Non-native species monitoring and control in the upper San Juan River, New Mexico 2006

FINAL REPORT

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SAN JUAN RIVER RECOVERY IMPLEMENTATION PROGRAM

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prepared by:

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EXECUTIVE SUMMARY

Intensive non-native removal in 2006 on the upper San Juan River marked the sixth year of such efforts. A total of 3,043 channel catfish *Ictalurus punctatus* and 569 common carp *Cyprinus carpio* were removed from RM's 166.6 – 147.9 during eight removal trips. Of the eight trips, four were conducted from PNM Weir to Hogback Diversion (RM's 166.6 – 159.0) and four from Hogback Diversion to Shiprock Bridge, New Mexico (RM's 158.8 – 147.9). Additionally, a total of 5,869 channel catfish and 718 common carp were removed from Shiprock Bridge to Mexican Hat, Utah (RM's 147.9 – 52.9). In addition to intensive removal efforts, opportunistic removal during riverwide monitoring trips continued in 2006.

PNM WEIR TO HOGBACK DIVERSION - SECTION 1

Channel catfish CPUE (fish/hour of electrofishing) varied little among trips in 2006. Among year comparisons revealed no reduction in CPUE, 2001-2006. Channel catfish CPUE was highly influenced by the season in which non-native removal occurred. Since 2001, CPUE was significantly higher during summer months than any other season of the year. Channel catfish mean total length (TL) was higher than 2005 but remain lower than 2001 values ($p \leq 0.001$). Fish $\leq$ 400 mm TL comprised 69.2% of the total channel catfish catch. Six individual fish collected were > 600 mm TL. The channel catfish population within this Section was highly dependent on the 300-400 mm size class.

Common carp CPUE varied little among trips in 2006 with all trips having a CPUE < 6 fish/hour. Common carp abundance remained low in 2006 and was similar to observed values in 2005. Similar to previous years, adult common carp (> 250 mm TL) comprised the majority of the total carp catch.

HOGBACK DIVERSION TO SHIPROCK BRIDGE – SECTION 2

Channel catfish CPUE varied among trips in 2006. Among year comparisons indicated a reduction in channel catfish relative abundance, 2003-2006 ($p \leq 0.001$). Reductions were a result of decreased CPUE for both juvenile and adult channel catfish. Mean TL was higher than

2005 but remained lower than 2003 ($p \leq 0.001$). Fish ≤ 400 mm comprised 51.4 % of the total catch in 2006 and fish > 501 mm comprised 6.8 % of the total catch.

Common carp CPUE among trips remained similar in 2006 and averaged 3.9 fish/hour. Common carp CPUE in 2006 was similar to 2005 but was significantly lower than in 2003 ($p \leq 0.001$). Adult fish composed the majority of the common carp catch.

SHIPROCK BRIDGE TO MONTEZUMA CREEK, UTAH

A total of two trips were conducted in this Section in 2006. Channel catfish CPUE ranged from 64.0 to 10.7 fish/hour of electrofishing between trips. Observed differences in channel catfish CPUE may have been a result of increased flow and turbidity that limited the netters ability to visually identify and capture channel catfish. Mean TL was similar between trips and ranged from 29-701 mm TL.

Common carp CPUE in 2006 was low with catch rates < 10 fish/hour during each of the two trips. Similar to trends riverwide, the majority of common carp collected were adult fish with juveniles comprising 2% of the total catch.

In addition, one removal pass was conducted from Montezuma Creek to Mexican Hat, Utah (RM's 93.6 – 52.9). A total of 2,345 channel catfish and 165 common carp were collected. Majority of channel catfish collected were juveniles. Spatial difference in catch existed with more juvenile fish collected as sampling proceeded downstream. Adult fish were captured at relatively equal rates throughout sampling.

RIVERWIDE REMOVAL

Channel catfish CPUE in 2006 was similar to 2005 but remained lower than values observed prior to the initiation of intensive non-native removal. Recent increases in riverwide channel catfish CPUE was attributed to continued increased abundance in Geomorphic Reaches 4 and 3, portions of the San Juan River where intensive removal efforts have been limited.

Common carp CPUE decreased in 2006 to 3.1 fish/hour, the lowest value recorded among the 1998-2006 sampling period ($p \leq 0.001$). Declines in CPUE were observed across all

Geomorphic Reaches. Observed declines in common carp CPUE appeared to be associated with the initiation of intensive non-native removal in 2001. Similar to previous years, overall common carp catch was highly dependent on adult fish (95% of common carp catch).

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INTRODUCTION

The presence of non-native fishes within the San Juan River may have deleterious effects on recovery efforts for Colorado pikeminnow and razorback sucker. Channel catfish and common carp may affect native aquatic communities through trophic interactions (direct predation, possible competition for food), spatial interactions (competition for habitat, spawning space or feeding areas), and by habitat alteration (Brooks et al. 2000; Minckley 1991; Sigler 1987; Tyus and Saunders 2000). Of these factors, only direct predation and aggressive behavior/harassment has been documented on the San Juan River (Brooks et al. 2000 and Ryden 2005). Opportunistic removal of non-native fishes began in 1996 and was formally adopted as a management tool in 1998. United States Fish and Wildlife Service (FWS), New Mexico Fishery Resources Office (NMFRO) evaluated numerous capture techniques and determined that raft mounted electrofishing was the most efficient method to remove large bodied non-native fish (Brooks and Smith 2005).

Removal efforts by NMFRO officially began in 1998 with intensified efforts beginning in 2001. Efforts focused on a 7.6 mile reach of river located near Fruitland, NM. Location of concentrated removal efforts was influenced by information on adult fish distribution and abundance reported on by Ryden (2000). Data suggested that numbers of channel catfish and common carp were lower upstream of PNM Weir (RM 166.6) and that the majority of non-native fishes within Geomorphic Reaches 6 and 5, as described by Bliesner and Lamarra (2000), were considered adult. The presence of water diversion structures that may serve as potential impediments to upstream fish movement and the propensity of large adult non-native fishes determined where intensive removal efforts would take place.

Efforts in 2006 marked the sixth consecutive year of removal from PNM Weir to Hogback Diversion (RM 166.6 - 159.0). Due to seasonal variance in catch rates (CPUE; fish/hour of electrofishing), efforts were expanded in 2003 to include an additional 11.1 river miles immediately downsteam. Mark/recapture work conducted by NMFRO documented upstream movement into the study reach by channel catfish and common carp (Davis and Coleman 2004). These movement patterns correspond with the completion of the non-selective Hogback fish ladder in 2001 at RM 159.0.

Due to increased channel catfish abundance in portions of the San Juan River that lacked intensive removal efforts, it was determined to expand efforts in 2006 to include intensive removal passes from Shiprock Bridge to Mexican Hat, Utah (22 February 2005 SJRIP Biology Committee meeting). A total of two trips were conducted in 2006. In addition to intensive non-native removal trips, opportunistic removal riverwide during sub-adult and adult fish monitoring trips continued in 2006. Removal of non-native fish during these trips has occurred, to some degree, since 1996.

Study objectives were:

1. Continue data collection and mechanical removal of large bodied non-native fish during main channel and rare fish monitoring efforts.
2. Evaluate distribution and abundance patterns of non-native species to determine effects of mechanical removal.
3. Expand intensive removal efforts downstream to Montezuma Creek, Utah (RM 93.6) while still maintaining sufficient effort to maintain current accomplishments within upstream sub-reaches.
4. Continue and expand transplantation of channel catfish to closed impoundments isolated from the San Juan River with the assistance of New Mexico Department of Game and Fish, Navajo Nation Fish and Wildlife Service and the SWTFC.
5. Characterize the seasonal distribution and abundance of striped bass upstream of Shiprock, NM during removal efforts and continue to document the predative impacts via stomach content analysis.

STUDY AREA

Non-native fishes were removed, during riverwide monitoring, from the San Juan River; Colorado, New Mexico, Utah; in all accessible habits from Farmington, New Mexico (Animas River confluence [RM 180.0]) downstream to Clay Hill's Landing (RM 2.9), Utah (Figure 1). Intensive non-native removal efforts were focused on 18.7 river miles located in the northwestern portion of New Mexico near the towns of Fruitland and Shiprock. Two removal Sections were sampled between RM's 166.6 – 147.9 and were located within Geomorphic Reaches 6 and 5 (Figure 1). These Sections were delineated by a water diversion structure, Hogback Diversion. The third intensive removal reach was from Shiprock Bridge downstream to Mexican Hat, Utah (RM 52.9).

METHODS

Sampling conducted during adult monitoring trips in 2006 followed similar protocols to previous years (Ryden 2000). Fishes were collected using raft mounted electrofishers. Rafts consisted of a rower and a netter and floated near the shoreline netting all fish seen. Sampling was conducted in one RM increments. At the end of each RM, all fish collected were enumerated by species and size class. At the end of every fifth mile fish were measured to the nearest millimeter (mm) for total and standard lengths and weighed to the nearest 5 grams (g) for mass. All non-native fishes were removed from the river with exception of anchor tagged fish that were returned to the river.

Sampling conducted in intensive removal reaches followed protocol similar to adult monitoring. However, only nonnative and rare fishes were netted during these efforts. In addition, a support raft was used both to collect any non-native fishes that surfaced behind the shocking rafts and to serve as a holding unit for transporting live fish. Fish collected by the support raft were included in the calculation of CPUE.

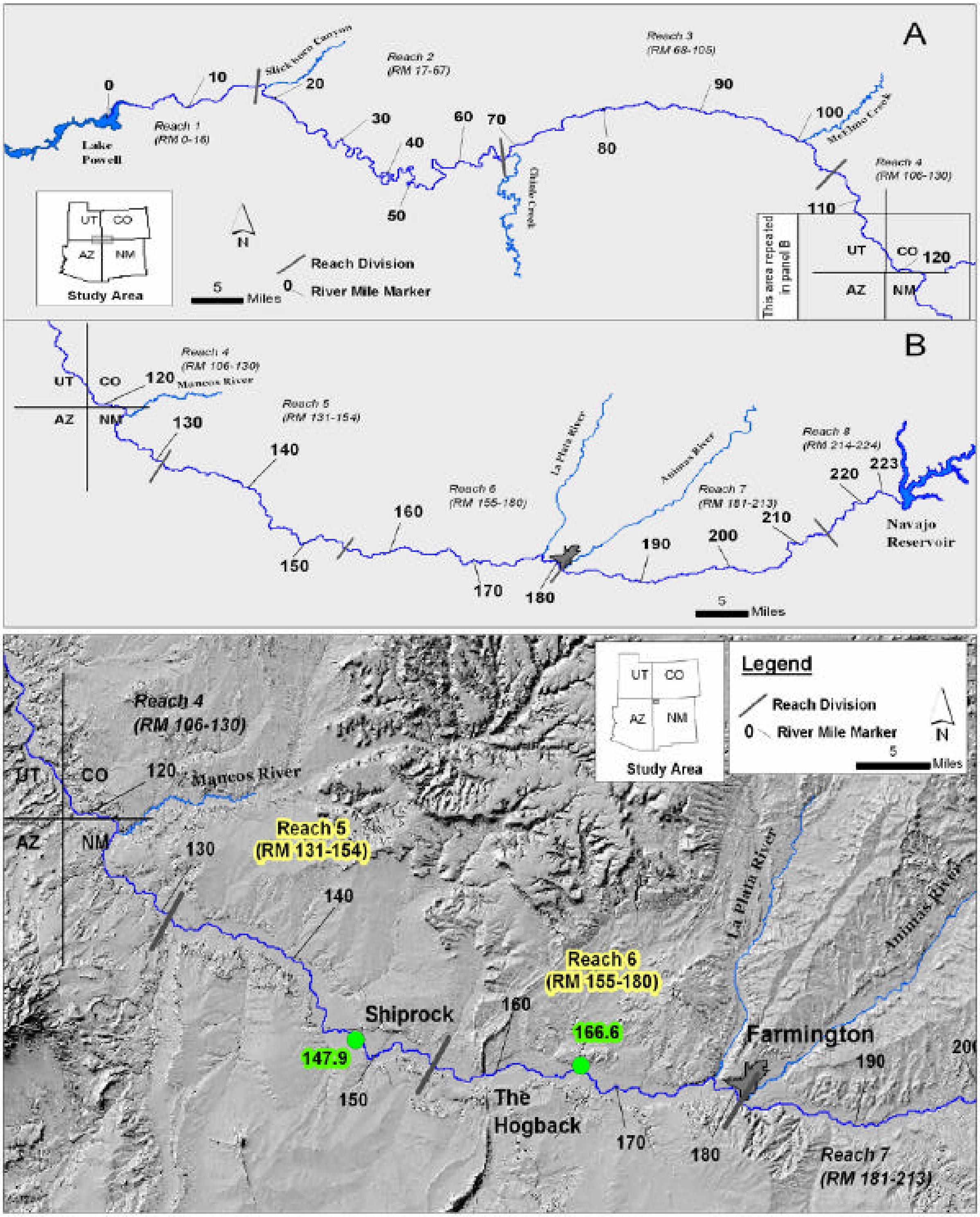

Figure 1. Map of study area including entire San Juan River basin (top) and a more detailed map of intensive removal reaches (green highlights; bottom). –map provided by UNM MSB

All non-native fishes or a representative sub-sample (blind grab) were measured (nearest 1 mm) for total and standard lengths and weighed (nearest 5 g) for mass. All non-native fishes were removed from the river. When possible, channel catfish were held for transplantation. Channel catfish were kept in live wells treated with salt and stress coat to alleviate stress caused by holding and transporting. A battery powered aeration system or compressed oxygen was used for circulation and aeration. Channel catfish were transported from the San Juan River in distribution trucks provided by the Navajo Nation Department of Fish and Wildlife.

All available capture data were analyzed independently by Section and project. For example, catch rates among years from PNM to Hogback, Hogback to Shiprock and Riverwide sampling were compared only with the same Section and not across Sections. To determine trends in distribution and abundance, mean CPUE and standard error were calculated using software package SPSS version 13.0. Species CPUE represents the total number of fish collected divided by the total effort of sampling (hours of electrofishing). Data were summarized by type of trip (i.e. intensive removal, riverwide), year, reaches and by individual trips. If CPUE data met the assumptions of normality and variance, a One Way Analysis of Variance (ANOVA) was conducted to determine if significant differences existed. Multi pairwise comparisons using Bonferroni post hoc tests were used to determine where specific differences existed. If data were heteroscedastic, and transformations were unsuccessful in attaining equal variance, an ANOVA on ranked data (Kruskal Wallis) was conducted with Nemenyi post hoc tests to determine where specific differences existed (Zar 1999)

To compare channel catfish and common carp abundance between Sections, a series of intensive non-native removal trips were conducted (2003-2006) in each Section within four to five days of each other. Trips were conducted in the same general time frame to ensure that sampling conditions, i.e. discharge, temperature, water clarity, etc., were essentially the same. Sampling under similar conditions helped to limit variability among comparisons.

RESULTS

PNM WEIR TO HOGBACK DIVERSION (RM 166.6 – 159.0) – SECTION 1

A total of 670 channel catfish and 175 common carp were collected during five trips and 49.5 hours of electrofishing (Appendix A-1). All nonnative fishes were removed from the river. In addition to channel catfish and common carp, other non-native fishes removed from Section 1 included rainbow trout *Oncorhynchus mykiss*, brown trout *Salmo trutta*, bullhead catfishes *Ameiurus spp.*, largemouth bass *Micropterus salmoides*, green sunfish *Lepomis cyanellus*, bluegill *Lepomis macrochirus*, and white sucker *Catostomus commersoni*. No striped bass *Morone saxatilis* were collected or observed.

CHANNEL CATFISH

Four trips were conducted from April to September (Appendix A-1). Channel catfish CPUE was initially low ranging from 0.3 to 1.0 fish/hour of electrofishing. Catch rates increased during the July trip to 33.3 fish/hour (Figure 2). During the September trip, CPUE decreased to 11.1 fish/hour. Overall channel catfish CPUE for all trips and all life stages combined was 14.2 fish/hour (Figure 3).

Channel catfish CPUE among years has not significantly declined since intensive non-native removal began in 2001. Although a significant decline was not observed, overall channel catfish CPUE was at the lowest level (14.2 fish/hour) observed among 2001-2006 comparisons (Figure 3). Juvenile CPUE was similar to 2005 and 2001-2002. A general declining trend in adult CPUE was observed from 2001-2006 but significant differences were not detected (Figure 3).

Shifts towards smaller sized channel catfish have been documented since 1999. Although mean total length (TL) increased to 380.7 mm (± 3.1 SE) in 2006, it was than less than in 2001 (ANOVA; $F = 416.284_{(5, 13769)}$; Nemenyi post-hoc, $p \leq 0.001$). Channel catfish < 401 mm TL comprised 69.2% of the fish collected compared to 18.8% in 1999 (Table 1, Figure 4). Channel catfish from 301-400 mm TL comprised 60.9% of the total catch. Juvenile fish ($\leq$ 300 mm TL) decreased in abundance from 2005-2006 but remained higher in abundance than values observed in 2001 and 2002. In addition, large channel catfish =501 mm TL comprised 52.6% of the catch in 1999

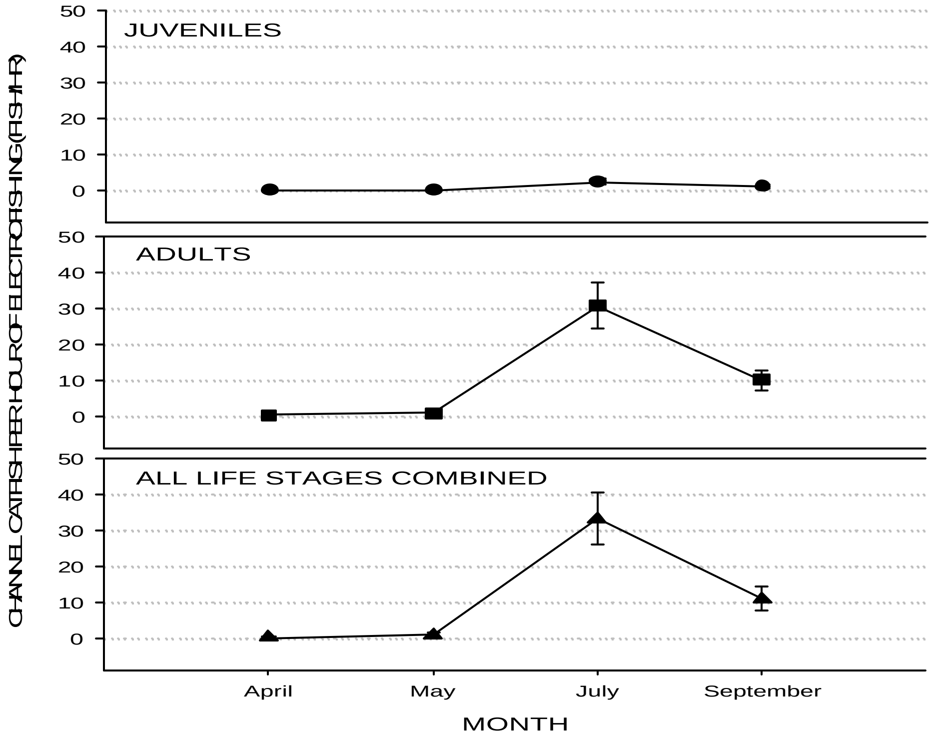

Figure 2. Channel catfish CPUE (fish/hour) by trip within the PNM Weir to Hogback Diversion Section. Error bars represent ± 1 SE.

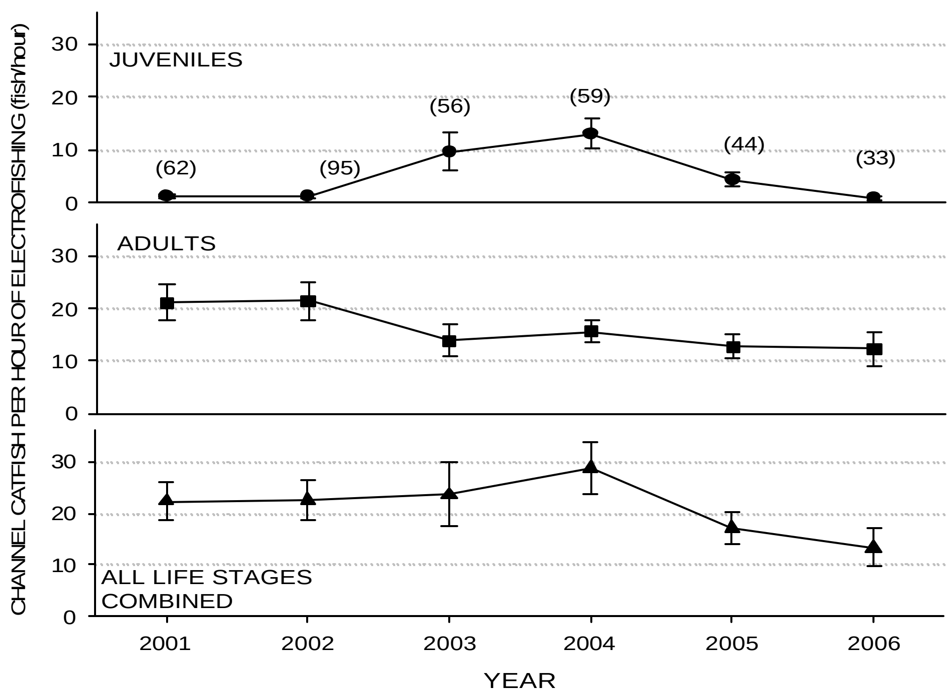

Figure 3. Channel catfish CPUE (fish/hour) by year within the PNM Weir to Hogback Diversion. Section. Total sample size listed parenthetically and error bars represent ±1 SE.

Table 1. Percentage of channel catfish by size class collected from PNM Weir to Hogback Diversion, 1999-2006. Intensive nonnative removal began in 2001.

	≤ 300 mm	301-400 mm	401-500 mm	501-600 mm	> 600 mm
1999	0	18.8	28.6	39.6	13
2000	4.3	48.1	37.8	7.5	2.3
2001	6.0	49.5	38.5	5.3	0.7
2002	5.7	63.4	28.7	2.1	0.1
2003	42.7	33.4	20.7	3.1	0.1
2004	47.7	30.7	18.2	3.3	0.2
2005	18.6	50.5	24.8	6.0	0.1
2006	8.3	60.9	23.7	6.1	1.0

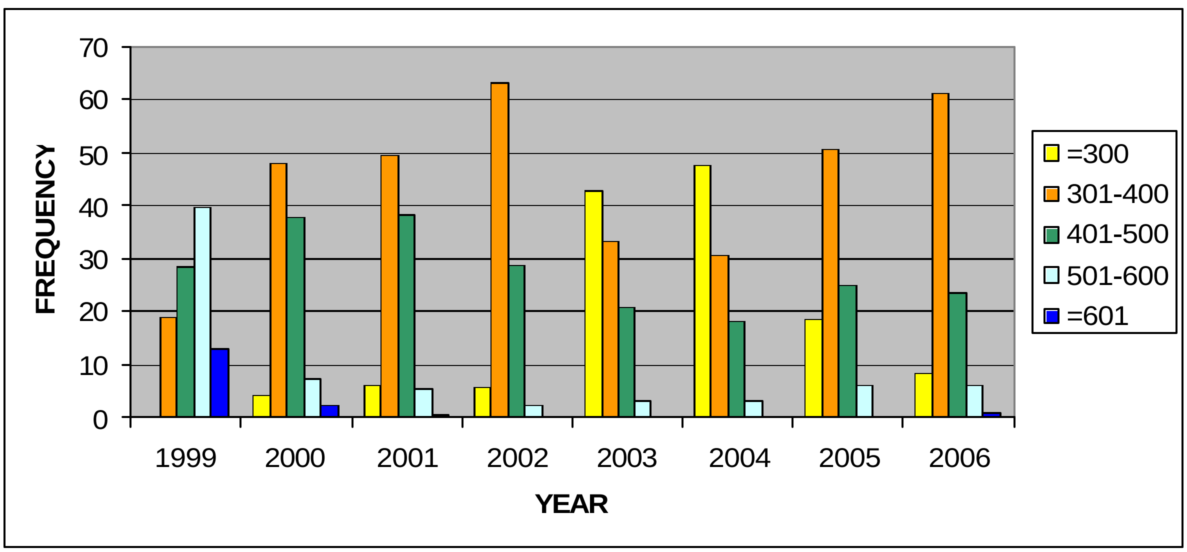

Figure 4. Size class distribution of channel catfish collected from PNM Weir to Hogback Diversion, 1999 – 2006.

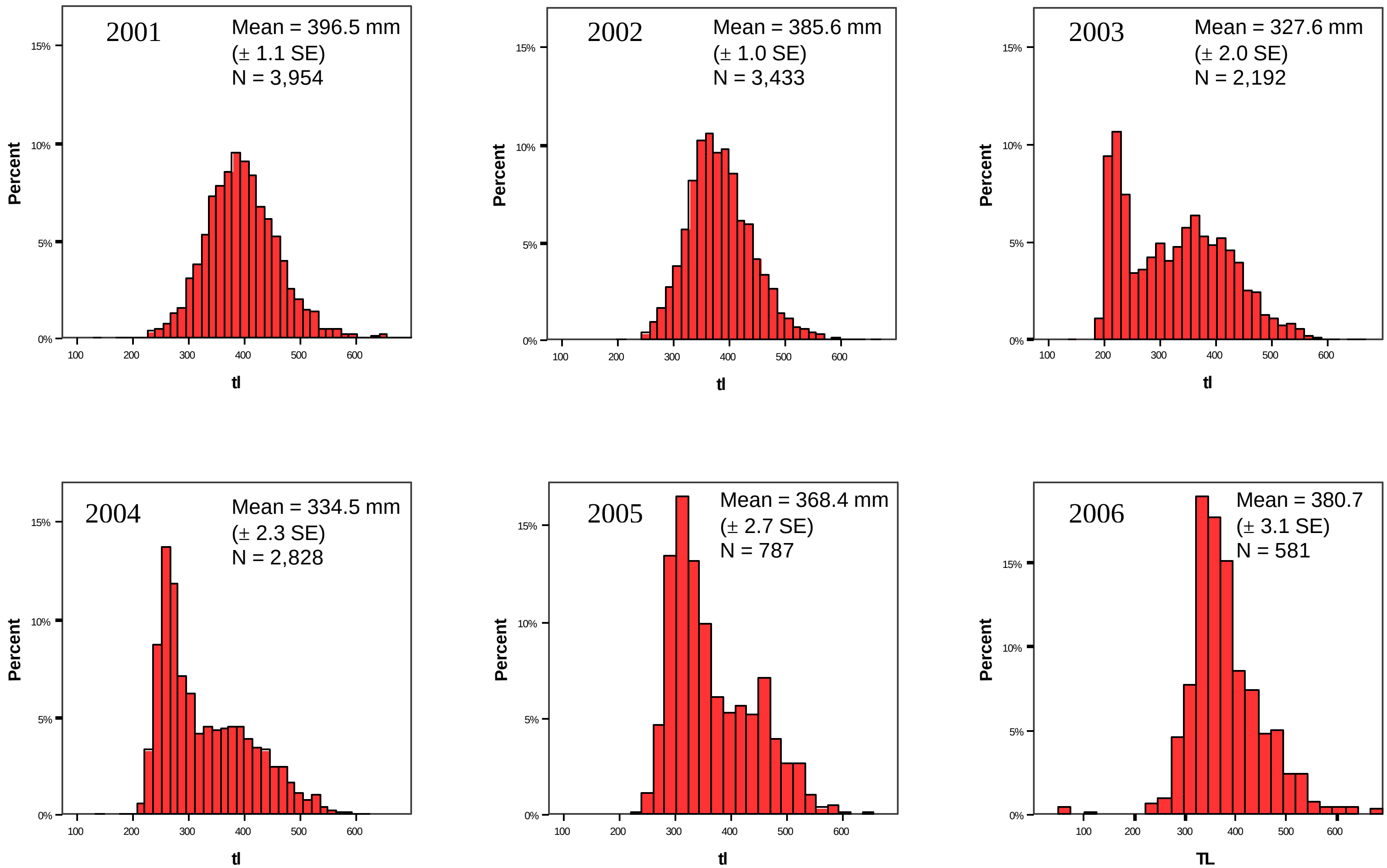

Figure 5. Length frequency histograms for channel catfish collected from PNM Weir to Hogback Diversion, 2001-2006. Mean total length and sample size listed for each year.

compared to 7.1% in 2006 (Table 1, Figures 4 and 5). Six individual catfish > 600 mm were collected in 2006.

COMMON CARP

Common carp CPUE varied little among 2006 sampling trips. The four trip mean CPUE was 3.4 fish/hour. Common carp CPUE remained below 5.0 fish/hour for each of the four trips (Figure 6). The highest values for CPUE occurred in April and July (4.5 fish/hour of electrofishing) and the lowest in May (0.8 fish/hour of electrofishing). Comparison of common carp CPUE among years showed significant declines since 2001 resulting in the lowest observed CPUE since intensive nonnative removal began (ANOVA; $F=16.446_{(5, 345)}$; Nemenyi post-hoc, $p \leq 0.001$). Common carp CPUE in 2006 was similar to values observed in 2005. Common carp CPUE declined with each subsequent year of removal until 2003 (Figure 7). Since 2003, common carp abundance has been < 5 fish/hour. The highest trip CPUE (4.5 fish/hour) in 2006 was lower than 80% of trips conducted in 2001. For example, 10 out of 19 trips (53%) conducted from 2001-2002 had common carp CPUE $\geq$ 15 fish/hour of electrofishing, more than three times the highest value observed in 2006. Common carp were considered uncommon in collections throughout this Section.

HOGBACK DIVERSION TO SHIPROCK BRIDGE (RM 158.8 – 147.9) – SECTION 2

A total of 2,373 channel catfish and 394 common carp were collected within this Section during four trips and 96.3 hours of electrofishing (Appendix A-2). All non-native fishes were removed from this Section. In addition to channel catfish and common carp, other non-native fishes removed included rainbow trout, brown trout, bullhead catfishes, largemouth bass, green sunfish, bluegill, and white sucker. No striped bass were collected or observed.

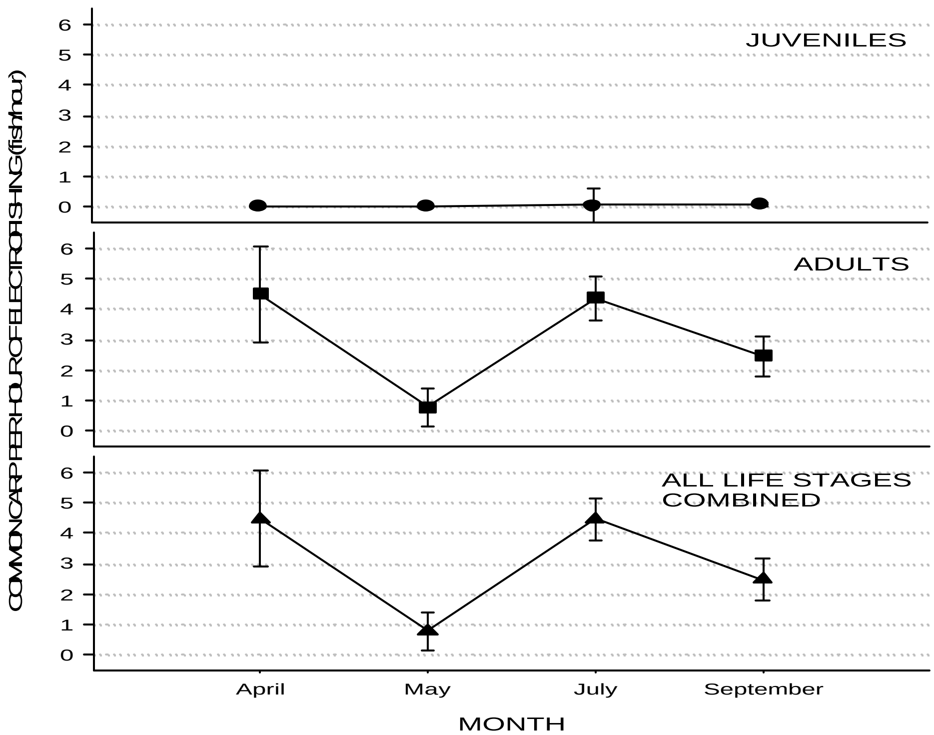

Figure 6. Common carp CPUE (fish/hour) by trip within the PNM Weir to Hogback Diversion Section, 2006. Error bars represent ± 1 SE.

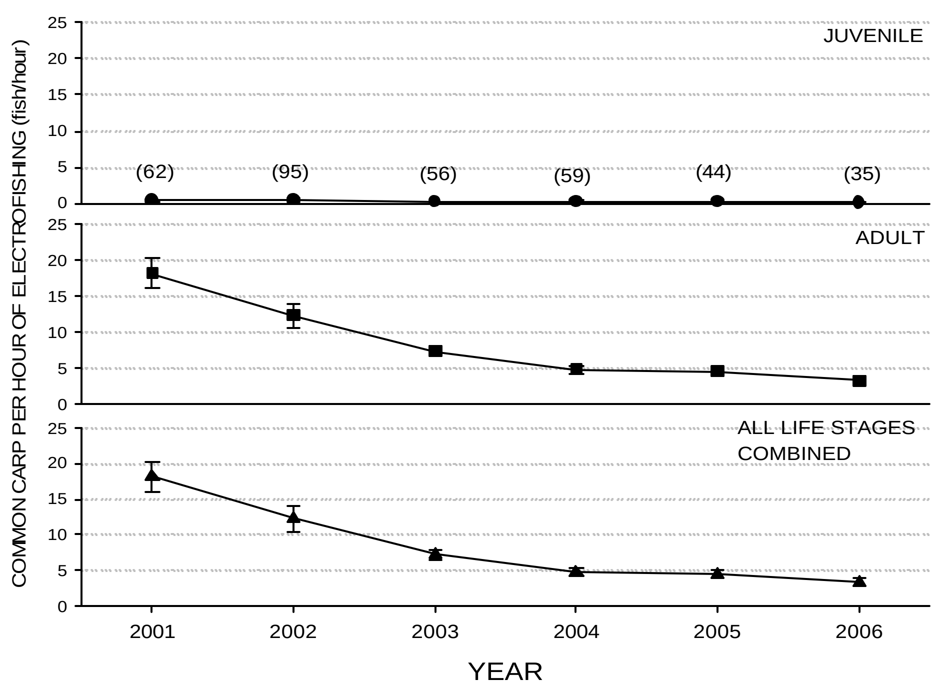

Figure 7. Common carp CPUE (fish/hour) by year within the PNM Weir to Hogback Diversion Section. Total sample size listed parenthetically and error bars represent ± 1 SE.

CHANNEL CATFISH

Four trips were conducted from April to November (Appendix A-2). Channel catfish CPUE varied by trip and ranged from 3.6 to 48.6 fish/hour (Figure 8). Channel catfish CPUE was < 10 fish/hour during trips in April and November. These values represent the lowest CPUE for channel catfish in this Section during the study period. Beginning in June, CPUE increased with the June trip yielding the highest CPUE of the four trips (Figure 8).

Channel catfish CPUE declined from 57.7 to 23.5 fish/hour, 2003-2006 (ANOVA; $F = 51.13_{(3, 559)}$; Nemenyi post-hoc, $p \leq 0.001$) (Figure 9). Juvenile and all life stages combined CPUE were similar to observed values in 2005. Adult CPUE exhibited a general increase in 2006 but remained significantly lower than 2003 (ANOVA; $F = 46.61_{(3,558)}$; Nemenyi post-hoc, $p \leq 0.001$). Juvenile CPUE decreased from 11.0 to 3.4 fish/hour (ANOVA; $F = 42.8_{(3,559)}$; Nemenyi post-hoc, $p \leq 0.001$) and adult CPUE decreased from 46.9 to 20.0 fish, 2003-2006 (Figure 9).

Although channel catfish mean TL saw a generalized increased from 361.5 mm (± 2.1 SE) to 370.4 (± 1.9 SE) mm between 2005 and 2006, mean TL in 2006 remained significantly lower than 2003 values (ANOVA; $F = 79.1_{(3, 9849)}$; Nemenyi post-hoc, $p \leq 0.001$). Fish ≤ 400 mm TL comprised 50.9% of the total catch in 2003 compared to 69.9% in 2006 (Table 2). Fish ≥ 501 mm TL continued to comprise a small portion of the total channel catfish catch in 2006, 9.1% (Figures 10 and 11).

COMMON CARP

Common carp CPUE varied little among trips averaging 3.9 fish/hour for 2006. Common carp CPUE ranged from 1.8 to 6.4 fish/hour and for the second consecutive year no individual trip exceeded 10 fish/hour (Figure 11). Majority of common carp collections consisted of adult fish with juveniles (< 250 mm TL) comprising less than 2% of the total catch (0.1 fish/hour).

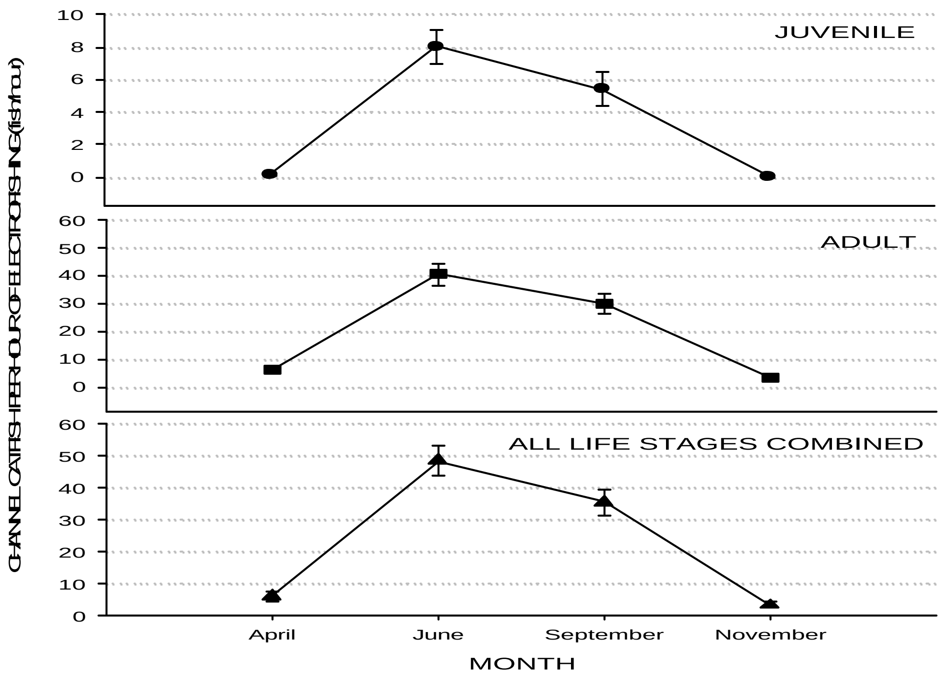

Figure 8. Channel catfish CPUE (fish/hour) by trip within the Hogback Diversion to Shiprock Bridge Section, 2006. Error bars represent ± 1 SE.

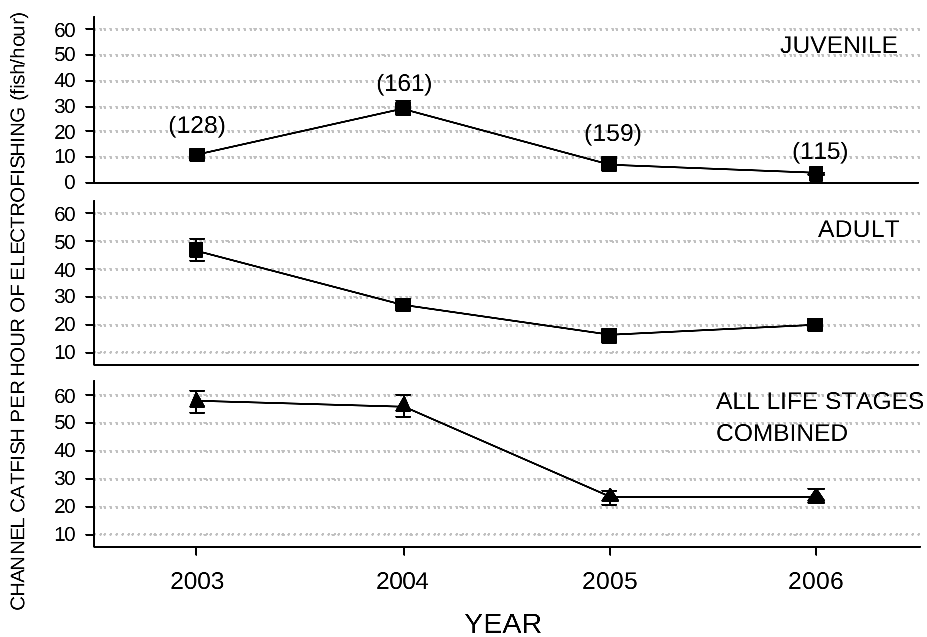

Figure 9. Channel catfish CPUE (fish/hour) by year within the Hogback Diversion to Shiprock Bridge Section, 2003-2006. Sample size listed parenthetically and error bars represent ± 1 SE.

Table 2. Percentage of channel catfish by size class collected from Hogback Diversion to Shiprock Bridge, 2003-2006. Intensive nonnative removal began in 2003.

	≤ 300 mm	301-400 mm	401-500 mm	501-600 mm	≥ 600 mm
2003	19.0	31.9	40.6	7.0	1.5
2004	48.3	24.5	22.9	4.0	0.3
2005	26.5	42.1	23.8	6.1	1.5
2006	12.4	57.5	21.0	6.3	2.8

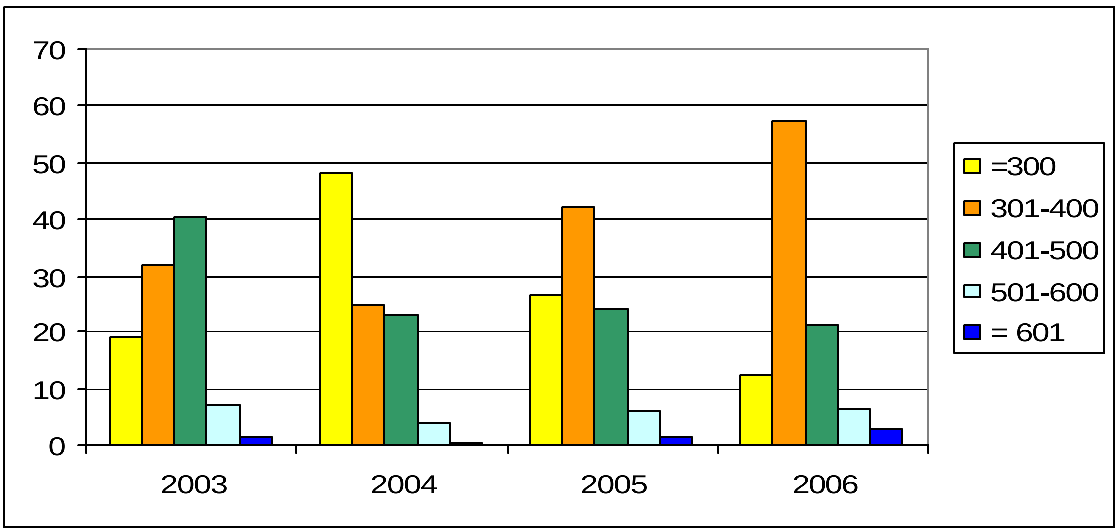

Figure 10. Size class distribution of channel catfish collected within the Hogback Diversion to Shiprock Bridge Section, 2003-2006.

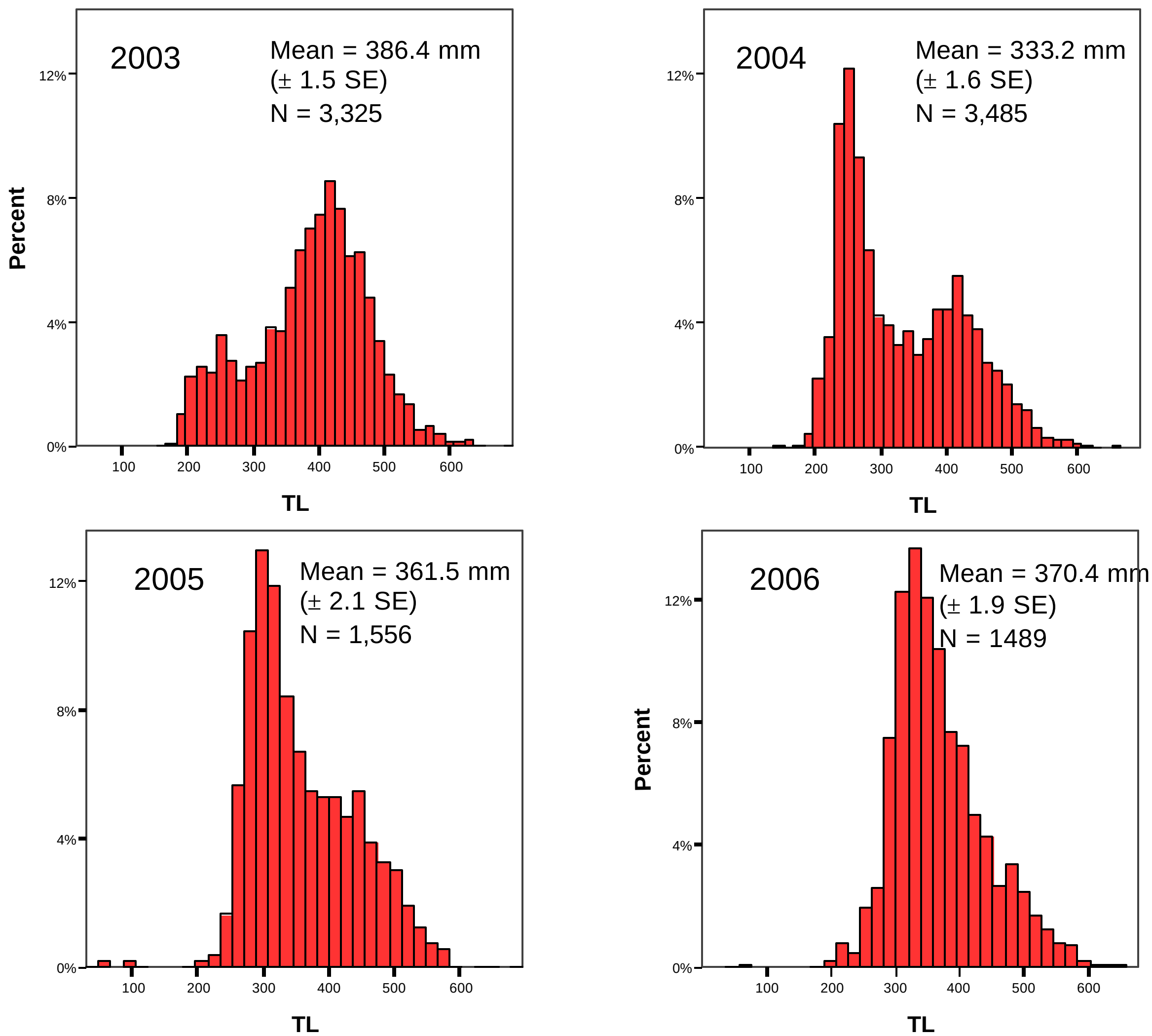

Figure 11. Length frequency histograms for channel catfish collected from Hogback Diversion to Shiprock Bridge, 2003-2006. Mean total length and sample size listed for each year.

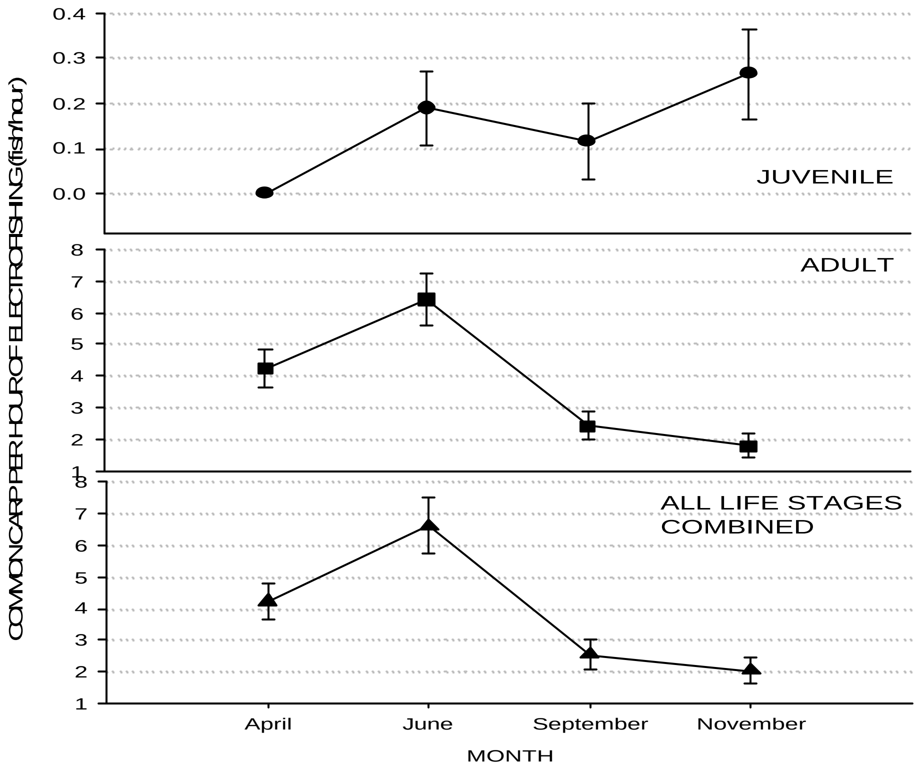

Figure 12. Common carp CPUE (fish/hour) by trip within the Hogback Diversion to Shiprock Bridge Section, 2006. Error bars represent ± 1 SE.

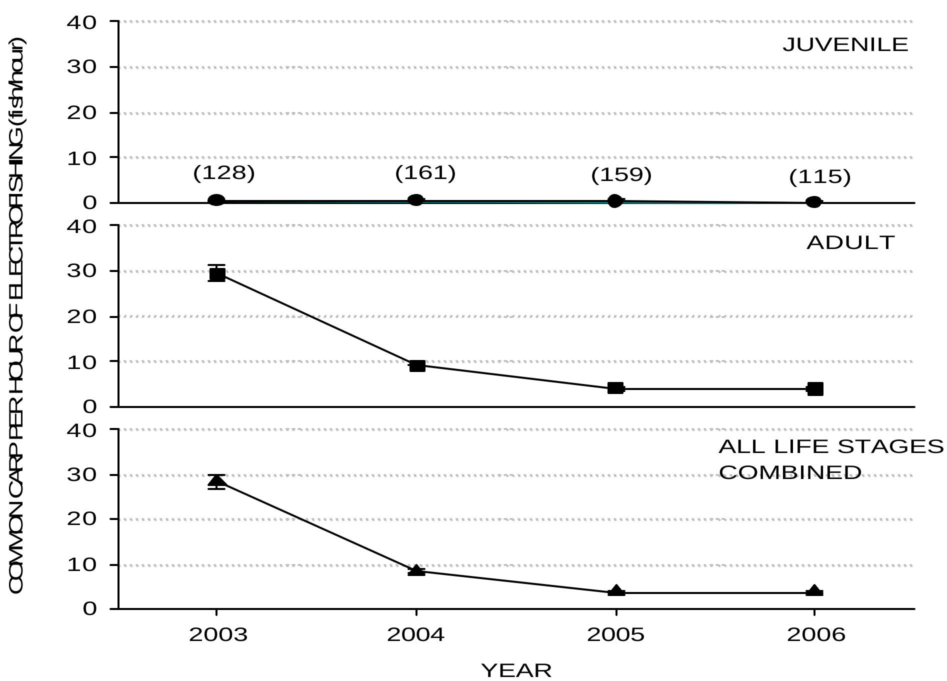

Figure 13. Common carp CPUE (fish/hour) by year within the Hogback Diversion to Shiprock Bridge Section. Sample size listed parenthetically and error bars represent ± 1 SE.

Common carp CPUE values were similar between 2006 and 2005 (Figure 13). Mean CPUE values in 2003, the initiation of intensive removal, were higher (29.4 fish/hour) compared to values in 2006 (3.9 fish/hour; ANOVA; $F = 150.24_{(3,\ 559)}$; Nemenyi post-hoc, $p \leq 0.001$). Mean CPUE for adult common carp was < 7.0 fish/hour during all trips in 2006 and was the lowest adult CPUE among 2003-2006 comparisons (Figure 12). Common carp were considered uncommon throughout this Section.

Seasonal Comparisons in Catch Rates

Channel catfish CPUE (PNM to Hogback) varied seasonally, 2001-2006. Channel catfish CPUE in 2006 was low during initial spring trips and increased 32 times during the post runoff (summer) trip (1.0 fish/hour to 33.3 fish/hour). Since intensive removal began in 2001, summer channel catfish CPUE ($\bar{x}$ = 42.3 fish/hour) has been higher than any other season (ANOVA; $F = 81.9_{(3,\ 347)}$; Nemenyi post-hoc, $p \leq 0.001$) (Figure 13).

Comparison of channel catfish CPUE during the summer indicated a general declining trend since 2002. Summer CPUE averaged 24.4 fish/hour in 2006 compared to 61.0 fish/hour in 2002. Due to high variability in catch these difference were not significant. Although channel catfish CPUE increased during the summer in 2006, it appears that the magnitude of the increase has been reduced when compared to 2001-2003 (Figure 13). Spring catch rates were similar to those observed in 2005. Generally, fall CPUE was < 10 fish/hour since 2002. Due to low catch rates removal during the winter no longer occurs.

Comparisons between Sections 1 and 2

Channel catfish CPUE varied between Sections with typically much higher CPUE below Hogback Diversion. Channel catfish CPUE from PNM Weir to Hogback Diversion (Section 1) in 2006 ranged from 0.3 to 33.3 fish/hour. The lowest channel catfish CPUE from Hogback Diversion to Shiprock Bridge (Section 2) in 2006 was 3.6 fish/hour and ranged up to 48.6 fish/hour. In 2006, the the four trip mean CPUE in Section 1 was 14.2 fish/hour compared to 23.5 fish/hour in Section 2.

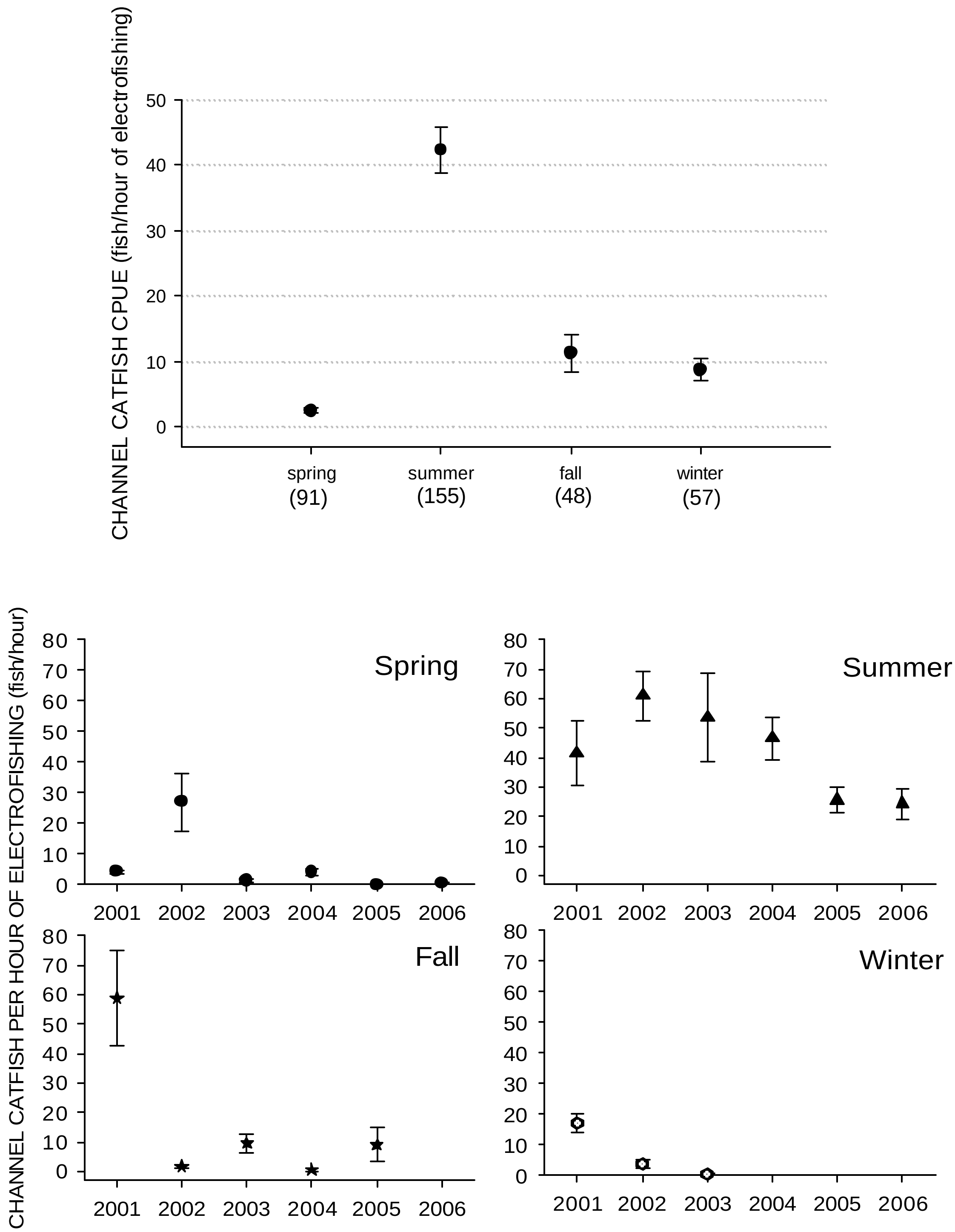

Figure 14. Channel catfish CPUE (fish/hour of electrofishing) by season and year (bottom) and by season alone (top) collected from PNM Weir to Hogback Diversion, 2001-2006. Error bars represent ±1 SE.

Differences in channel catfish abundance among Sections was further illustrated during sampling trips conducted in both Sections within one week of each other. In general, under similar sampling conditions, channel catfish CPUE was higher in the Hogback to Shiprock Section for all years combined (t-test; $F = 1.554_{(141)}$; $p \leq 0.001$) (Figure 14). Common carp CPUE varied between reaches with values in 2003 of 6.8 fish/hour within Section 1 and 38.4 fish/hour in Section 2. However, common carp CPUE in 2006 between Sections was similar with 2.4 fish/hour in Section 1 and 2.0 fish/hour in Section 2 (Figure 14). Inter-Section comparison of abundance trends for common carp followed similar declining trends observed in each Section individually and suggest that common carp abundance was low in both Sections in 2006.

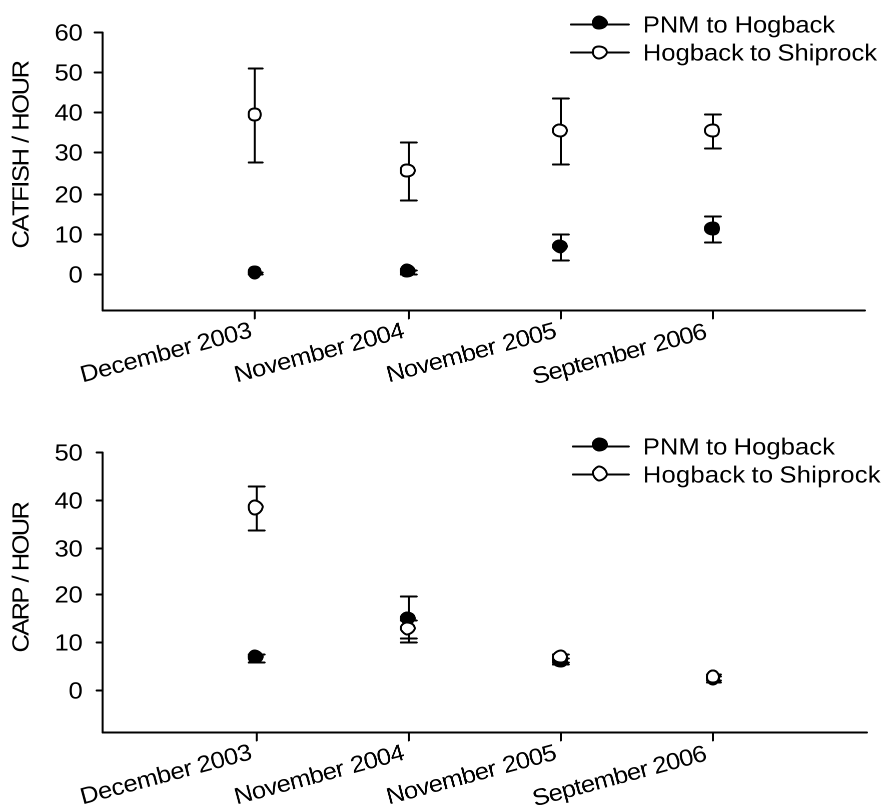

Figure 15. Comparison of channel catfish and common carp CPUE between separate Sections where intensive non-native removal takes place. Error bars represent ± 1 SE.

SHIPROCK BRIDGE TO MEXICAN HAT, UTAH (RM 147.9 -52.9)

Removal efforts conducted from Shiprock Bridge to Montezuma Creek, Utah (RM 93.6) yielded a total of 3,434 channel catfish and 553 common carp were collected during 88.7 hours of electrofishing (Appendix A-3). All non-native fishes were removed from this Section. In addition to channel catfish and common carp, other non-native fishes removed included bullhead catfishes, and bluegill. No striped bass were collected or observed.

In 2006, mean channel catfish CPUE was significantly different between the two trips, dropping from 64.0 fish/hour in May to 10.7 fish/hour in August ($t = 12.3_{(70)}$; $p \leq 0.001$) (Figure 15). Based on high catch rates during adult fall-monitoring the differences in catch rates were believed to be primarily a factor of increased flows and decreased visibility as a result of summer rainstorm events and did not represent an actual decline in relative abundance. These sampling conditions decreased the netters ability to visually identify and capture channel catfish.

During the May trip, 69.6% of channel catfish collected were adults, 30.4% were juveniles, and 0.6% were young-of-year. Adult fish comprised 71.9% of the channel catfish catch during the August trip while juvenile fish comprised 25.4% of the catch. Mean total length did not differ between trips with a mean of 366.0 mm during the May trip and 357.3 mm during the August trip. Total length ranged from 29 – 701 mm.

Common carp CPUE was similar between trips. During the May trip, mean CPUE was 6.7 compared to 5.9 fish/hour in August. Similar to trends riverwide, the majority of common carp collected were adults with juveniles comprising less than 2% of the total catch.

In addition, one removal pass was conduced by NMFRO from Montezuma Creek to Mexican Hat and occurred at the completion of the May trip to Montezuma Creek. A total of 2,435 channel catfish and 165 common carp were collected during 39.0 hours of electrofishing (Appendix A-3). Mean channel catfish CPUE was 61.6 fish/hour with juvenile fish comprising the majority of the catch. Juvenile fish comprised 67.7% of the catch while 121 individuals were classified as young-of-year. Spatial difference in catch existed with more juvenile fish collected as sampling proceeded

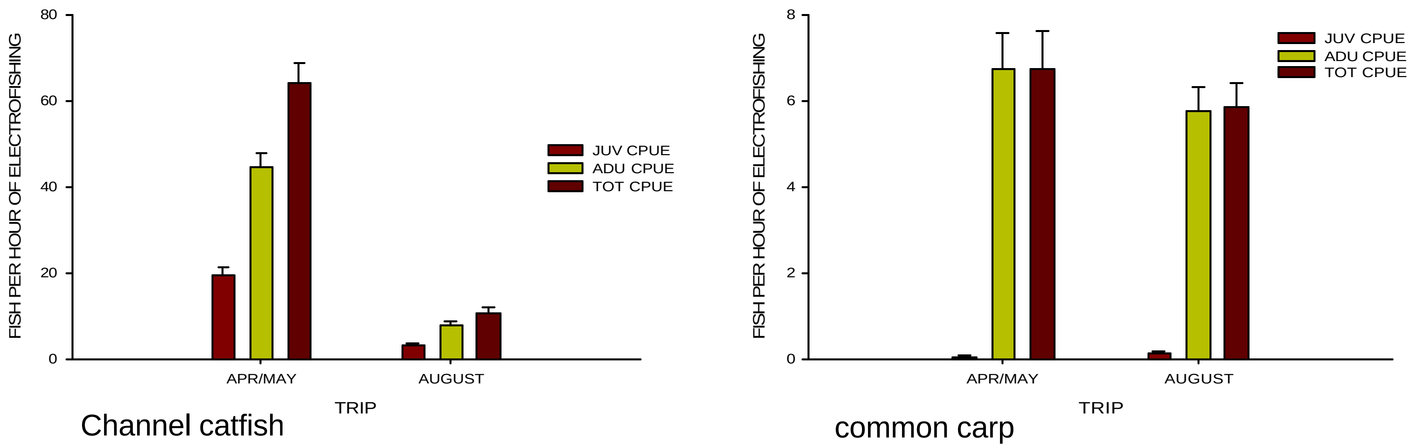

Figure 16. Channel catfish and common carp CPUE (fish/hour of electrofishing) collected during intensive non-native removal trips from Shiprock Bridge to Montezuma Creek, Utah; 2006. Error bars represent ± 1 SE.

downstream. Adult fish were captured at relatively equal rates throughout sampling. Common carp were considered uncommon throughout this Section.

RIVERWIDE REMOVAL EFFORTS (RM 180.0 – 0.00)

A total of 3,059 channel catfish and 361 common carp were opportunistically removed during monitoring trips in 111.3 hours of electrofishing, 2006 (Appendix A-4). The majority of channel catfish collected in 2006 were young-of-year or juvenile fish (n = 1,660; 54.3%). In 2006, an increase in the number of adult channel catfish was observed with adults comprising 45.7% of the total channel catfish catch. Numbers of channel catfish removed increased for the third straight year. Common carp removed were primarily adult fish and comprised 94.7% of the total common carp catch. Numbers of common carp (n = 361) were the lowest observed among 1999-2006 comparisons and decreased in numbers for the second straight year (Appendix A-4).

CHANNEL CATFISH

Channel catfish CPUE for all Geomorphic Reaches and all life stages combined varied since 1998 but has generally remained stable (Figure 17). Catch rates increased in 2006 for the third straight year, but remained lower than 2001 values (ANOVA; $F = 57.127_{(8, 3,127)}$; Nemenyi post-hoc, $p \leq 0.001$). Juvenile CPUE was similar to 2005 but remained lower than values observed in 1999-

2001. Adult CPUE increased in 2006 for the second straight year after a six year low of 12.6 fish/hour in 2003. Although adult channel catfish CPUE was similar from 2005 to 2006, rates remained lower than in 1999 (Figure 17) (ANOVA; $F = 27.37_{(8, 3179)}$; Nemenyi post-hoc; $p = 0.005$).

Channel catfish CPUE in Geomorphic Reache 6 decreased in 2006 and was significantly lower than in 2001 (Reach 6: ANOVA; $F = 5.885_{(8, 380)}$; Nemenyi post-hoc, $p \leq 0.001$). In addition, channel catfish CPUE in Geomorphic Reach 5 significantly decreased (ANOVA; $F = 5.885_{(8, 380)}$; Nemenyi post hoc, $p = 0.03$) from 2005 (Figure 18). Intensive non-native removal was conducted throughout portions of both Geomorphic Reaches 6 and 5.

Although CPUE in other reaches declined, channel catfish CPUE in Geomorphic Reaches 4 and 3 increased sufficiently to increase the mean riverwide CPUE (Figures 19). Channel catfish CPUE in Geomorphic Reach 4 increased for the third straight year and was significantly higher than 2003 (ANOVA; $F = 20.921_{(8, 615)}$; Nemenyi post-hoc, $p \leq 0.001$). Catch rates in Geomorphic Reach 3 increased in 2006 and were similar to catch rates from 1999-2001 (Figure 19). Channel catfish CPUE within Geomorphic Reaches 2-1 remained relatively low in 2006 and were lower than observed values in 2001 (Figure 20). Intensive removal of non-native fishes by Utah Division of Wildlife Resources has occurred in portions of both of these Geomorphic Reaches, 2002-2006.

Riverwide trends in channel catfish mean CPUE indicate similar trends observed when analyzing data by Geomorphic Reach. Channel catfish CPUE by five river mile segments indicated relatively low CPUE within portions of the San Juan River where intensive removal occurs (RM's 166.6 – 147.9 and RM's 52.9 – 0.00) while higher capture rates were observed in portions of the river where only opportunistic removal has occurred (Figure 21). A total of 2,150 (70.3% of catch) channel catfish were collected from RM's 120.0-66.0, areas that were only opportunistically sampled until 2006.

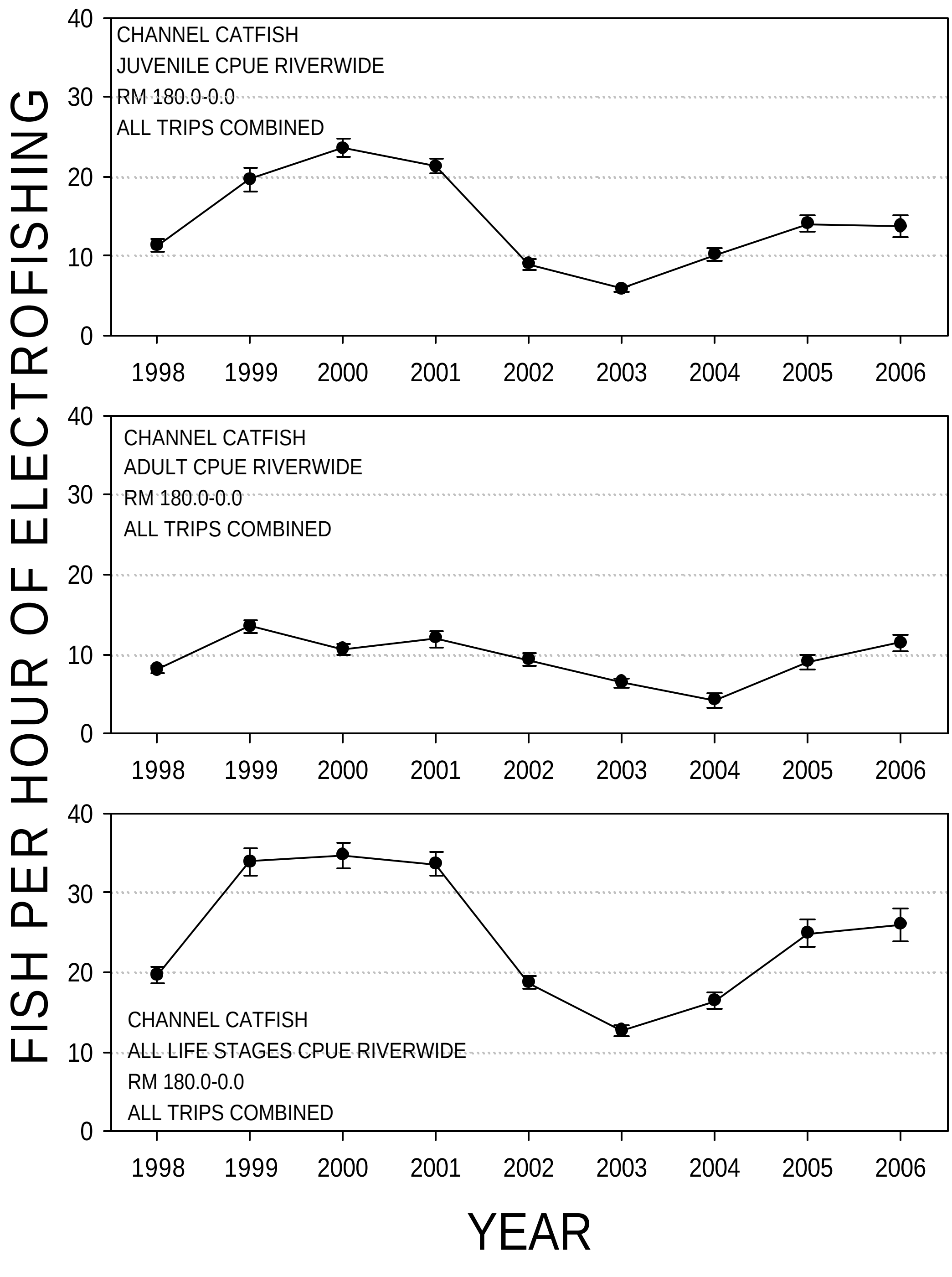

Figure 17. Channel catfish CPUE (fish/hour) by size class and by year, 1998-2006. Fish collected during riverwide monitoring efforts conducted by FWS-GJ in the spring and fall of each year. Error bars represent ± 1 SE.

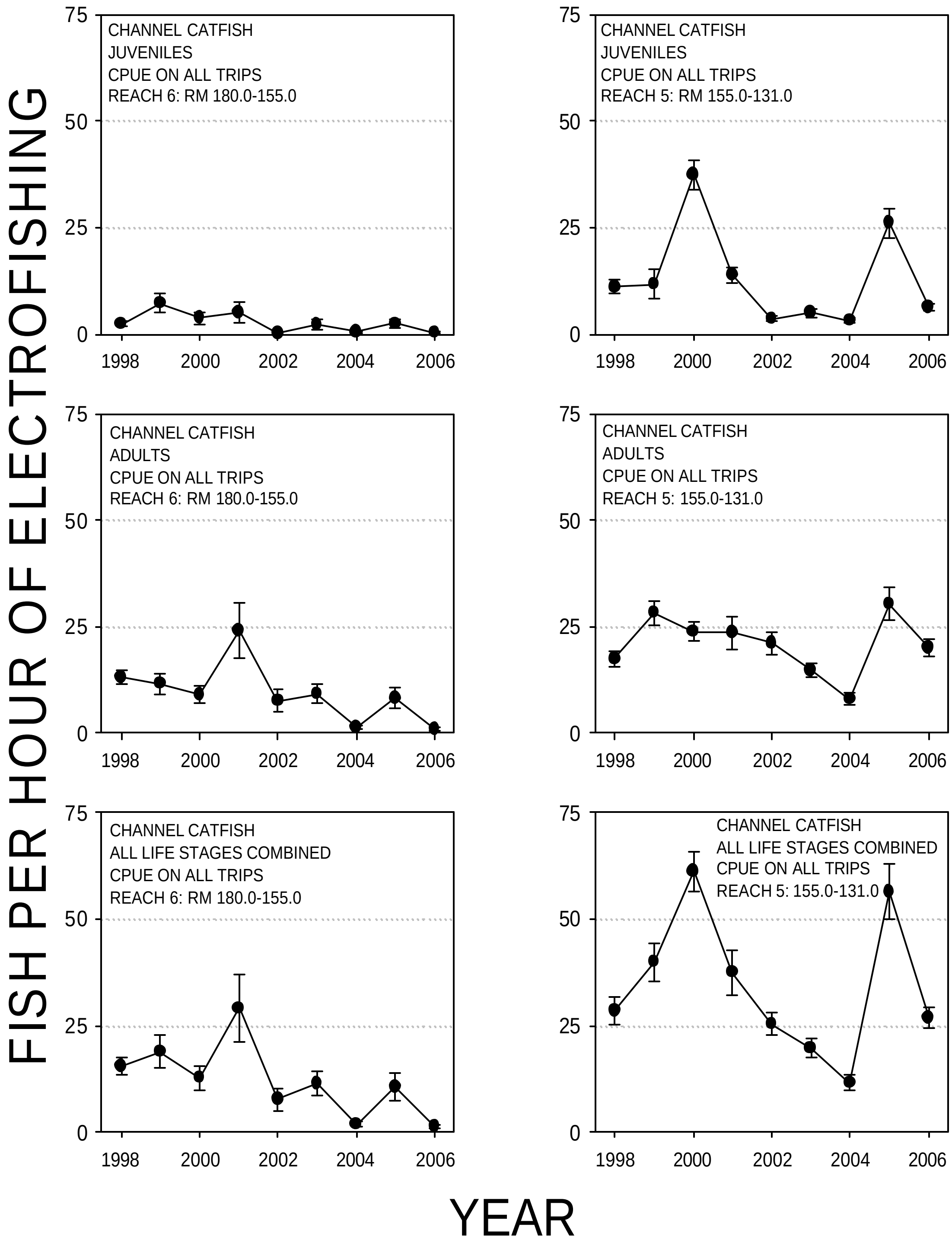

Figure 18. Channel catfish CPUE (fish/hour) in Geomorphic Reaches 6 and 5 by size class and by year, 1998-2006. Fish collected during riverwide monitoring efforts conducted by FWS-GJ in the spring and fall of each year. Error bars represent ± 1 SE.

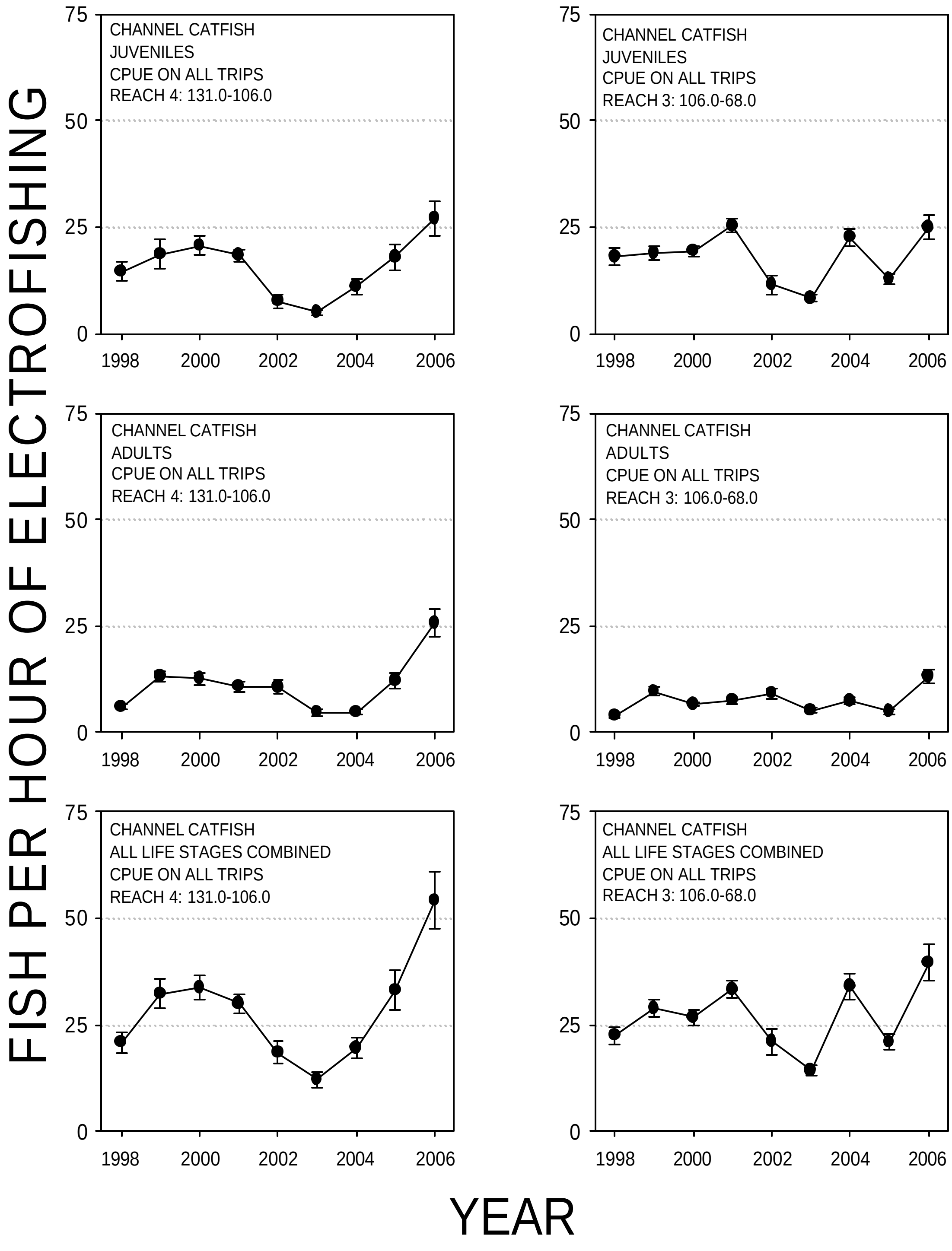

Figure 19. Channel catfish CPUE (fish/hour)in Geomorphic Reaches 4 and 3 by size class and by year, 1998-2006. Fish collected during riverwide monitoring efforts conducted by FWS-GJ in the spring and fall of each year. Error bars represent ± 1 SE.

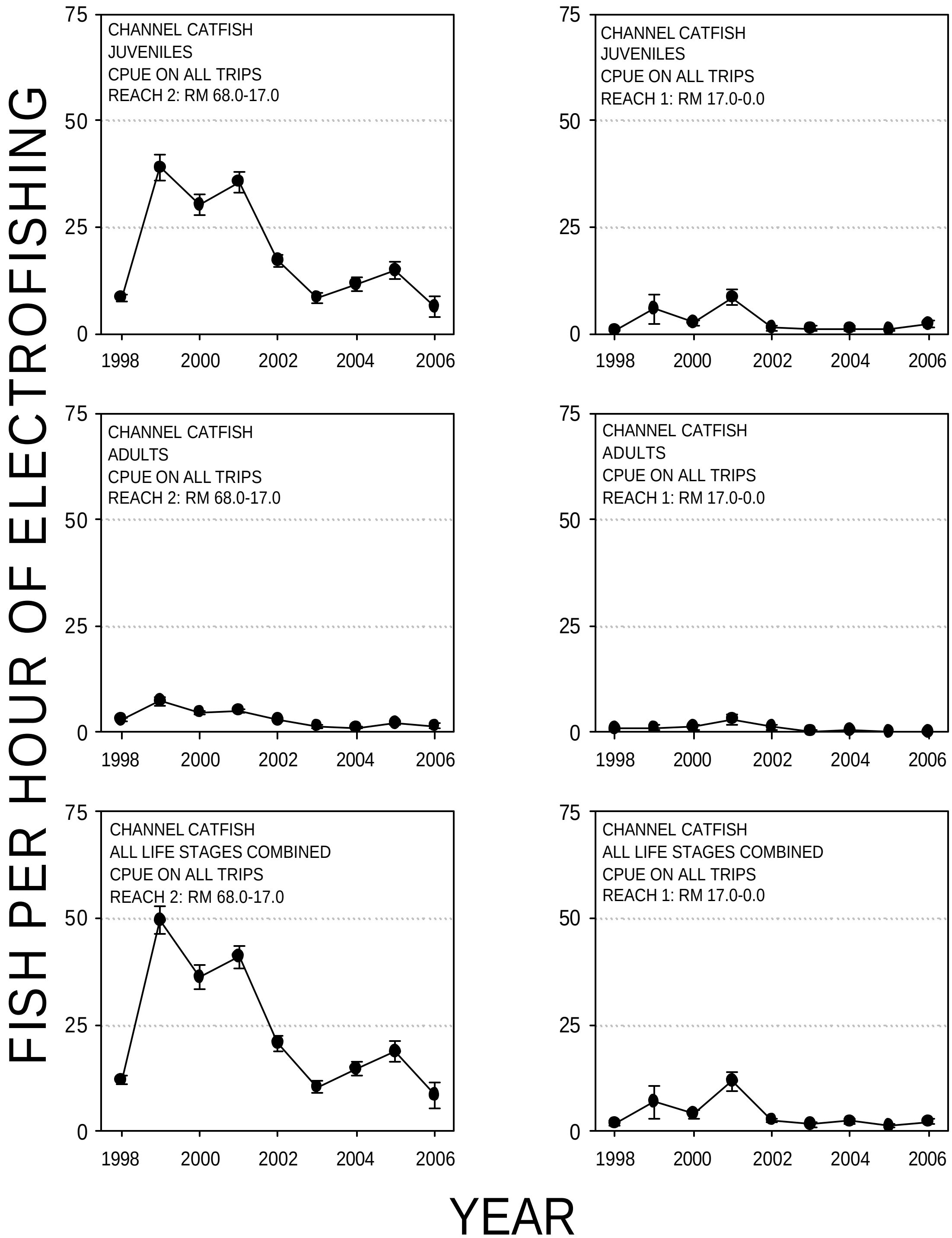

Figure 20. Channel catfish CPUE (fish/hour)in Geomorphic Reaches 2 and 1 by size class and by year, 1998-2006. Fish collected during riverwide monitoring efforts conducted by FWS-GJ in the spring and fall of each year. Error bars represent ± 1 SE.

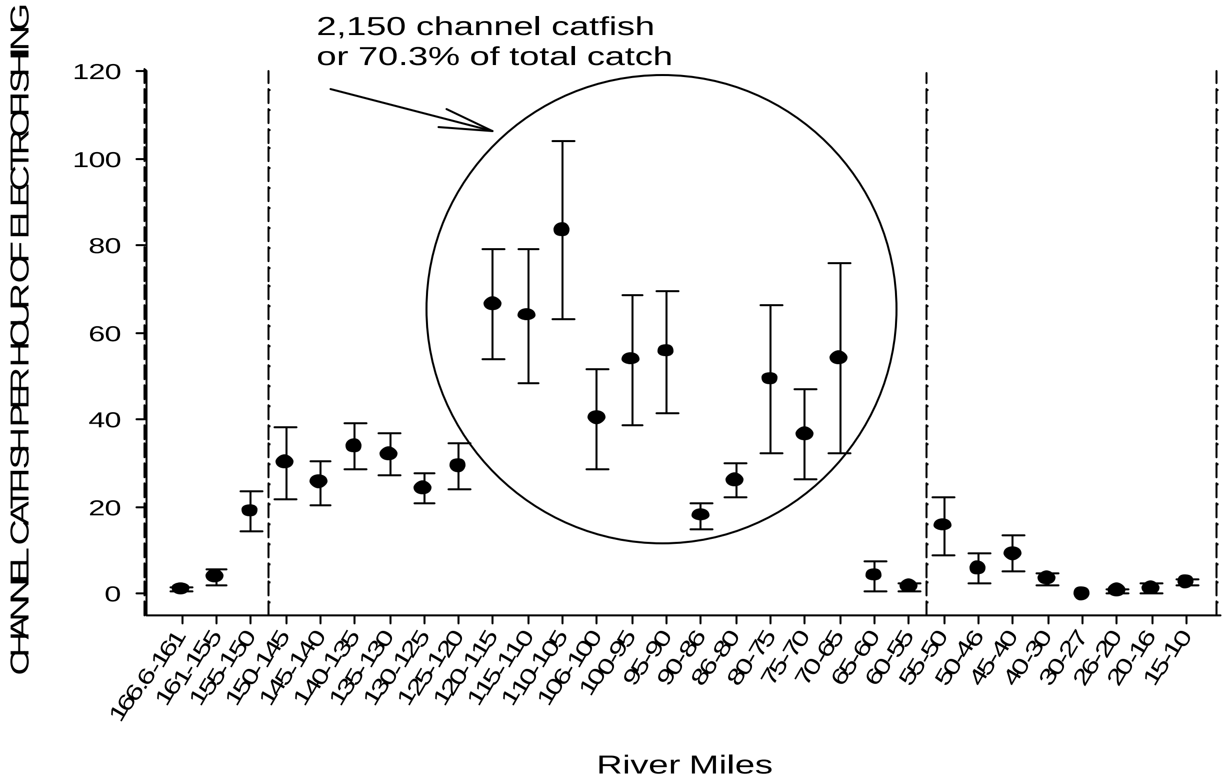

Figure 21. Channel catfish mean CPUE (fish/hour) collected during 2006 fall monitoring. Dashed vertical lines indicate where intensive removal efforts begin and end. Error bars represent ± 1 SE.

COMMON CARP

Common carp CPUE for all Geomorphic Reaches and all life stages combined has declined over the period of study, with sharp declines observed since the onset of intensive removal in 2001 (Figure 22). Mean CPUE in 2006 was 3.1 fish/hour and was the lowest catch rate among 1998-2006 comparisons. Catch rates in 2006 were significantly lower than all years (ANOVA; $F = 92.62_{(8, 3174)}$; Nemenyi post-hoc, $p \leq 0.001$) excluding 2005, and common carp have become uncommon in collections. Similar to previous years, the common carp catch was almost exclusively adult fish (Figure 22).

Across all Geomorphic Reaches, excluding Geomorphic Reach 6, common carp CPUE declined in 2006 (Figures 23 – 25); riverwide CPUE was significantly lower in 2006 compared to

2001 (ANOVA; $F = 92.62_{(8, 3174)}$; Nemenyi post-hoc, $p \leq 0.001$). Significant declines were not observed between 2005 and 2006.

Since 2002, common carp CPUE was < 15 fish/hour in each individual Geomorphic Reach and exhibited general decreased abundance as sampling continued downstream. The highest recorded CPUE among 1998-2006 comparisons occurred within Geomorphic Reach 5 in 1999 with a CPUE of 33.4 fish/hour compared to 6.4 fish/hour in 2006 (Figure 23). In addition, common carp CPUE in Geomorphic Reaches 4 and 3 in 2006 was significantly ($p \leq 0.05$) lower than all other years, excluding 2005 (Figure 24).

RARE FISH COLLECTIONS

A total of 631 Colorado pikeminnow *Ptychocheilus lucius* and 437 razorback sucker *Xyrauchen texanus* were collected during 10 removal trips in 2006. Of these, 87 Colorado pikeminnow (70 – 366 mm TL) and 14 razorback sucker (393 – 502 mm TL) were collected in sampling from PNM Weir to Hogback Diversion. A total of 282 Colorado pikeminnow (50 – 491 mm TL) and 350 razorback sucker (134 – 560 mm TL) were collected from Hogback Diversion to Shiprock Bridge. Lastly, a total of 262 Colorado pikeminnow (127 – 515 mm TL) and 73 razorback sucker (311 – 550 mm TL) were collected from Shiprock Bridge to Mexican Hat.

On three occasions Colorado pikeminnow were collected with channel catfish lodged in their mouths. On August 17 at RM 102.1, along a shallow shoreline riffle (.34 m depth), a Colorado pikeminnow measuring 419 mm TL and 390 grams was collected with a channel catfish measuring 129 mm TL and 20g anchored by the pectoral and dorsal spines in its throat. This Colorado pikeminnow had been stocked just 14 days prior to its capture. On September 12 and 13, two more Colorado pikeminnow were collected with channel catfish lodged in their throats. In the first instance the Colorado pikeminnow measured 157 mm TL and 27 grams (no data collected on channel catfish). In the second encounter the Colorado pikeminnow measured 194 mm TL and 52 grams, the channel catfish measured 53 mm TL (mass not recorded).

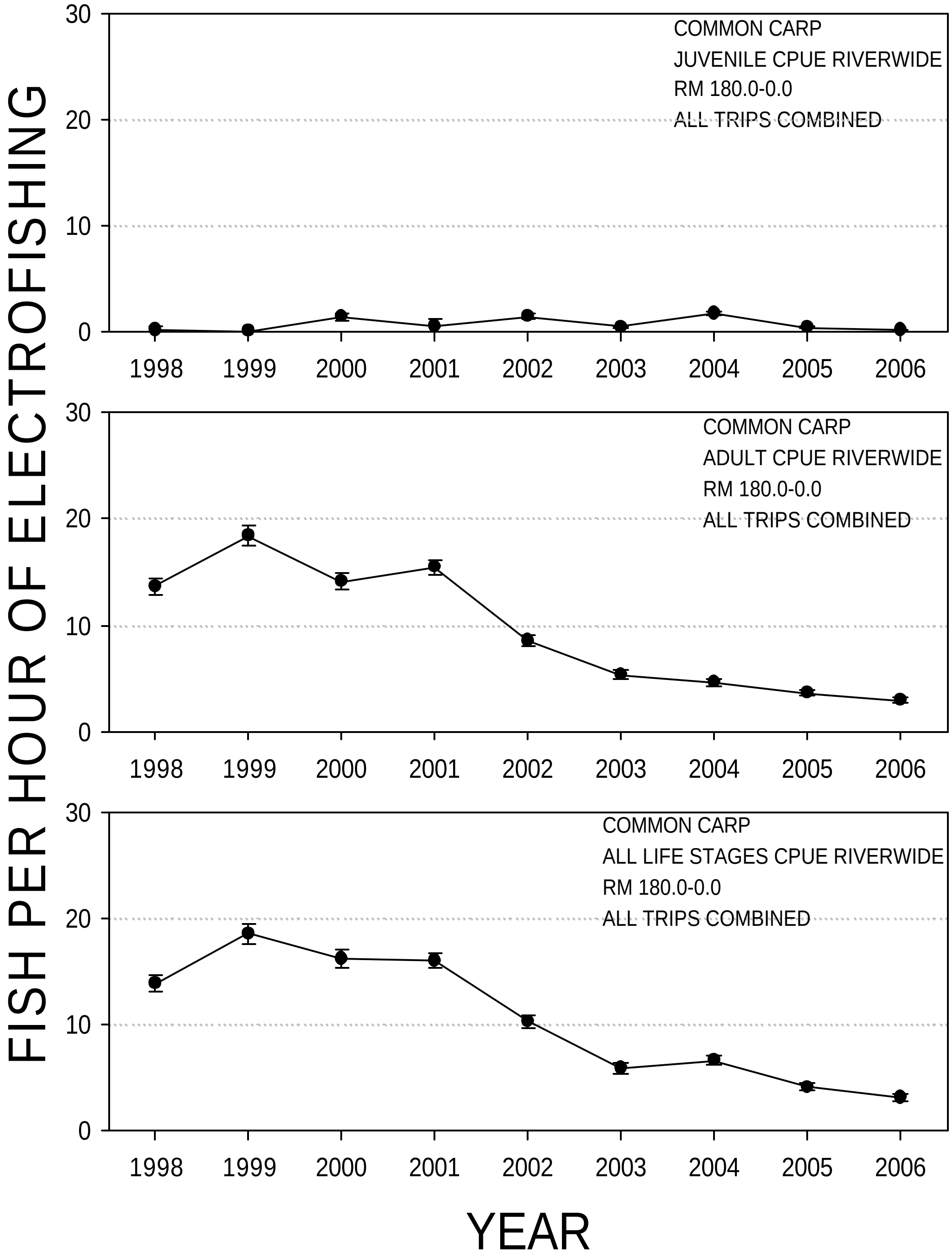

Figure 22. Common carp CPUE (fish/hour) by size class and by year, 1998-2006. Fish collected during riverwide monitoring efforts conducted by FWS-GJ in the spring and fall of each year. Error bars represent ± 1 SE.

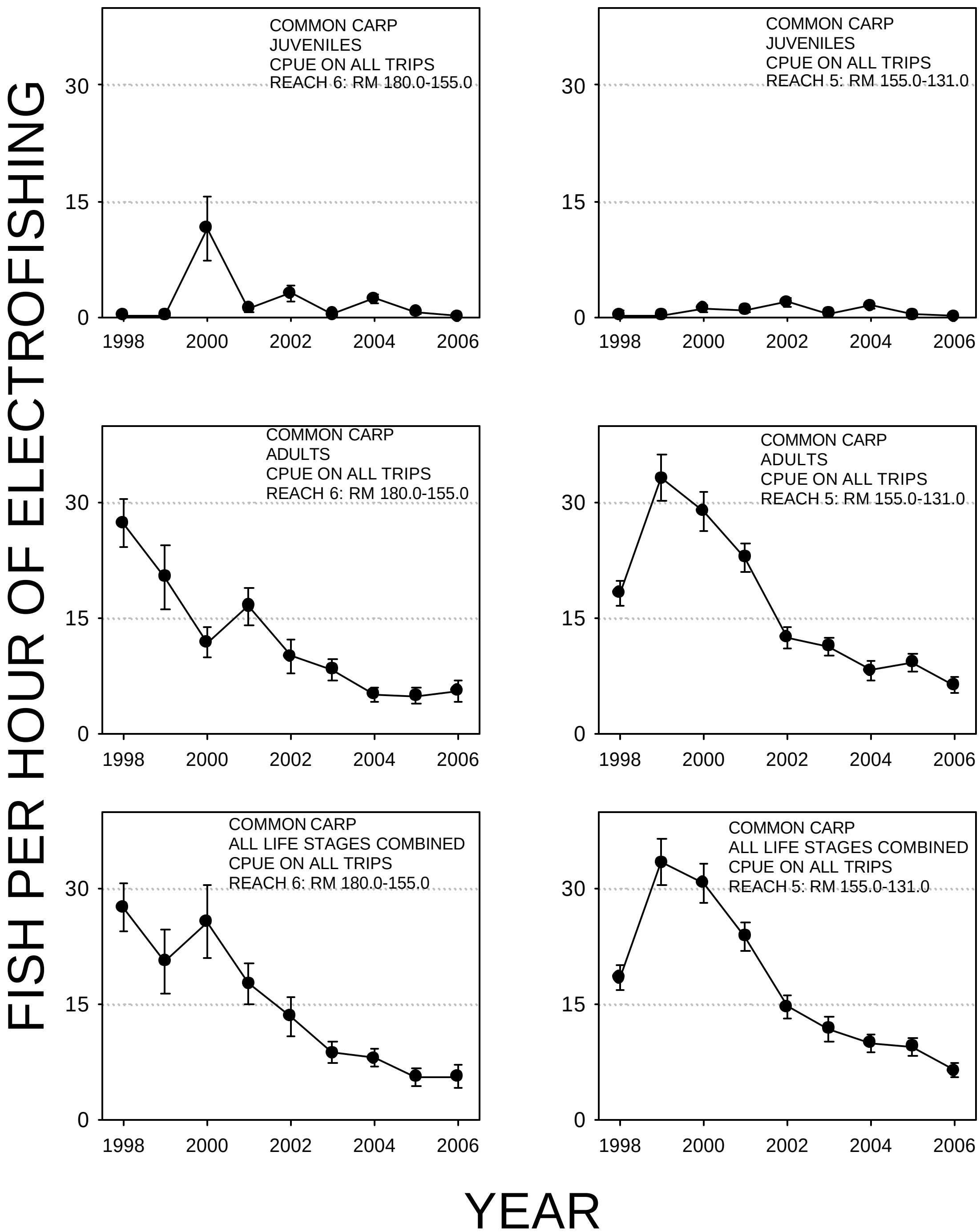

Figure 23. Common carp CPUE fish/hour in Geomorphic Reaches 6 and 5 by size class and by year, 1998-2006. Fish collected during riverwide monitoring efforts conducted by FWS-GJ in the spring and fall of each year. Error bars represent ± 1 SE.

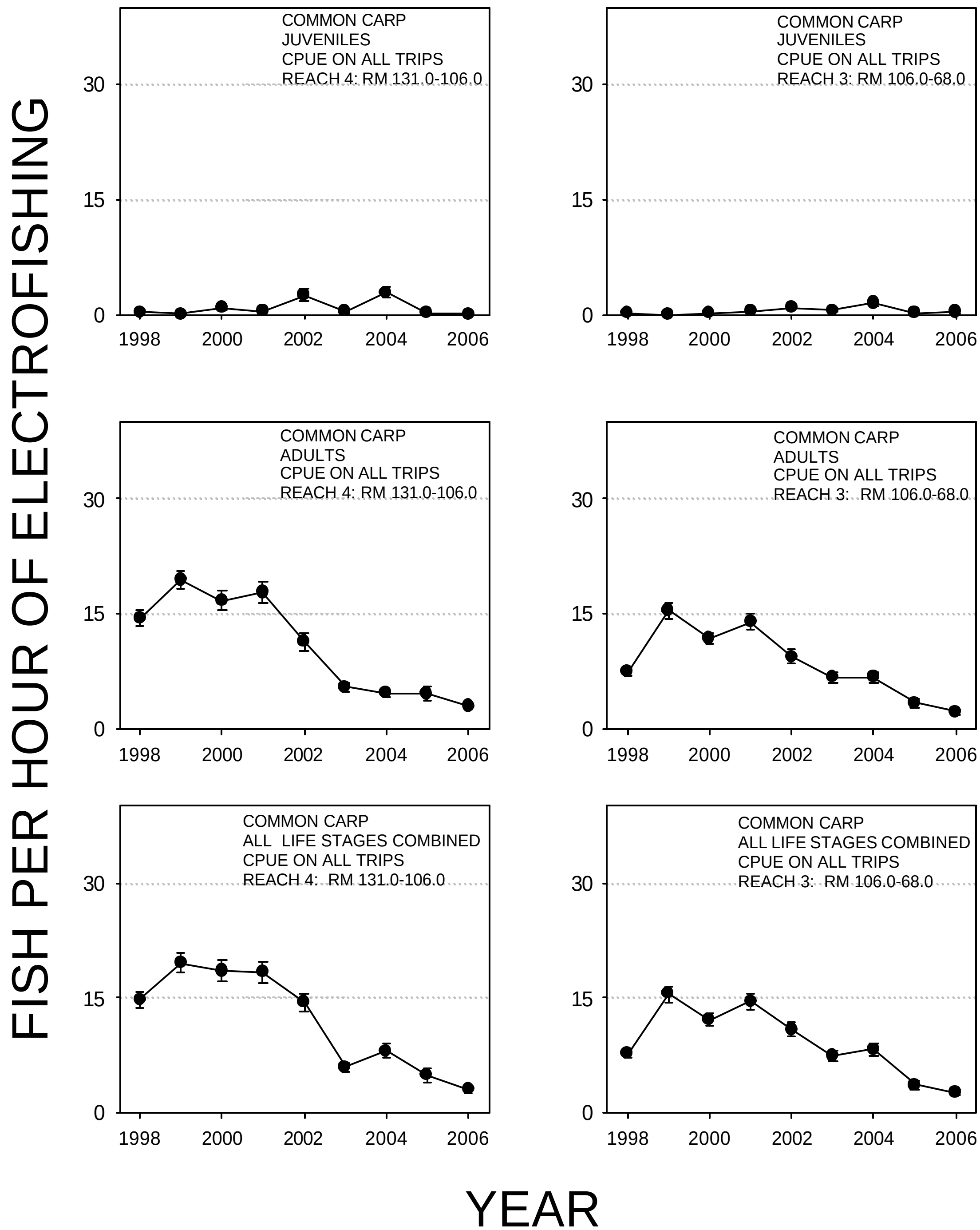

Figure 24. Common carp CPUE (fish/hour) in Geomorphic Reaches 4 and 3 by size class and by year, 1998-2006. Fish collected during riverwide monitoring efforts conducted by FWS-GJ in the spring and fall of each year. Error bars represent ± 1 SE.

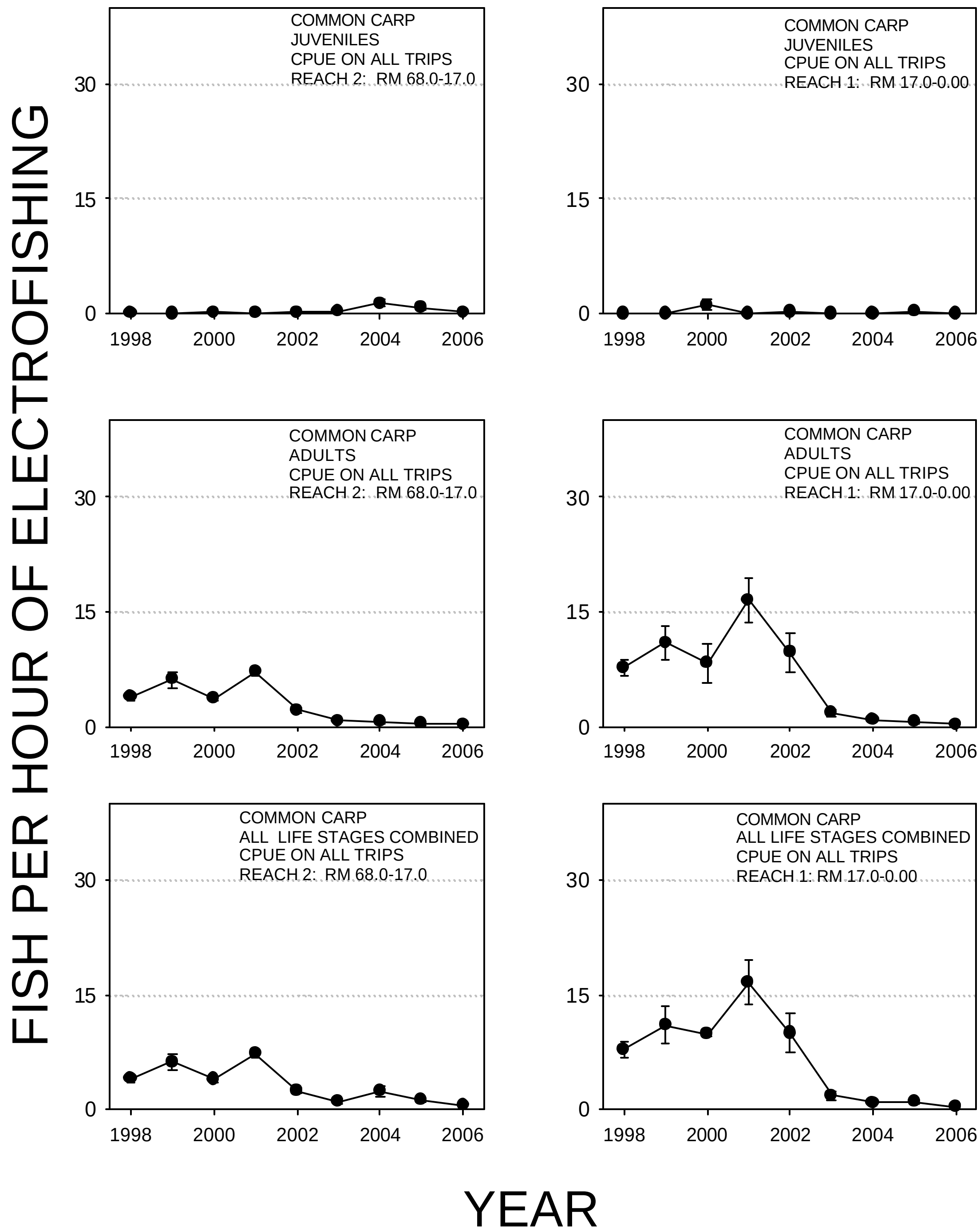

Figure 25. Common carp CPUE (fish/hour) in Geomorphic Reaches 2 and 1 by size class and by year, 1998-2006. Fish collected during riverwide monitoring efforts conducted by FWS-GJ in the spring and fall of each year. Error bars represent ± 1 SE.

In each case needle nosed pliers were required to dislodge or break the spines to extract the channel catfish. It is unclear if these situations arose from Colorado pikeminnow predation upon channel catfish, a defensive response to proximity of channel catfish, or from Colorado pikeminnow feeding on channel catfish recently stunned by electrofishing.

DISCUSSSION

The lack of clear, significant declines in channel catfish abundance from PNM Weir to Hogback Diversion can be attributed to large seasonal fluctuations in CPUE. Since the initiation of removal efforts, channel catfish CPUE was typically low early in the year and significantly increased during the warmer summer months. Spring CPUE was < 10 fish/hour in five out of six of the last years. Sampling conducted post-runoff and during the summer months was higher in comparison and were often > 40 fish/hour. This trend continued in 2006, however summer catch rates were the lowest observed from 2001 to 2006. Although increases in summer catch rates were still observed, the magnitude of the increase appeared to be reduced. These data suggest that although channel catfish were still relatively common in collections, intensive removal may be reducing their overall abundance.

Probable influences causing CPUE fluctuations include: 1.) lower water temperatures influencing catch (Quinn 1988, Justus 1996), 2.) increased activity, and 3.) seasonal movement patterns (Dames et al. 1989, Funk 1955). Other factors which may influence channel catfish CPUE include morning water temperature (C) and discharge (ft^3/second) at time of sampling. Although the relationships between water temperature and discharge to catch rates is unclear further investigation is encouraged. Sampling conditions in 2006 may have influenced the efficacy of electrofishing specific to channel catfish and may explain the observed variability in CPUE.

Turbid water conditions influenced the uncertainty of channel catfish captures in portions where their abundance is relatively low. For example, during turbid river conditions channel catfish catch was unpredictable within intensive removal Sections where abundance was relatively low (i.e. PNM Weir to Hogback Diversion). However, under similar sampling conditions, catch rates were more predicable within Sections where overall abundance was higher (i.e. Hogback Diversion to Shiprock Bridge and Shiprock Bridge to Mexican Hat). Essentially, turbid water conditions had less influence, although efficacy did decline to a certain degree, on catch rates in portions of the San Juan River where channel catfish abundance was high.

Due to observed seasonal fluctuations, intensive non-native removal trips were timed to maximize the ability to capture and remove the highest numbers of channel catfish. It appears that in order to maximize removal efforts, trips should be conducted during summer months when channel catfish are more active, post spring movement has occurred, and water temperature has increased. However, trips are still recommended during the spring to remove as many adults as possible prior to reproduction.

The observed declining trends in CPUE of large channel catfish and shifts in size class distribution to smaller, less fecund fish was encouraging. Shifts towards smaller fish may be important in long term suppression and reduction of channel catfish numbers in the San Juan River by reducing overall reproductive potential and recruitment. Helms (1975) found that 1 of 10 channel catfish were sexually mature at 330 mm TL, compared to 5 of 10 at 380 mm TL. In addition, he found that channel catfish at 330 mm TL produced around 4,500 eggs/fish compared to the production of 41,500 eggs at 380 mm TL.

A shift towards smaller channel catfish may also be important in limiting overall predatory impacts on native fishes by channel catfish. Brooks et al. (2000) found that San Juan River channel catfish < 300 mm TL consumed almost exclusively macroinvertebrates and Russian olive fruits. Piscivory occurred most frequently in fish > 450 mm TL. Documentation of predation on endangered fishes during their study was not observed due to the relatively low numbers of in the San Juan River at the time of their study, but has been documented elsewhere in SJRIP work (Jackson 2005). If unchecked, as augmentation efforts continue and the numbers of rare fishes increase, predation by channel catfish will undoubtedly increase.

Continued reduction in mean TL and shifts to smaller size class distributions of channel catfish are considered important indicators of successful removal and exploitation efforts. Results from the upper San Juan River are similar to those Pitlo (1997) observed as evidence of overexploitation of channel catfish in the Mississippi River. It was observed that as the numbers of large fish decline, the population became highly dependent on newly recruited fish, resulting in large fluctuations in catch and dependence on the strength of individual year-classes. Dependence on individual year-classes may be occurring within intensive removal reaches with the majority of fish collected in 2006 falling in the 300-400 mm TL size class. With continued exploitation, it is anticipated that these fish will be removed prior to reproduction which may subsequently limit recruitment in future years.

Although decreasing trends in overall channel catfish abundance was encouraging, much debate has been generated on the costs/benefits associated with shifting the size class structure to a higher dependence on smaller sized fish. It has been suggested that non-native removal efforts on the San Juan River are simply increasing the numbers of juvenile fish and argue that these efforts could actually increase predation pressure on early life stages of native fishes (Mueller 2005). The observed shift towards smaller sized channel catfish may indeed create more occurrences of negative interactions (i.e. harassment, interspecific competition) in the short term. However continuing a non-size selective removal program may result in an overall, measurable effect on predation pressure by limiting channel catfish abundance. Recently it has also been suggested that changes in size class structure may shift the potential for channel catfish to reproduce at younger ages and smaller sizes. In addition, as channel catfish abundance and intra-specific competition is reduced the potential for resident channel catfish to undergo more rapid growth exsists. These occurrences have yet to be documented but investigation is strongly encouraged.

Channel catfish CPUE, riverwide, increased in 2006 for the third straight year. If the efficacy of mechanical removal was to be determined by riverwide trends only one might be tempted to fail to reject the null hypothesis ($H_{?} = \bar{x}_{1998} = \bar{x}_{1999} = \ldots \bar{x}_{2006}$). However, when CPUE trends were analyzed by Geomorphic Reach a different story is told. The highest observed CPUE in 2006 occurred within Geomorphic Reaches 4 and 3 and coincide with areas of the river where intensive removal occurred only twice in 2006. Intensive removal, prior to 2006, by FWS-ABQ encompassed RM's 166.6 – 147.9 while intensive removal by UDWR was conducted from RM's 53.0 – 0.0. Whether intensive removal had a measurable effect or repeated efforts chased channel catfish out of the study areas to those that are only opportunistically sampled was unclear. It does however appear that a 'stronghold' for channel catfish developed in these portions of the San Juan River. Based on these data, it has been recommended to expand intensive removal efforts in 2007 to include a total of eight electrofishing passes from RM 147.9 to RM 52.9.

Common carp were once ubiquitous in the San Juan River and during 1991-1997 SJRIP studies were found to be the fourth most abundant fish in electrofishing collections (Ryden 2000). Corresponding with the initiation of intensive removal, common carp abundance was greatly reduced to a point that common carp were uncommon in all collections across all studies.

Significant reductions in common carp abundance may be a result of the "catchability" of common carp under various sampling conditions. Common carp oftentimes exhibit electrotaxis (induced movement towards the anode) or oscillotaxis (induced movement without orientation or thrashing motion) when exposed to pulsed direct current (PDC). This behavior enables netters easily identify and net common carp in turbid conditions. Conversely, channel catfish oftentimes exhibit tetany (electrically induced immobility with rigid muscles) when exposed to PDC and are slow in breaching the water surface (Kolz et al. 1998). This reaction makes it difficult for netters to effectively identify and capture channel catfish during turbid river conditions and may influence the lack of significant declines in channel catfish abundance.

Decreased common carp abundance may possibly limit competitive interactions with native fishes and negative habitat modifications often associated with common carp (i.e. uprooting of aquatic plants causing increased turbidity, possible cause of noxious algae blooms by recycling of nutrients from silt substrates) (Cooper 1987). These decreases and the subsequent decreases in carp biomass may allow for higher utilization of resource use by native fishes with limited levels of interspecific competition.

With recent flow conditions in the San Juan River lacking out of bank flow, available low flow or slackwater, spawing and nursery habitats for common carp has likely been limited. Lack of available nursery habitat may have influenced recent common carp abundance trends as much as mechanical removal has and close watch on trends post out of bank flow is recommended.

The frequency of intensive non-native removal trips has contributed to the gathering of important information on rare fish distribution, abundance, and interactions with non-native fishes. The collection of Colorado pikeminnow with channel catfish lodged in their mouths was not surprising and has been documented before (Ryden 2002, McCada 1983). Although this is known to occur, the frequency of occurrence in 2006 may be of concern. The level of occurrence of these encounters and the percentage leading to Colorado pikeminnow mortalities is currently unknown. It is anticipated that as augmentation efforts continue documentation of Colorado pikeminnow with channel catfish lodged in their mouths will increase. These data provide additional supporting information for continued removal of non-native fishes. Continued collection and documentation of this occurrence may be important in identifying additional limiting factors to Colorado pikeminnow recovery.

CONCLUSIONS

PNM Weir to Hogback Diversion (RM 166.6 – 159.0)

- A total of 670 channel catfish and 175 common carp were collected in 2006.
- Channel catfish CPUE among year comparisons revealed no reduction, 2001-2006.
- Majority of channel catfish were collected during post-runoff or summer trips suggesting high rates of immigration into the study reach.
- It appeared that sampling conditions (i.e. turbidity/clarity) influenced variability in CPUE in areas of low channel catfish abundance.
- Channel catfish mean total length (TL) was higher than 2005 but remained lower than 2001 values ($p < 0.001$).
- High dependence on single size class (300-400 mm TL) appeared to occur in 2006.
- Common carp CPUE in 2006 varied little among trip comparisons and was < 5 fish/hour.
- Common carp CPUE was similar to 2005 values but were significantly lower than 2001 values ($p < 0.001$).
- Common carp were uncommon in collections.

Hogback Diversion to Shiprock Bridge (RM 158.8 – 147.9)

- A total of 2,373 channel catfish and 394 common carp were collected in 2006.
- Among year comparisons indicate a reduction ($p < 0.001$) in channel catfish CPUE from 2003-2006.
- Mean TL of channel catfish was similar between 2005 and 2006 but remained lower than 2003 values ($p < 0.001$).
- High dependence on single size class (300-400 mm TL) appeared to occur in 2006.
- Channel catfish CPUE was higher in this Section than in the adjacent upstream Section.
- Common carp CPUE was similarly low between 2005 and 2006 and remained lower than 2003 ($p < 0.001$).
- Common carp were uncommon in collections.

Shiprock Bridge to Mexican Hat, Utah (RM 147.9 – 52.9)

- A total of 5,869 channel catfish and 718 common carp were collected in 2006.
- Channel catfish catch rates varied between trips (64.0 to 10.7 fish/hour) and was attributed to differences in sampling conditions.
- Mean TL of channel catfish decreased as sampling proceeded downstream.

- Common carp CPUE was similar between trips and was relatively low (< 7 fish/hour).
- Common carp were uncommon in collections.

Riverwide Removal Efforts (RM 180.0 – 0.00)

- A total of 3,059 channel catfish and 361 common carp were collected in 2006.
- Riverwide, channel catfish CPUE was similar from 2005-2006 but remained lower than values observed in 2001, when intensive non-native removal began.
- Channel catfish CPUE was highest in Geomorphic Reaches 4 and 3, reaches that lie between those where intensive non-native removal trips are conducted.
- Common carp CPUE decreased in 2006 to 3.1 fish/hour; the lowest value recorded in the 1998-2006 sampling period ($p = 0.001$).
- Common carp CPUE declined across all Geomorphic Reaches.

Future of intensive removal on the upper San Juan River

- Continue intensive removal efforts from RM 166.6 to 147.9.
- Expansion of removal trips to include eight electrofishing passes from Shiprock Bridge to Mexican Hat, Utah (RM 147.9 – 52.9).
- Develop measurable criteria to be used in evaluating the efficacy of non-native removal.
- Relate native fish distribution/abundance trends to non-native removal.

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Appendix A-1. Total count of major species collected during intensive non-native removal efforts from PNM Weir to Hogback Diversion, 2006. Species listed by the first three letters of the Genera and first three letters of Species (i.e. *Ptychocheilus lucius = Ptyluc)*

Trip	*Ptyluc*	*Xyrtex*	*Ictpun*	*Cypcar*	*Micsal*	*Ameiurus spp*	*Saltru*
April	2	1	5	68	0	1	5
May	0	8	7	4	0	0	4
July	35	1	494	66	85	9	0
September	50	4	164	37	3	5	1
Totals	**87**	**14**	**670**	**175**	**88**	**15**	**10**

Appendix A-2. Total count of major species collected during intensive non-native removal efforts from Hogback Diversion to Shiprock Bridge, 2006.

Trip	*Ptyluc*	*Xyrtex*	*Ictpun*	*Cypcar*	*Micsal*	*Ameiurus* spp	*Saltru*
April	6	58	164	109	0	1	1
June	15	17	1,336	186	17	15	0
September	81	155	789	54	0	17	0
November	180	120	84	45	1	10	0
Totals	**282**	**350**	**2,373**	**394**	**18**	**43**	**1**

Appendix A-3. Total count of major species collected during intensive non-native removal efforts from Shiprock Bridge to Mexican Hat, Utah; 2006.

Trip	*Ptyluc*	*Xyrtex*	*Ictpun*	*Cypcar*	*Micsal*	*Ameiurus* spp	*Saltru*
Shiprock to Montezuma Creek							
May	9	34	2,982	305	0	5	0
August	239	30	452	248	0	4	0
Totals	**248**	**64**	**3,434**	**553**	**0**	**9**	**0**
Montezuma Creek to Mexican Hat							
May	14	9	2,435	165	1	3	0
Totals	**14**	**9**	**2,435**	**165**	**1**	**3**	**0**
Grand Total	**262**	**73**	**5,869**	**718**	**1**	**12**	**0**

Appendix A-4. Total number of channel catfish and common carp and percent abundance by size class collected during main channel electrofishing surveys, 1999-2006.

Species	Year	Young of Year	Juvenile	Adult	Total	Total Effort (Hours)
Channel catfish	1999	114 (2.2)	2,798 (54.5)	2,224 (43.3)	5,136	158.88
	2000	112 (1.8)	4,305 (68.1)	1,907 (30.2)	6,320	178.06
	2001	110 (1.6)	4,435 (65.1)	2,269 (33.3)	6,814	212.05
	2002	40 (1.7)	1,193 (49.5)	1,166 (48.4)	2,409	243.45
	2003	52 (3.3)	774 (48.4)	773 (48.3)	1,599	126.64
	2004	253 (10.9)	1,387 (59.6)	689 (29.6)	2,327	128.19
	2005	179 (6.0)	1,680 (56.7)	1,106 (37.3)	2,965	119.41
	2006	97 (3.2)	1,563 (51.1)	1,399 (45.7)	3,059	111.33
	Total	**957 (3.1)**	**18,135 (59.2)**	**11,533 (37.7)**	**30,629**	**1,278.02**
Common carp	1999	0 (0.0)	13 (0.4)	3,075 (99.6)	3,088	
	2000	99 (3.6)	235 (8.5)	2,430 (87.9)	2,764	
	2001	0 (0.0)	98 (2.7)	3,508 (97.3)	3,606	
	2002	31 (2.4)	154 (12.1)	1,082 (85.3)	1,268	
	2003	3 (0.4)	52 (6.4)	757 (93.2)	812	
	2004	29 (3.2)	191 (21.2)	681 (75.6)	901	
	2005	2 (.4)	46 (8.6)	488 (91.0)	536	
	2006	0 (0)	19 (5.3)	342 (94.7)	361	
	Total	**164 (1.2)**	**808 (6.1)**	**12,363 (92.7)**	**13,336**	