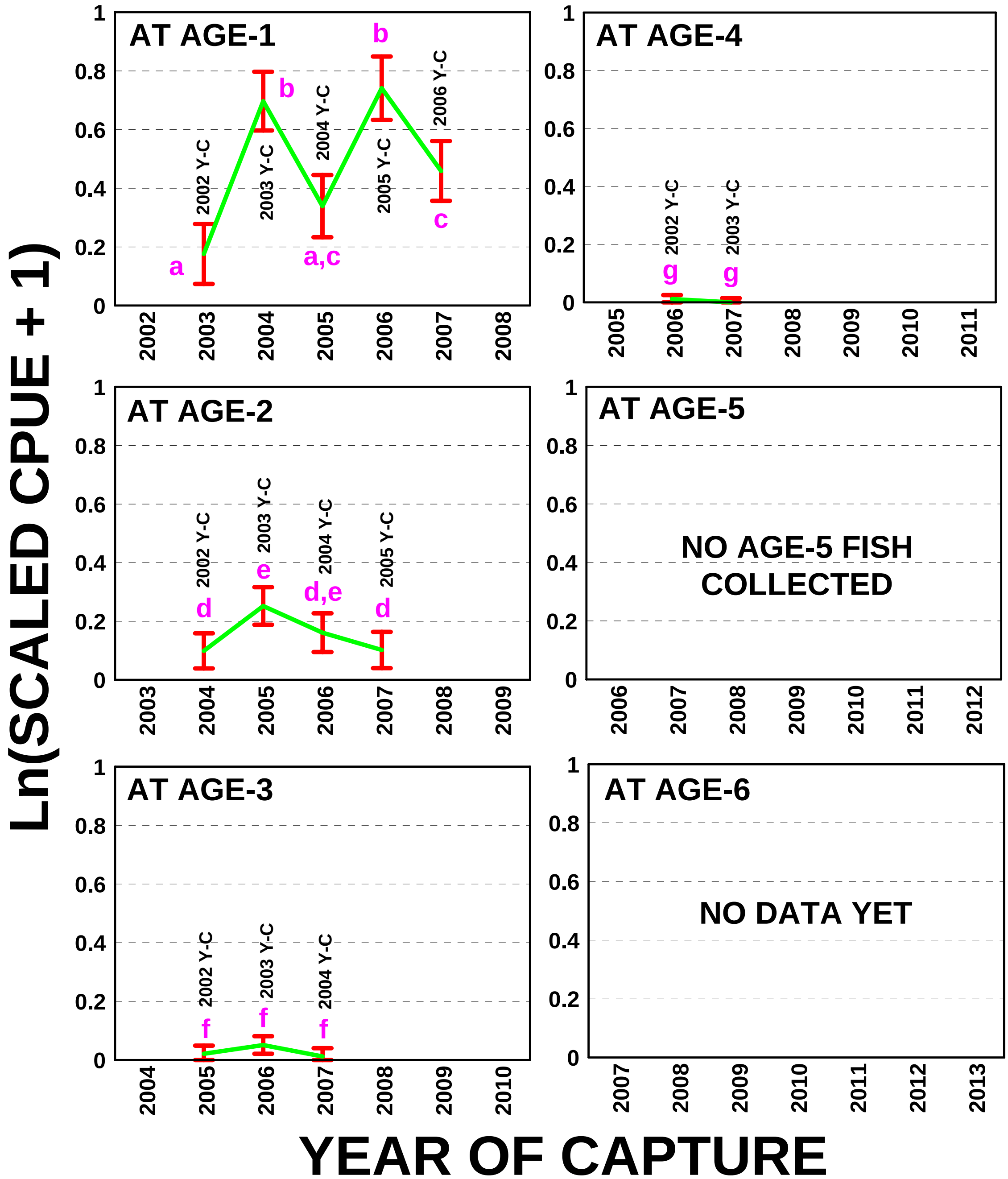

Figure 1. A comparison of scaled CPUE at age among groups of Colorado pikeminnow stocked as age-0 fish and captured during subsequent Adult Monitoring trips, 2003-2007. The green line shows the difference in scaled CPUE values between years. Red error bars are two standard errors. Purple letters are within-age multi-year comparisons. Letters that are the same within a graph are not significantly different from one another. Letters that are different within a graph are significantly different from one another. Y-C = year-class.

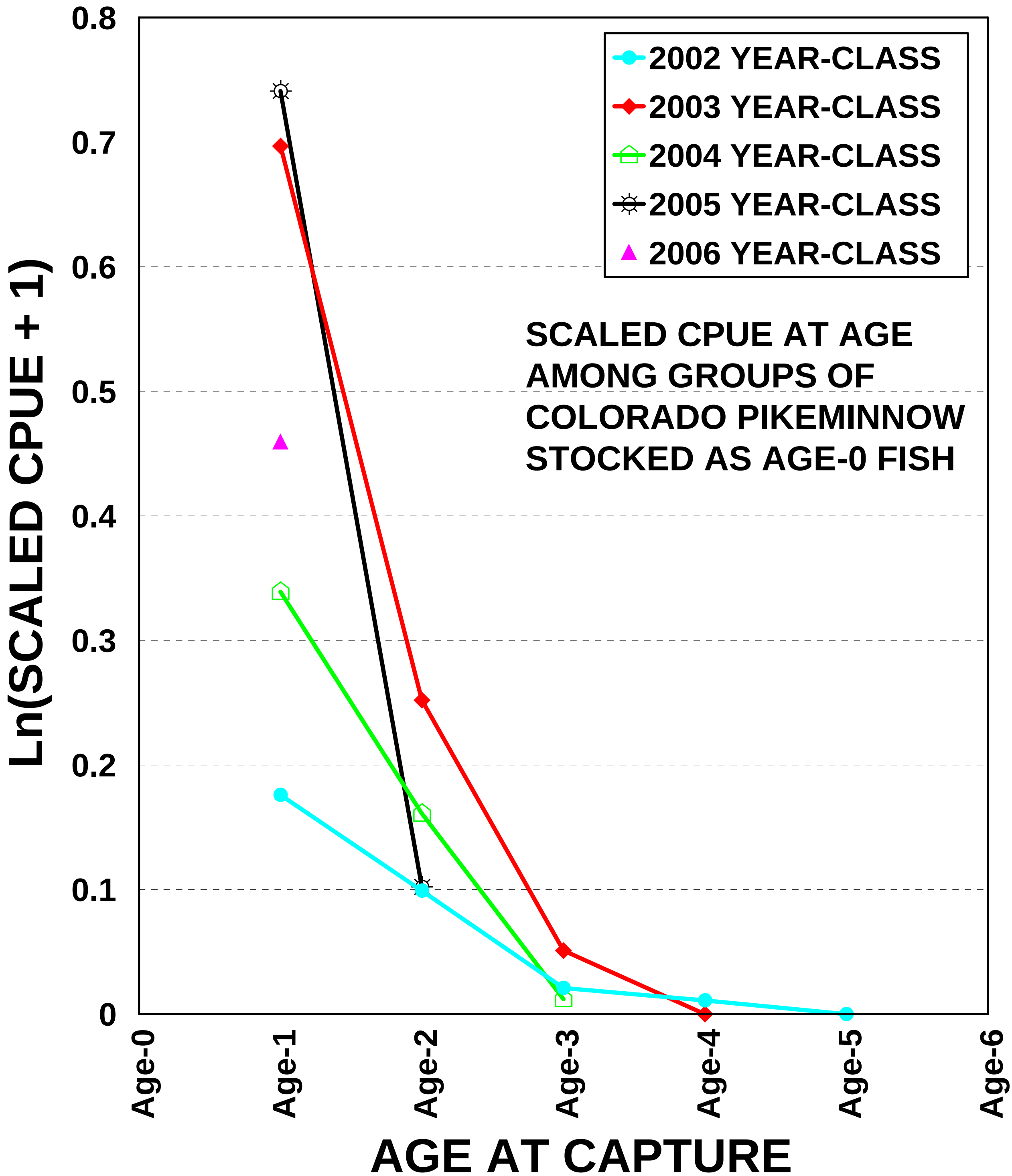

Figure 2. Scaled CPUE at age among groups of Colorado pikeminnow that were stocked as age-0 fish in the fall of the year (2002-2006) and subsequently captured during Adult Monitoring trips from 2003-2007. This graph begins with captures of fish in the calendar year following the year in which they were stocked (i.e., 1 overwinter periods).

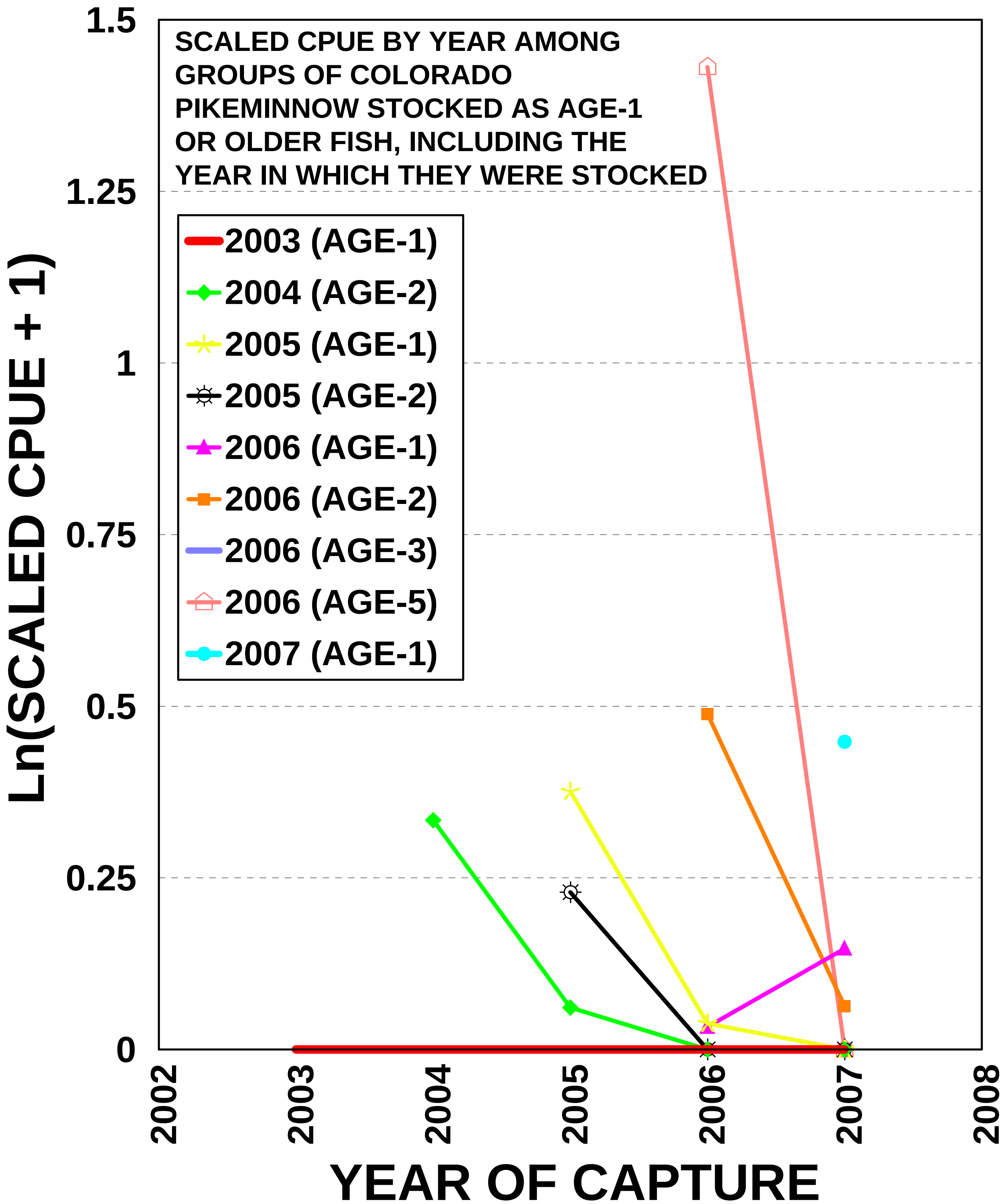

Figure 3. Scaled CPUE by calendar year among groups of Colorado pikeminnow that were stocked as age-1 or older fish and subsequently captured during Adult Monitoring trips from 2004-2007. This graph begins with captures of fish during the same year in which they were stocked (i.e., 0 overwinter periods).

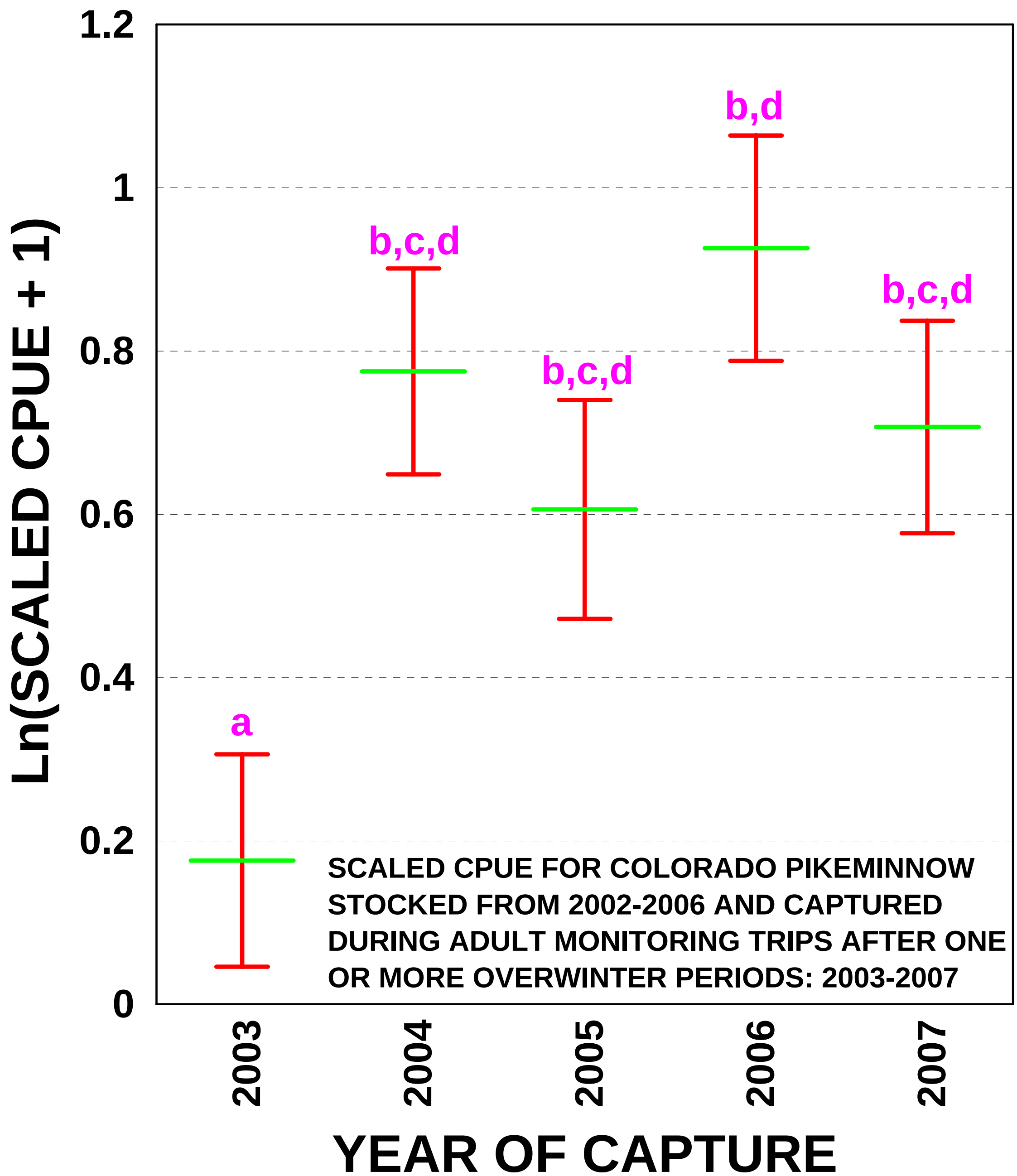

Figure 4. Year-to-year comparison of scaled CPUE for all Colorado pikeminnow collected on Adult Monitoring trips that were in the river for one or more overwinter periods following stocking (regardless of age). The green lines show the mean scaled CPUE values for each year. Red error bars are two standard errors. Purple letters are between-year comparisons (using Tukey's HSD post-hoc test). Letters that are the same between years are not significantly different from one another. Letters that are different between years are significantly different from one another.

Razorback Sucker

No wild razorback sucker were collected in 2007. A total of 207 stocked razorback sucker were collected in 2007 (Table 5). This marked the third consecutive year during which > 50 razorback sucker (2006 = 144; 2005 = 52; 2004 = 117) were collected during an Adult Monitoring trip.

Razorback sucker captures ranged from RM 170.0-7.0 (Table 5). The majority (n = 177; 85.5%) occurred upstream of the canyon-bound reaches (RM 68.0-0.0) of the river. Thirteen razorback sucker (6.2%) were collected upstream of the Hogback Diversion, with two of those collections being upstream of the PNM Weir and fish ladder (RM 166.6). Fifty razorback sucker were collected in Reach 6, 55 in Reach 5, 39 in Reach 4, 33 in Reach 3, 24 in Reach 2, and 6 in Reach 1.

Table 5. General information on stocked razorback sucker collected in 2007.

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 127 razorback sucker captured with PIT tags in 2007:					
26-174 (0)	Age-1 To Age-6 (105)	221-512	170.0-16.0	2007	Age-1 To Age -6 (2001-2006)
375-442 (1)	Age-2 To Age-6 (12)	302-506	161.0-7.0	2006	Age-1 To Age-5 (2001-2005)
1162-1275 (3)	Age-6 To Age-7 (3)	414-474	133.0-13.0	2004	Age-3 To Age-4 (2000-2001)
1633 (4)	Age-6 (1)	462	98.0	2003	Age-2 (2001)
2147-2163 (6)	Age-7 To Age-8 (5)	458-516	158.0-106.0	2001	Age-1 To Age-2 (1999-2000)
4389 (12)	Age-15 (1)	496	103.0	1995	Age-3 (1992)
Information on the 80 razorback sucker captured without PIT tags in 2007:					
≤ 472 (0-1)	Age-2 To Age-6 (80)	249-514	169.0-16.0	2006 or 2007	Age-1 To Age-5 (2001-2005)

Because salvage operations at the NAPI ponds in 2006 and 2007 led to several thousand razorback sucker being stocked without PIT tags (Ryden 2008b), it was impossible to determine the length of time that 80 of the razorback sucker captured during 2007 Adult Monitoring (without PIT tags) had been in the river post-stocking (Table 5). Of the 127 razorback sucker recaptured with PIT tags in 2007, 105 (82.7%) were in the river < 365 days post-stocking. All 105 of these fish were in the river < 1 overwinter period when they were collected. The other 22 (17.3%) were in the river > 365 days post-stocking and had been in the river from 1-12 overwinter periods (Table 5).

Comparisons of capture data for razorback sucker that were in the river for 1+ overwinter periods showed that the number of older fish being collected during Adult Monitoring trips has not increased over the last seven years (Table 6). However, razorback sucker that were in the river for 1+ overwinter periods did demonstrate a much longer post-stocking persistence (up to 12 overwinter periods or 4,389 days post-stocking) than did Colorado pikeminnow. On every Adult Monitoring trip since 2001, razorback sucker were collected that had been in river for at least 6 overwinter periods post-stocking (Table 6). As with older Colorado pikeminnow (Appendix A), the razorback sucker collected on the 2007 Adult Monitoring trip that was stocked in 1995 seems to indicate that older razorback sucker are present in the San Juan River in low numbers, but are just very difficult to detect during single-pass electrofishing efforts, such as Adult Monitoring.

Scaled CPUE for razorback sucker that were in the river 1+ overwinter periods showed no significant differences from 2003-2007 (Figure 5).

Table 6. Information on stocked razorback sucker collected from 1999-2007 that had been in the river for 1+ overwinter periods.

Information For Fish Collected During The Entire Adult Monitoring Trip:			Information For Fish That Were In The River For 1+ Overwinter Periods At Time Of Capture:			
Year	Effort (Total Hours Electrofished)	Total Number Of Razorback Sucker Collected	Number Of Fish Collected That Were In River 1+ Overwinter Periods	Year-Classes Of Captured Razorback Sucker	Days In River Post-Stocking (Number Of Overwinter Periods)	Years During Which These Fish Were Stocked
1999	88.36	5	5	1993, 1997	350-744 (1-2)	1997 (1 fish) 1998 (4 fish)
2000	116.89	8	3	1997	415 (1)	1999 (3 fish)
2001	109.61	16	16	1992, 1993, 1996, 1997, 1999	362-2505 (1-7)	1994 (5 fish) 1995 (2 fish) 1997 (3 fish) 1998 (2 fish) 2000 (4 fish)
2002	92.17	23	20	1992, 1993, 1996, 1997, 1999, 2000	326-2864 (1-8)	1994 (2 fish) 1995 (1 fish) 1997 (1 fish) 1998 (1 fish) 1999 (1 fish) 2000 (3 fish) 2001 (11 fish)
2003	94.42	19	19	1992, 1999, 2000, 2001	518-3246 (1-9)	1994 (2 fish) 2000 (4 fish) 2001 (10 fish) 2002 (2 fish) wild fish = 1
2004	93.75	117	18	1992, 1998, 1999, 2000, 2001	527-3609 (1-10)	1994 (1 fish) 1999 (1 fish) 2000 (3 fish) 2001 (9 fish) 2002 (3 fish) 2003 (1 fish)
2005	85.95	52	30	1998, 1999, 2000, 2001, 2002	394-2254 (1-6)	1999 (1 fish) 2000 (3 fish) 2001 (6 fish) 2003 (1 fish) 2004 (19 fish)
2006	77.80	145	23	1997, 2000, 2001, 2002	382-2914 (1-8)	1998 (1 fish) 2001 (1 fish) 2002 (1 fish) 2004 (16 fish) 2005 (4 fish)
2007	90.95	207	22	1992, 1999, 2000, 2001, 2004, 2005	375-4389 (1-12)	1995 (1 fish) 2001 (5 fish) 2003 (1 fish) 2004 (3 fish) 2006 (12 fish)

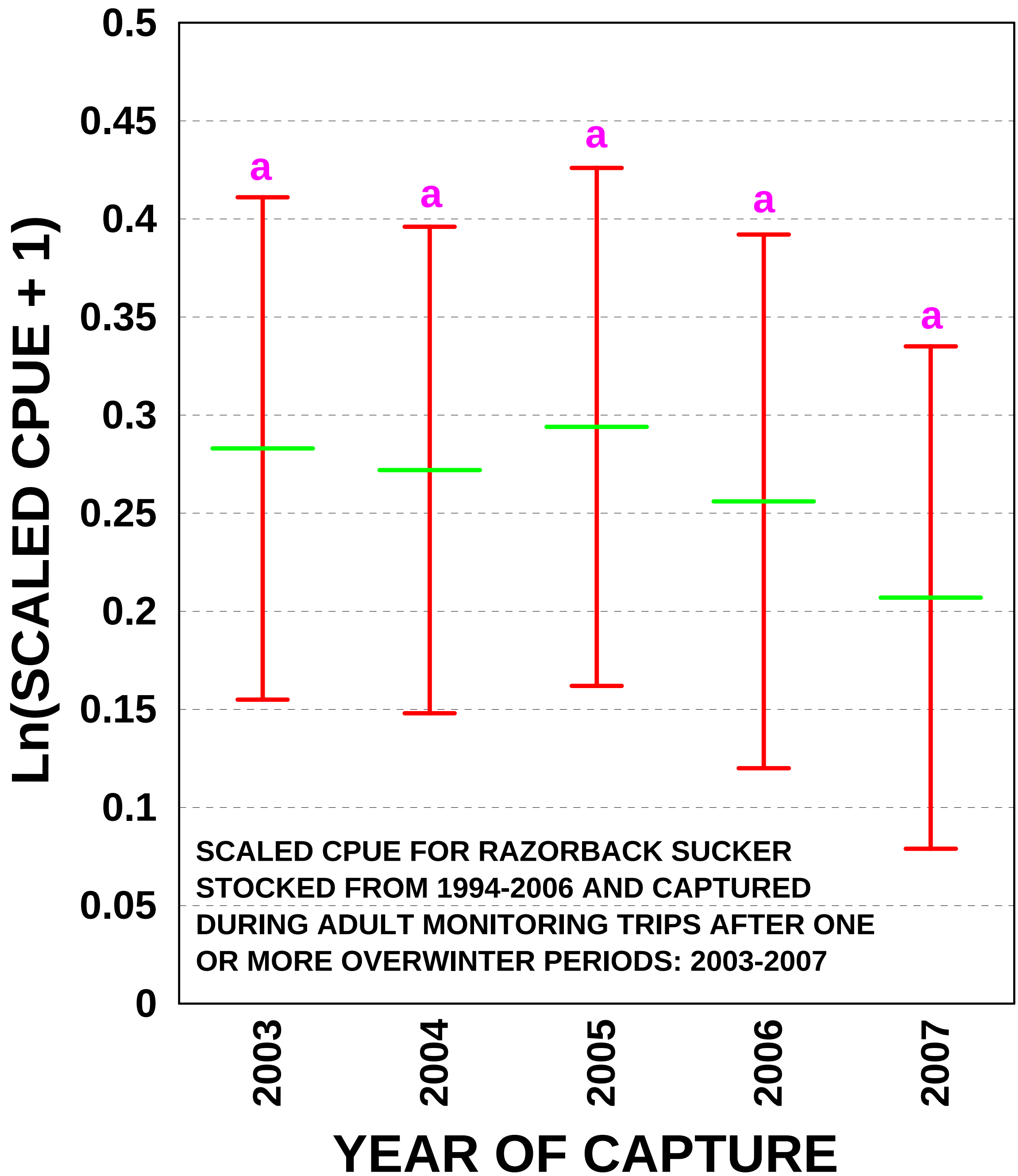

Figure 5. Year-to-year comparison of scaled CPUE for all razorback sucker collected on Adult Monitoring trips that were in the river for one or more overwinter periods following stocking (regardless of age). The green lines show the mean scaled CPUE values for each year. Red error bars are two standard errors. Purple letters are between-year comparisons (using Tukey's HSD post-hoc test). Letters that are the same between years are not significantly different from one another. Letters that are different between years are significantly different from one another.

Roundtail Chub

No roundtail chub were collected during 2007 Adult Monitoring collections.

Common Native Fishes

Flannelmouth Sucker

Catch Information

Flannelmouth sucker continue to be the most common large-bodied fish collected riverwide during Adult Monitoring trips (Table 3, Figure 6; Ryden 2000a, 2001, 2003, 2004, 2005, 2006, 2007a). Flannelmouth sucker have remained numerically dominant in both overall numbers of specimens collected and in frequency of occurrence in electrofishing samples. Flannelmouth sucker were collected in all six river reaches in 2007 (from RM 179.0-5.0).

Riverwide flannelmouth sucker juvenile CPUE has shown much more variation than has CPUE for adult flannelmouth sucker over the last nine years (Figure 7). Juvenile flannelmouth sucker abundance is heavily influencing variation in the total annual CPUE for flannelmouth sucker. While flannelmouth sucker adult CPUE riverwide was significantly lower in 2007 than seven of the previous eight years, juvenile CPUE was significantly lower than only four of the previous eight years and not significantly different from the 2006 value (Figure 7). In past years, significant declines in flannelmouth sucker CPUE have been followed the very next year by significant increases in CPUE (Figure 7, Ryden 2007a). Thus, the declines in adult and total CPUE observed in 2007 are not yet cause for concern. In general, the long-term trend for flannelmouth sucker CPUE riverwide over the last nine years is essentially flat (Figure 7).

Length Information

Flannelmouth sucker ranging in size from 65-556 mm TL (mean TL = 377 mm) were collected during 2007 Adult Monitoring.

The 2007 riverwide length-frequency histogram for flannelmouth sucker was bimodal with one mode of being centered around 351-400 mm TL subadult fish (likely spawned in 2003-2004) and the second, slightly larger mode centered around adult fish between 426-475 mm TL (Figure 8). As was observed in the CPUE data (Figure 7), few smaller juvenile flannelmouth sucker (i.e., < 301 mm TL) were collected during 2007 Adult Monitoring (Figure 8).

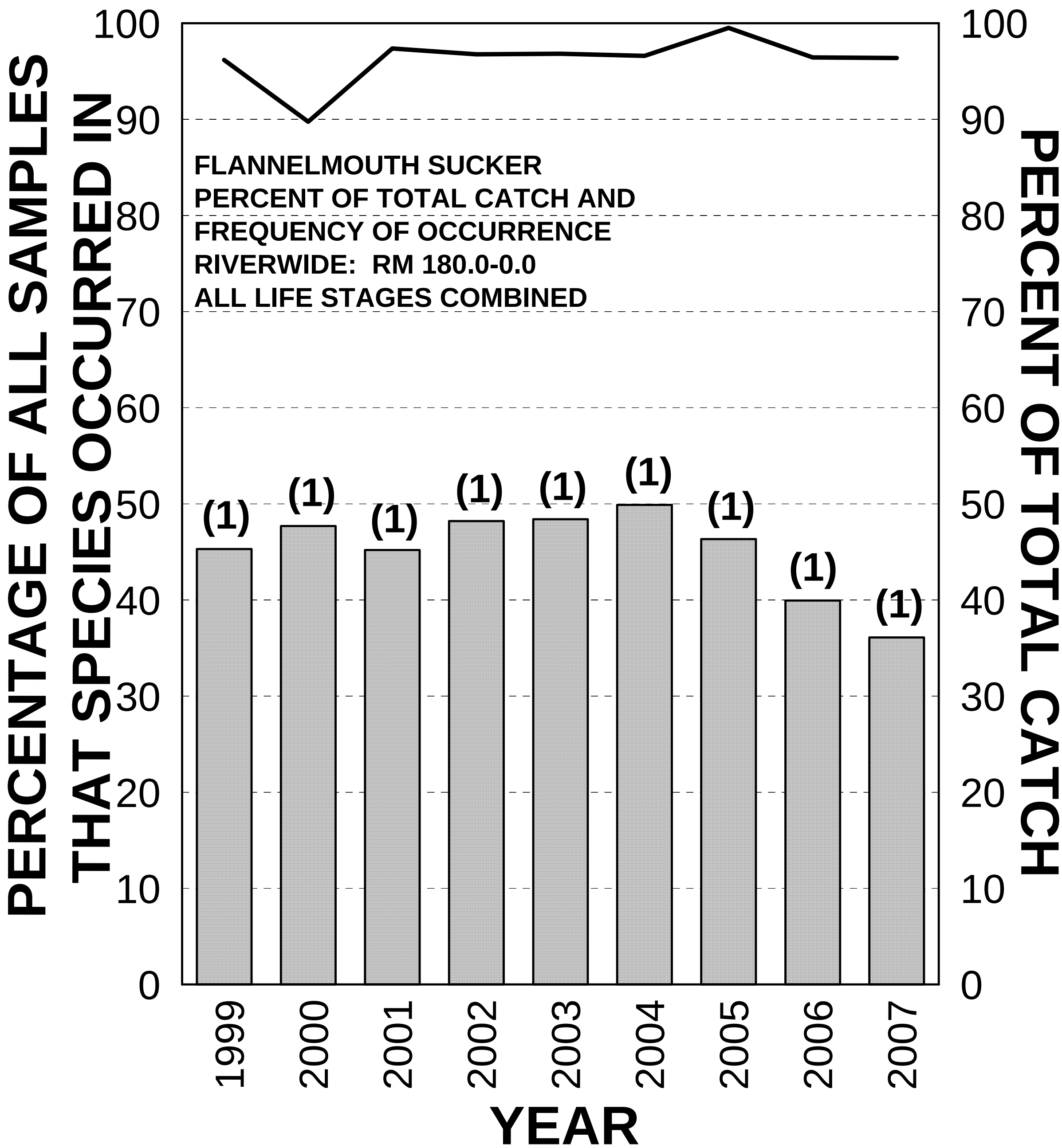

Figure 6. A summary of flannelmouth sucker relative abundance in riverwide Adult Monitoring collections, 1999-2007. The solid black line represents the percentage of all electrofishing samples on a given Adult Monitoring trip in which this species occurred (i.e., frequency of occurrence). The gray bars 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.

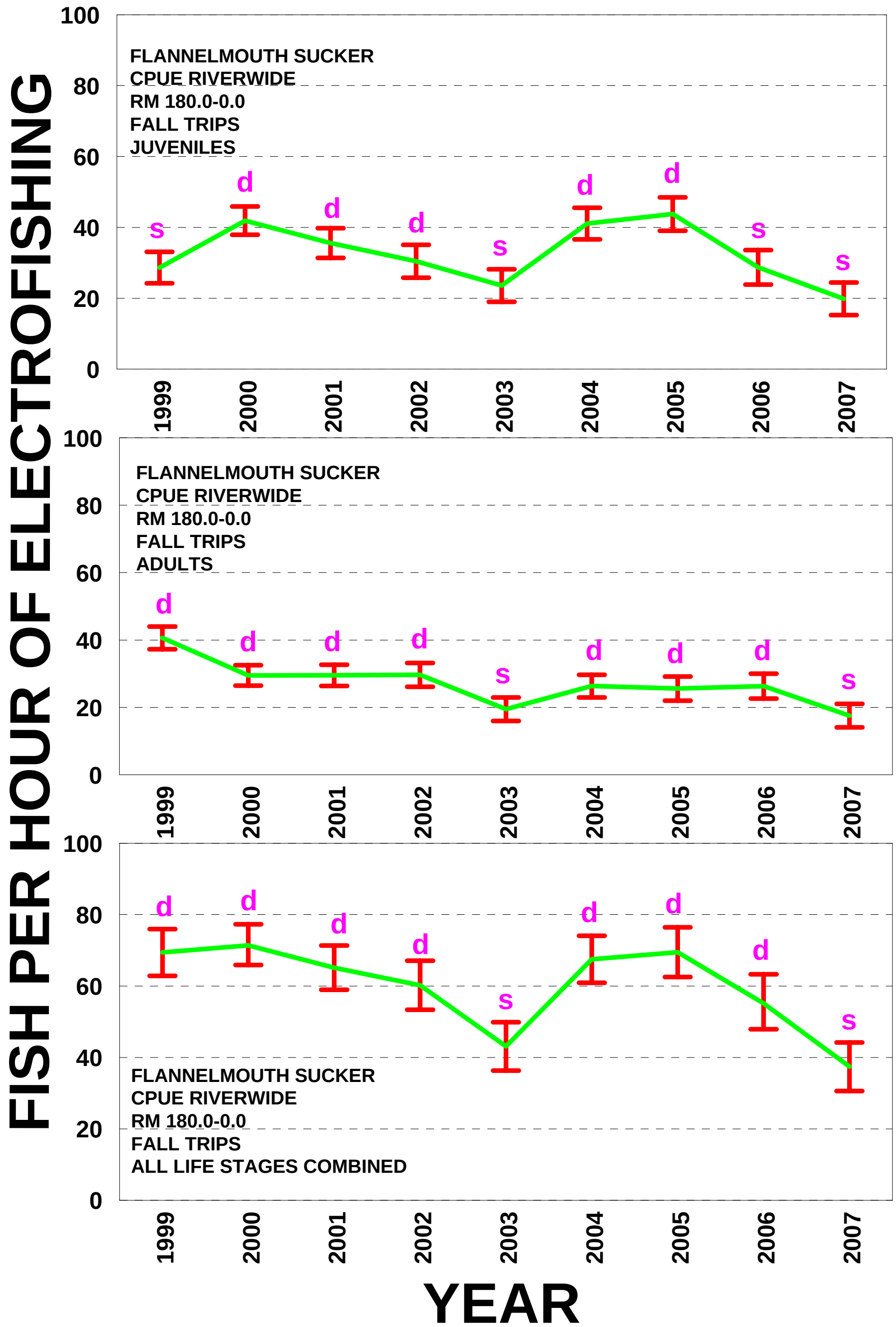

Figure 7. Flannelmouth sucker CPUE (green line) riverwide (RM 180.0-0.0) on fall Adult Monitoring trips, for juvenile fish (< 410 mm TL; top), adult fish ($\geq$ 410 mm TL; middle), and for all life stages combined (juveniles + adults; bottom). Error bars equal two standard errors. Purple letters are multi-year comparisons. The letter "s" means the value is not significantly different from the 2007 value. The letter "d" means the value is significantly different from the 2007 value.

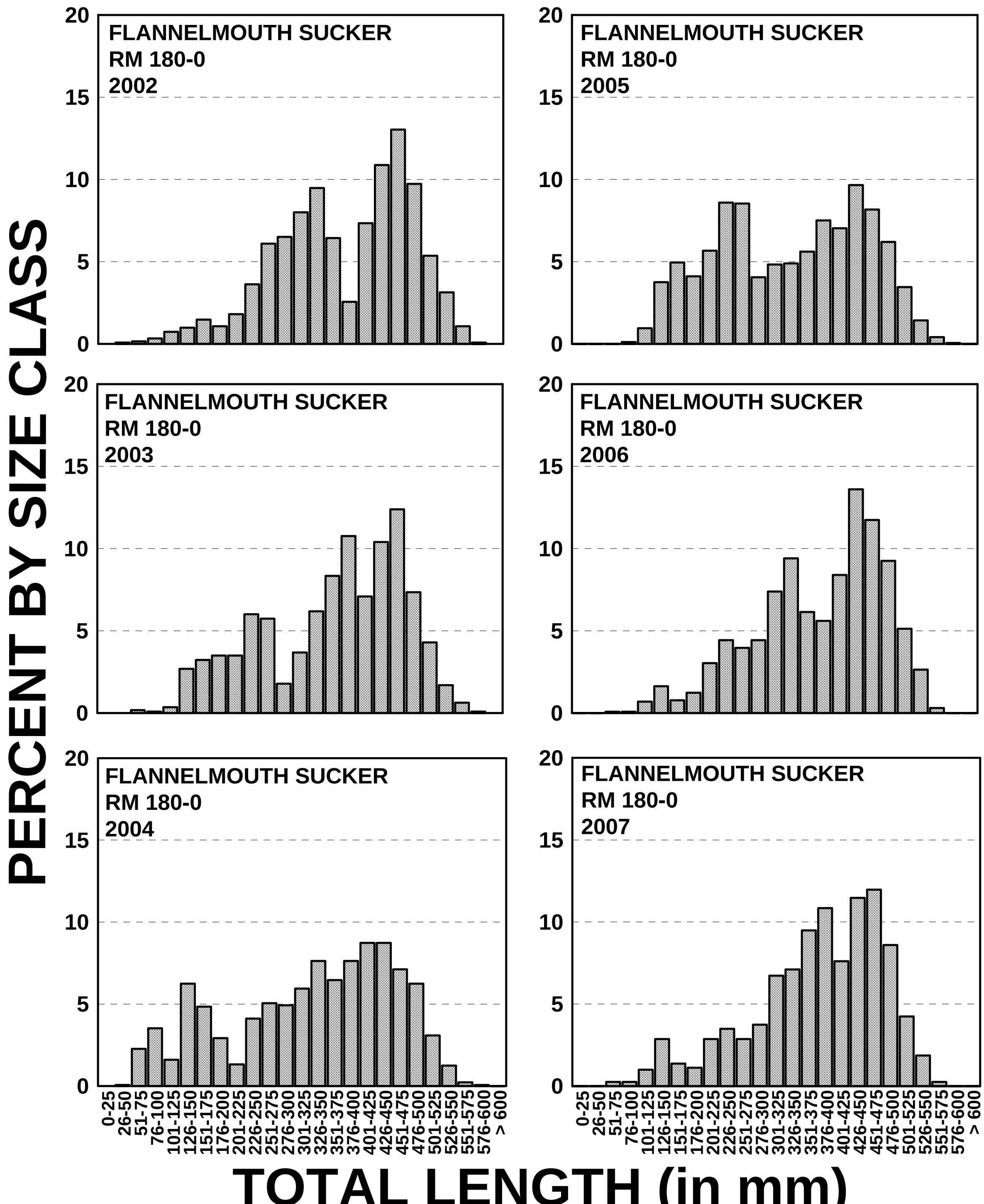

Figure 8. Length-frequency histograms showing the riverwide (RM 180.0-0.0) size-class distribution of flannelmouth sucker on fall Adult Monitoring trips in the San Juan River, 2002-2007.

Bluehead Sucker

Catch Information

Bluehead sucker were the third most commonly-collected large-bodied fish species during 2007 Adult Monitoring (Table 3, Figure 9). The percentage of the total catch composed by bluehead sucker in 2007 (18.6%) was the median value, being higher than four of the previous eight years, but lower than the other four years. Bluehead sucker continue to be collected regularly in Reaches 6-2, with small numbers of bluehead sucker being collected in Reach 1 in four of the last five years (prior to 2003, bluehead sucker were never collected in Reach 1, adjacent to Lake Powell). Bluehead sucker have also become noticeably more widely distributed throughout the San Juan River since 2001 (Figure 9, pers. obs.), consistently occurring in over 80% of all electrofishing samples riverwide over the last seven years and in > 90% in four of those years (Figure 9). Bluehead sucker were collected from RM 179.0-7.0 in 2007.

Bluehead sucker adult CPUE has not changed significantly over the last eight years (Figure 10). Thus, the changes in the bluehead sucker total CPUE are being driven completely by fluctuations in juvenile catch rates. While bluehead sucker juvenile CPUE was significantly lower in 2007 than it was in 2006, it was not significantly different from five of the previous eight years (Figure 10). It looks as if the up and down fluctuations in numbers of juvenile bluehead sucker may be a cyclical event that repeats about every 3-5 years. In general, the long-term trend for bluehead sucker CPUE riverwide over the last nine years is essentially flat (Figure 10).

Length Information

Bluehead sucker ranging from 109-485 mm TL (mean TL = 289 mm) were collected during 2007 Adult Monitoring.

In 2007 the bluehead sucker collected were centered around a group of young adult fish that were 301-325 mm TL, with the second biggest group being large subadults (276-300 mm TL; Figure 11). Smaller juvenile fish (≤ 200 mm TL accounted for only 14.1% of all bluehead sucker collected in 2007 (Figure 11).

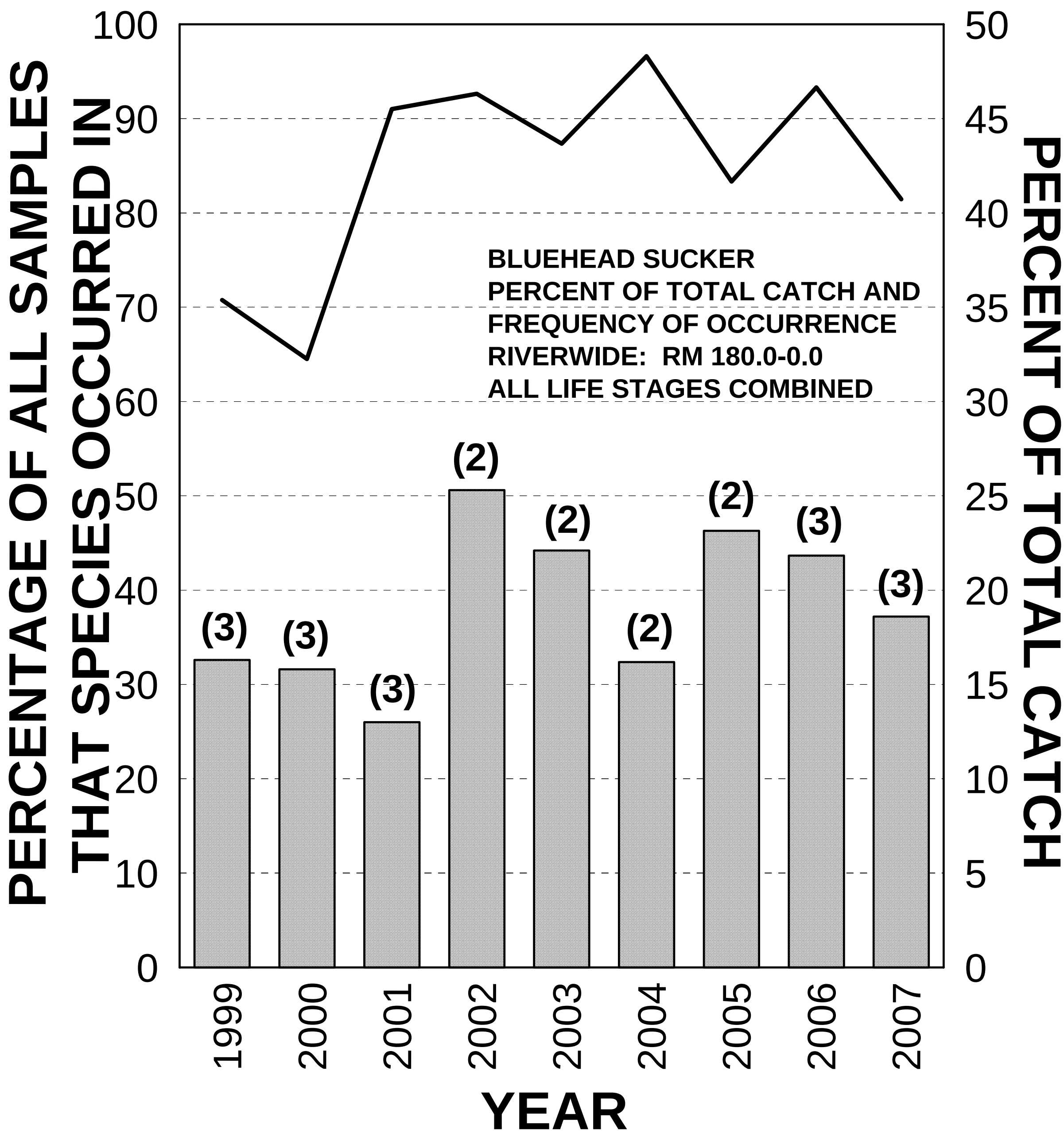

Figure 9. A summary of bluehead sucker relative abundance in riverwide Adult Monitoring collections, 1999-2007. The solid black line represents the percentage of all electrofishing samples on a given Adult Monitoring trip in which this species occurred (i.e., frequency of occurrence). The gray bars represent 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.

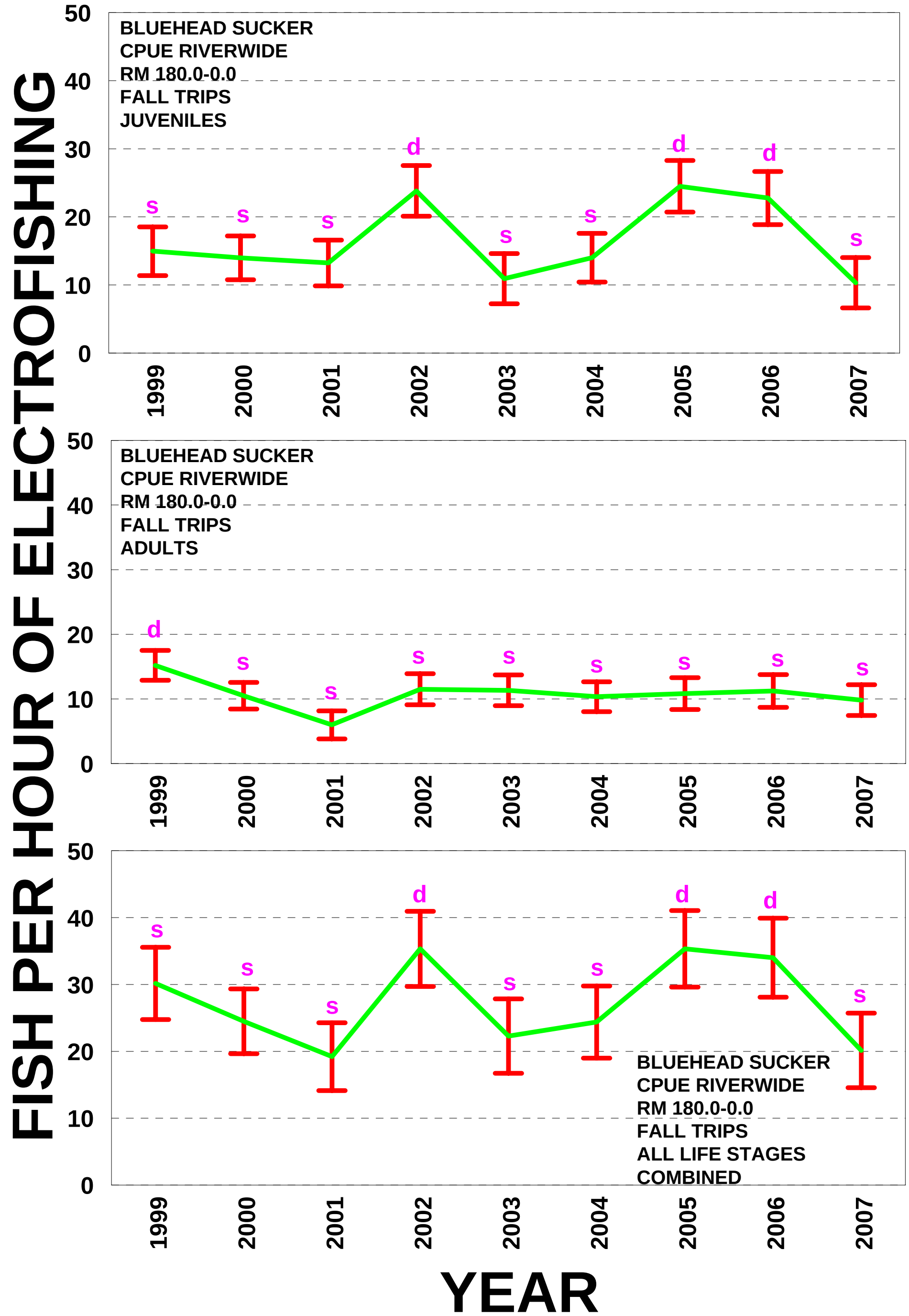

Figure 10. Bluehead sucker CPUE (green line) riverwide (RM 180.0-0.0) on fall Adult Monitoring trips, for juvenile fish (< 300 mm TL; top), adult fish (≥ 300 mm TL; middle), and for all life stages combined (juveniles + adults; bottom). Error bars equal two standard errors. Purple letters are multi-year comparisons. The letter “s” means the value is not significantly different from the 2007 value. The letter “d” means the value is significantly different from the 2007 value.

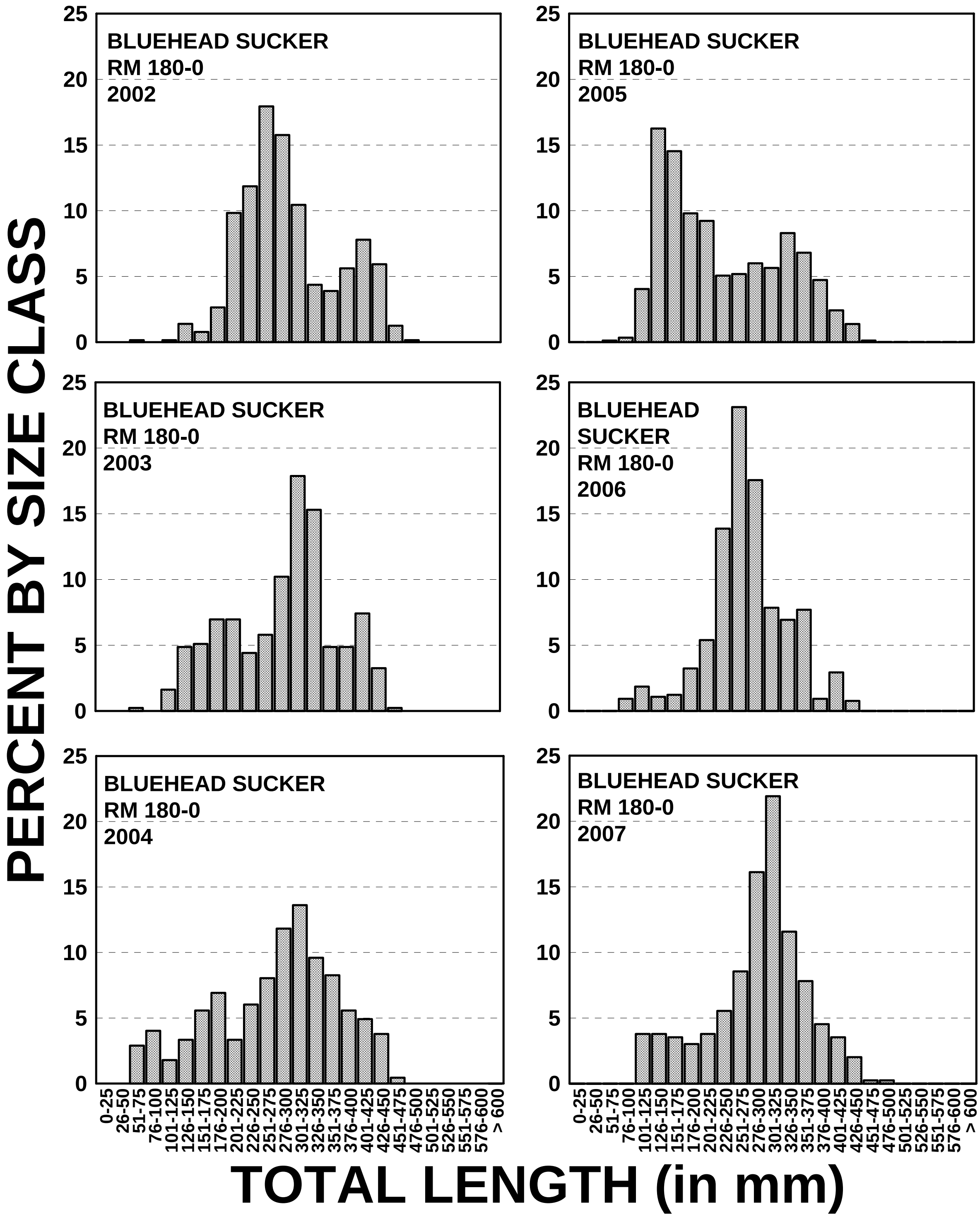

Figure 11. Length-frequency histograms showing the riverwide (RM 180.0-0.0) size-class distribution of bluehead sucker on fall Adult Monitoring trips in the San Juan River, 2002-2007.

Common Nonnative Fishes

Channel Catfish

Catch Information

Channel catfish are the most common nonnative fish collected during Adult Monitoring (Table 3) and have remained among the three most commonly-collected fish species in each of the last nine years (Figure 12). In 2007, channel catfish were the second most commonly-collected fish species, accounting for 34.4% of the total catch and were collected in almost as great of numbers as were flannelmouth sucker (Table 3). After being collected in only 73.6% of electrofishing samples in 2006, channel catfish were much more ubiquitous in 2007, being collected in almost 90% of electrofishing samples riverwide (Figure 12). Channel catfish were collected in all six river reaches in 2007 (from RM 173.0-5.0).

Riverwide CPUE values for adult channel catfish have demonstrated little variation, with values for six of the previous eight years not being significantly different from the 2007 value. Like flannelmouth and bluehead sucker, channel catfish total CPUE is essentially driven by fluctuations in numbers of juvenile fish. After intensive, multiple-pass nonnative removal efforts began in 2001, juvenile channel catfish CPUE dropped significantly and remained low from 2002-2004 (Figure 13). However, between 2004 and 2007, juvenile channel catfish CPUE increased significantly. While 2007 juvenile channel catfish CPUE was significantly higher than 2002-2004, it was not significantly different than either 2005-2006 or 1999-2001 (Figure 13).

Data suggest that the channel catfish population has shifted downstream since nonnative removal efforts began in 2001. In 2001, the largest part of this population resided from RM 166.6-147.9 (PNM Weir to Shiprock bridge) with relatively large numbers (36.3-42.0 fish/hr) of channel catfish in all downstream river sections (Figure 14). However, in 2007 the largest part of the channel catfish population was found in the "middle" sections of the San Juan River -- from RM 119.2-52.9 (Four Corners bridge to Mexican Hat boat launch). Numbers of channel catfish from RM 158.6-119.2 (Hogback diversion to Four Corners bridge) and from RM 52.9-2.9 (Mexican Hat boat launch to Clay Hills boat launch) were significantly lower than those observed in 2001 (Figure 14).

Intensive nonnative fish removal efforts appear to be effective in the limited river sections where they have been implemented. Three river sections in or adjacent to the upper removal section that had "hot spots" where > 200 channel catfish per hour of electrofishing were collected in 2001 (i.e., RM 166.6-119.2) showed greatly reduced maximum total CPUE values in 2007 (Figure 15). Likewise, the lower removal section also showed a greatly reduced maximum total CPUE value in 2007 versus 2001 (Figure 15). Additionally, the number of adult channel catfish

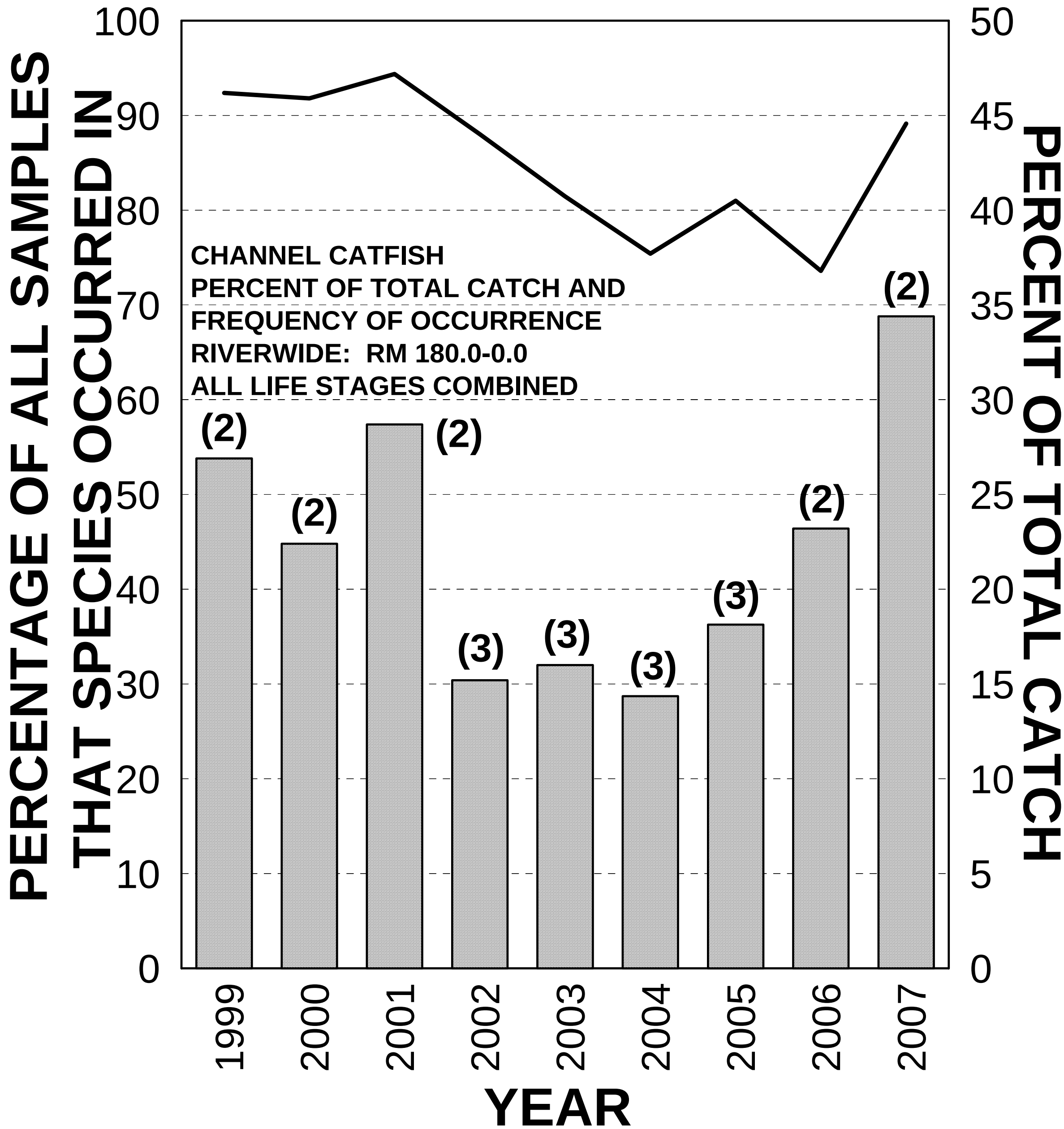

Figure 12. A summary of channel catfish relative abundance in riverwide Adult Monitoring collections, 1999-2007. The solid black line represents the percentage of all electrofishing samples on a given Adult Monitoring trip in which this species occurred (i.e., frequency of occurrence). The gray bars 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.

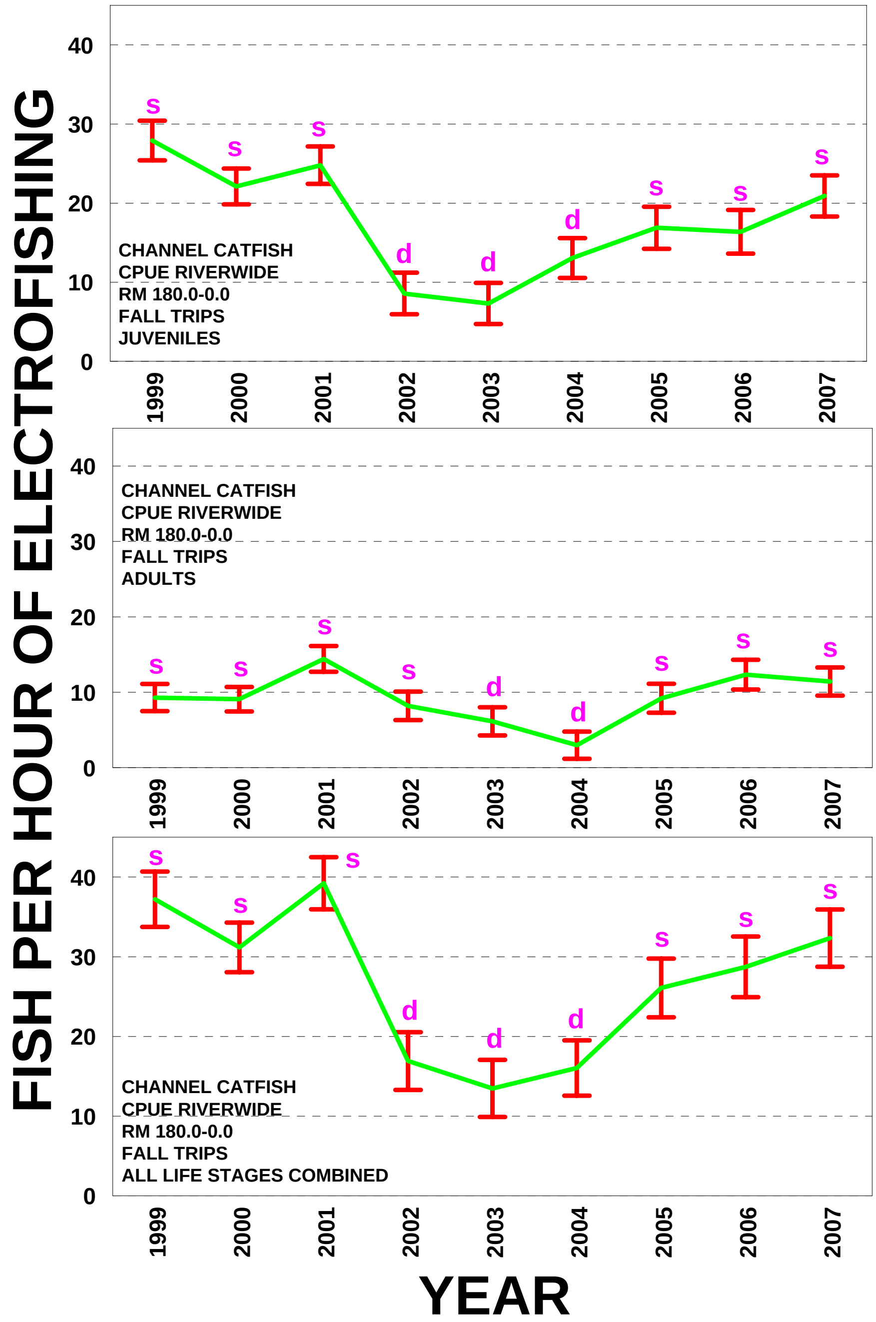

Figure 13. Channel catfish CPUE (green line) riverwide (RM 180.0-0.0) on fall Adult Monitoring trips, for juvenile fish (< 300 mm TL; top), adult fish (≥ 300 mm TL; middle), and for all life stages combined (juveniles + adults; bottom). Error bars equal two standard errors. Purple letters are multi-year comparisons. The letter "s" means the value is not significantly different from the 2007 value. The letter "d" means the value is significantly different from the 2007 value.

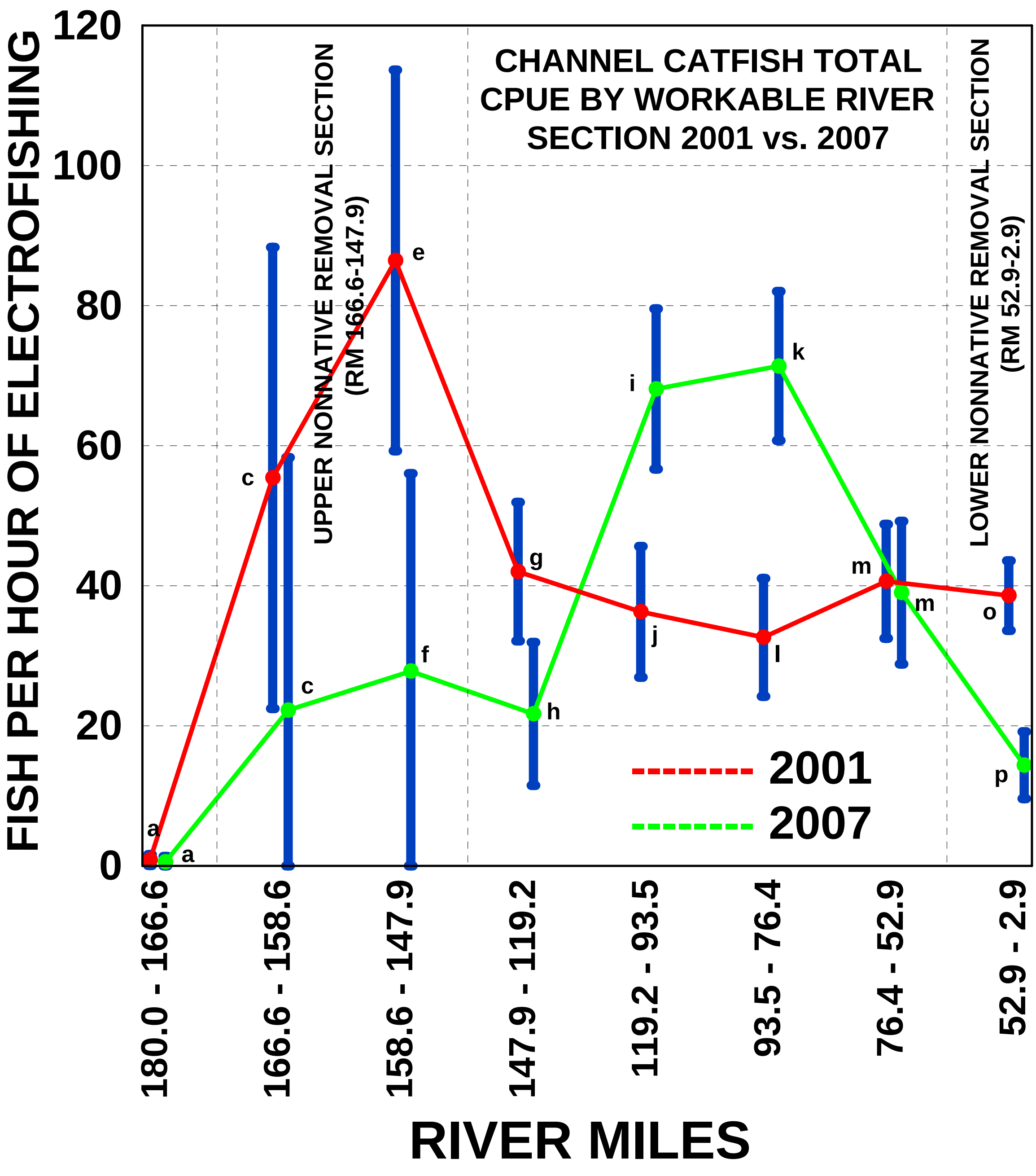

Figure 14. Channel catfish total CPUE in workable sections of the San Juan River (i.e., areas between boat launches) in 2001 versus 2007. The red and green sloping horizontal lines represent the mean total CPUE. The blue error bars equal two standard errors. Letters by the mean CPUE values represent between-year comparisons, within workable river sections. Where letters differ, total CPUE values were significantly different. Where letters are alike, there was no significant difference in total CPUE.

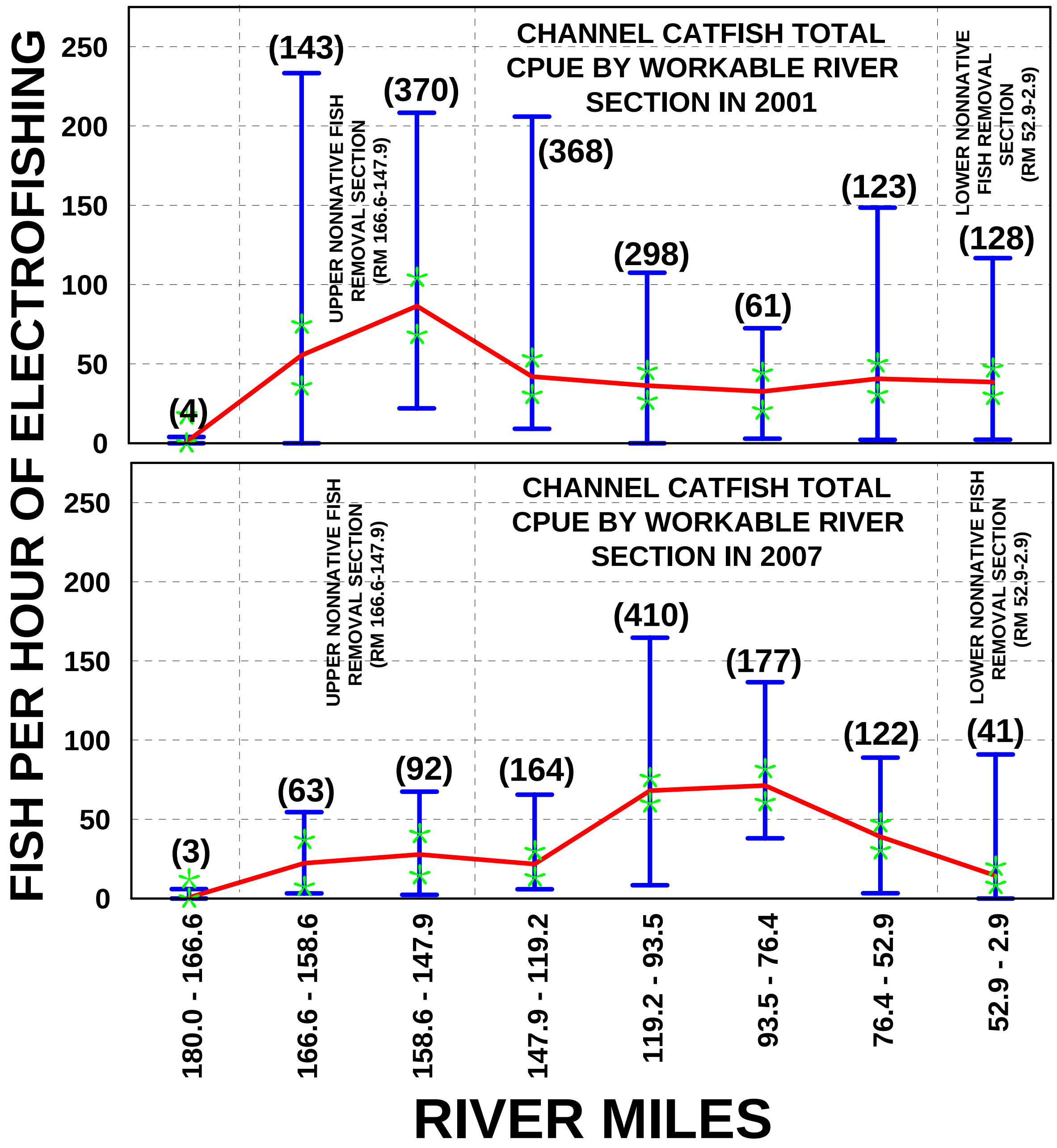

Figure 15. Channel catfish total CPUE in workable sections of the San Juan River (i.e., areas between boat launches) in 2001 compared to 2007. The red sloping horizontal lines represent the mean total CPUE. The blue error bars represent the minimum and maximum observed total CPUE values for each river section. The green asterisks equal two standard errors. Numbers in parentheses represent the number of adult channel catfish (i.e., fish ≥ 300 mm TL) collected in each river section.

being collected from both the upstream and downstream intensive removal sections in 2007 was noticeably lower than in 2001 (Figure 15). Conversely, the number of adult channel catfish being collected from the middle sections of the San Juan River either stayed the same or increased between 2001 and 2007 (RM 119.2-52.9; Figure 15).

Length Information

Channel catfish ranging from 46-778 mm TL (mean TL = 253 mm) were collected during 2007 Adult Monitoring.

In the 2007 length-frequency histogram, the largest group of channel catfish were juvenile fish (likely age-2 fish) centered around 201-225 mm TL (Figure 16). A sizeable group of age-0 fish, centered around 51-75 mm TL, were also very evident (Figure 16). In addition, there was a major distribution (49.3% of all channel catfish collected) of larger subadult and adult channel catfish from 226-450 mm TL (Figure 16). Large influxes of young age-0 and age-1 channel catfish have been evident over the last six years' length frequency histograms.

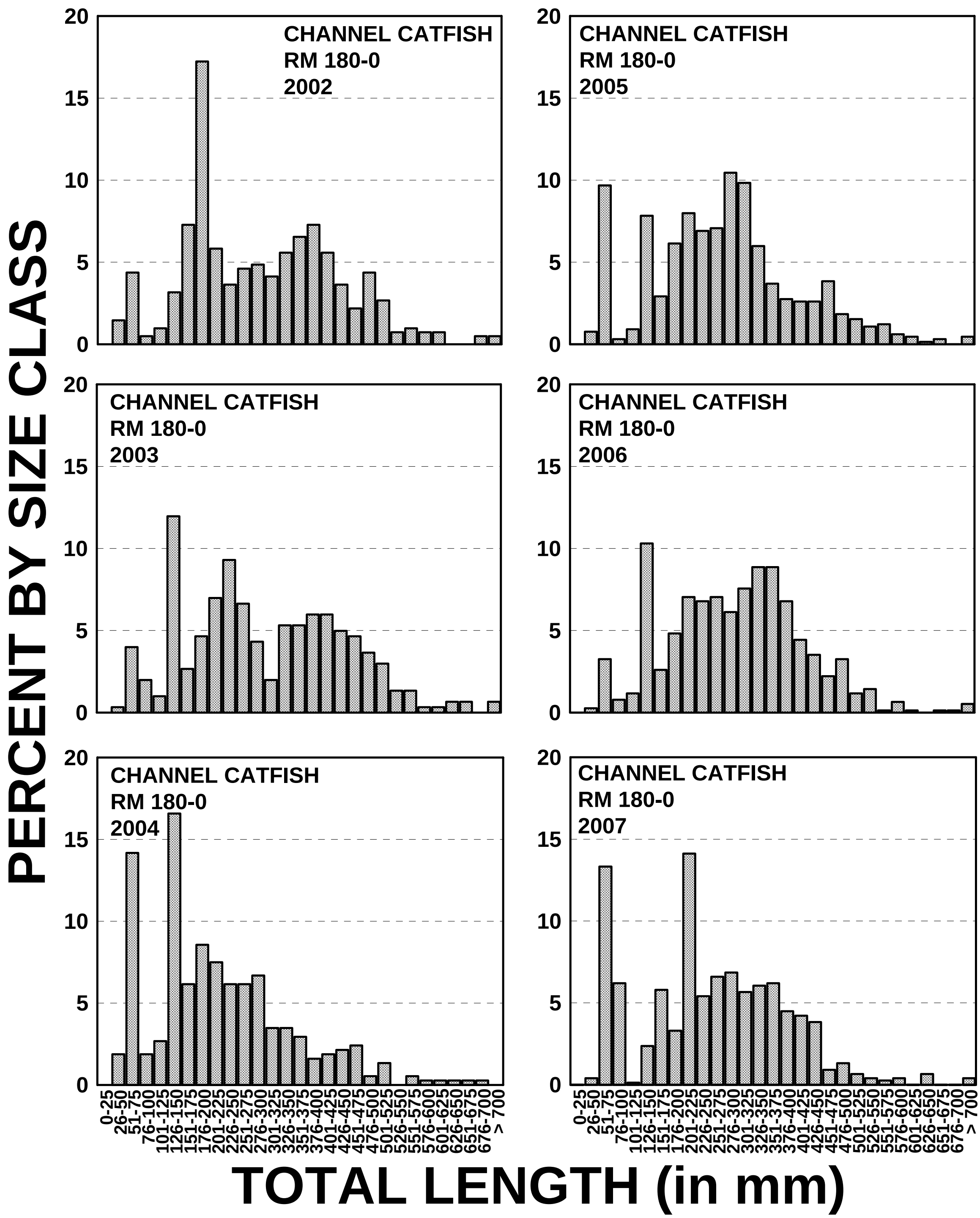

Figure 16. Length-frequency histograms showing the riverwide (RM 180.0-0.0) size-class distribution of channel catfish on fall Adult Monitoring trips in the San Juan River, 2002-2007.

Common Carp

Catch Information

Common carp were the seventh most commonly-collected fish during 2007 Adult Monitoring (Table 3, Figure 17). This marks the fourth consecutive year that common carp have not been among the four most commonly-collected fish species during Adult Monitoring (Figure 17). Only 138 total common carp were collected riverwide in 2007 (Table 3). Though their numbers were low, common carp were collected in all six river reaches in 2007 (from RM 179.0-13.0).

Common carp have composed less of the total catch in each consecutive year since 1999, dropping to a low of 1.51% of the total catch in 2007 (Table 3; Figure 17). Common carp were collected in only 30.77% of all electrofishing collections in 2007, compared to being collected in 83.87%-89.14% of all electrofishing collections riverwide between 1999 and 2002 (Figure 17).

The decline in common carp abundance riverwide was reflected in a significant decline in adult common carp CPUE riverwide from 1999-2007 (Figure 18). During this same period, CPUE among juvenile common carp riverwide increased significantly in 2000, 2002, and 2004 (Figure 18). However, these pulses of juvenile fish did not last more than one year and have not led to a comeback in numbers of adult fish, suggesting that most of the juvenile common carp seen in these pulses are not recruiting into the adult population.

Length Information

Common carp ranging from 139-714 mm TL (mean TL = 538 mm) were collected during 2007 Adult Monitoring. As in past years, the 2007 length-frequency histogram for common carp was dominated by large, adult fish, with very few juvenile fish being observed (Figure 19).

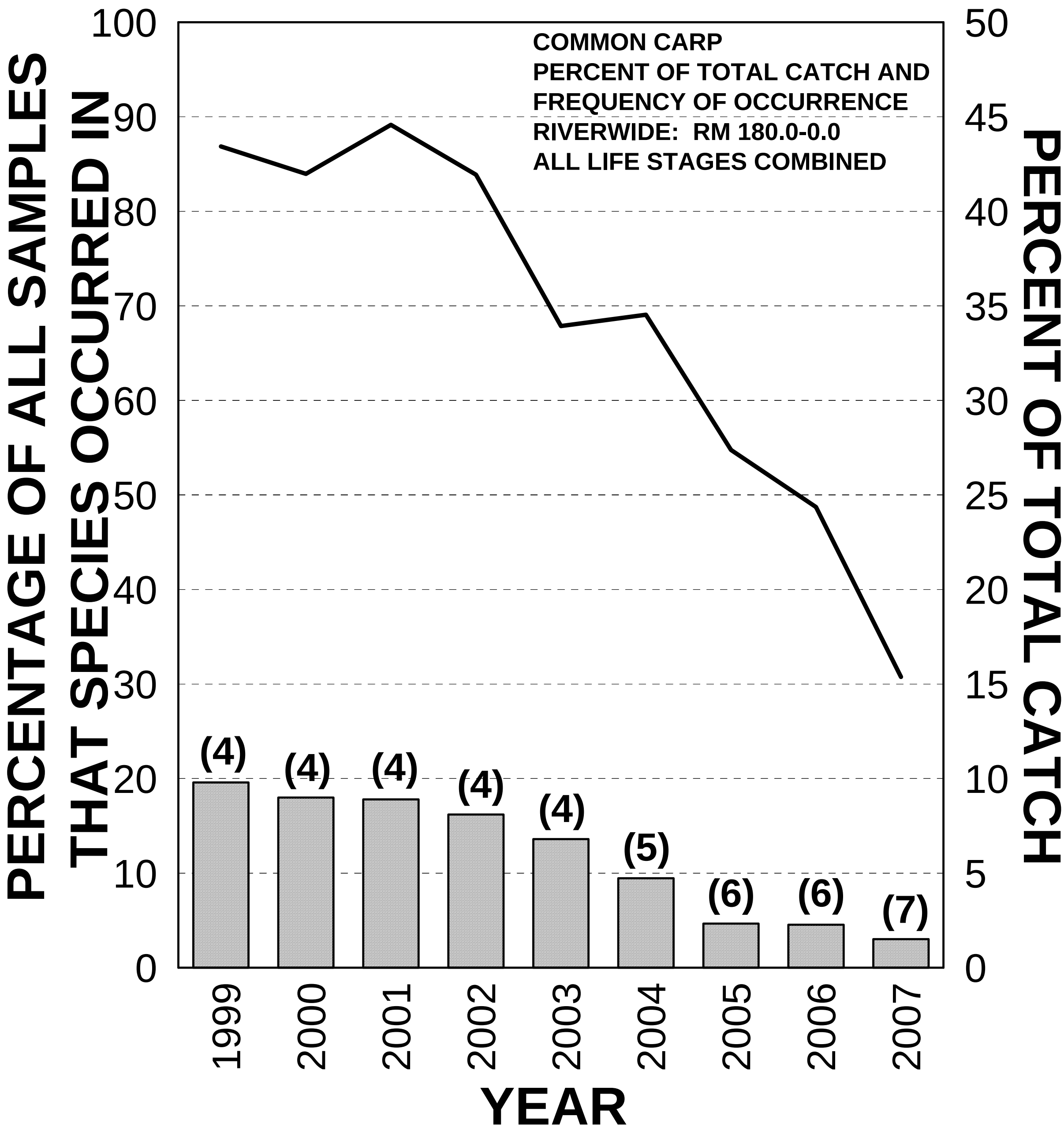

Figure 17. A summary of common carp relative abundance in riverwide Adult Monitoring collections, 1999-2007. The solid black line represents the percentage of all electrofishing samples on a given Adult Monitoring trip in which this species occurred (i.e., frequency of occurrence). The gray bars represent 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.

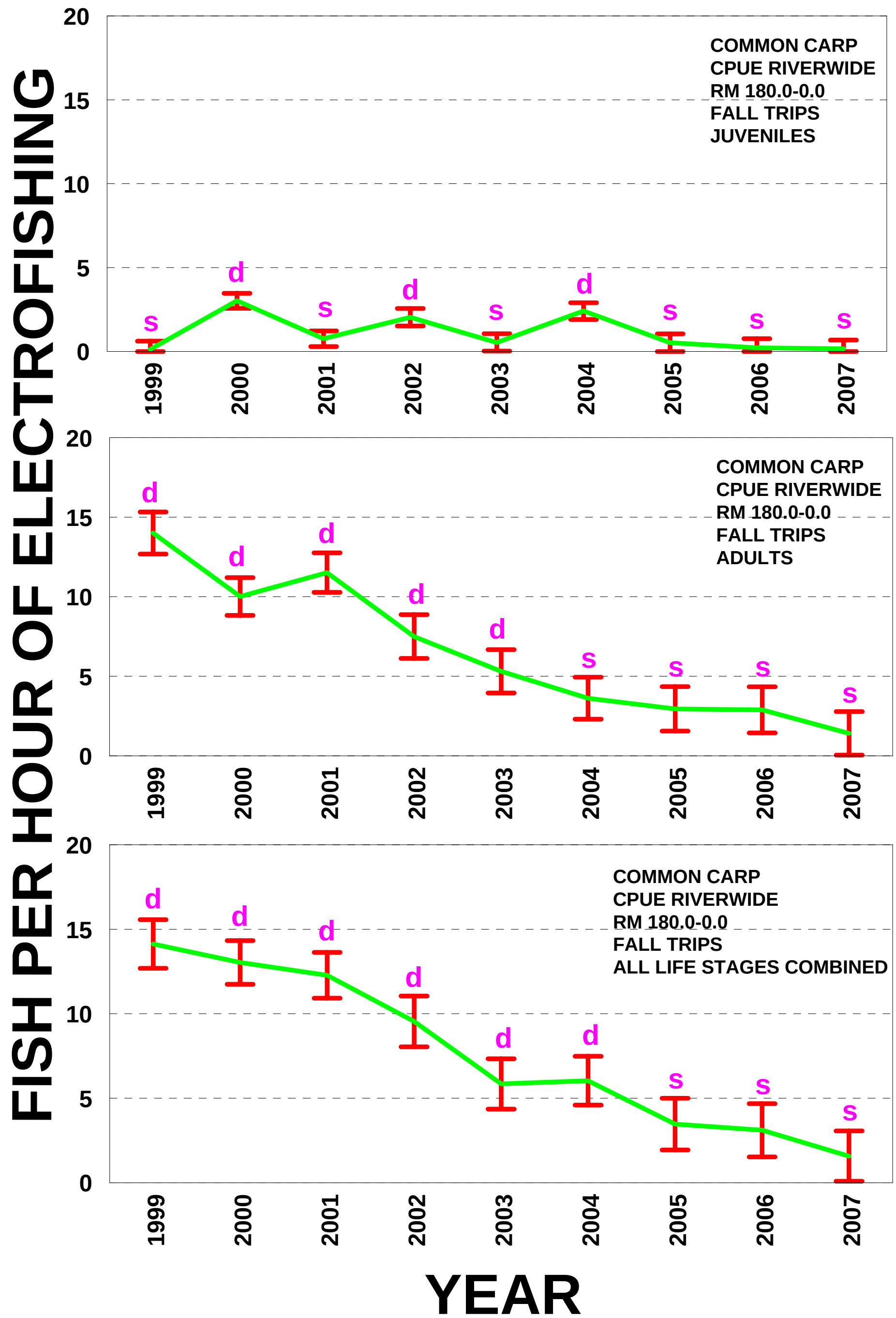

Figure 18. Common carp CPUE (green line) riverwide (RM 180.0-0.0) on fall Adult Monitoring trips, for juvenile fish (< 250 mm TL; top), adult fish (≥ 250 mm TL; middle), and for all life stages combined (juveniles + adults; bottom). Error bars equal two standard errors. Purple letters are multi-year comparisons. The letter "s" means the value is not significantly different from the 2007 value. The letter "d" means the value is significantly different from the 2007 value.

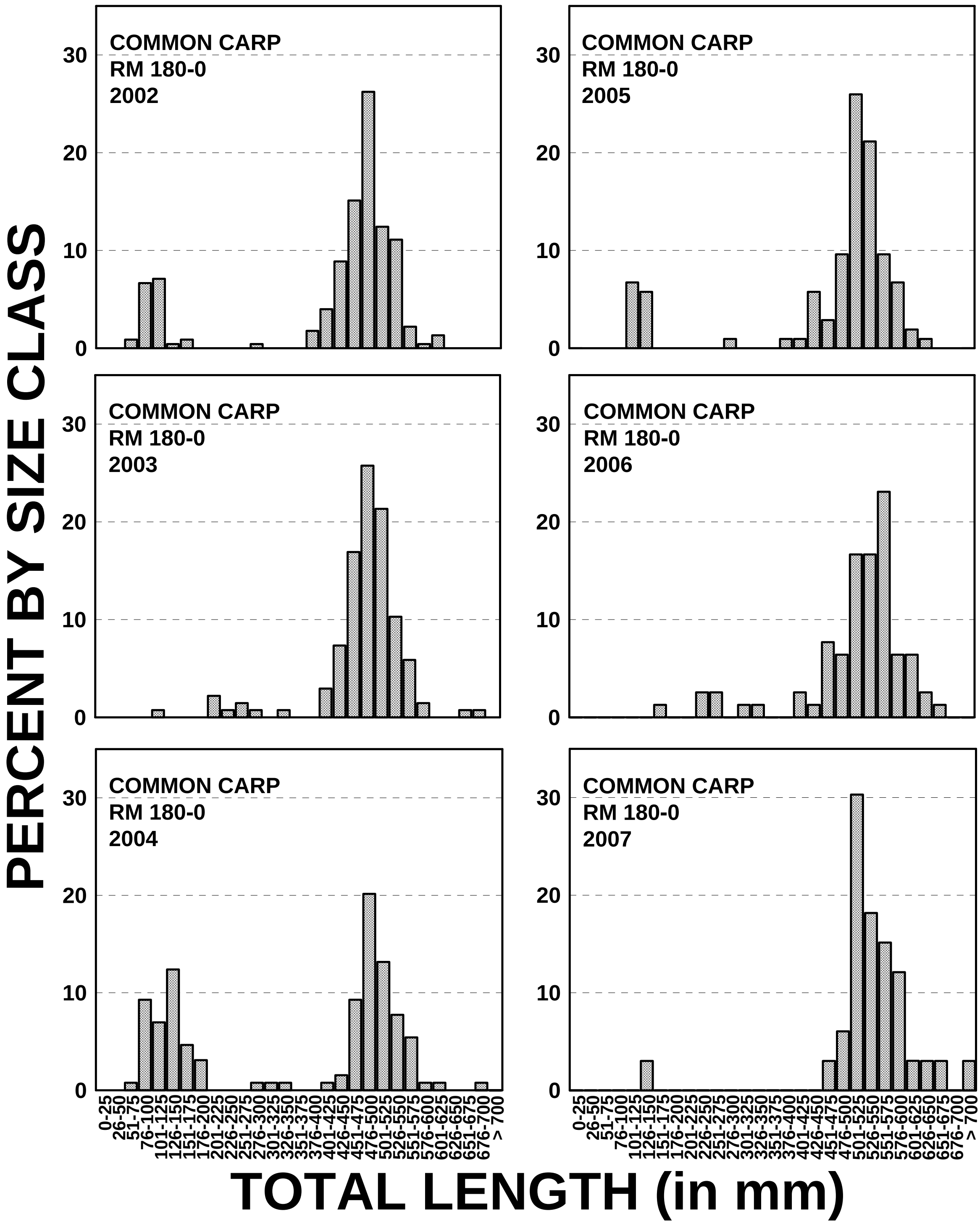

Figure 19. Length-frequency histograms showing the riverwide (RM 180.0-0.0) size-class distribution of common carp on fall Adult Monitoring trips in the San Juan River, 2002-2007.

DISCUSSION

Rare Native Fishes

Colorado Pikeminnow

Wild Colorado pikeminnow continue to be absent from Adult Monitoring collections.

The 167 stocked Colorado pikeminnow collected during 2007 Adult Monitoring marked the fourth consecutive year that > 100 Colorado pikeminnow were collected during Adult Monitoring. While this is an encouraging trend, care must be taken when interpreting that result. The large numbers of Colorado pikeminnow being collected over the last four years have essentially just been a reflection of the large numbers of fish being stocked. Survivors from the large groups of Colorado pikeminnow stocked as age-0 fish are evident in Adult Monitoring collections for only about four overwinter periods post-stocking. In contrast, survivors from the smaller groups of older Colorado pikeminnow that have been stocked since 2003 are essentially absent from Adult Monitoring collections by their second overwinter period post-stocking.

This is not to say that because stocked Colorado pikeminnow are no longer collected in Adult Monitoring collections after a number of years that they have ceased to inhabit the San Juan River or to exist altogether. Survival estimates (Appendix A) indicate that small numbers of these fish do remain in the river, but that their numbers are low enough and they are widely distributed enough to avoid detection by single-pass electrofishing efforts, such as Adult Monitoring. Indeed, two pieces of evidence from other studies also point to the continued persistence of small numbers of stocked Colorado pikeminnow into later years. First are the collections of eight adult Colorado pikeminnow (i.e., < 450 mm TL) between April 2002 and June 2007 that were all either recruits from age-0 fish stocked from 1996-1997 or were wild-spawned fish (Appendix B). These seven fish were collected over a period of six years during multiple-pass sampling trips for the nonnative fish removal effort. Eight of the ten capture events with these fish occurred in the lower canyon (RM 53.0-2.9) where ten passes per year are done by nonnative removal crews, as opposed to a single pass done by Adult monitoring crews (Appendix B). Second was the collection of three larval Colorado pikeminnow during 2007 (Brandenburg and Farrington 2008). While these three larval fish could have been produced by extant wild fish, the chances are equally as good that they are progeny of stocked Colorado pikeminnow that have recruited to adulthood and are now reproducing.

Colorado pikeminnow were collected in Reaches 6-2 in 2007, including upstream of Hogback Diversion in Reach 6. Range expansion of Colorado pikeminnow upstream of this structure was identified as being an important recovery factor for this species (U. S. Bureau of Reclamation 2001). However, this range expansion has been accomplished by stocking hatchery-reared fish directly into this area of the river, as opposed to colonizing upstream areas of the river on their own. Whether or not recently-stocked fish will survive and remain resident in the river upstream of Hogback Diversion is unknown.

Starting in 2003, the SJRIP implemented stricter protocols for the handling, transport, tempering, stocking and acclimation of Colorado pikeminnow aimed at increasing long-term retention and survival among stocked fish. Scaled CPUE comparisons among Colorado pikeminnow stocked as age-0 fish showed that CPUE varied significantly among age-1 fish, with the scaled CPUE for age-0 fish stocked in fall 2002 (when these procedures were not yet in place) and recaptured as age-1 fish in 2003 being significantly lower than all but one other year. However, by the time Colorado pikeminow stocked as age-0 fish had reached age-2, scaled CPUE values were virtually identical among years. By age-3 and again at age-4 there were no significant differences whatsoever in scaled CPUE between years. Thus it would seem that the protocols implemented in 2003 help stocked Colorado pikeminnow survive in greater numbers through their first overwinter period, but at first glance, seem to make little difference after that point. However, it should also be considered that the low numbers of Colorado pikeminnow recaptures in subsequent years reduce statistical power such that any statistical effect of greater survivorship related to stocking protocols might not be detectable (S. Ross pers. comm.).

Razorback Sucker

No wild razorback sucker were collected in 2007.

Numerically, more razorback sucker were collected during 2007 Adult Monitoring than any previous year. Of the 127 razorback sucker recaptured with PIT tags in 2007, most (82.7%) were recently-stocked fish, being in the river < 365 days post-stocking.

Far more razorback sucker were stocked in 2006 (18,793) and in 2007 (22,836) than in any previous year (Ryden 2008b). Yet, there was no significant increase observed in scaled CPUE values for razorback sucker over the last five years. The most likely explanation for the 2006 and 2007 stockings not resulting in a higher associated CPUE value during 2007 and 2008 Adult Monitoring collections would be that many of the razorback sucker stocked in 2006 (n = 7,599; 40.4%) and 2007 (n = 5,937; 26.0%) were salvaged from grow-out ponds as they were being drained. Since the draining and salvage process tends to be very stressful on fish, an unknown (but possibly very large) number of them likely succumbed to either delayed mortality or extended downstream drift (possibly into Lake Powell) after stocking. Additionally, 80.5% of all razorback sucker stocked during 2006 and 93.1% of those stocked in 2007 were < 300 mm TL when stocked (Ryden 2007b, 2008b). It has long been known that razorback sucker stocked at < 300 mm TL tend to be captured much less frequently post-stocking than do razorback sucker stocked at larger sizes (Ryden 2000b). The exact reasons for the relatively poor return rate observed among smaller razorback sucker that were stocked in 2006 and 2007 are unknown. If in the future it becomes apparent that fish collected during pond draining and salvage are being lost due to stress-related factors, it may be necessary to acclimate these fish, as has been done with age-0 Colorado pikeminnow, in order to increase post-stocking survival.

Razorback sucker were collected from all six geomorphic reaches in 2007. While only one razorback sucker was collected upstream of the Hogback fish ladder in 2006 (at RM 160.0; Ryden 2007a), in 2007 a total of 13 razorback sucker were collected upstream of this structure, with two of them being collected upstream of both the APS weir and the PNM weir/fish ladder as well. This increase in razorback sucker collected upstream of the Hogback fish ladder in 2007 may be due to the larger numbers of razorback sucker that were stocked just downstream of this structure over the last two years.

Common Native Fishes

Flannelmouth Sucker

Flannelmouth sucker are still the most abundantly-collected large-bodied fish species in the San Juan River. This species is consistently collected in > 90% of all electrofishing riverwide each year. Flannelmouth sucker are found throughout all six river reaches in the Adult Monitoring study area and 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. Long-term trend lines show that despite year-to-year fluctuations observed in riverwide CPUE, the flannelmouth sucker population has remained relatively stable over the last nine years.

Bluehead Sucker

Bluehead sucker continue to be among the three most commonly large-bodied fish species collected during Adult Monitoring. Bluehead sucker are collected in Reaches 6-2 in most years, with low numbers being collected in Reach 1 adjacent to Lake Powell in four of the last five years. Since 2001, bluehead sucker have become more widely distributed, longitudinally, throughout the San Juan River. The reason for this is unknown. This time period corresponds nicely to the time that intensive nonnative fish removal efforts were initiated in the San Juan River. However, whether the increased distribution and number of juvenile bluehead sucker riverwide is actually tied to nonnative fish removal efforts, or whether these two things are purely coincidental is unknown.

Common Nonnative Fishes

Channel Catfish

Channel catfish are the most common nonnative fish collected during Adult Monitoring. They continue to be collected in all six geomorphic reaches, although their numbers in reaches encompassed by nonnative fish removal efforts have been visibly reduced. Riverwide, CPUE values for channel catfish are essentially the same as they were in 2001 (when intensive nonnative fish removal efforts began); however, the longitudinal distribution of this species has changed. The majority of channel catfish were residing between RM 119.2 and 52.9 during the 2007 Adult monitoring trip. The exact causes of the longitudinal shift in channel catfish distribution between 2001 and 2007 are unknown. However, the fact that this species is now more heavily concentrated in areas of the river where there are no repetitive, intensive removal efforts, hints that this shift may be related to nonnative fish removal.

Strong year-classes of young channel catfish continue to be observed in riverwide length-frequency histograms. This points to the resilience of the channel catfish population in the San Juan River. This species when left alone, even in a fairly truncated section of the river, has demonstrated an impressive capacity for reproduction and recolonization, thus counteracting many of the gains made by intensive nonnative removal efforts both up- and downstream river sections. Hopefully with intensive nonnative removal being applied in this middle section of the San Juan River (beginning in 2008), it will be possible to effectively reduce the number of channel catfish riverwide.

Common Carp

Common carp fell to being the seventh most commonly-collected species during 2007 Adult Monitoring. Common carp were collected in all six geomorphic reaches in 2007, although just a single individual was collected in Reach 1 adjacent to Lake Powell. Over the last four years, common carp numbers have become much reduced. While the exact causes of the large-scale decline of common carp are unknown, nonnative fish removal is likely a major factor. Common carp were numerically less "common" in 2007 than were both endangered Colorado pikeminnow and razorback sucker. Common carp accounted for barely 1.5% of the total catch and were collected in less than a third of all electrofishing samples riverwide in 2007. Only 138 common carp were collected during 2007 Adult Monitoring. In comparison, during 1998 Adult Monitoring, 77 common carp were collected in just one electrofishing sample (RM 163-162). During 2007 Adult Monitoring, less than twice that number were collected in 221 electrofishing samples. If there has been a real success story associated with the nonnative removal efforts in the San Juan River to date, it would appear to be the marked reduction in numbers of common carp riverwide.

As in past years, large, adult common carp continue to be the dominant life stage collected during Adult Monitoring trips. It remains to be seen whether out-of-bank flows, anticipated to occur during the 2008 runoff season, will allow common carp to pull off a large-scale spawning effort, or whether their numbers are now reduced enough to make large-scale spawning efforts unfeasible. These anticipated high flows should allow common carp remaining in the San Juan River access to spawning habitats (e.g., flooded vegetation) that they have not had access to for several years.

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APPENDIX A

A preliminary attempt to predict year-to-year survival among groups of Colorado pikeminnow that are stocked as age-0 fish in the fall of the year.

INTRODUCTION

One of the ongoing difficulties in the augmentation programs for both endangered fish is the difficulty in predicting year-to-year survival among groups of stocked fish. This problem is caused by numerous factors, including: 1) highly variable numbers of fish stocked between years; 2) different age-classes of fish stocked within and among years; and 3) a generalized lack of captures of older stocked fish. This third factor tends to become more problematic with increasing years post-stocking.

Since numbers of endangered fish captures tend to decrease markedly with increasing time post-stocking, doing mark-recapture studies on these fish is not feasible at this time. Rather, as a first attempt to determine post-stocking survival, I examined the recaptures among Colorado pikeminnow stocked as age-0 fish over a five-year period (2002-2006) in an attempt to do some preliminary survival calculations. These calculations make possible preliminary predictions on the numbers of Colorado pikeminnow that might be expected to be seen in the river per every 100,000 age-0 fish that are stocked in the fall of the year (i.e., late October to early November).

All of the following discussion applies strictly to Colorado pikeminnow stocked as age-0 fish in the fall of the year.

METHODS

Captures of Colorado pikeminnow from Adult Monitoring trips from 2003-2007 were partitioned by age-class at stocking. Age-class at stocking was determined either by the presence the of a PIT tag or by comparing untagged fish against growth curves generated for Colorado pikeminnow stocked as age-0 fish between 2002 and 2005 (unpublished data). Captures of Colorado pikeminnow stocked as age-0 fish and subsequently captured during Adult Monitoring trips as age-1 through age-4 fish were totaled up for each year. In this manner, the actual number of Colorado pikeminnow from a particular stocking of age-0 fish could be tracked across years (Table A-1).

Since the actual number of Colorado pikeminnow collected was obtained from our electrofishing samples, this number was then multiplied by five to account for "20% first-pass electrofishing" rule of thumb generated by Bill Miller and Vince Lamarra. This rule of thumb basically states that during the first electrofishing pass through a given RM, sampling crews will collect an average of 20% of all of the fish that are actually present in that RM. This gave me the total number of fish expected to be present in all sampled RMs within our 180-RM study area (with 2 of every 3 RMs being sampled; Table A-2).

After applying the 20% rule of thumb, I then extrapolated the total expected number within our electrofishing samples to include the unsampled RMs in our 180-RM study area. The expected number (from Table A-2) was multiplied by 1.5 to predict what it might be expected to be had all 180 RMs been sampled, assuming fish were evenly distributed throughout all the RMs in the study area. This gave me the total number of fish expected to be present within the entirety of our 180-RM study area (Table A-3).

The total number of fish expected to be present within the entirety of our 180-RM study area was then divided by 180 to obtain the expected average number of Colorado pikeminnow per RM present during our sampling efforts (Table A-4).

Dividing the total number of fish expected to be within the entire 180-RM study area at age-1 (Table A-3) by the actual number of age-0 fish that were stocked allowed me to obtain an expected survival rate between age-0 and age-1. By continuing this calculation across a given row in Table A-3, I was able to obtain an expected year-to-year survival rate for each individual group of stocked age-0 fish through 2007 (Table A-5, top row). Multiplying the mean expected year-to-year survival rate by 100,000 allowed me predict how many age-0 Colorado pikeminnow would likely be present within our 180-RM study area for every 100,000 age-0 fish stocked (Table A-5, middle row). This could then be divided by 180 to determine the expected number of fish per RM (Table A-5, bottom row). Table A-5 uses data from all five stockings of age-0 Colorado pikeminnow that occurred from 2002-2006, even though age-0 fish stocked in 2002 were not tempered for as long prior to stocking and none of them were acclimated prior to their release into the river.

I was also interested in whether or not there was any difference in expected survival between fish stocked in 2002 and fish stocked from 2003-2006 (i.e., when longer tempering times and pre-release, in-river acclimation were being employed). To examine this, I first excised the data from the 2002 stocking of age-0 fish, then repeated the procedures detailed in the previous paragraph (Table A-6).

RESULTS AND DISCUSSION

My calculations predicted that at age-1, Colorado pikeminnow stocked as age-0 fish the prior year, occurred from 1.33-7.13 fish/RM (Table A-4). By age-2, this wide variation had dropped to 0.67-1.38 fish/RM. By age-3, there was even less variation, with occurrence being 0.08-0.25 fish/RM. So, despite the wide variation in numbers of age-0 fish being stocked each year, by age 3, there was little difference in the number of fish being collected in our electrofishing samples. It appears that the efforts to be more careful during the handling, transport, tempering, and acclimating of age-0 fish since 2003 have increased their survival at age-1. However, this difference does not appear to last into subsequent years. In fact, at age-2 and beyond, Colorado pikeminnow from the 2002 stocking of age-0 fish actually have slightly better survival numbers than those stocked from 2003-2006 (Tables A-5 and A-6).

Put in terms of survival per 100,000 fish stocked, at age-1 Colorado pikeminnow are common enough (at a little more than 1 fish every half RM) to be collected on a fairly regular basis. However, the number of fish per RM drops markedly in subsequent years, such that by age-3 there is predicted to be only one Colorado pikeminnow per every 50 RMs. This would explain why age-3+ Colorado pikeminnow are extremely rare in electrofishing collections, especially given the 20% rule discussed earlier.

Therefore, the lack of age-4 and age-5 Colorado pikeminnow during the 2007 Adult Monitoring trip are almost certainly a result of having a very low capture probability for these age-classes of fish, because there are so few of them in the river and we know that electrofishing samples do not collect all the fish that are present.

Table A-1. Actual number of Colorado pikeminnow (stocked as age-0 fish) that were captured during subsequent years' Adult Monitoring trips (with 2 of every three RMs being sampled).

Year-Class & (Number Stocked)	Year Of Capture				
	2003	2004	2005	2006	2007
2002 (210,418)	32	16	3	1	0
2003 (175,928)	-----	130	33	6	0
2004 (280,000)	-----	-----	67	26	2
2005 (302,270)	-----	-----	-----	171	20
2006 (313,854)	-----	-----	-----	-----	115

Table A-2. Predicted number of Colorado pikeminnow (stocked as age-0 fish) occupying the study area (180 RMs) during subsequent years' Adult Monitoring trips, based on actual numbers collected and extrapolated using the 20% first-pass electrofishing capture rule (with 2 of every three RMs being sampled).

Year-Class & (Number Stocked)	Year Of Capture				
	2003	2004	2005	2006	2007
2002 (210,418)	160	80	15	5	0
2003 (175,928)	-----	650	165	30	0
2004 (280,000)	-----	-----	335	130	10
2005 (302,270)	-----	-----	-----	855	100
2006 (313,854)	-----	-----	-----	-----	575

Table A-3. Predicted number of Colorado pikeminnow (stocked as age-0 fish) occupying the entire study area (180 RMs) during subsequent years' Adult Monitoring trips, based on predicted numbers generated in Table A-2 extrapolated to what they might be expected to be if all 180 RMs were sampled.

Year-Class & (Number Stocked)	Year Of Capture				
	2003	2004	2005	2006	2007
2002 (210,418)	240	120	23	8	?
2003 (175,928)	-----	975	248	45	?
2004 (280,000)	-----	-----	503	195	15
2005 (302,270)	-----	-----	-----	1,283	150
2006 (313,854)	-----	-----	-----	-----	863

Table A-4. Predicted average number of Colorado pikeminnow (stocked as age-0 fish) per RM expected to be distributed throughout the entire study area (180 RMs) during subsequent years' Adult Monitoring trips, based on predicted numbers generated in Table A-3 divided by the length of the study area.

Year-Class & (Number Stocked)	Year Of Capture				
	2003	2004	2005	2006	2007
2002 (210,418)	1.33	0.67	0.13	0.04	?
2003 (175,928)	-----	5.42	1.38	0.25	?
2004 (280,000)	-----	-----	2.79	1.08	0.08
2005 (302,270)	-----	-----	-----	7.13	0.83
2006 (313,854)	-----	-----	-----	-----	4.79

Table A-5. Predicted survival parameters for Colorado pikeminnow stocked as age-0 fish during subsequent years' Adult Monitoring trips, based on numbers generated in Tables A-1 through A-4.

	Age-0 to Age-1	Age-1 to Age-2	Age-2 to Age-3	Age-3 to Age-4	Age-4 to Age-5
Predicted Year-To-Year Survival	Mean = 0.31% Range = 0.11%-0.55% (5 data points)	Mean = 31.47% Range = 11.69%-50.00% (4 data points)	Mean = 15.00% Range = 7.69%-19.16% (3 data points)	Mean = 17.39% Range = 0.00%-34.78% (2 data points)	Mean = 0.00% Observed Range = 0.00% (1 data point)
	At Age-1	At Age-2	At Age-3	At Age-4	At Age-5
Predicted Number Of Fish Occupying The Entire 180-RM Study Area (Per 100,000 Fish stocked)	310	98	15	3	?
Predicted Number Of Fish Per RM Throughout The Entire 180-RM Study Area (Per 100,000 Fish stocked)	1.72 (= 1 Fish Per Every 0.58 RMs)	0.54 (= 1 Fish Per Every 1.85 RMs)	0.08 (= 1 Fish Per Every 12.50 RMs)	0.02 (= 1 Fish Per Every 50.00 RMs)	? (= 1 Fish Per Every ? RMs)

Table A-6. Predicted survival parameters for Colorado pikeminnow stocked as age-0 fish during subsequent years' Adult Monitoring trips, based on numbers generated in Tables A-1 through A-4 and excising the data from the 2002 stocking (i.e., just including data that was collected after longer tempering times and acclimation of stocked fish were implemented) .

	Age-0 to Age-1	Age-1 to Age-2	Age-2 to Age-3	Age-3 to Age-4	Age-4 to Age-5
Predicted Year-To-Year Survival	Mean = 0.36% Range = 0.18%-0.55% (4 data points)	Mean = 25.30% Range = 11.69%-38.77% (3 data points)	Mean = 12.92% Range = 7.69%-18.15% (2 data points)	Mean = 0.00% Observed Range = 0.00% (1 data point)	? (0 data points)
	At Age-1	At Age-2	At Age-3	At Age-4	At Age-5
Predicted Number Of Fish Occupying The Entire 180-RM Study Area (Per 100,000 Fish stocked)	360	91	12	0	?
Predicted Number Of Fish Per RM Throughout The Entire 180-RM Study Area (Per 100,000 Fish stocked)	2.00 (= 1 Fish Per Every 0.50 RMs)	0.51 (= 1 Fish Per Every 1.96 RMs)	0.07 (= 1 Fish Per Every 14.29 RMs)	0.00 (= 1 Fish Per Every ? RMs)	? (= 1 Fish Per Every ? RMs)

APPENDIX B

Data on eight adult Colorado pikeminnow captured as adult fish from 2002-2007 that were likely stocked as age-0 fish from 1996-1997.

Table B-1. Eight adult Colorado pikeminnow collected from 2002-2007 that were likely recruits from the 1996-1997 stockings of age-0 Colorado pikeminnow by the Utah Division of Wildlife Resources (detailed in Archer et al. 2000).

Capture information:						
Capture Date	Capture RM	TL At Capture	Possible Age At Capture	PIT Tag Number	Source Report	Likely Stocking Year:
4/16/2002	45.8	539 mm	6	5312122813	Jackson 2003	1996
6/12/2002	21.4	507 mm	6	51247F0B49	Jackson 2003	1996
6/26/2002	23.7	475 mm	5	423D133353	Jackson 2003	1997
6/27/2002	19.8	460 mm	5	5228305F22	Jackson 2003	1997
3/27/2003	16.0	530 mm	7	53180D4E7E 3D9257C69CA71	Jackson 2004	1996
4/29/2003	34.0	535 mm	7	522A213C40	Jackson 2004	1996
4/30/2003	21.4	590 mm	7	4269392329	Jackson 2004	1996
3/25/2004	16.4	547 mm	7	423D133353 ®	SJRIP database	1997
7/28/2005	157.6	603 mm	9	3D91BF18D723B	Davis 2006	1996
6/20/2007	119.0	709 mm	11	53180D4E7E ® 3D9257C69CA71	Davis and Furr 2008	1996

® = Recapture