LONG TERM MONITORING OF SUB-ADULT AND ADULT LARGE-BODIED FISHES IN THE SAN JUAN RIVER, 2000

INTERIM PROGRESS REPORT
(Final)

SUBMITTED BY:

DALE W. RYDEN
FISHERY BIOLOGIST

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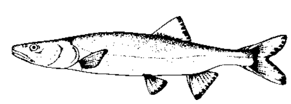

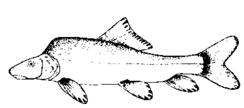

U.S. FISH AND WILDLIFE SERVICE
COLORADO RIVER FISHERY PROJECT
764 HORIZON DRIVE, BUILDING B
GRAND JUNCTION, COLORADO 81506-3946

EXECUTIVE SUMMARY

This past year, 2000, was the second year of long term monitoring of sub-adult and adult large-bodied fishes in the San Juan River. The long-term monitoring program was based on the main channel adult fish community monitoring study which preceded it. The sampling protocols for long-term monitoring were designed to allow for data comparisons between these two studies.

Flannelmouth sucker total (juvenile + adult) catch per unit effort (CPUE) in the core sampling area (RM 158.6-53.0), which demonstrated statistically significant declines from 1992-1997, ceased to decline in 1998 then increased in both 1999 and 2000. Flannelmouth sucker total CPUE for the section of river between RM 180.0 and 53.0 showed this same trend. Very few flannelmouth sucker were collected in Reach 1, adjacent to Lake Powell, again in 2000. Over the last several years, small size-class flannelmouth sucker (< 400 mm TL) have virtually disappeared from electrofishing collections in Reach 1. This may be associated with the invasion of the lower San Juan River by striped bass and walleye that started in 1995. Large numbers of age-0 flannelmouth sucker were collected in 2000, mostly upstream of the PNM Weir (RM 166.6) in Reach 6.

Total CPUE of bluehead sucker in Reach 6 has increased tremendously over the last two years (1999-2000). Comparisons of bluehead sucker total CPUE in the area of the river from RM 180.0-53.0 showed significantly more bluehead sucker in both 1999 and 2000 than in all previous years in which this entire area was sampled on the same trip. Like flannelmouth sucker, large numbers of age-0 bluehead sucker were also collected in 2000, again mostly upstream of the PNM Weir (RM 166.6) in Reach 6.

No wild Colorado pikeminnow were collected in 2000. Only one stocked juvenile Colorado pikeminnow was collected during 2000 adult monitoring. Numbers of stocked juvenile Colorado pikeminnow collected on sampling trips for other studies were also markedly lower in 2000. All other studies combined collected only three more individual Colorado pikeminnow.

Stocked razorback sucker continue to be collected from the San Juan River, although in fairly low numbers, eight were collected during 2000 adult monitoring. Five of these fish were implanted with radio transmitters and will be monitored during the 2000 spawning season. Three untagged razorback sucker were collected upstream of the PNM Weir at RM 169.0 in 2000. These fish probably entered the river when the dike at Ojo Pond broke during heavy rains on 3 August 1998 and the fish from this grow-out pond were swept into Ojo Wash. This wash enters the San Juan River at about RM 170.8.

No roundtail chub were collected during 2000 adult monitoring. Roundtail chub, as a population, have demonstrated no documented long-term persistence in the San Juan River since studies began in 1991.

In 1999, several trends were noted in channel catfish data (both total CPUE and total length data) that seemed to indicate that mechanical removal efforts were beginning to adversely impact the San Juan River channel catfish population. However, channel catfish CPUE data in 2000 was highly variable and did not clearly follow any discernible trend, riverwide. In 2000, channel catfish total CPUE in Reach 6 (where intensive mechanical removal efforts have been based in recent years) was the lowest it had been in three years. Yet channel catfish total CPUE in adjacent Reach 5 in 2000 was the highest observed for any reach and any year since studies began in 1991. Probably the most significant finding for channel catfish in 2000 was that unlike the other three common large-bodied fishes (flannelmouth sucker, bluehead sucker, and common carp), large numbers of age-0 channel catfish were not collected, in any reach, in 2000.

Common carp continue to be ubiquitous throughout the San Juan River, downstream of the Animas River confluence. Large numbers of age-0 common carp were collected in 2000. Like flannelmouth sucker and bluehead sucker, these age-0 common carp were concentrated mostly upstream of the PNM Weir (RM 166.6) in Reach 6.

More largemouth bass were collected during October 2000 electrofishing than during any previous adult monitoring trip, regardless of time of year. The large majority of the largemouth bass (109 of 111 collected) were juvenile fish. Collections of largemouth bass were concentrated upstream of RM 100.0, suggesting that these fish entered the river from upstream sources, not Lake Powell.

Relatively large numbers of striped bass were collected on the October 2000 sampling trip. Large numbers of striped bass were also collected from the PNM Weir (RM 166.6) downstream to RM 129.0 during summer 2000 collections for other studies. The abundance and distribution of striped bass in the San Juan River pose a serious threat to young native fishes of all species. This presence of large numbers of lacustrine predators in the San Juan River could preclude the success of future stocking efforts for Colorado pikeminnow and razorback sucker, if it is repeated on a regular basis.

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INTRODUCTION

Research performed between 1991 and 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 the development of flow recommendations for the reoperation of Navajo Reservoir, mechanical removal of nonnative fishes, modification or removal of several instream water diversion structures, and augmentation efforts for both endangered fish species–Colorado pikeminnow and razorback sucker. In order to assess the effects of these management actions over the duration of the SJRIP, a long-term monitoring program (Propst et al. 2000) was initiated. Standardized data collection under long-term monitoring plan guidelines began in 1999 and will continue until the termination of the SJRIP.

One component of the long-term monitoring program, the “sub-adult and adult large-bodied fish monitoring,” was the primary responsibility of the U.S. Fish and Wildlife Service’s Colorado River Fishery Project office in Grand Junction, CO. Numerous other state and federal agencies supplied manpower, equipment, and logistical support for these sampling efforts.

The objectives of the sub-adult and adult large-bodied fish monitoring (referred to herein as “adult monitoring”) are as follows:

1) Determine shifts in fish community structure, species abundance and distribution, and length/weight frequencies under the reoperation flow regime.

2) Monitor Colorado pikeminnow population trends (spawning and staging areas, habitat needs).

3) Monitor stocked razorback sucker and Colorado pikeminnow (growth rates, dispersal patterns, and habitat use).

The study area for adult monitoring began at the Animas River confluence (river mile {RM} 180.0) and continued to Clay Hills boat landing (RM 2.9) just upstream of Lake Powell.

METHODS

Sampling in 2000 followed the protocols for long-term monitoring set forth in Propst et al. (2000). The entire study area (RM 180.0-2.9) was sampled between 19 September and 10 October 2000. Electrofishing was performed in a continuos downstream direction from put-in to take-out. One electrofishing raft sampled each shoreline. Electrofishing crews consisted of one rower and one netter. Rafts shocked perpendicular to the shoreline at a fairly constant rate of speed, with an effort being made to net all fishes stunned by the electrofisher. Electrofishing was done in one-RM increments, with two of every three RM being sampled. At the end of each sampled RM, all fish were identified and enumerated by life stage and species. At the end of every fourth sampled RM (known as a designated mile, or “DM” for short), all fish were weighed (± 5 grams {g}) and measured (± 1 mm total {TL} and standard {SL} lengths). All common native fishes were then returned alive to the river. All nonnative fishes were removed from the river. Rare native fishes (i.e., Colorado pikeminnow, razorback sucker, and roundtail chub) were weighed, measured, had distinguishing characteristics (i.e., sex, external parasites, etc.) noted, and scanned for PIT tags. If no PIT tag was found, one was implanted before the fish was returned to the river. Sampling effort was recorded as elapsed time (in seconds) fished by each raft in each RM.

Electrofishing data were pooled for all rafts to obtain total catch numbers for each sampling trip. Numbers of fish (juvenile + adult life stages) collected by all rafts were combined to obtain total catch for each species. Total catch numbers for each species were then divided by the number of seconds (converted to hours) fished by all rafts combined to obtain total catch per unit effort (CPUE) values. Total CPUE for each species was then partitioned by whole geomorphic reach or common sampled areas and compared to 1991-1999 electrofishing data to evaluate long-term trends. After total CPUE data were normalized by ranking, a one-way analysis of variance (ANOVA) with a post-hoc, Bonferroni-adjusted, pairwise multiple comparison test was used to test for significant differences between total CPUE values, by species, in selected river reaches between years. Since total CPUE data represented a sample of a population collected under field conditions and not a specifically known value (i.e., population parameter), significance was determined at $p < 0.10$. This high alpha value was used in order to help avoid making a Type II Error (i.e., failing to statistically detect a change in total CPUE values when there was indeed a change).

RESULTS

A total of 18 species and three catostomid hybrid forms representing eight families of fishes were collected from the San Juan River in 2000 (Table 1). Native fishes were represented by six species and one catostomid hybrid form (Tables 1 and 2). Native fishes composed 66.72% (n = 11,049) of all fish collected in 2000 (Table 1). Rare native fishes (i.e., Colorado pikeminnow and razorback sucker) contributed only nine individuals (< 0.1%) to the total

Table 1. Total number of fish collected in standardized electrofishing collections, 2000.

Species (Status)[a]	Total number of specimens	Percent of total	Rank	Frequency of occurrence
flannelmouth sucker(N)	7,904	47.7	1	263
channel catfish(I)	3,704	22.4	2	269
bluehead sucker(N)	2,609	15.8	3	189
common carp(I)	1,498	9.0	4	246
speckled dace(N)	498	3.0	5	109
largemouth bass(I)	111	0.7	6	58
striped bass(I)	109	0.7	7	64
red shiner(I)	50	0.3	8	24
bluehead sucker X flannelmouth sucker(H,N)	21	0.1	9	15
brown trout(I)	12	---[b]	10	7
razorback sucker(N)	8	---	11	6
mottled sculpin(N)	8	---	11	6
walleye(I)	7	---	12	6
fathead minnow(I)	7	---	12	5
white sucker(I)	5	---	13	3
green sunfish(I)	3	---	14	3
black bullhead(I)	2	---	15	2
Colorado pikeminnow(N)	1	---	16	1
white sucker X bluehead sucker(H,I)	1	---	16	1
white sucker X flannelmouth sucker(H,I)	1	---	16	1
rainbow trout(I)	1	---	16	1
2000 Native Fishes	11,049 (66.72%)			
2000 Introduced Fishes	5,511 (33.28%)			
Native:Introduced Fishes Ratio = 2.00:1				
GRAND TOTAL	16,560		2000 collections = 293	

[a] = Native species(N); Introduced species(I); Hybrid considered a native species(H,N); Hybrid considered an introduced species(H,I)

[b] = less than 0.1%

Table 2. Scientific and common names, status, and six-letter codes for fish species collected during "adult monitoring" trips in the San Juan River, 2000 (following Robins et al. 1991 and Nelson et al. 1998[a]).

SCIENTIFIC NAME	COMMON NAME	STATUS	CODE
Class Osteichthyes-Bony Fishes			
Order Cypriniformes			
Family Catostomidae-suckers			
Catostomus commersoni	white sucker	introduced	Catcom
Catostomus discobolus	bluehead sucker	native	Catdis
Catostomus latipinnis	flannelmouth sucker	native	Catlat
C.commersoni X *C.discobolus*	hybrid	introduced	comXdis
C.commersoni X *C.latipinnis*	hybrid	introduced	comXlat
C.latipinnis X *C.discobolus*	hybrid	native	latXdis
Xyrauchen texanus	razorback sucker	native	Xyrtex
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[a]	native	Ptyluc
Rhinichthys osculus	speckled dace	native	Rhiosc
Order Perciformes			
Family Centrarchidae-sunfishes			
Lepomis cyanellus	green sunfish	introduced	Lepcya
Micropterus salmoides	largemouth bass	introduced	Micsal
Family Percichthyidae-temperate basses			
Morone saxatilis	striped bass	introduced	Morsax
Family Percidae-perches			
Stizostedion vitreum	walleye	introduced	Stivit
Order Salmoniformes			
Family Salmonidae-trouts			
Oncorhynchus mykiss	rainbow trout	introduced	Oncmyk
Salmo trutta	brown trout	introduced	Saltru
Order Scorpaeniformes			
Family Cottidae-sculpins			
Cottus bairdi	mottled sculpin	native	Cotbai
Order Siluriformes			
Family Ictaluridae-bullhead catfishes			
Ameiurus melas	black bullhead	introduced	Amemel
Ictalurus punctatus	channel catfish	introduced	Ictpun

catch in 2000 (Table 1). No roundtail chub were collected during 2000 adult monitoring. Nonnative fishes were represented by twelve species and two catostomid hybrid forms (Tables 1 and 2). Nonnative fishes composed 33.28% (n = 5,511) of all fish collected in 2000 (Table 1). Four species, two native (flannelmouth sucker and bluehead sucker) and two nonnative (channel catfish and common carp), composed 94.9% (n = 15,715) of all fish collected during 2000 adult monitoring (Table 1).

Common Native Fishes

Flannelmouth Sucker

Total CPUE for flannelmouth sucker in 2000 was almost identical to that observed in reaches 5-3 in 1999 (Figure 1). Flannelmouth sucker total CPUE in Reach 6 in 2000 was the highest observed for this species in any reach or year since our sampling began in 1991 (Figure 1). The only other reach close to these catch rates for flannelmouth sucker was Reach 5 in 1992. Conversely, flannelmouth sucker total CPUE in Reach 2 in 2000 was markedly lower than in 1999 and was the lowest observed in this reach since 1991 (Figure 1). As has been the case since 1996, very few flannelmouth sucker were collected in Reach 1, adjacent to Lake Powell (Figure 1).

Comparisons of flannelmouth sucker total CPUE from RM 180.0-53.0 for all trips on which this area was sampled contiguously (Figure 2) revealed that between October 1994 and October 1997 there was a statistically significant decline in flannelmouth sucker total CPUE in this section of river (Table 3). However, total CPUE for this particular river section between October 1997 and

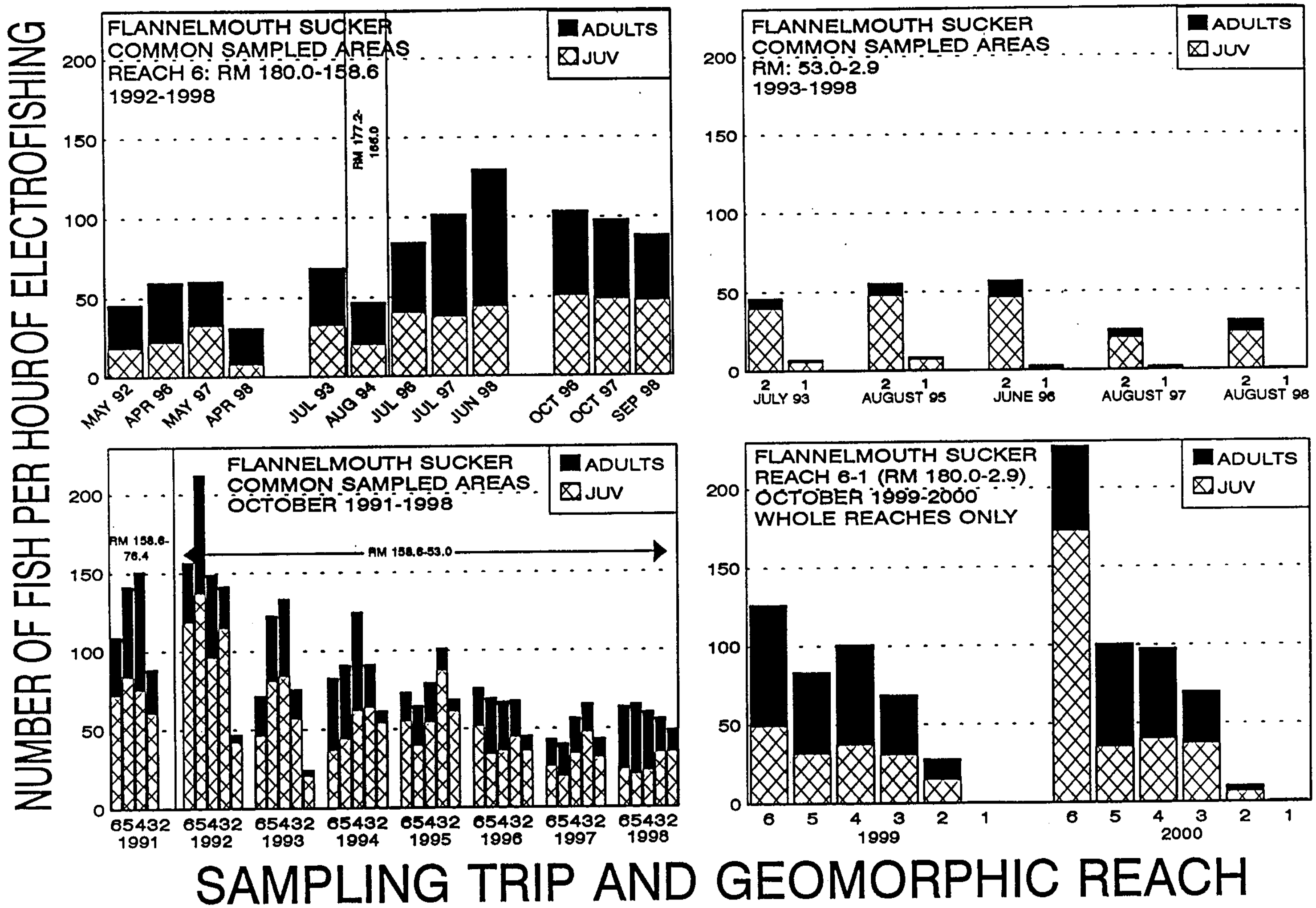

Figure 1. Number of flannelmouth sucker, by life stage, collected per hour of electrofishing in the San Juan River during "adult monitoring" trips, 1991-2000.

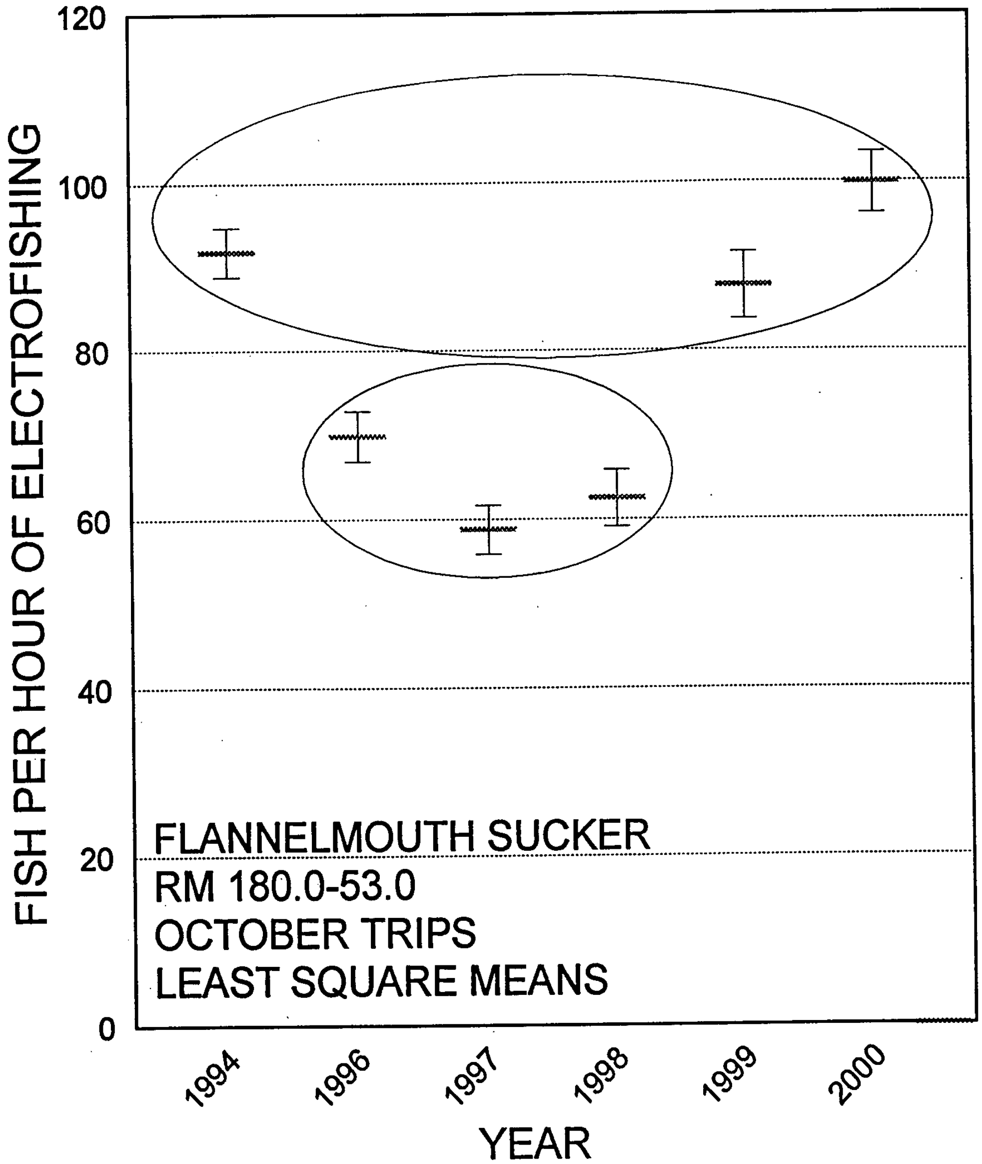

Figure 2. Number of flannelmouth sucker, all life stages combined, collected per hour of electrofishing in the San Juan River, RM 180.0-53.0, during "adult monitoring" trips, 1994-2000. Error bars represent standard error values. Circles include years whose values are not significantly different from one another. Only those sampling trips on which this entire river section was sampled are presented.

Table 3. One-way ANOVA statistics and matrix of Bonferroni-adjusted pairwise comparisons of total (juvenile + adult) flannelmouth sucker CPUE data, in the San Juan River, RM 180.0-53.0, October 1994 to October 2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 26.774, $r^2 = 0.079$, $p = 0.000$*

Scheffe matrix:

	1994	1996	1997	1998	1999	2000
1994	1.000					
1996	0.000*	1.000				
1997	0.000*	0.120	1.000			
1998	0.000*	1.000	1.000	1.000		
1999	1.000	0.006*	0.000*	0.000*	1.000	
2000	1.000	0.000*	0.000*	0.000*	0.357	1.000

October 2000 increased significantly between 1997 and 2000. When comparisons are made between flannelmouth sucker total CPUE in October 1994 and October 2000 in this section of river, there is no significant difference between the two values (Table 3, Figure 2). In fact, total CPUE for flannelmouth sucker in the section of river from RM 180.0-53.0 (i.e., the area where the large majority of flannelmouth sucker in the San Juan River are located) in 2000 was the highest observed value since our studies began in 1991.

Plots of flannelmouth sucker mean total length values from 1991-1999 show that small size-class flannelmouth sucker (< 400 mm TL) have virtually disappeared from Reach 1 (RM 17.0-0.0), adjacent to Lake Powell (Figure 3). This decline in numbers of small flannelmouth sucker appears to have begun in August 1995 (as is evidenced by the steadily increasing mean TL in Reach 1) and was essentially complete by August 1997. No flannelmouth sucker < 300 mm TL were collected in Reach 1 in 1997 and no flannelmouth sucker < 400 mm TL were collected in Reach 1 in either 1998 or 1999 (Figure 3). During that time, flannelmouth sucker of all size-classes were being collected throughout the rest of our study area (Figure 3). In 2000, only seven flannelmouth sucker were collected in Reach 1 (Figure 1), but these seven did represent several size classes (mean TL = 336 mm, range = 112-531 mm TL, n = 5 measured; Figure 3).

The flannelmouth sucker population in Reach 6 in 2000 was dominated by large numbers of small, age-0 fish (< 151 mm TL), which lowered the mean TL in this reach to a value lower than that observed at any other time this reach was sampled (Figure 3). The large number of small flannelmouth sucker can be clearly seen on the histogram of flannelmouth sucker measured by 25 mm size-classes (Figure 4). In fact, over half (63.2%)of the age-0 flannelmouth sucker collected riverwide in October 2000 were collected in Reach 6 (Figure 5). An examination of age-0 flannelmouth sucker collections in Reach 6, reveals that almost twice as many were collected upstream of the PNM Weir (RM

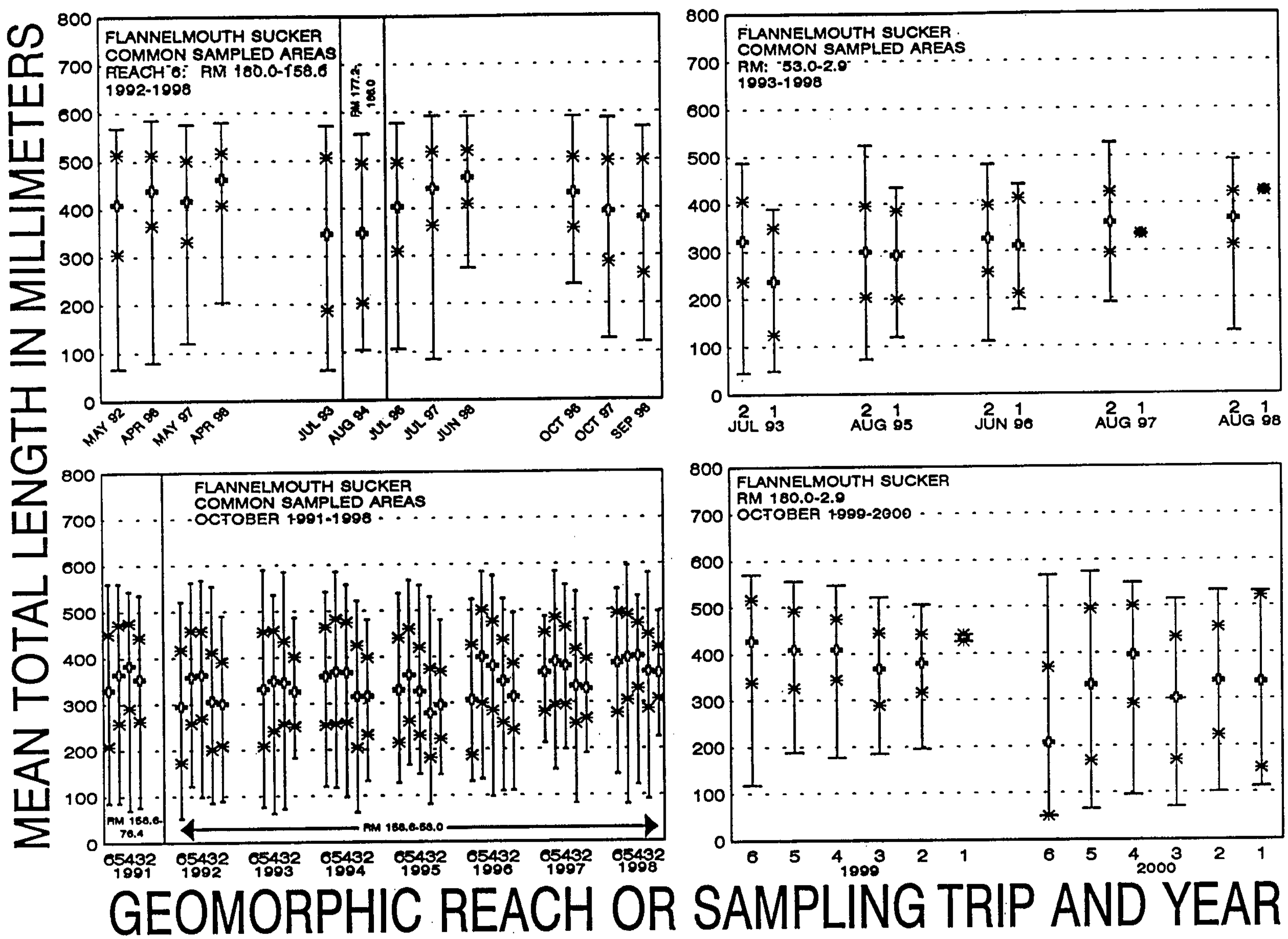

Figure 3. Mean total length (TL) in millimeters for flannelmouth sucker collected on "adult monitoring" trips, 1991-2000. Crosses represent the mean values, error bars the range, and asterisks represent the standard deviation.

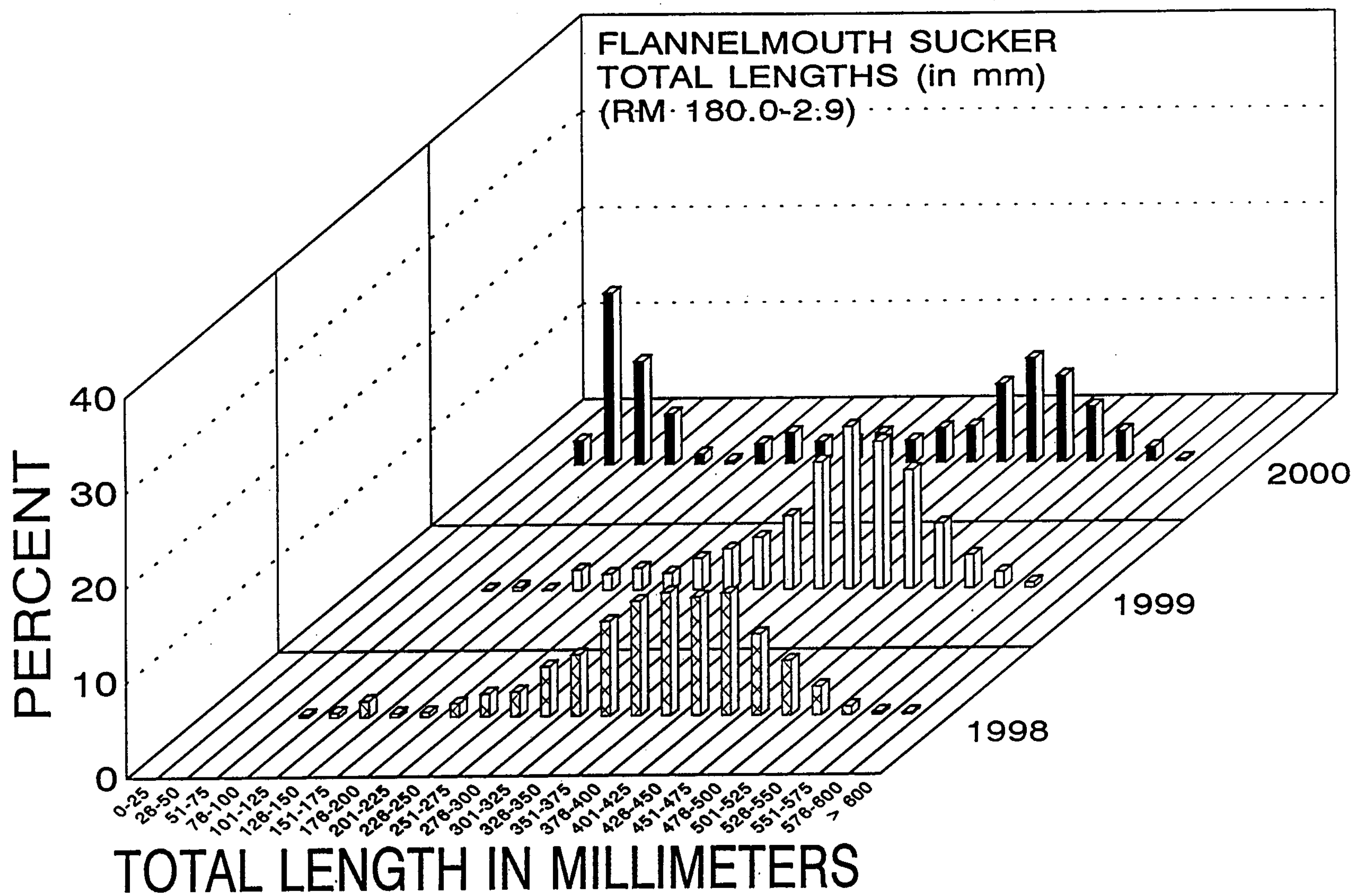

Figure 4. Percentages of flannelmouth sucker by 25-mm size class measured on "adult monitoring" trips, 1998-2000.

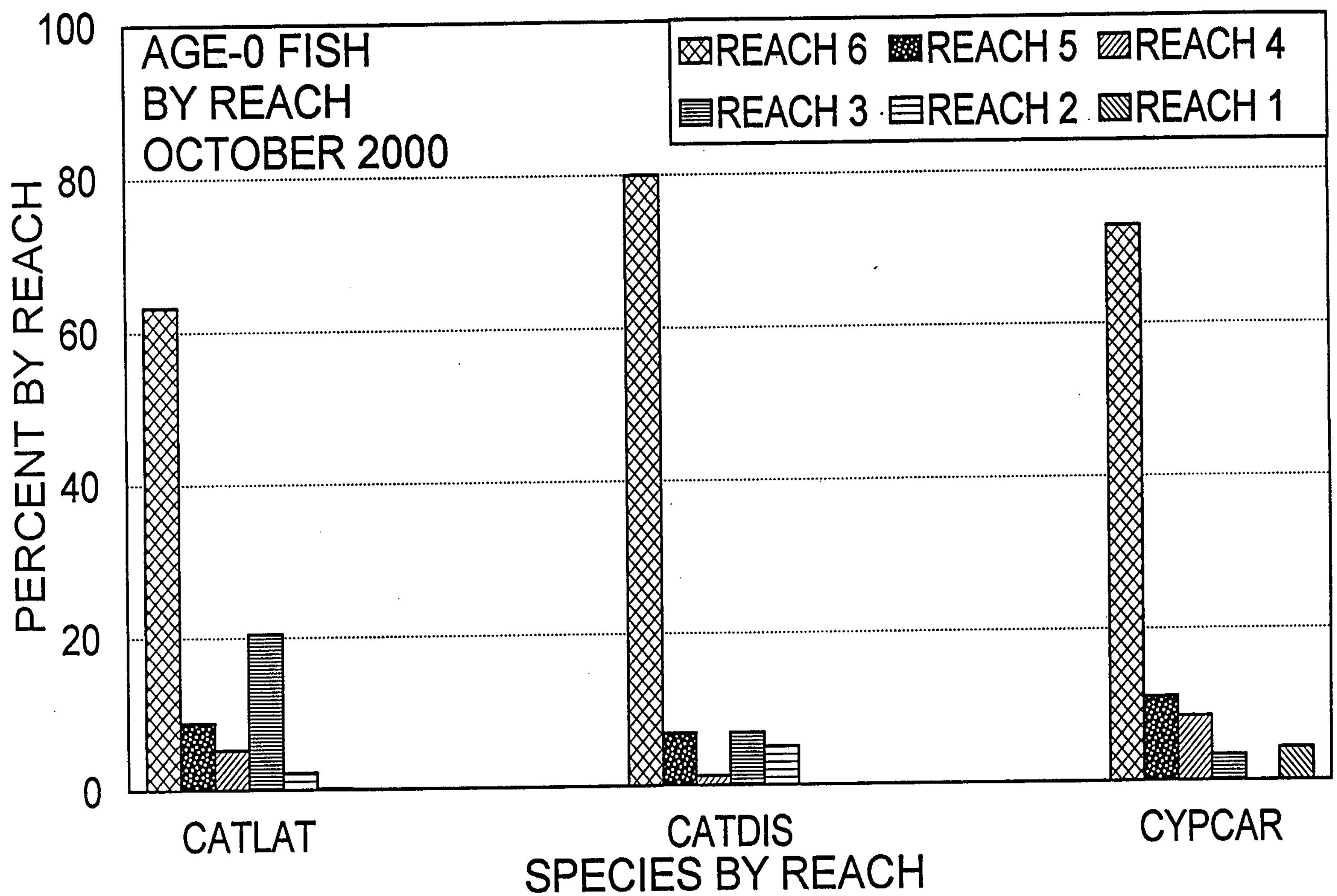

Figure 5. Distribution of all age-0 fish collected, by reach, for three of the four common large-bodied fish species in the San Juan River, 2000. Not enough age-0 channel catfish were collected during 2000 "adult monitoring" to be included here.

166.6) as downstream. A total of 1,530 age-0 flannelmouth sucker (222.4/hour of electrofishing) were collected from RM 180.0-166.6 as opposed to 365 age-0 flannelmouth sucker (118.9/hour of electrofishing) from RM 166.6-158.6.

Flannelmouth sucker total CPUE in the lower portion of Reach 6 (RM 166.6-158.6), the area in which channel catfish mechanical removal efforts have been concentrated since 1996, was significantly higher in both 1999 and 2000 than 1996-1998 (Table 4a, Figure 6). These significant increases in total CPUE were driven by significant increases in juvenile flannelmouth sucker CPUE in 1999 and 2000 (Table 4b, Figure 6). Adult flannelmouth sucker CPUE in this section of river did rise steadily from 1997 to 1999, but then declined again slightly in 2000 (Table 4c, Figure 6).

Bluehead sucker

Total CPUE for bluehead sucker in 2000 was almost identical to that observed in reaches 5-3 in 1999 (Figure 7). Bluehead sucker total CPUE in Reach 6 in 2000 was the highest observed for this species in any reach or year since our sampling began in 1991 (Figure 7). The only other reach close to these catch rates for bluehead sucker was Reach 6 in 1999. Bluehead sucker total CPUE values in Reach 5 in 1999 and 2000 were higher than any observed in this reach since 1993 (Figure 7). Bluehead sucker total CPUE values in Reaches 4, 3, and 2 in 2000 were within the range of CPUE values observed for these reaches over the last several years (Figure 7). As in past years, no bluehead sucker were collected in Reach 1 in 2000 (Figure 7).

Comparisons of bluehead sucker total CPUE from RM 180.0-53.0 for all trips on which this area was sampled contiguously (Figure 8) showed that between October 1994 and October 1998 total CPUE in this section of river did

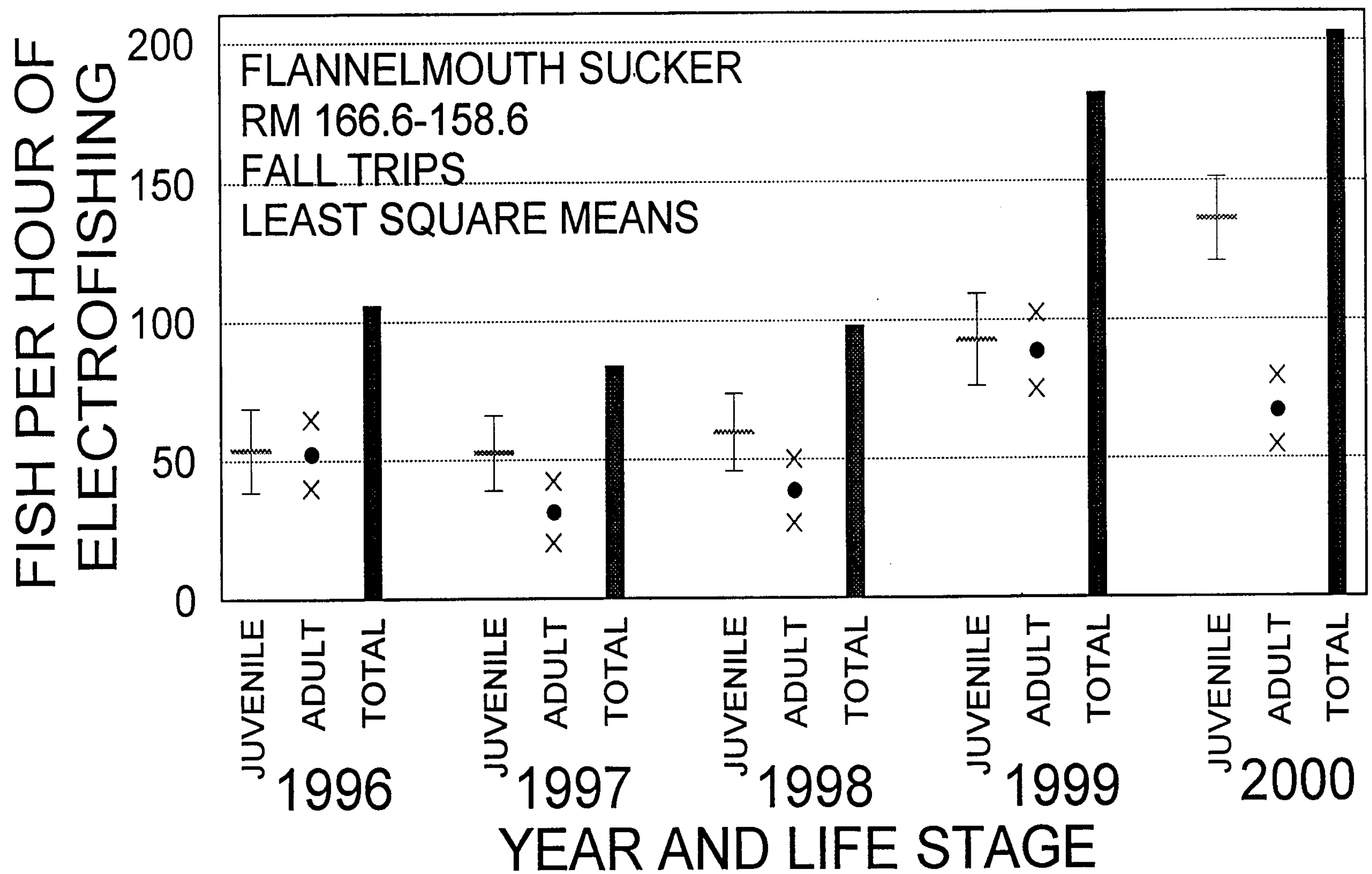

Figure 6. Flannelmouth sucker catch per unit effort (CPUE) values from RM 166.6-158.6, 1996-2000. Solid vertical bars represent the values for flannelmouth sucker total (juvenile + adult) CPUE. Dark horizontal lines represent mean CPUE values for juvenile flannelmouth sucker and the error bars, the associated standard error values for juvenile CPUE. Solid circles represent mean CPUE values for adult flannelmouth sucker and the crosses, the associated standard error values for adult CPUE.

Table 4a. One-way ANOVA statistics and matrix of Bonferroni pairwise comparisons of total (juvenile + adult) flannelmouth sucker CPUE data, in the San Juan River, RM 166.6-158.6, on fall sampling trips 1996-2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 7.033, r^2 = 0.327, p = 0.000*

Scheffe matrix:

	1996	1997	1998	1999	2000
1996	1.000				
1997	1.000	1.000			
1998	1.000	1.000	1.000		
1999	0.166	0.014*	0.068*	1.000	
2000	0.015*	0.001*	0.004*	1.000	1.000

Table 4b. One-way ANOVA statistics and matrix of Bonferroni pairwise comparisons of juvenile flannelmouth sucker CPUE data, in the San Juan River, RM 166.6-158.6, on fall sampling trips 1996-2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 5.845, r^2 = 0.287, p = 0.001*

Scheffe matrix:

	1996	1997	1998	1999	2000
1996	1.000				
1997	1.000	1.000			
1998	1.000	1.000	1.000		
1999	0.863	0.654	1.000	1.000	
2000	0.003*	0.001*	0.005*	0.578	1.000

Table 4c. One-way ANOVA statistics and matrix of Bonferroni pairwise comparisons of adult flannelmouth sucker CPUE data, in the San Juan River, RM 166.6-158.6, on fall sampling trips 1996-2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 3.414, r^2 = 0.191, p = 0.014*

Scheffe matrix:

	1996	1997	1998	1999	2000
1996	1.000				
1997	1.000	1.000			
1998	1.000	1.000	1.000		
1999	0.523	0.018*	0.066*	1.000	
2000	1.000	0.351	0.968	1.000	1.000

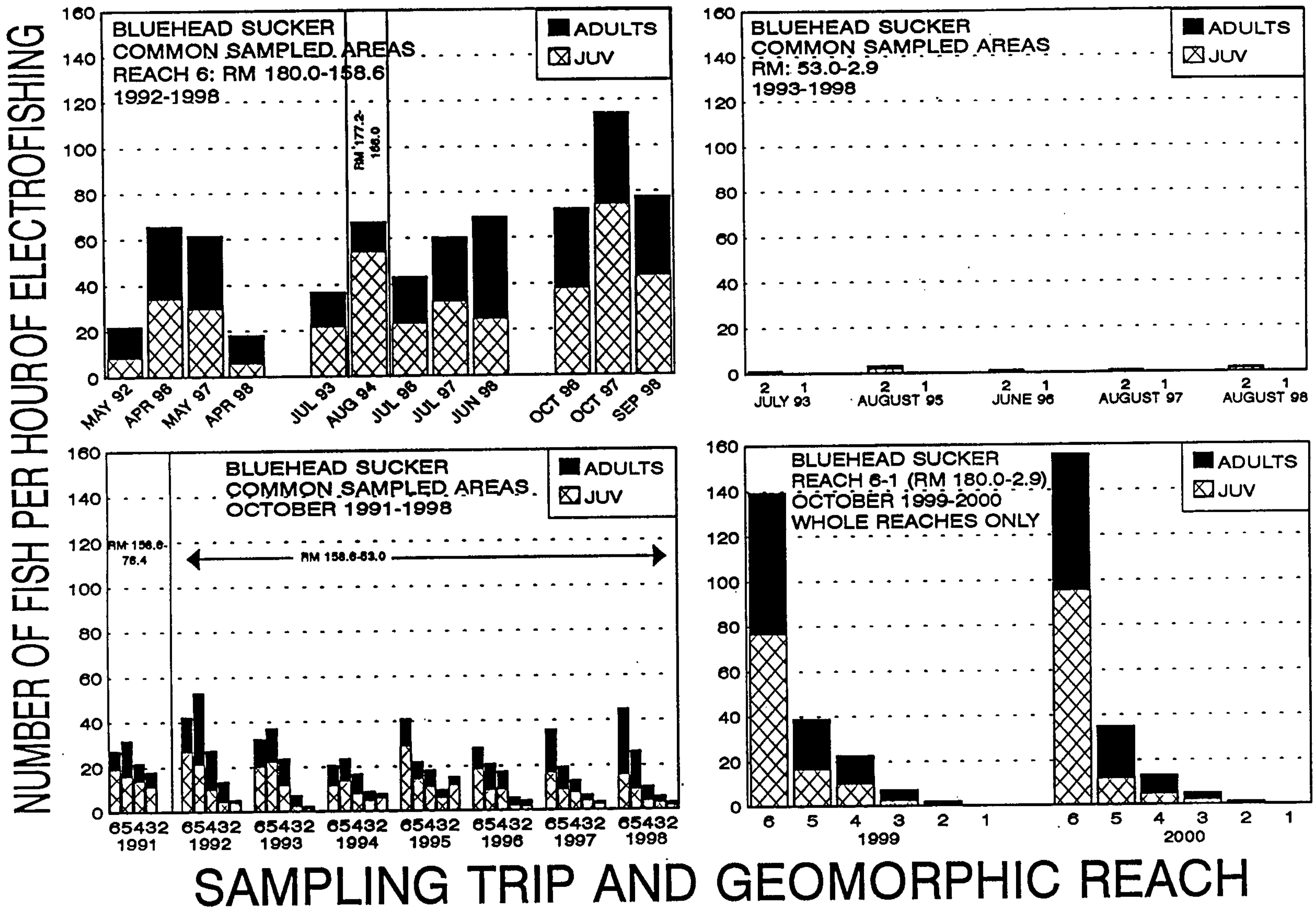

Figure 7. Number of bluehead sucker, by life stage, collected per hour of electrofishing in the San Juan River during "adult monitoring" trips, 1991-2000.

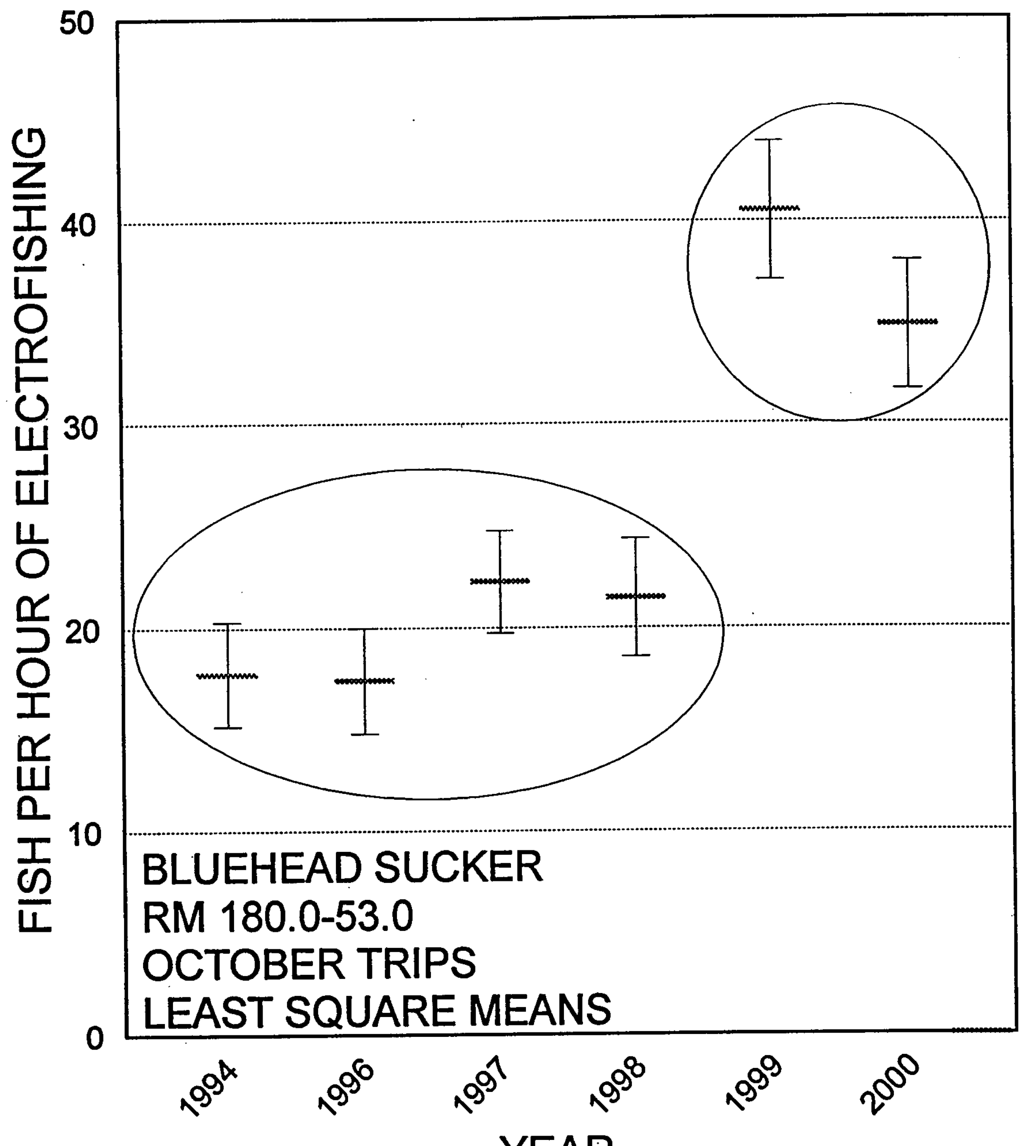

Figure 8. Number of bluehead sucker, all life stages combined, collected per hour of electrofishing in the San Juan River, RM 180.0-53.0, during "adult monitoring" trips, 1994-2000. Error bars represent standard error values. Circles include years whose values are not significantly different from one another. Only those sampling trips on which this entire river section was sampled are presented.

not change significantly, although it was higher in 1997 and 1998 than in previous years (Table 5, Figure 8). In 1999 and 2000 bluehead sucker total CPUE from RM 180.0-53.0 was significantly higher than in previous years (Table 5) and while total CPUE in this section of river dipped slightly in 2000, it was not significantly different from 1999 (Figure 8).

Bluehead sucker of all size-classes continue to be collected in all river reaches except Reach 1 (Figure 9). In 2000, the lower range of bluehead sucker TL observed was consistently lower riverwide (i.e., all reaches having low values at the same time) than any values observed for this species since our studies began in 1991 (Figure 9).

The bluehead sucker population in Reach 6 included large numbers of small, age-0 fish (< 151 mm TL; Figures 7 and 10). This large number of age-0 bluehead sucker can be clearly seen on a histogram of bluehead sucker measured by 25 mm size-classes (Figure 10). In fact, over three-quarters (79.9%)of the age-0 bluehead sucker collected riverwide in 2000 were collected in Reach 6 (Figure 5). An examination of age-0 bluehead sucker collections in Reach 6, reveals that over twice as many were collected upstream of the PNM Weir (RM 166.6) as downstream. A total of 906 age-0 bluehead sucker (131.7/hour of electrofishing) were collected from RM 180.0-166.6 as opposed to 162 age-0 bluehead sucker (52.8/hour of electrofishing) from RM 166.6-158.6.

Bluehead sucker total CPUE in the lower portion of Reach 6 (RM 166.6-158.6), the area in which channel catfish mechanical removal efforts have been concentrated since 1996, was significantly higher in 1999 than in all other years (i.e., 1996-1998 and 2000; Table 6a, Figure 11). As was observed with flannelmouth sucker, the significant increase observed in bluehead sucker total CPUE was driven more by the significant increases in juvenile bluehead sucker CPUE in 1999 (Table 6b, Figure 11). Adult bluehead sucker CPUE in 1999 was also significantly higher than all years except 2000, but to a lesser extent than that observed among juvenile fish (Tables 6b and 6c, Figure 11).

Table 5. One-way ANOVA statistics and matrix of Bonferroni-adjusted pairwise comparisons of total (juvenile + adult) bluehead sucker CPUE data, in the San Juan River, RM 180.0-53.0, October 1994 to October 2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 9.609, r^2 = 0.030, p = 0.000*

Scheffe matrix:

	1994	1996	1997	1998	1999	2000
1994	1.000					
1996	1.000	1.000				
1997	1.000	1.000	1.000			
1998	1.000	1.000	1.000	1.000		
1999	0.000*	0.000*	0.000*	0.000*	1.000	
2000	0.000*	0.000*	0.030*	0.030*	1.000	1.000

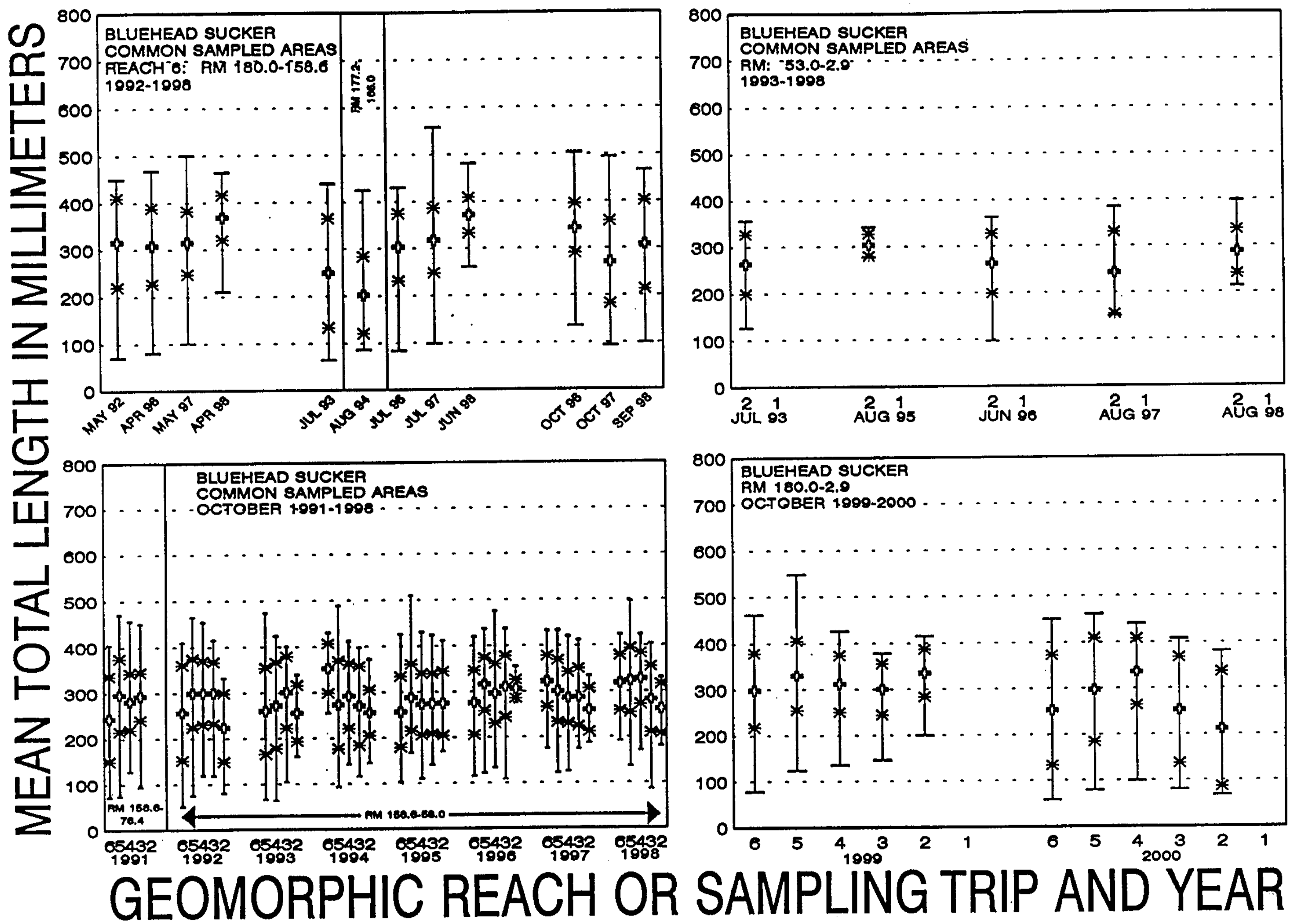

Figure 9. Mean total length (TL) in millimeters for bluehead sucker collected on "adult monitoring" trips, 1991-2000. Crosses represent the mean values, error bars the range, and asterisks represent the standard deviation.

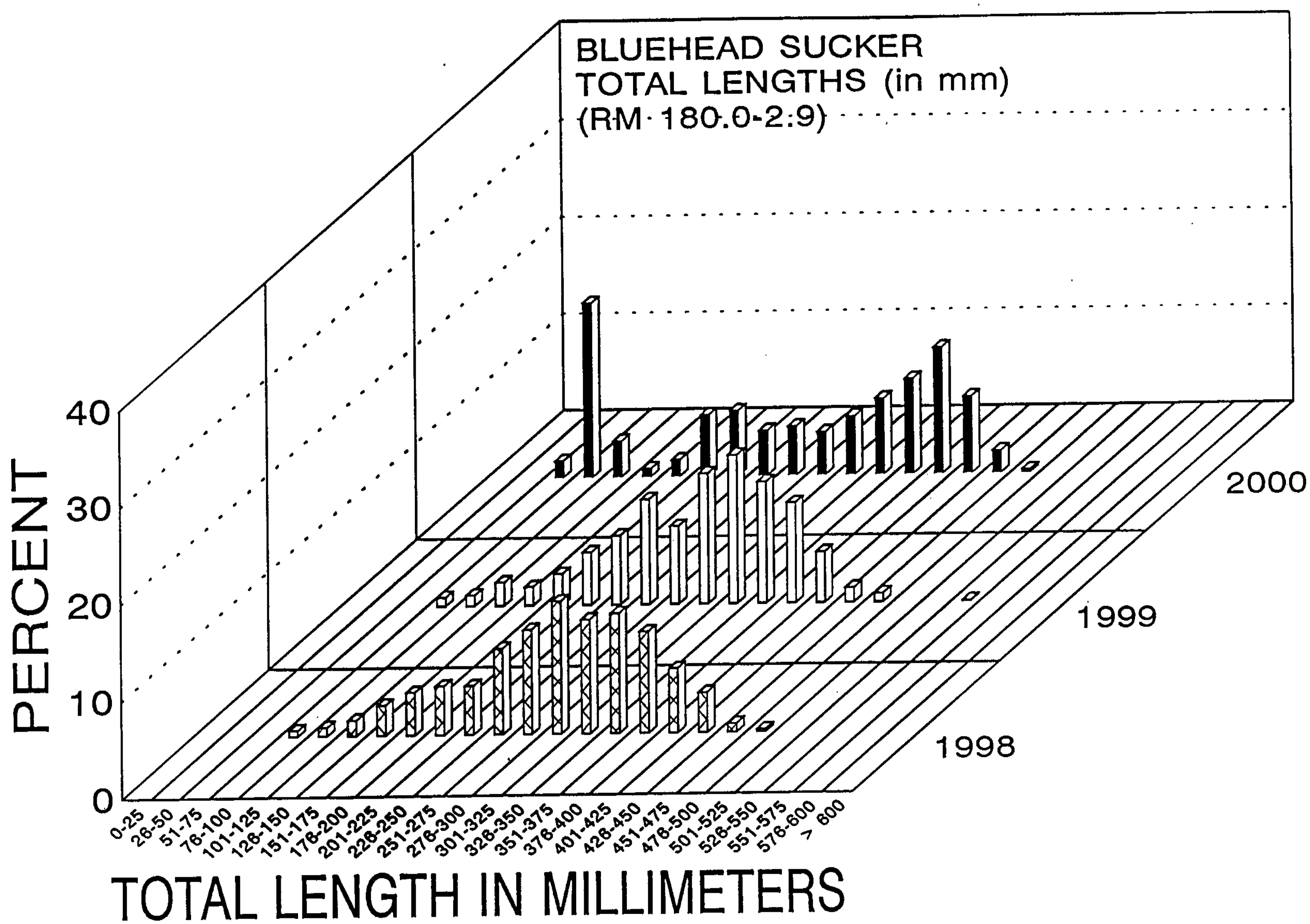

Figure 10. Percentages of bluehead sucker by 25-mm size class measured on "adult monitoring" trips, 1998-2000.

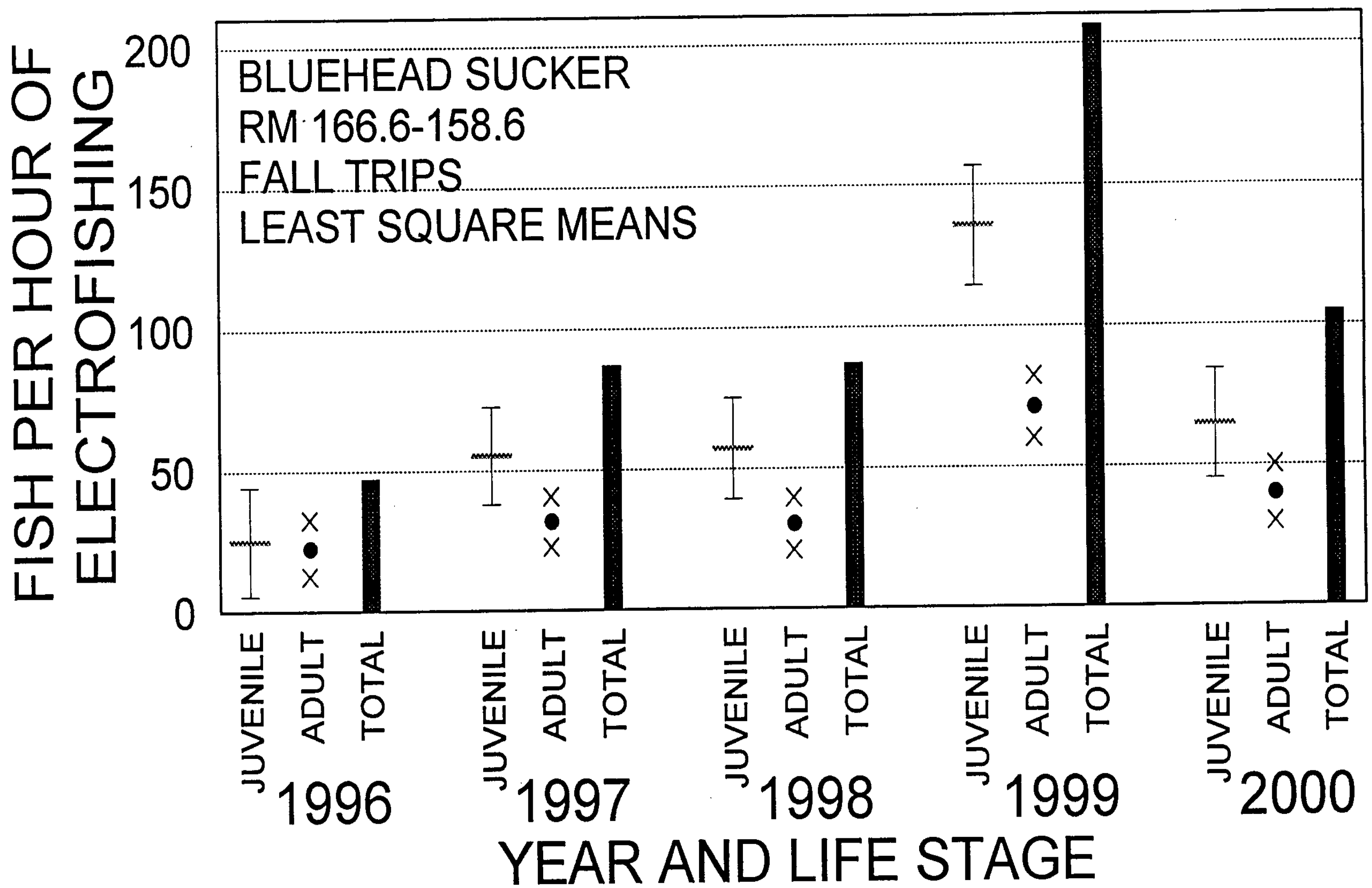

Figure 11. Bluehead sucker catch per unit effort (CPUE) values from RM 166.6-158.6, 1996-2000. Solid vertical bars represent the values for bluehead sucker total (juvenile + adult) CPUE. Dark horizontal lines represent mean CPUE values for juvenile bluehead sucker and the error bars, the associated standard error values for juvenile CPUE. Solid circles represent mean CPUE values for adult bluehead sucker and the crosses, the associated standard error values for adult CPUE.

Table 6a. One-way ANOVA statistics and matrix of Bonferroni pairwise comparisons of total (juvenile + adult) bluehead sucker CPUE data, in the San Juan River, RM 166.6-158.6, on fall sampling trips 1996-2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 5.238, r^2 = 0.265, p = 0.001*

Scheffe matrix:

	1996	1997	1998	1999	2000
1996	1.000				
1997	1.000	1.000			
1998	1.000	1.000	1.000		
1999	0.001*	0.011*	0.013*	1.000	
2000	1.000	1.000	1.000	0.070*	1.000

Table 6b. One-way ANOVA statistics and matrix of Bonferroni pairwise comparisons of juvenile bluehead sucker CPUE data, in the San Juan River, RM 166.6-158.6, on fall sampling trips 1996-2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 3.948, r^2 = 0.214, p = 0.007*

Scheffe matrix:

	1996	1997	1998	1999	2000
1996	1.000				
1997	1.000	1.000			
1998	1.000	1.000	1.000		
1999	0.003*	0.049*	0.066*	1.000	
2000	1.000	1.000	1.000	0.171	1.000

Table 6c. One-way ANOVA statistics and matrix of Bonferroni pairwise comparisons of adult bluehead sucker CPUE data, in the San Juan River, RM 166.6-158.6, on fall sampling trips 1996-2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 3.159, r^2 = 0.179, p = 0.020*

Scheffe matrix:

	1996	1997	1998	1999	2000
1996	1.000				
1997	1.000	1.000			
1998	1.000	1.000	1.000		
1999	0.019*	0.074*	0.063*	1.000	
2000	1.000	1.000	1.000	0.409	1.000

Adult bluehead sucker CPUE in this section of river declined from that observed in 1999, and though the 2000 adult CPUE value was higher than that observed in 1996-1998, the difference was not significant (Table 6c, Figure 11).

Rare Native Fishes

Colorado Pikeminnow

Only one Colorado pikeminnow was recaptured during the October 2000 adult monitoring trip (Table 7). This fish, a 402 mm TL juvenile, was recaptured at RM 149.0 on 21 September 2000. This was a recapture of a fish stocked by the Utah Division of Wildlife Resources (UDWR), probably in August 1998. Three more Colorado pikeminnow were collected during sampling for other studies in 2000 (Table 7). These three fish were also recaptures of fish stocked by the UDWR. These four Colorado pikeminnow collections ranged from RM 149.0-10.7 (Table 7). No more than one Colorado pikeminnow was caught on any sampling trip (adult monitoring or otherwise) in 2000. No wild Colorado pikeminnow were collected in 2000.

Table 7. Colorado pikeminnow collected from the San Juan River on “adult monitoring” and other sampling trips in 2000.

Date of Capture	PIT Tag Number	Radio Freq.	Total Length (mm)	Weight (grams)	Sex	River Mile
On “Adult Monitoring” Trips:						
Recaptured, stocked Colorado pikeminnow						
09/21/2000	51247D4B57	NONE	402	470	I	149.0
On “Razorback Sucker Monitoring” Trips:						
Recaptured, stocked Colorado pikeminnow						
05/04/2000	512737211D	NONE	220	90	I	97.0
07/25/2000	7F7B113D5C	NONE	404	425	I	137.3
On UDWR’s sampling trips:						
Recaptured, stocked Colorado pikeminnow[a]						
06/13/2000	NONE	NONE	8.5(SL)	----	I	114.9
06/13/2000	NONE	NONE	8.5(SL)	----	I	78.8
06/13/2000	NONE	NONE	8.0(SL)	----	I	78.1
06/13/2000	NONE	NONE	8.5(SL)	----	I	78.1
07/09/2000	NONE	NONE	65	----	I	106.7
07/11/2000	5127726507	NONE	340	----	I	10.7

[a] = These fish were not weighed

(SL) = Standard length measurement

Razorback Sucker

Eight stocked razorback suckers were recaptured during 2000 adult monitoring (Table 8). These eight collections ranged from RM 169.0-11.0 (Table 8). Five of these razorback sucker (collected from RM 108.7-11.0) were implanted with radio tags. For the first time, razorback sucker (three fish) were collected upstream of the PNM Weir at RM 166.6. These fish did not have PIT tags at the time of recapture. It is likely that these fish came from Ojo Pond which washed out on 3 August 1998 when the dike broke during heavy rains. These fish were washed into Ojo Wash which empties into the San Juan River at RM 170.8, upstream of the PNM Weir. Three more razorback sucker were collected on a razorback sucker monitoring trip in May 2000 and five more were collected during trammel-netting efforts in Lake Powell (Table 8). For more detailed information on razorback sucker collections, see Ryden 2001.

Roundtail Chub

No roundtail chub were collected during 2000 adult monitoring.

Table 8. Razorback sucker collected from the San Juan River on “adult monitoring” and other sampling trips in 2000.

Date of Capture	PIT Tag Number	Radio Freq.	Total Length (mm)	Weight (grams)	Sex	River Mile
On “Adult Monitoring” Trips:						
Recaptured, stocked razorback sucker–2000						
09/21/2000	NONE	NONE	410	820	I	169.0
09/21/2000	NONE	NONE	380	615	I	169.0
09/21/2000	NONE	NONE	351	457	I	169.0
10/02/2000	420F365F58	751	474	1120	I	108.7
10/03/2000	1F43597253	831	510	1400	M	100.0
10/03/2000	42131C4420	811	508	1400	F	100.0
10/04/2000	1F743D161A	820	422	1800	M	77.0
10/09/2000	7F7B124458	791	483	1005	M	11.0
On “Razorback Sucker Monitoring” Trips:						
Recaptured, stocked razorback sucker–2000						
05/01/2000	7F7D175C49	NONE	398	740	F	141.0
05/03/2000	507F727F1E	NONE	469	1500	M	115.0
05/04/2000	7F7D1B6654	639	449	760	M	88.0
On “Lake Powell Razorback Sucker Hunt” Trips:						
Recaptured, stocked razorback sucker–2000						
06/06/2000	1F41482038	NONE	492	1294	I	0.0
06/06/2000	7F7B11352B	NONE	485	982	M	0.0
06/06/2000	1F6B2D9356	NONE	472	1202	I	0.0
06/07/2000	1F732D724F	NONE	505	1392	M	-4.1[a]
07/18/2000	1F43686353	475	522	1540	M	0.0

[a] = This recapture was in Lake Powell, 4.1 miles downstream of the San Juan River-Lake Powell confluence.

Common Nonnative Fishes

Channel Catfish

As was observed in past years, channel catfish total CPUE was highly variable, riverwide, again in 2000 (Figure 12). In all sampled reaches (with the exception of Reach 5) channel catfish total CPUE was lower in 2000 than it was in 1999. In Reach 5, channel catfish total CPUE was higher in 2000 than in 1999 and was the highest value observed in any reach or year since studies began in 1991 (Figure 12). Channel catfish total CPUE in Reach 6, where intensive mechanical removal efforts have been taking place, was lower in 2000 than it has been for several years (Figure 12). With the exception of Reach 6, juvenile channel catfish accounted for more than half of the total CPUE in all river reaches (Figure 12).

October 2000 channel catfish total CPUE from RM 180.0-53.0 (Figure 13) was intermediate between previous high values observed in this river section, being lower than in 1999 and higher than 1996, but not significantly different from either (Table 9).

Channel catfish mean TL values observed during October 1999 adult monitoring were lower than values observed for previous years' sampling (Figure 14). In 2000 however, channel catfish mean TL increased in Reaches 6-4, and in Reach 1 (Figure 14). In 2000, channel catfish mean TL in Reaches 3 and 2, was almost identical to 1999 values. In 1999, it was observed that while large individual channel catfish continued to be collected in Reaches 5-1, the TL standard deviation values for all five reaches had shifted noticeably downward from previous years' values (Figure 14). In 2000, TL standard deviation values remained low in Reaches 3-1, but increased in

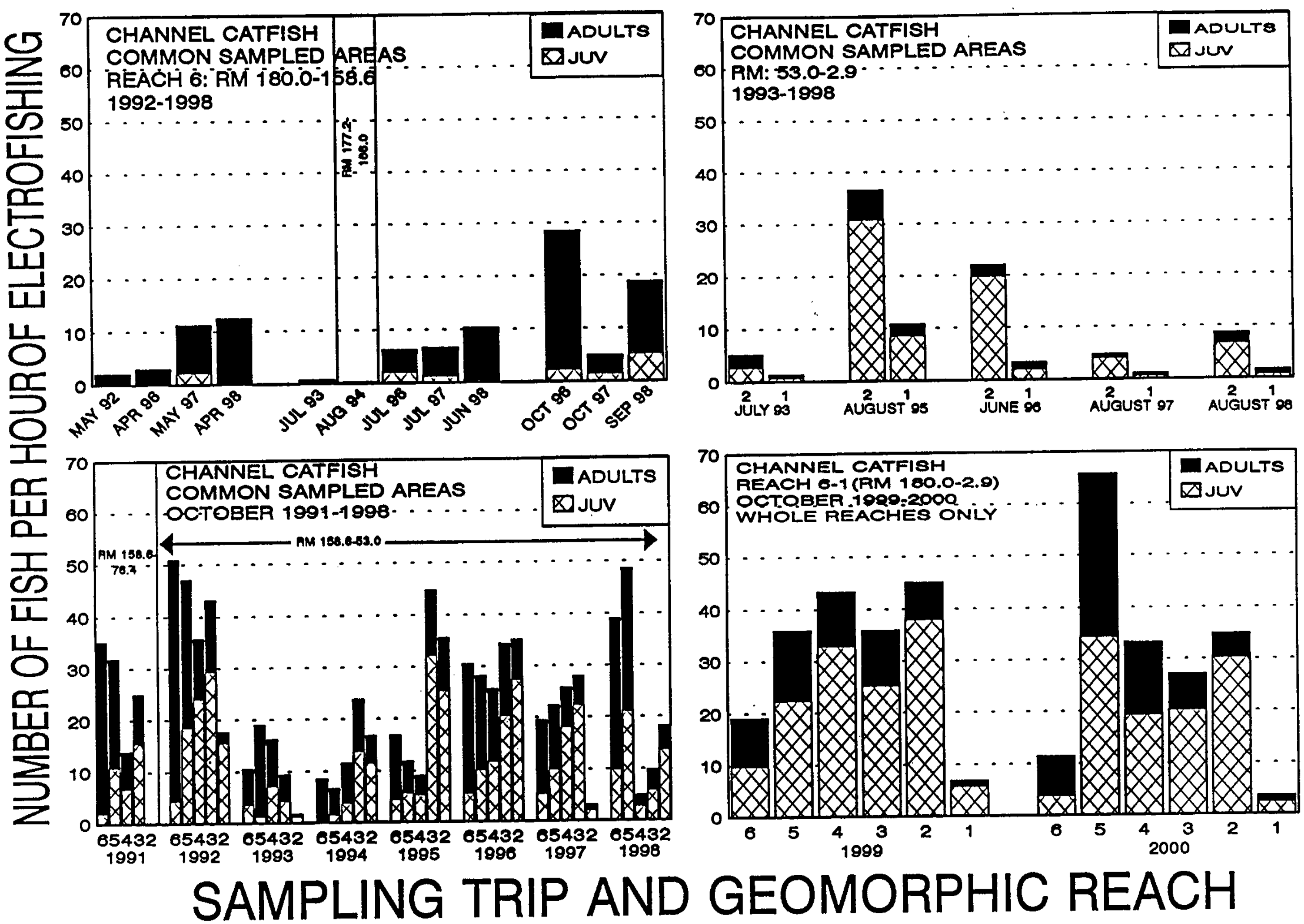

Figure 12. Number of channel catfish, by life stage, collected per hour of electrofishing in the San Juan River during "adult monitoring" trips, 1991-2000.

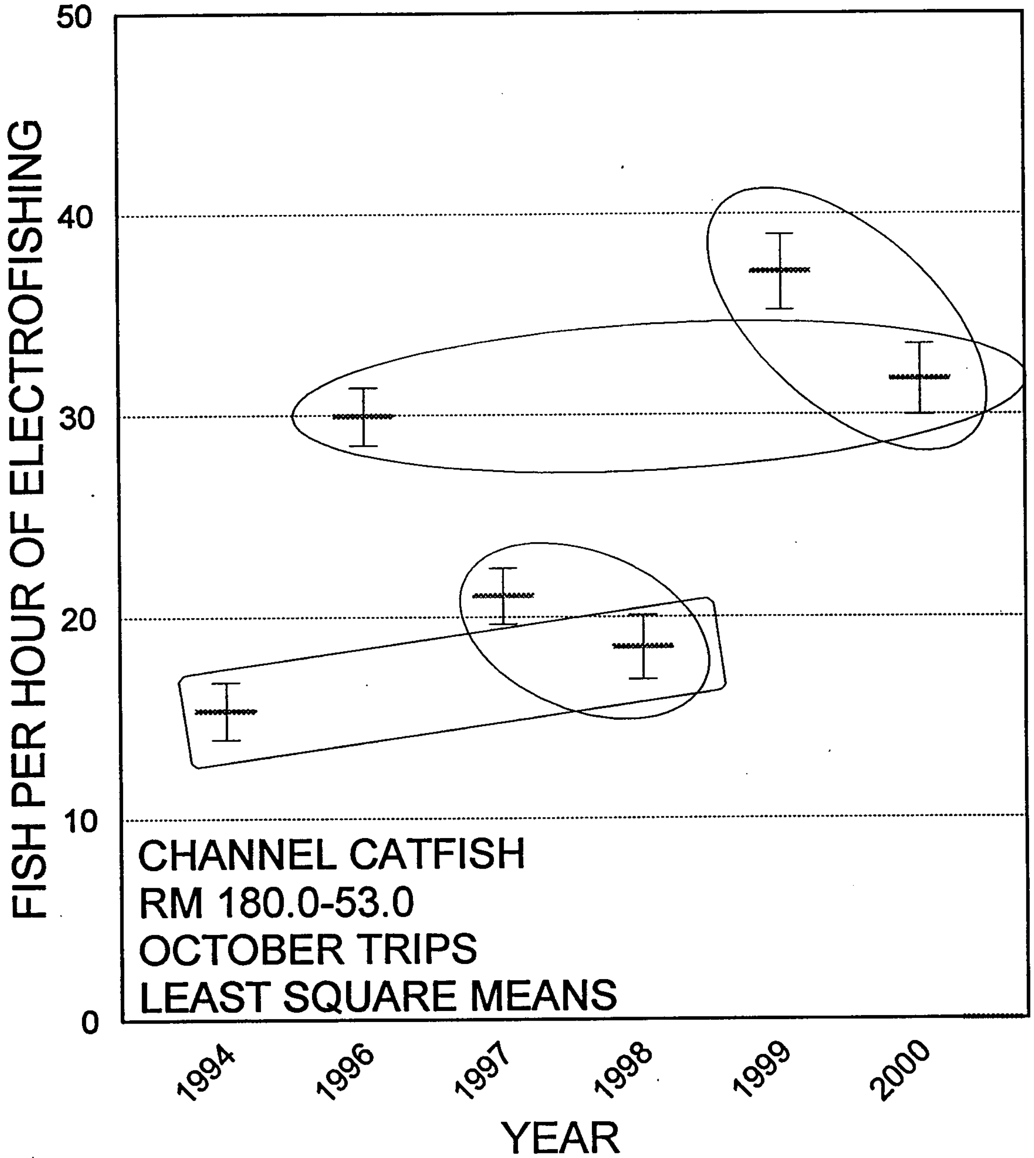

Figure 13. Number of channel catfish, all life stages combined, collected per hour of electrofishing in the San Juan River, RM 180.0-53.0, during "adult monitoring" trips, 1994-2000. Error bars represent standard error values. Circles include years whose values are not significantly different from one another. Only those sampling trips on which this entire river section was sampled are presented.

Table 9. One-way ANOVA statistics and matrix of Bonferroni-adjusted pairwise comparisons of total (juvenile + adult) channel catfish CPUE data, in the San Juan River, RM 180.0-53.0, October 1994 to October 2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 27.695, $r^2 = 0.082$, p = 0.000*

Scheffe matrix:

	1994	1996	1997	1998	1999	2000
1994	1.000					
1996	0.000*	1.000				
1997	0.060*	0.000*	1.000			
1998	1.000	0.000*	1.000	1.000		
1999	0.000*	0.039*	0.000*	0.000*	1.000	
2000	0.000*	1.000	0.000*	0.000*	0.566	1.000

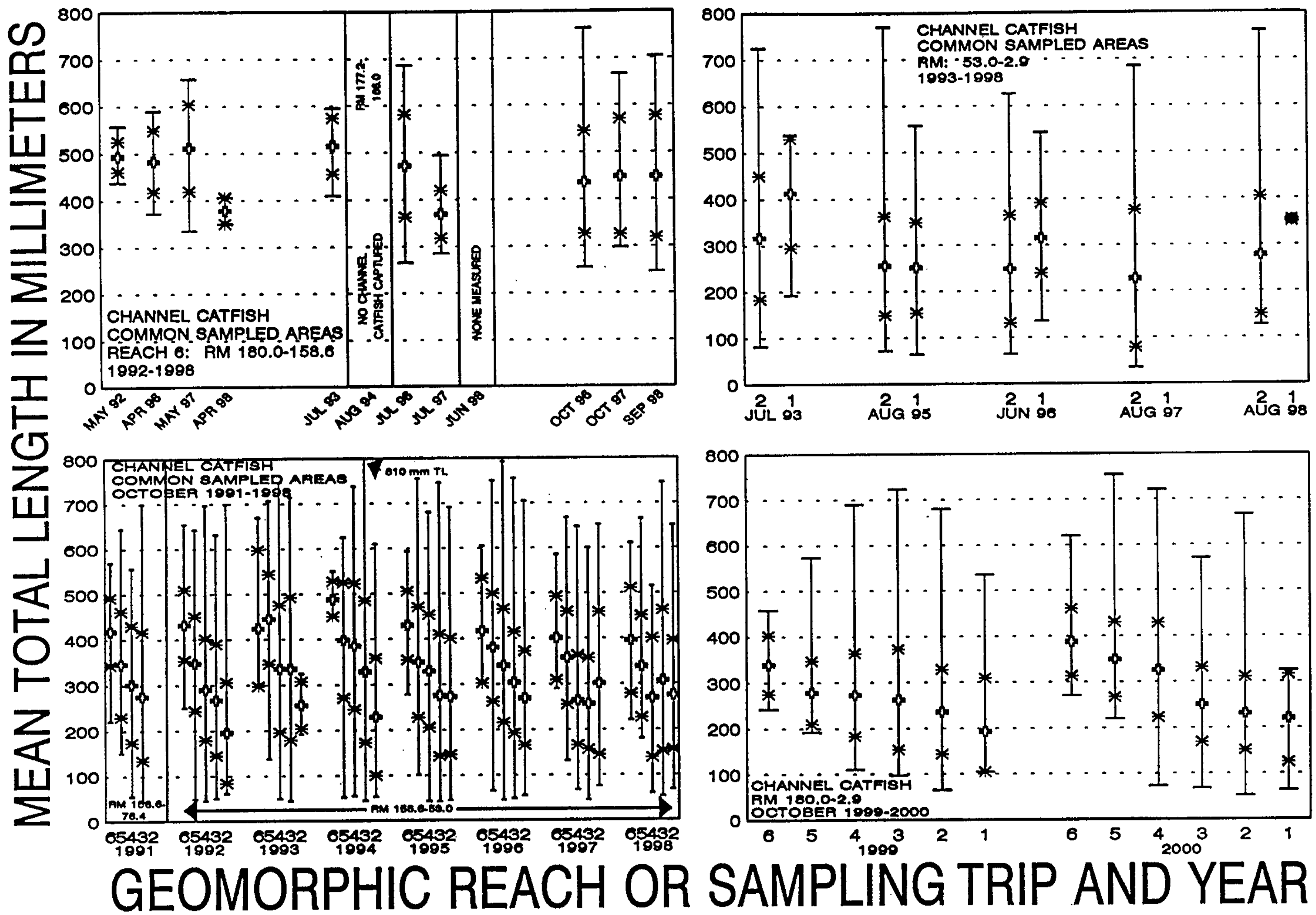

Figure 14. Mean total length (TL) in millimeters for channel catfish collected on "adult monitoring" trips, 1991-2000. Crosses represent the mean values, error bars the range, and asterisks represent the standard deviation.

Reaches 6-4 (Figure 14). Unlike native flannelmouth sucker and bluehead sucker and nonnative common carp, breakdowns of channel catfish TL's by 25-mm size-classes did not reveal large numbers of age-0 fish in 2000 (Figure 15).

Channel catfish total CPUE in the lower portion of Reach 6 (RM 166.6-158.6), the area of river from which this species has been intensively removed via electrofishing over the last five years, in 2000 was significantly lower than was observed in both 1998 and 1999 (Table 10a, Figure 16). Channel catfish juvenile CPUE in this section of the river demonstrated an upward trend between 1996 and 1999, with 1999 being significantly higher than in previous years, but juvenile CPUE dropped again significantly in 2000 compared to 1999 (Table 10b, Figure 16). Though channel catfish adult CPUE was significantly lower in 1997 than all other years (i.e., 1996, 1997-2000), the general trend for adult CPUE between 1996 and 2000 was steadily downward (Table 10c, Figure 16).

Common Carp

In 2000, common carp total CPUE increased slightly in Reaches 6-4, but decreased slightly in Reaches 3-1 compared to 1999 values (Figure 17). However, there was a large difference between 2000 common carp catch rates and those observed for previous years' sampling. Adult common carp CPUE in 2000 was lower in all reaches compared to 1999 (Figure 17). The real difference, however, was in juvenile common carp CPUE. Juvenile common carp CPUE in Reach 6 was the highest observed for this age-class in any reach or year since our studies began in 1991 (Figure 17). In addition, more juvenile common carp were collected in Reaches 5 and 4 in 2000 than had been collected in these two reaches since 1995 (Figure 17).

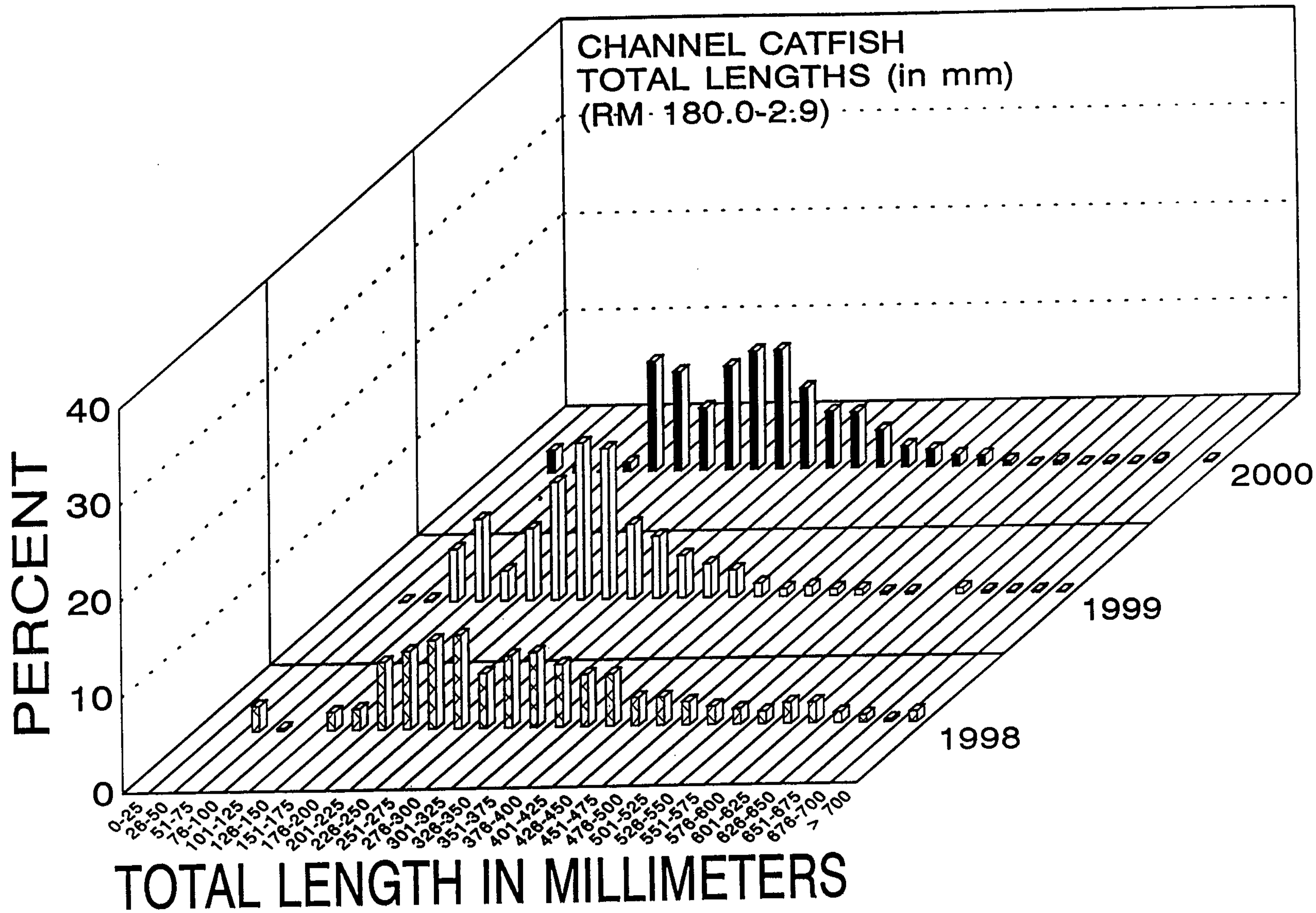

Figure 15. Percentages of channel catfish by 25-mm size class measured on "adult monitoring" trips, 1998-2000.

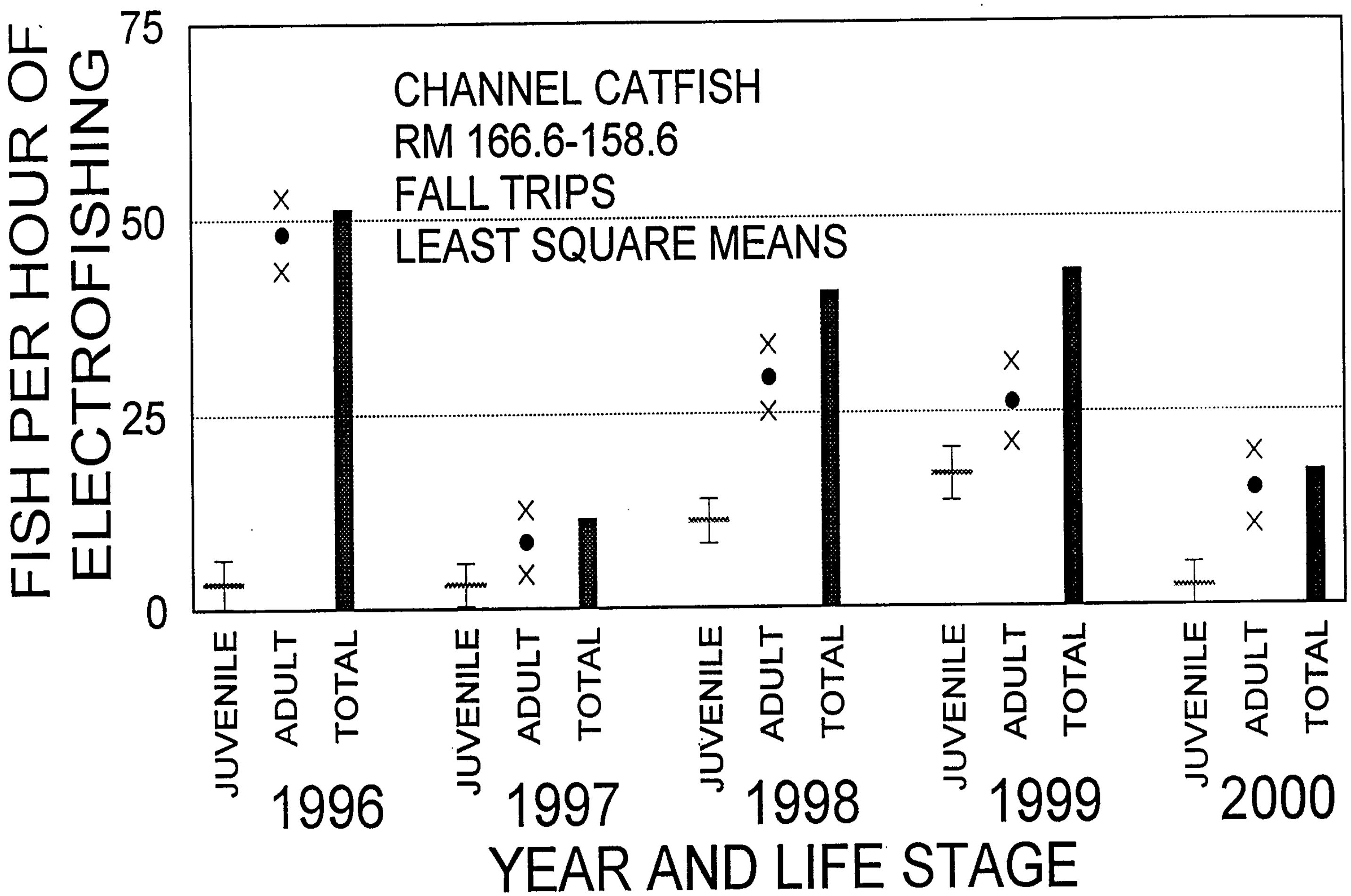

Figure 16. Channel catfish catch per unit effort (CPUE) values from RM 166.6-158.6, 1996-2000. Solid vertical bars represent the values for channel catfish total (juvenile + adult) CPUE. Dark horizontal lines represent mean CPUE values for juvenile channel catfish and the error bars, the associated standard error values for juvenile CPUE. Solid circles represent mean CPUE values for adult channel catfish and the crosses, the associated standard error values for adult CPUE.

Table 10a. One-way ANOVA statistics and matrix of Bonferroni pairwise comparisons of total (juvenile + adult) channel catfish CPUE data, in the San Juan River, RM 166.6-158.6, on fall sampling trips 1996-2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 7.990, r^2 = 0.355, p = 0.000*

Scheffe matrix:

	1996	1997	1998	1999	2000
1996	1.000				
1997	0.000*	1.000			
1998	1.000	0.008*	1.000		
1999	1.000	0.009*	1.000	1.000	
2000	0.004*	1.000	0.097*	0.084*	1.000

Table 10b. One-way ANOVA statistics and matrix of Bonferroni pairwise comparisons of juvenile channel catfish CPUE data, in the San Juan River, RM 166.6-158.6, on fall sampling trips 1996-2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 4.170, r^2 = 0.223, p = 0.005*

Scheffe matrix:

	1996	1997	1998	1999	2000
1996	1.000				
1997	1.000	1.000			
1998	0.657	0.460	1.000		
1999	0.039*	0.022*	1.000	1.000	
2000	1.000	1.000	0.406	0.022*	1.000

Table 10c. One-way ANOVA statistics and matrix of Bonferroni pairwise comparisons of adult channel catfish CPUE data, in the San Juan River, RM 166.6-158.6, on fall sampling trips 1996-2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 11.533, r^2 = 0.443, p = 0.000*

Scheffe matrix:

	1996	1997	1998	1999	2000
1996	1.000				
1997	0.000*	1.000			
1998	0.046*	0.009*	1.000		
1999	0.023*	0.096*	1.000	1.000	
2000	0.000*	1.000	0.264	1.000	1.000

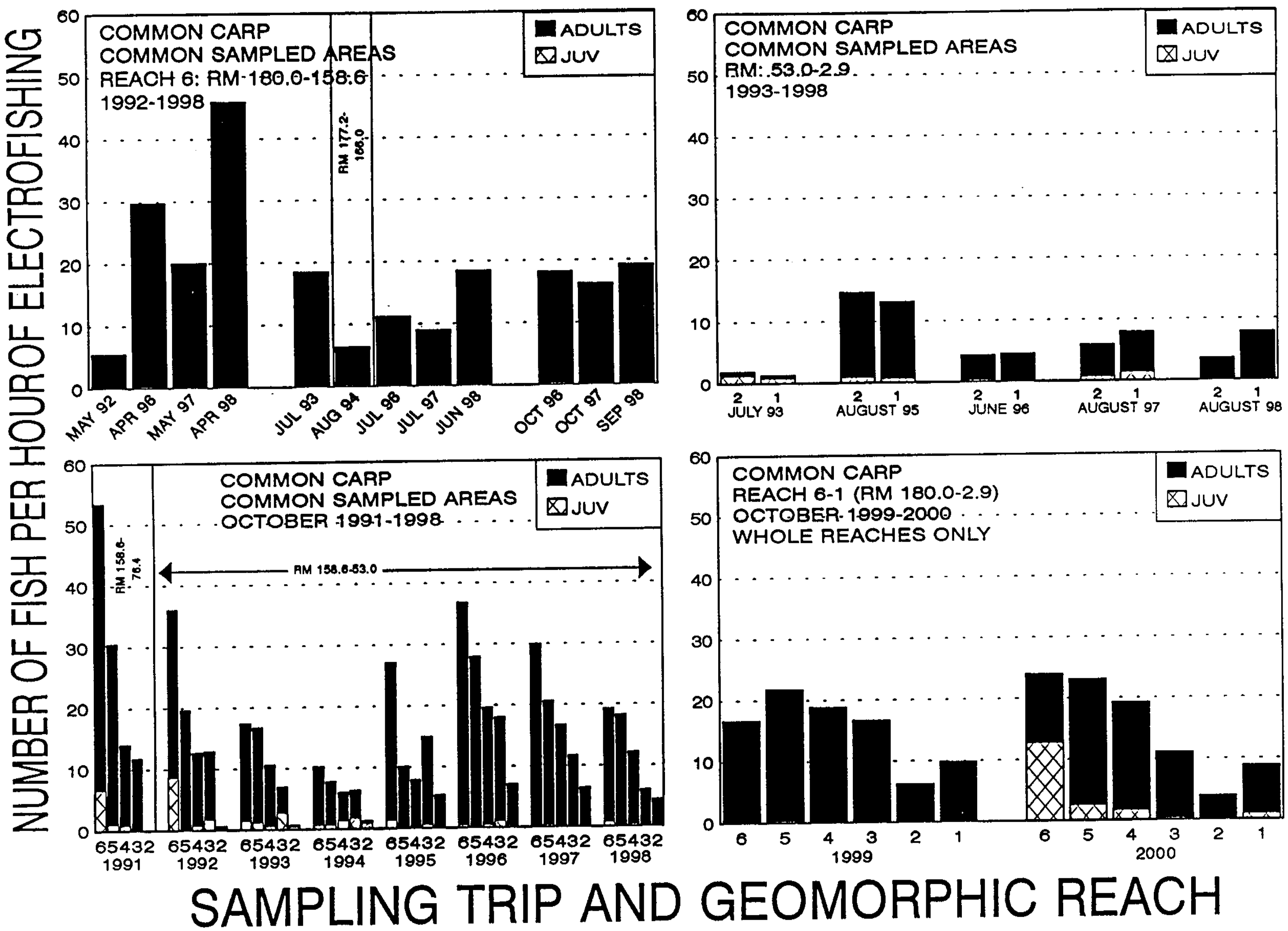

Figure 17. Number of common carp, by life stage, collected per hour of electrofishing in the San Juan River during "adult monitoring" trips, 1991-2000.

Common carp total CPUE from RM 180.0-53.0 (Figure 18) in October 1999 and October 2000 was almost identical. October 1999 and 2000 common carp total CPUE values were intermediate to previous years' high values, being higher than in October 1997 and lower than in October 1996, but not significantly different from either year (Table 11, Figure 18).

Common carp mean TL in Reach 6 was the lowest ever observed in that reach and among the lowest ever observed in any reach or year since studies began in 1991 (Figure 19). The lower range of common carp TL's by river reach observed in 2000 was consistently lower than in 1999, with the exception of Reach 2 (Figure 19). Range values by reach observed for common carp TL in 2000 (again with the exception of Reach 2) more closely resembled those seen from 1991-1995 (Figure 19). Plots of common carp TL by 25-mm size-classes show that, like native flannelmouth sucker and bluehead sucker, comparatively large numbers of age-0 common carp were collected in 2000 (Figure 20). Almost three-quarters (72.7%) of the age-0 common carp collected riverwide in 2000 were collected in Reach 6 (Figure 5). In Reach 6, over eleven times as many age-0 common carp were collected upstream of the PNM Weir (RM 166.6) as downstream. A total of 159 age-0 common carp (23.1/hour of electrofishing) were collected from RM 180.0-166.6 as opposed to 6 age-0 common carp (2.0/hour of electrofishing) from RM 166.6-158.6.

Channel catfish total CPUE in the lower portion of Reach 6 (RM 166.6-158.6), the area in which channel catfish mechanical removal efforts have been concentrated since 1996, has demonstrated a steady, but not significant, decline over the last three years (1998-2000; Table 12a, Figure 21). Juvenile common carp, which are very rare made up more of the total CPUE in 2000 in ths section of the river than they have since 1992 (Figures 17 and 21). Yet even though juvenile common carp were collected in relatively large numbers in 2000 when compared to previous years' sampling in this river section, the difference was (with one exception) not significant (Table 12b, Figure 21).

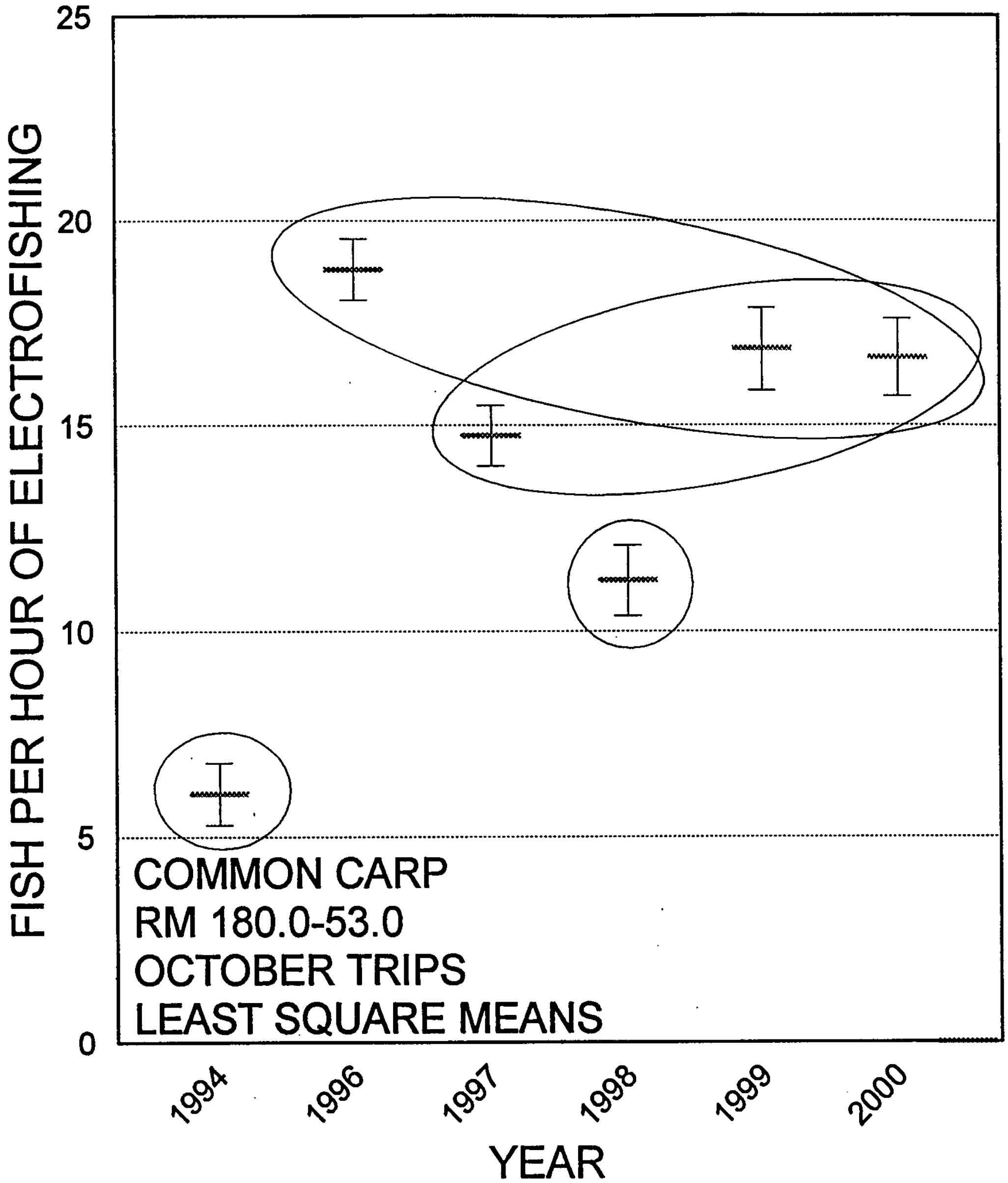

Figure 18. Number of common carp, all life stages combined, collected per hour of electrofishing in the San Juan River, RM 180.0-53.0, during "adult monitoring" trips, 1994-2000. Error bars represent standard error values. Circles include years whose values are not significantly different from one another. Only those sampling trips on which this entire river section was sampled are presented.

Table 11. One-way ANOVA statistics and matrix of Bonferroni-adjusted pairwise comparisons of total (juvenile + adult) common carp CPUE data, in the San Juan River, RM 180.0-53.0, October 1994 to October 2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 35.739, $r^2 = 0.103$, p = 0.000*

Scheffe matrix:

	1994	1996	1997	1998	1999	2000
1994	1.000					
1996	0.000*	1.000				
1997	0.000*	0.002*	1.000			
1998	0.000*	0.000*	0.026*	1.000		
1999	0.000*	1.000	1.000	0.000*	1.000	
2000	0.000*	1.000	1.000	0.000*	1.000	1.000

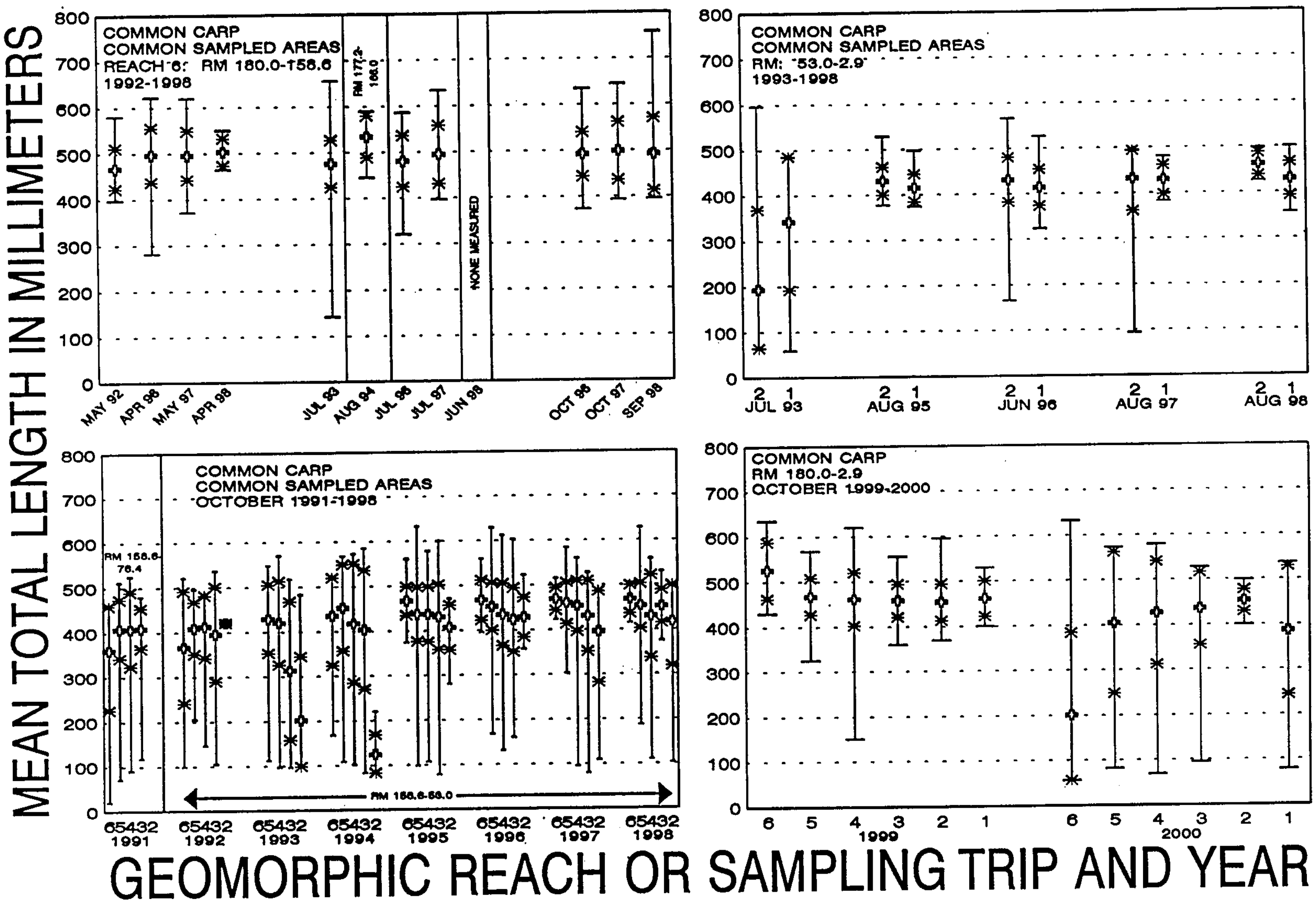

Figure 19. Mean total length (TL) in millimeters for common carp collected on "adult monitoring" trips, 1991-2000. Crosses represent the mean values, error bars the range, and asterisks represent the standard deviation.

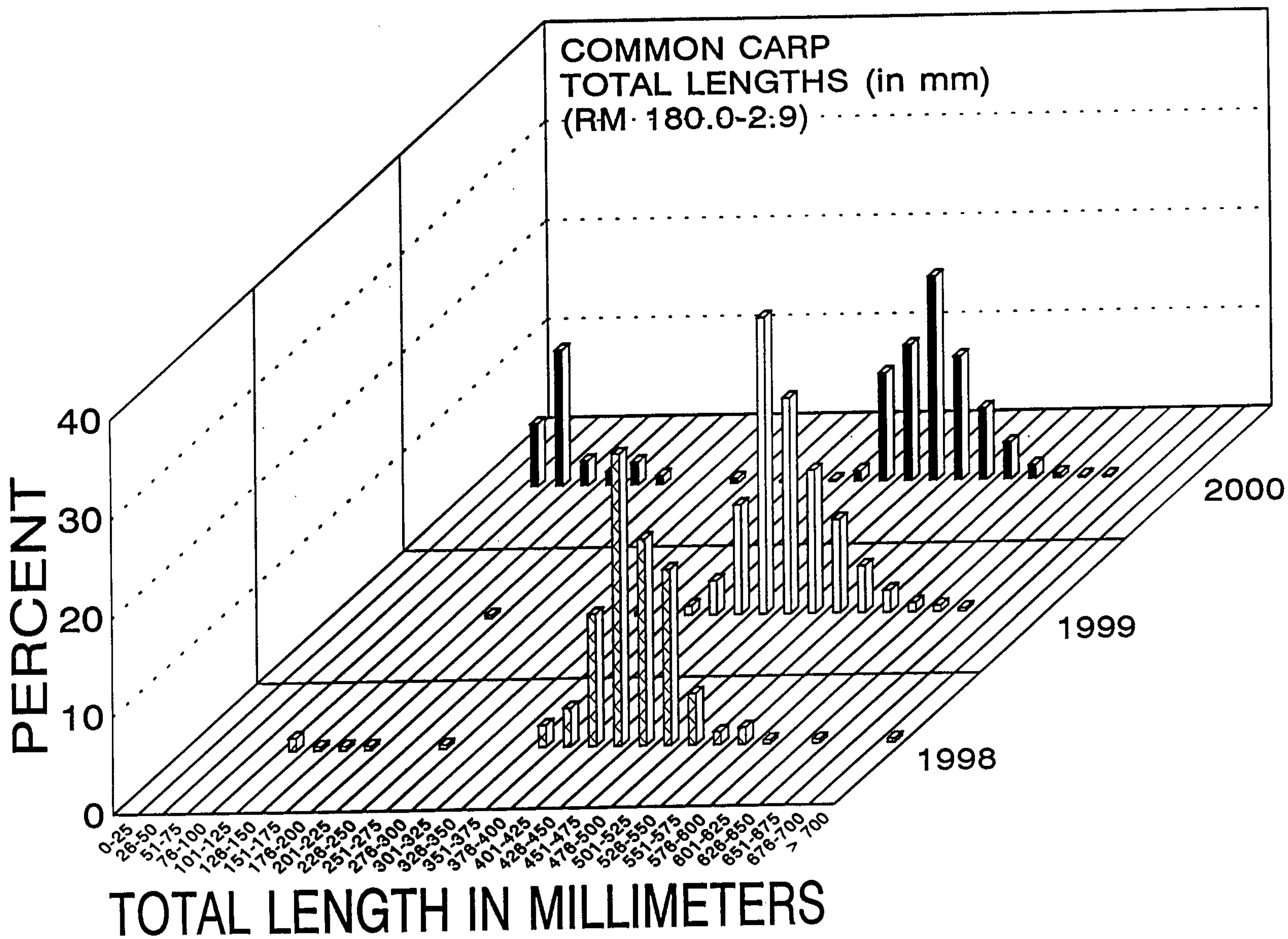

Figure 20. Percentages of common carp by 25-mm size class measured on "adult monitoring" trips, 1998-2000.

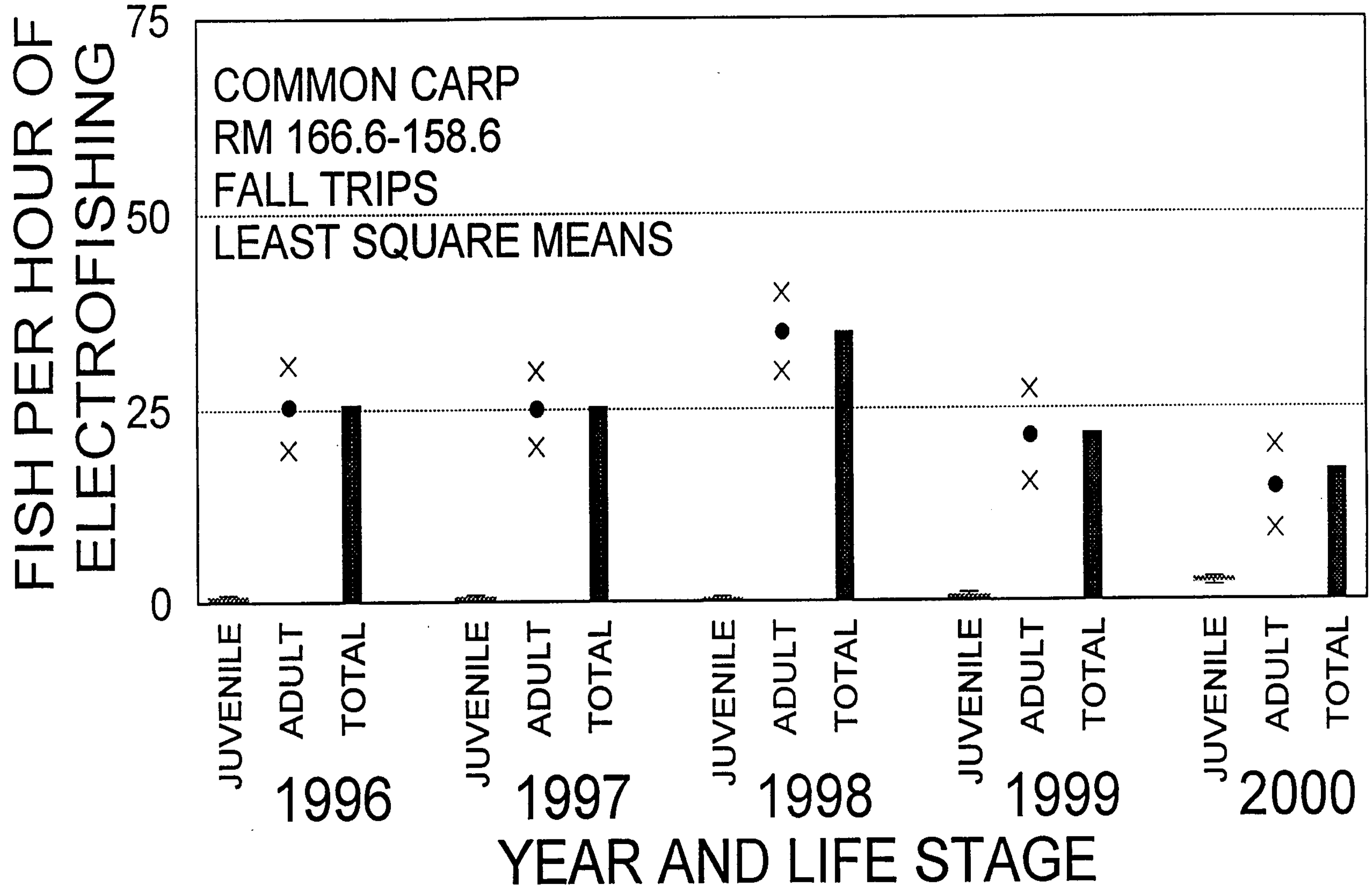

Figure 21. Common carp catch per unit effort (CPUE) values from RM 166.6-158.6, 1996-2000. Solid vertical bars represent the values for common carp total (juvenile + adult) CPUE. Dark horizontal lines represent mean CPUE values for juvenile common carp and the error bars, the associated standard error values for juvenile CPUE. Solid circles represent mean CPUE values for adult common carp and the crosses, the associated standard error values for adult CPUE.

Table 12a. One-way ANOVA statistics and matrix of Bonferroni pairwise comparisons of total (juvenile + adult) common carp CPUE data, in the San Juan River, RM 166.6-158.6, on fall sampling trips 1996-2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 1.548, $r^2 = 0.096$, p = 0.200

Scheffe matrix:

	1996	1997	1998	1999	2000
1996	1.000				
1997	1.000	1.000			
1998	1.000	1.000	1.000		
1999	1.000	1.000	1.000	1.000	
2000	1.000	1.000	0.201	1.000	1.000

Table 12b. One-way ANOVA statistics and matrix of Bonferroni pairwise comparisons of juvenile common carp CPUE data, in the San Juan River, RM 166.6-158.6, on fall sampling trips 1996-2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 2.629, $r^2 = 0.153$, p = 0.043*

Scheffe matrix:

	1996	1997	1998	1999	2000
1996	1.000				
1997	1.000	1.000			
1998	1.000	1.000	1.000		
1999	1.000	1.000	1.000	1.000	
2000	0.186	0.131	0.055*	0.239	1.000

Table 12c. One-way ANOVA statistics and matrix of Bonferroni pairwise comparisons of adult common carp CPUE data, in the San Juan River, RM 166.6-158.6, on fall sampling trips 1996-2000 ($p < 0.10$ = * = statistically significant relationship).

One-way ANOVA: F-statistic = 1.940, $r^2 = 0.118$, p = 0.116

Scheffe matrix:

	1996	1997	1998	1999	2000
1996	1.000				
1997	1.000	1.000			
1998	1.000	1.000	1.000		
1999	1.000	1.000	0.911	1.000	
2000	1.000	1.000	0.086*	1.000	1.000

Common carp adult CPUE mirrored the trends seen for common carp total CPUE. However, in the case of adult common carp the downward trend in CPUE from 1998-2000 was significant (Table 12c, Figure 21).

During July 2000 razorback sucker monitoring, several 40-50 mm TL common carp were collected from striped bass stomachs, as was a scale from an adult common carp (unpublished data).

Other Nonnative Fishes

Largemouth Bass

More largemouth bass were collected during 2000 adult monitoring than have ever been collected since our studies began in 1991. A total of 111 largemouth bass were collected during 2000 adult monitoring (Table 1). Of these, 109 were juveniles. Largemouth bass collections ranged from RM 178.0-4.0, but almost all of these fish (n = 104, 93.7%) were collected upstream of the canyon reaches (RM 68.0-0.0). The largest majority , 83.8% (n = 93), of those 111 were collected upstream of RM 100.0.

Striped Bass

A total of 109 striped bass were collected during 2000 adult monitoring (Table 1, Figure 22). Of these, 108 were adults. Collections ranged from RM 158.0-11.0 (Figure 22). Nine more adult striped bass were collected on the

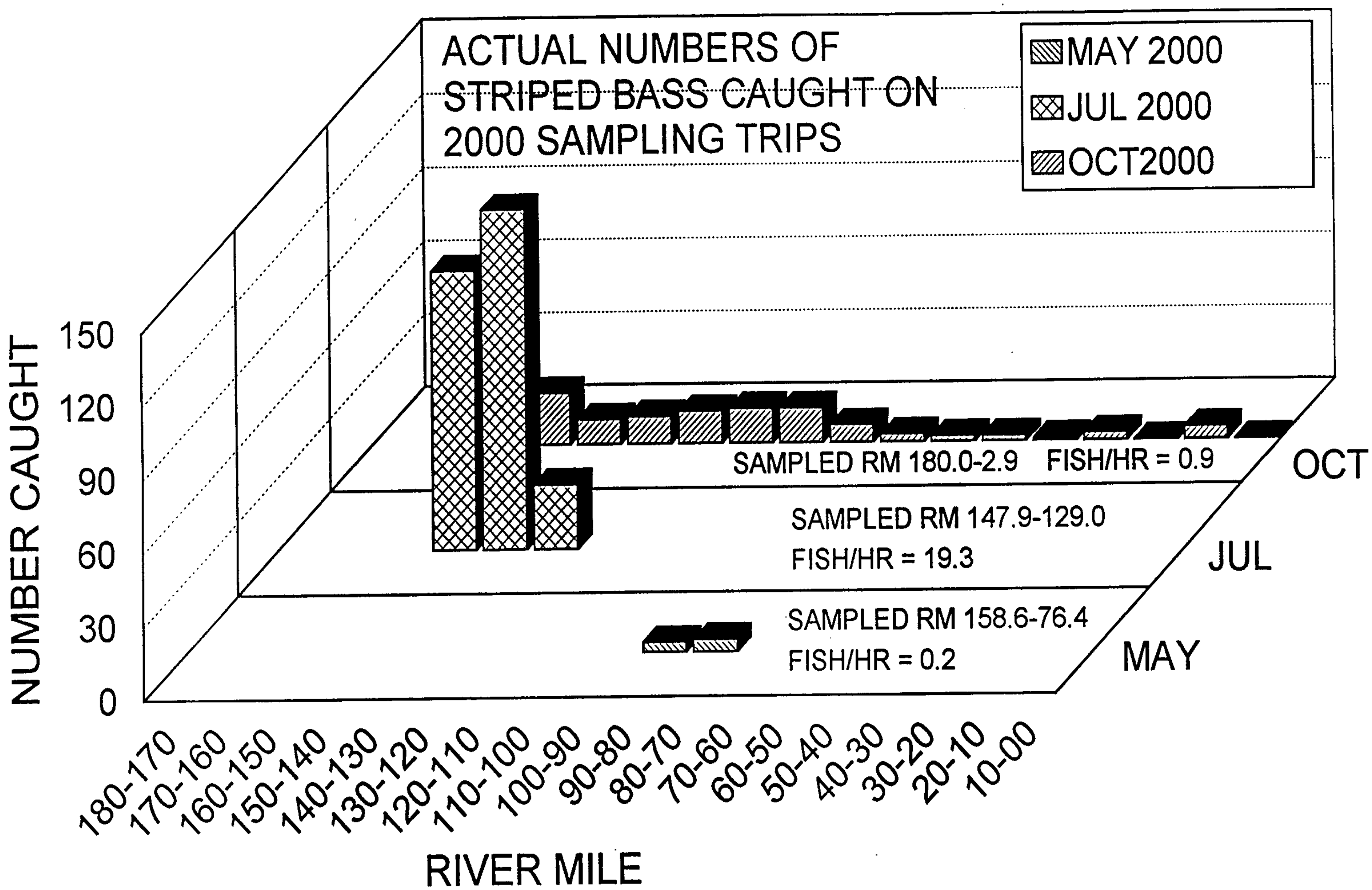

Figure 22. Striped bass collections on sampling trips performed by the U.S. Fish and Wildlife Service (Grand Junction) in 2000. While the distribution of striped bass appears to be very limited on the July trip, very few RM's were actually sampled. Given the very large number of striped bass collected in this short section of river, it seems likely that their numbers and distribution in the river in summer 2000 were actually much greater than it appears here.

May 2000 razorback sucker monitoring trip, which sampled from RM 147.9-76.4 (striped bass collections ranged from RM 87.0-76.8; Figure 22), and 279 more adult striped bass were collected on the July 2000 razorback sucker monitoring trip, which sampled from RM 147.9-129.0 (striped bass collections ranged from RM 147.0-129.0; Figure 22; Ryden 2001). Another 35 adult striped bass were collected on channel catfish mechanical removal trips (which sampled from RM 166.6-158.6) during the summer of 2000 (J. Brooks, pers. comm.).

This is the largest concentration of striped bass ever to be scientifically documented in the San Juan River. The numbers and timing of striped bass collections indicate that striped bass moved upstream from Lake Powell (at least as far as the PNM Weir) during or just after runoff. By October, numbers of striped bass remaining in the San Juan River had greatly diminished. However, while fall monitoring numbers were not nearly as high as those observed during July razorback sucker monitoring, several hundred of these lacustrine predators did remain in the San Juan River into fall 2000.

Stomach samples harvested from striped bass during July 2000 razorback sucker monitoring included adult speckled dace, juvenile flannelmouth sucker, age-0 common carp (and one scale from an adult carp), a juvenile channel catfish, and adult crayfish (unpublished data). One 500 mm TL, female striped bass collected at RM 141.0-140.0 also had a hook in its stomach with the line still protruding from its mouth (unpublished data).

DISCUSSION

Common Native Fishes

Flannelmouth Sucker

The decline in flannelmouth sucker total CPUE in the core sampling area (RM 158.6-53.0) observed between 1992 and 1997 (Ryden 2000a) has ceased. In addition, the increase in flannelmouth sucker total CPUE in Reach 6 (upstream of RM 158.6) in 1999 and 2000 is likely a sign that the San Juan River flannelmouth sucker population in this reach is responding positively to flow manipulations. When these two river sections are combined (RM 180.0-53.0) and total CPUE examined, it shows that flannelmouth sucker numbers increased significantly in 1999 and again in 2000 compared to 1996-1998 numbers. In 2000, the majority of flannelmouth sucker collected in Reach 6 were age-0 juveniles. The reason for this large increase in age-0 flannelmouth sucker is not clear. However, several years of experimental flows from Navajo Reservoir have improved substrates and increased productivity in Reach 6. This fact combined with a good reproductive effort by the flannelmouth sucker in this reach and low, stable flows likely combined for very good survival of the 2000 year class of flannelmouth sucker.

It is intriguing that the large spike in age-0 flannelmouth sucker numbers occurred upstream of the area in which the majority of the striped bass were collected. During July 2000 razorback sucker monitoring, when 279 striped bass were collected in 15.8 RM of electrofishing, an almost complete absence of “smaller” flannelmouth sucker in collections was noted (pers.

obs.). It is likely that the large number of adult striped bass observed in summer 2000 adversely effected the survival of flannelmouth sucker < 300 mm TL in the river sections where they occurred. Adult striped bass have been documented preying upon flannelmouth sucker as large as 280 mm TL (unpublished data). The presence of the PNM Weir, which acts as an impediment to upstream fish movements (Ryden 2000a), likely sheltered age-0 flannelmouth sucker occurring upstream of this barrier from striped bass predation in 2000.

However, there may be alternative explanations for the large number of age-0 flannelmouth sucker collected in Reach 6 above the PNM Weir. One alternative explanation (P. Holden, pers. comm.) assumes that some condition or set of conditions in Reach 6, upstream of the PNM Weir, was especially beneficial to a the common large-bodied fish species that are spring spawners (i.e., flannelmouth sucker, bluehead sucker, and common carp). Relatively large numbers of age-0 fish of all three of these species were collected upstream of the PNM Weir in 2000, with average or below average numbers of age-0 fish of these species being collected in downstream reaches. The other common large-bodied fish species, channel catfish (a summer spawner), did not demonstrate the same trend in numbers or distribution of age-0 fish. It is possible that some beneficial condition or set of conditions favored successful spring spawning of common large-bodied fishes upstream of the PNM Weir in 2000, but did not benefit channel catfish either because conditions had changed by summer 2000, or because channel catfish do not occur in sufficient numbers upstream of the PNM Weir to have benefitted from these conditions.

The declining total CPUE of flannelmouth sucker in Reach 1 (immediately adjacent to Lake Powell) and the almost complete disappearance of small size-class flannelmouth sucker from this river reach may be directly related to nonnative predators. This decline first became apparent in our data sets in June 1996, a little over a year after the waterfall separating Lake Powell and the San Juan River was inundated, once again allowing lacustrine predators free access into the lower San Juan River. This same trend may be taking place in Reach 2 as well, as evidenced by total CPUE declines in October 1999 and 2000. Striped bass, walleye (Stizostedion vitreum), and the ubiquitous channel catfish have been documented to prey on flannelmouth sucker (Brooks et al. 2000, Ryden 2000a) and the majority of walleye and, up until summer 2000, striped bass were collected in Reach 1 and adjacent Reach 2 (Ryden 2000a). All of the above data forms a compelling circumstantial argument to say that lacustrine predatory fish are a detriment to the native fish community, even effecting species as abundant as the flannelmouth sucker.

However, like the situation in Reach 6, alternative explanations may apply to the disappearance of flannelmouth sucker from Reach 1. Over the last several years, The San Juan River in Reach 1 has accumulated an extremely heavy sediment load (R. Bliesner pers. comm.). This accumulation of sediment may have had a drastic enough effect on the productivity of this reach to reduce the forage base to a point where flannelmouth sucker (and other species) could no longer find sufficient forage, thus they vacated the reach.

The statistically significant increase in numbers of juvenile flannelmouth sucker collected in the lower portion of Reach 6 (RM 166.6-158.6) between 1998 and 2000 may be directly linked to mechanical removal of channel catfish in this section of the river. Adult channel catfish (> 300 mm TL) were very abundant in this portion of Reach 6 throughout the 1990's. However, intensive removal efforts appear to have been at least moderately successful in reducing the number of adult channel catfish in this section of the river. Since channel catfish are the only predatory nonnative fish commonly found in this portion of river, it seems logical to relate the decrease in numbers of adult channel catfish to the increase in numbers of juvenile flannelmouth sucker, the most abundant forage fish in this section of the river. These two species do seem to share more interactions (life history, distribution, etc.)

than do any of the other common large-bodied native and nonnative fish species. However, with only three years of strong trend data, it is impossible to make definite conclusions at this time.

Bluehead Sucker

Bluehead sucker in the San Juan River tend to be concentrated in upstream reaches of the river, specifically Reach 6 in our study area. In 1999, bluehead sucker total CPUE in Reach 6 was the highest that had ever been observed in this reach. In 2000, bluehead sucker total CPUE in Reach 6 increased yet again. Bluehead sucker total CPUE for Reach 6 and the core sampling area combined (RM 180.0-53.0) in 2000 was not as high as in 1999 (though not significantly different), but was still significantly higher than that observed from 1994-1998. Thus, it appears that reoperation of flows from Navajo Reservoir has been a boon to the San Juan River bluehead sucker population, especially in Reach 6.

Like flannelmouth sucker, the majority of age-0 bluehead sucker collected in Reach 6 during 2000 adult monitoring were collected upstream of RM 166.6 and were probably also sheltered form striped bass predation by the presence of the PNM Weir. As with flannelmouth sucker, “smaller” bluehead sucker were essentially absent from collections during July 2000 razorback sucker monitoring (pers. obs.). Although bluehead sucker occur in lesser numbers in downstream reaches (i.e., Reach es 4-2) than do flannelmouth sucker, they are still common enough that they were probably effected adversely by the presence of large numbers of adult striped bass during summer 2000. While there is no documentation to date of striped bass preying on bluehead sucker, the fact that they prey on both sympatric flannelmouth sucker and speckled dace would argue for them being eaten when striped bass are present.

Like flannelmouth sucker, the alternative explanation for the large number of age-0 bluehead sucker in Reach 6 above the PNM Weir (P. Holden, pers. comm.), may also apply here.

Juvenile bluehead sucker in the lower portion of Reach 6 (RM 166.6-158.6) did not show the same significant increase in number between 1998 and 2000 as did juvenile flannelmouth sucker. Numbers of juvenile bluehead sucker in this section of the river were significantly higher in 1999 than in any previous year, but declined markedly (though not significantly) in 2000. As was the case throughout the "adult monitoring" studies of 1991-1998 (Ryden 2000a), bluehead sucker exhibit population trends independent of those observed for the sympatric flannelmouth sucker. This is logical, given the two species often occupy different habitats, with bluehead sucker being more limited to clean cobble habitats such as riffles, whereas flannelmouth sucker are more of a generalist species, being found in many habitats. Also, bluehead sucker are more limited in their distribution than are flannelmouth sucker. Thus the factors that effect flannelmouth sucker may effect bluehead sucker differently or not at all.

Rare Native Fishes

Colorado Pikeminnow

No wild Colorado pikeminnow were collected in 2000. Collections of wild adult Colorado pikeminnow have been rare since 1995. Stocked juvenile Colorado pikeminnow continue to be recaptured, but numbers recaptured in 2000 were much lower than in previous years. It is evident that at least small numbers (relative to total numbers stocked) of stocked Colorado pikeminnow continue to persist and grow in the San Juan River and the likelihood that at least a few of these fish will recruit and become spawning adults seems good. However, the reason for the rather severe drop-off in numbers of stocked fish recaptured in 2000 as compared to previous years is unknown. The very low numbers of stocked Colorado pikeminnow recaptured in 2000 may just be a one-year anomaly in sampling, or these numbers may indeed reflect a severe drop-off (i.e., bottleneck) in the survival of these fish. It is possible that some stocked juvenile Colorado pikeminnow were lost to striped bass predation. While there is no direct evidence of this, striped bass are known to prey on sympatric native fishes, some as large as 280 mm TL (unpublished data). Furthermore, Colorado pikeminnow stocked between 1996 and 1998 would have been completely piscivorous by 2000 and very likely using many of the same habitats as adult striped bass to pursue their prey. The size ranges (mm TL) observed for recaptured individuals would place many of them within the size range vulnerable to striped bass predation and any overlap in habitat use between these two species would increase the chances of young Colorado pikeminnow being eaten.

Hopefully, sampling in 2001 will help to answer some of these questions about stocked Colorado pikeminnow survival before augmentation efforts for this species begin anew in 2002.

Razorback Sucker

Stocked razorback sucker continue to persist throughout the San Juan River. Unfortunately, due to difficulties in obtaining and rearing enough razorback sucker for stocking, many fewer razorback sucker have been stocked than were originally planned (Ryden 1997, 2001). However, the few razorback sucker that have been stocked continue to grow and have begun to spawn. Larval razorback sucker were collected in both 1998 and 1999 (S. Platania pers. comm.) and suspected spawning aggregations of razorback sucker were identified near Aneth, UT (at RM 100.2) in both May 1997 and April 1999 (Ryden 2000b). Some razorback sucker that washed out of Ojo Pond in August 1998, have survived and are now resident in the San Juan River upstream of many of the instream diversion structures. Numerous razorback sucker have also been recaptured in Lake Powell in areas that were occupied by wild razorback sucker (i.e., Piute Farms) as recently as the late 1980's.

Based on the numbers stocked versus numbers recaptured, stocked razorback sucker have had much higher survival post-stocking than have stocked Colorado pikeminnow in the San Juan River. One reason for this may be their size at time of stocking. Razorback sucker stocked at larger sizes (> 350 mm TL) have survived much better than smaller stocked fish (Ryden 2001). To date very few large Colorado pikeminnow have been stocked into the San Juan River, and the few adults that have been stocked were in poor health when stocked.

For more detailed information on stocked razorback sucker, see Ryden 2001.

Roundtail Chub

Roundtail chub collections continue to be very rare in San Juan River. No roundtail chub were collected in 2000. There appears to be no persistent roundtail chub population in the mainstem San Juan River, as might be documented by recaptures of tagged fish or population length-frequencies indicating recruitment. Only a very few, scattered adult fish appear to be resident in the mainstem San Juan River. The few juvenile roundtail chub collected in the mainstem river appear to be transient residents at best, rarely if ever recruiting into adulthood.

Common Nonnative Fishes

Channel Catfish

Total CPUE for channel catfish continues to vary widely from year to year and reach to reach. In 2000, channel catfish total CPUE dropped in every reach except Reach 5, compared to 1999 values. The trend towards a lower CPUE for adult channel catfish still appeared to be taking place (again with the exception of Reach 5) in 2000, though this trend was not as easily discernible in 2000 as it was in 1999 CPUE data. Unlike the three other common large-bodied fishes in the San Juan River, large numbers of age-0 channel catfish were not collected in 2000.

The most logical explanation for the observed trend towards smaller fish in channel catfish populations is mechanical removal efforts. Since electrofishing tends to be somewhat size selective for larger fishes, it would make sense that larger channel catfish would be more dramatically effected by mechanical removal efforts based around electrofishing. The removal of larger size-class fish would make more resources available for smaller channel catfish (i.e., less intraspecific competition). Survival of smaller size-classes of channel catfish may also increase due to reduced intraspecific predation by larger members of their own species. Thus, in effect, small channel catfish would have greater survival rates, but the species as a whole would have diminished reproductive potential as large numbers of fecund adults were removed. If numbers of mature adult channel catfish can continue to be effectively removed and younger fish can be mechanically culled as they begin to recruit to the adult life-stage, the population should eventually start to show dramatic reductions in numbers. However, this will be a long and labor-intensive process.

This argument seems to be supported by channel catfish CPUE data from the lower portion of Reach 6 (RM 166.6-158.6) over the last five years. Following the theories espoused for anticipated reaction of channel catfish populations to mechanical removal efforts (J. Brooks, pers. comm.), there has been a downward trend in adult channel catfish CPUE in ths section of the river over the last five years. Numbers of adult channel catfish in 2000 in this reach were significantly lower than when mechanical removal began in this section of river in 1996. During this same time frame, juvenile channel catfish CPUE in this section of river increased significantly between 1996 and 1999, then declined significantly between 1999 and 2000. Only time will tell if this downward trend continues.

While a reduction in numbers of large channel catfish bodes well for native fishes by reducing the predation potential, the increase in small channel catfish poses some unique, albeit hopefully short-lived problems for native fishes. A stocked, subadult Colorado pikeminnow has already been documented choking on a channel catfish it tried to ingest (Ryden 2000c, Ryden and Smith 2001). In addition, higher numbers of small size-class channel catfish may also cause increased competition for food and other resources with certain native fishes (specifically flannelmouth sucker and roundtail chub).

To date, few easily identified or interpreted trends are obvious in channel catfish total CPUE or length data. Preliminary data on the effects of mechanical removal efforts on this species look encouraging, but fluctuating numbers in the data sets continue to be hard to interpret.

Common Carp

As was the case with native flannelmouth sucker and bluehead sucker, large numbers of age-0 common carp were collected in Reach 6 in 2000, almost all upstream of the PNM Weir. At the same time adult common carp CPUE in Reach 6 was the lowest ever observed in this reach on a fall sampling trip. It is probable that the same factors that contributed to there being such large numbers of age-0 native suckers in 2000 (discussed previously) were also responsible for the large number of age-0 common carp.

The drop in adult common carp CPUE in Reach 6 in 2000 may indicate an adverse effect of mechanical removal efforts on adults of this species in this reach. If so, this would be the first evidence ever collected that shows researchers could have an impact on the San Juan River common carp population. Only further monitoring will tell.

Other Nonnative Fishes

Largemouth Bass

Given that most of the striped bass in 2000 were collected upstream of RM 100.0 and that most of them were juvenile, it would appear that these fish are entering the San Juan River from upstream sources. Largemouth bass (mostly juveniles) have been collected in Reaches 6 and 5 in past years, usually near or in the mouths of irrigation return ditches. Off-channel sources linked to these ditches may very well be the source of these fish. Low, clear flows and stable conditions throughout 2000 may have contributed to a higher-than-usual survival rate of juvenile largemouth bass once they entered the river.

Despite numbers of largemouth bass collected in 2000 being markedly higher than in previous years, when compared to other fish species in the river, the percent of the fish community composed by this species was still relatively low. However, while largemouth bass juveniles are not a threat to native fishes by themselves, they are just one more stressor in a system already overloaded with stressors. Largemouth bass are known to prey on native speckled dace (unpublished data), and will provide competitive and predative pressures on sympatric native species when they are present.

Striped Bass

Striped bass are a problem in the San Juan River. The numbers of this particular predator found at any given time in the San Juan River are highly variable. Yet even one striped bass in the river represents the loss of native fish through predation. Striped bass have been documented preying upon common fish species, both native and nonnative, in the San Juan River. Data collected during the July 2000 razorback sucker monitoring trip (i.e., absence of small native suckers in the catch and common native and nonnative fishes documented in striped bass stomachs; Ryden 2001) and October 2000 adult monitoring trip (i.e., the skewed distribution of age-0 flannelmouth sucker, bluehead sucker, and common carp in upstream river reaches) indicates adult striped bass may have cropped large numbers of juvenile common fishes during summer 2000. There is no reason to believe that rare native fishes occupying the same habitats as adult striped bass would not be eaten as well. Just because rare fish are less abundant and predation on them is that much harder to document, does not mean it doesn't happen. This becomes an issue of concern to the SJRIP as significant financial and manpower resources are being shifted towards stocking efforts for Colorado pikeminnow and razorback sucker. If influxes of large numbers of striped bass from Lake Powell occur with any regularity, whole stockings of endangered could be lost.

The quandary that the SJRIP finds itself in is that there are few remedial actions that can be taken to address this problem. Mechanical removal efforts can be intensified when striped bass invasions are identified and angler bag limits on striped bass in the mainstem San Juan River can be removed, but realistically, there is little else that can be done.

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