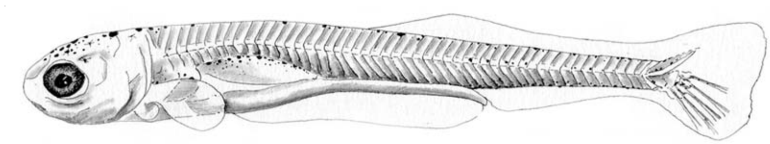
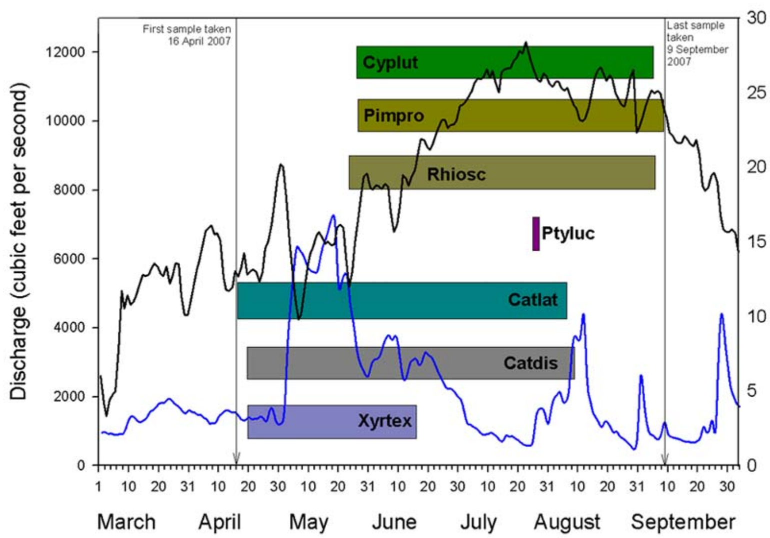
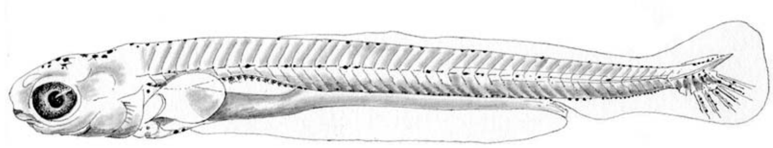
Colorado pikeminnow and razorback sucker larval fish survey in the San Juan River during 2007

FINAL REPORT



Colorado pikeminnow, *Ptychocheilus lucius*, larva





razorback sucker, *Xyrauchen texanus*, larva

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SAN JUAN RIVER BASIN RECOVERY IMPLEMENTATION PROGRAM

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Final Report

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submitted to:

San Juan River Basin Biology Committee
under the authority of the
San Juan River Basin Recovery Implementation Program

30 May 2008

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Executive Summary

1. There were 374 fish collections made at 269 unique sites between river miles 141.2 and 2.9 under the auspices of the 2007 larval Colorado pikeminnow and 2007 larval razorback sucker surveys.

2. The 374 collections resulted in the collection of 49,720 age-0 fishes and 3,359 age-1+ fishes representing six families and 15 species.

3. In 2007, the riverwide CPUE for age-0 fishes was 370.1 fish per 100m^2 .

4. Native species accounted for 61.0% of the 2007 age-0 catch by number. Flannelmouth sucker was the numerically dominant (n=16,539) and most frequently encountered native species.

5. Non-native species accounted for 39.0% of the 2007 age-0 catch by number. Red shiner was the numerically dominant (n=16,800) and most frequently encountered non-native species.

6 Within the study period, age-0 CPUE for flannelmouth sucker was highest during trip 1 (April) at 516.9 fish per 100m^2. Age-0 CPUE for bluehead sucker peaked during trips 3 and 4 (June and July) with 159.0 and 174.8 fish per 100m^2, respectively.

7 A total of 200 larval/age-0 razorback suckers were collected in 2007 at 25 distinct localities in reaches 1 through 5. Backwater habitats spread across all five reaches produced 182 of the 200 razorback sucker collected.

8. The first larval razorback sucker was collected on 19 April and the last age-0 (juvenile) razorback sucker was collected on 26 July. The single largest (n=56) collection of razorback sucker occurred on 21 May in a backwater site at river mile 8.1 (Steer Gulch).

9. Back-calculated hatching dates for larval razorback sucker ranged between 26 March and 17 June 2007.

10. The year 2007 marks 10 consecutive years of successful reproduction by razorback sucker in the San Juan River.

11. A total of three age-1+ razorback sucker were collected in 2007. It is unclear if these fish were wild or the result of stocking efforts.

12. Three larval Colorado pikeminnow were collected in 2007 at three distinct localities in reaches 2, 3 and 4. The specimen collected in reach 2 was from an edge pool; the specimens found in reaches 3 and 4 were from backwater habitats.

13. Trip 4 (July) produced all three of the larval Colorado Pikeminnow. The back-calculated spawning date for all three specimens was 27 June 2007.

14. A total of 181 age-1+ Colorado pikeminnow were collected in 2007. It is assumed that these fish were the result of recent stocking efforts.

Introduction

Colorado pikeminnow, *Ptychocheilus lucius*, and razorback sucker, *Xyrauchen texanus,* are two endangered populations of cypriniform fish native to the San Juan River, a large tributary of the Colorado River. The decline of these and other native fishes in the San Juan River has been attributed to flow modifications, the resultant changes to the thermal regime, and instream barriers. In addition, the introduction of non-native fishes may have altered predation dynamics and competition for habitat and resources (Ryden and Pfeifer 1994; Clarkson and Childs 2000).

Colorado pikeminnow (family Cyprinidae) was listed as an endangered species by the U.S. Department of the Interior in 1974. It is endemic to the Colorado River Basin where it was once abundant and widespread (Tyus, 1991). Currently this species occupies only about 20% of its historic range (Behnke and Benson 1983; Tyus, 1990), with the majority of the remaining Upper Basin individuals occuring in the Green River (Holden and Wick, 1982; Bestgen et al., 1998). No Colorado pikeminnow have been reported in the Lower Basin since the 1960’s (Minckley and Deacon, 1968; Minckley, 1973; Moyle, 1976).

Studies in the Upper Colorado River Basin (Yampa and Green rivers) demonstrated that Colorado pikeminnow spawn on the descending limb of the summer hydrograph at water temperatures between 20^{o}C and 25 ^{o}C (Haynes et al., 1984; Nesler et al., 1988; Tyus 1990). Larval Colorado pikeminnow employ drift as a dispersal mechanism and appear to begin this passive movement approximately five days after hatching. The five-day time frame corresponds with the swim-up period of this fish as reported by Hamman (1981, 1986). Drift of the newly hatched fishes counteracts upstream migrations of the adults and moves offspring to favorable nursery habitats downstream.

Razorback sucker (family Catostomidae) was listed as an endangered species in 1991. There are few historic San Juan River records of razorback sucker despite the fact that this is one of three endemic Colorado River basin catostomids. There are anecdotal reports from the late 1800’s of razorback sucker occurring in the Animas River as far upstream as Durango, Colorado (Jordan 1891). However, there are no specimens to substantiate this claim. The first verified record of razorback sucker in the San Juan River was in 1976 when two adult specimens were collected at an irrigation pond near Bluff, Utah (VTN Consolidated, Inc., and Museum of Northern Arizona, 1978).

In the Green River, spawning of razorback sucker has been associated with the ascending limb of the hydrograph, peak spring discharge and warming river temperatures. Adults congregate in riffles with cobble, gravel, and sand substrate. Spawning has been documented from mid April to early June in the Green River at mean water temperatures of 14^{o}C (Tyus and Karp 1990). Razorback sucker larvae have been collected from Lake Mohave at 9.5 –15.0^{o}C, indicating successful incubation of eggs at these temperatures (Bozek et. al. 1990). Spawning of razorback sucker coincides with spawning of other native catostomids, particularly flannelmouth sucker, *Catostomus latipinnis*. Hybridization between flannelmouth sucker and razorback sucker have been documented where these two species co-ocuur(Douglas and Marsh 1984; Tyus and Karp 1990).

In the early ontogeny of fishes there are substantial mortality rates (Harvey 1991; Jennings and Philipp 1994). Many biotic and abiotic factors often operate simultaneously and affect the survival rates in the early life history of fishes. Starvation, the presence and duration of important environmental conditions during early ontogeny, and biotic interactions such as competition and predation (Bestgen 1996) all affect the survival of larvae. Early-life mortality can be especially significant in populations of slow-growing fishes (Kaeding and Osmundson 1988).

Abiotic factors, such as water temperature and discharge, affect growth rates and available food supplies. In turn, these abiotic factors affect mortality rates, activity and searching ability, and risk of predation (Miller et. al. 1988). Mimicry of a natural flow regime in regulated systems maintain cues for activities such as spawning and migration of native fishes as well as creating and maintaining nursery habitat for larval fishes. Natural flow regimes also favor the downstream displacement or drifting behavior of larval fishes and exploitation of the most advantageous feeding and rearing areas (Muth and Schumulbach 1984; Pavlov 1994). In many western river systems, higher spring and early summer flows increase sediment transport and turbidity and has been shown to reduce predation of larvae (Johnson and Hines 1999). Sediment transport during high flows scour large substrates providing critical spawning habitat (Blisner and Lamarra, 1996; Osmundson et. al. 2002).

Food production, competition for food resources and starvation, especially in limited nursery habitats, result in high mortality rates of larval fishes (Houde 1987). These factors are compounded in modified systems with high numbers of non-native fishes. For example, the non-native red shiner has been documented to prey on cypriniform larvae (Brandenburg and Gido 1999; Bestgen 2006). Red shiner comprise up to 80% of the ichthyofaunal community in nursery habitats in the San Juan River (Brandenburg and Farrington 2004; Propst et. al 2003) and therefore can have significant impacts on fish populations. In addition, non-native fish contribute significant biomass to the system and may compete for resources including food and available habitat.

Larval drift surveys were conducted on the San Juan River from 1991 to 2001 to document reproduction of Colorado pikeminnow as well as locate possible spawning bars. During that period of passive sampling only six larval Colorado pikeminnow were collected (Table 1).

Table 1. Summary of larval Colorado pikeminnow collected in the San Juan River (1993-2006) and back-calculated dates of spawning.

Field Number	MSB Catalog Number	Number specimen	Total Length mm	Date Collected	Date Spawned	River Mile	Sample Method
MH72693-2	18098	1	9.2	26 Jul 93	08 Jul 93	53.0	drift netting
MH72793-2	18099	1	9.2	27 Jul 93	09 Jul 93	53.0	drift netting
JPS95-205	26187	1	9.2	02 Aug 95	15 Jul 95	53.0	drift netting
JPS95-207	26191	1	9.0	03 Aug 95	17 Jul 95	53.0	drift netting
WHB96-037	29717	1	8.6	02 Aug 96	18 Jul 96	128.0	drift netting
FC01-054	50194	1	8.5	01 Aug 01	17 Jul 01	128.0	drift netting
MAF04-046	53090	1	14.2	22 Jul 04	24 Jun 04	46.3	larval seine
MAF04-059	53130	1	18.1	26 Jul 04	25 Jun 04	17.0	larval seine
TOTAL		8					

Beginning in 2002, the sampling protocol was switched to active collection of larval fishes using larval seines and utilizing a raft to navigate the San Juan River. Two larval Colorado pikeminnow were collected in 2004 using this active approach.

Larval surveys using the same active sampling methods as that of the larval Colorado pikeminnow survey began in 1998 on the San Juan River in an attempt to document reproduction of stocked razorback sucker. The 1998 survey produced the first documentation of reproduction by the stocked razorback suckers. Larval razorback sucker have been documented every year since (Table 2).

Objectives

This work was conducted as required by the San Juan River Basin Implementation Program Monitoring Plan and Protocol dated 31 March 2000. The objectives of this specific monitoring effort are identified in the aforementioned document (1a, 3a, and 3b) and listed below:

- Determine if Colorado pikeminnow reproduction occurred in the San Juan River and the relative level of any such effort (1a).
- Determine if reproduction by razorback sucker occurred in the San Juan River and the relative level of any such effort (1a).
- Determine the spawning periodicity of catostomids between mid-April and early September and examine potential correlations with temperature and discharge.
- Provide a comparative analysis of the reproductive effort of catostomids.
- Provide annual summaries of monitoring results (3a).
- Provide detailed analysis of data collected to determine progress towards endangered species recovery in three years and thence every five years (3b).

Table 2. Summary of larval and YOY razorback sucker collected in the San Juan River (1998-2006).

Year	Study Area	Project Dates	Effort m^2	Xyrtex	Sample Method
1998	127.5 - 53.0	17 Apr - 6 Jun	-	2	larval seine/ light trap
1999	127.5 - 2.9	5 Apr - 10 Jun	2,713.5	7	larval seine/ light trap
2000	127.5 - 2.9	4 Apr - 23 Jun	2,924.6	129	larval seine/ light trap
2001	141.5 - 2.9	10 Apr - 14 Jun	5,733.1	50	larval seine/ light trap
2002	141.5 - 2.9	15 Apr - 12 Sep	9,647.5	813	larval seine/ light trap
2003	141.5 - 2.9	15 Apr - 19 Sep	13,564.6	472	larval seine
2004	141.5 - 2.9	19 Apr - 14 Sep	11,820.3	41	larval seine
2005	141.5 - 2.9	19 Apr - 14 Sep	10,368.6	19	larval seine
2006	141.5- 2.9	17 Apr - 15 Sep	12,582.6	202	larval seine
TOTAL				1,735	

Study Area

The San Juan River is a major tributary of the Colorado River and drains 38,300 mi^2 in Colorado, New Mexico, Utah, and Arizona (Figure 1). The major perennial tributaries to the San Juan River are (from upstream to downstream) Navajo, Piedra, Los Pinos, Animas, La Plata, Mancos Rivers, and McElmo Creek. In addition there are numerous ephemeral arroyos and washes that contribute relatively little flow annually but input large sediment loads during rain events.

The San Juan River is now a 224 mile lotic system bounded by two reservoirs (Navajo Reservoir near its head and Lake Powell at its mouth). From Navajo Dam to Lake Powell, the mean gradient of the San Juan River is 10.1 ft/mi, but can be as high as 21.2 ft/mi. Except in canyon-bound reaches, the river is bordered by non-native salt cedar, *Tamarix chinensis*, Russian olive, *Elaeagnus angustifolia*, native cottonwood, *Populus fremontii*, and willow, *Salix* sp. Nonnative woody plants dominate nearly all sites and resulted in heavily stabilized banks. Cottonwood and willow comprise a much smaller protion of the riparian vegetation.

The characteristic annual hydrographic pattern in the San Juan River is typical of rivers in the American Southwest, with large flows during spring snowmelt followed by low summer, autumn, and winter base flows. Summer and early autumn base flows are frequently punctuated by convective storm-induced flow spikes. Prior to closure of Navajo Dam, about 73% of the total annual San Juan River drainage discharge (based on USGS Gauge # 9379500; Bluff, Utah) occurred during spring runoff (1 March through 31 July). Mean daily peak discharge during spring runoff was 10,400 cfs (range = 3,810 to 33,800 cfs). Although flows resulting from summer and autumn storms contributed a comparatively small volume to total annual discharge, the magnitude of storm-induced flows exceeded the peak snowmelt discharge in about 30% of the years, occasionally exceeding 40,000 cfs (mean daily discharge). Both the magnitude and frequency of these storm induced flow spikes are greater than those recorded in the Green or Colorado rivers.

Operation of Navajo Dam altered the annual discharge pattern of the San Juan River. The natural flow of the Animas River ameliorated some aspects of regulated discharge by augmenting spring discharge. Regulation resulted in reduced magnitude and increased duration of spring runoff in wet years and substantially reduced magnitude and duration of spring flow during dry years. Overall, flow regulation by operation of Navajo Dam has resulted in post-dam peak spring discharge averaging about 54% of pre-dam values. Conversely, post-dam base flow increased markedly over pre-dam base flows. Since 1992, Navajo Dam has been operated to mimic a “natural” San Juan River.

Methods

Access to the river and collection localities was gained through the use of a 16' inflatable raft that transported both personnel and collecting gear. There was not a predetermined number of collections per river mile or geomorphic reach for this study. Instead, we collected in as many suitable larval fish habitats as possible within the river reach being sampled. Previous San Juan River investigations clearly demonstrated that larval fish most frequently occur and are most abundant in low velocity habitats such as pools and backwaters. Sampling of the entire study area is done during a single week in which the study area is divided into an “upper” section (Cudei, NM to Mexican Hat, UT) and a “lower” section (Mexican Hat, UT to Clay Hills, UT) [Figure 2]. Sampling trips for both portions of the study area were initiated on the same day.

Collecting efforts for larval fish concentrated on low velocity habitats using small mesh seines (1 m x 1 m x 0.8 mm). Several seine hauls (between 3 and 12) were made through an individual collecting site depending on the size of the habitat. For each seine collection, the length (in meters) of each seine haul was determined in addition to the number of seine hauls per site. Meso-habitat type, length, maximum depth, substrate, and turbidity (using a secchi disk) were recorded in the field data sheet for the particular collecting site (Appendix VII). Water quality measurements (dissolved oxygen, conductivity, salinity, and temperature) were also obtained using a multi-parameter YSI-85 water quality meter. A minimum of one digital photograph was recorded at each collection site.

River mile was determined to tenth of a mile using the 2003 standardized aerial maps

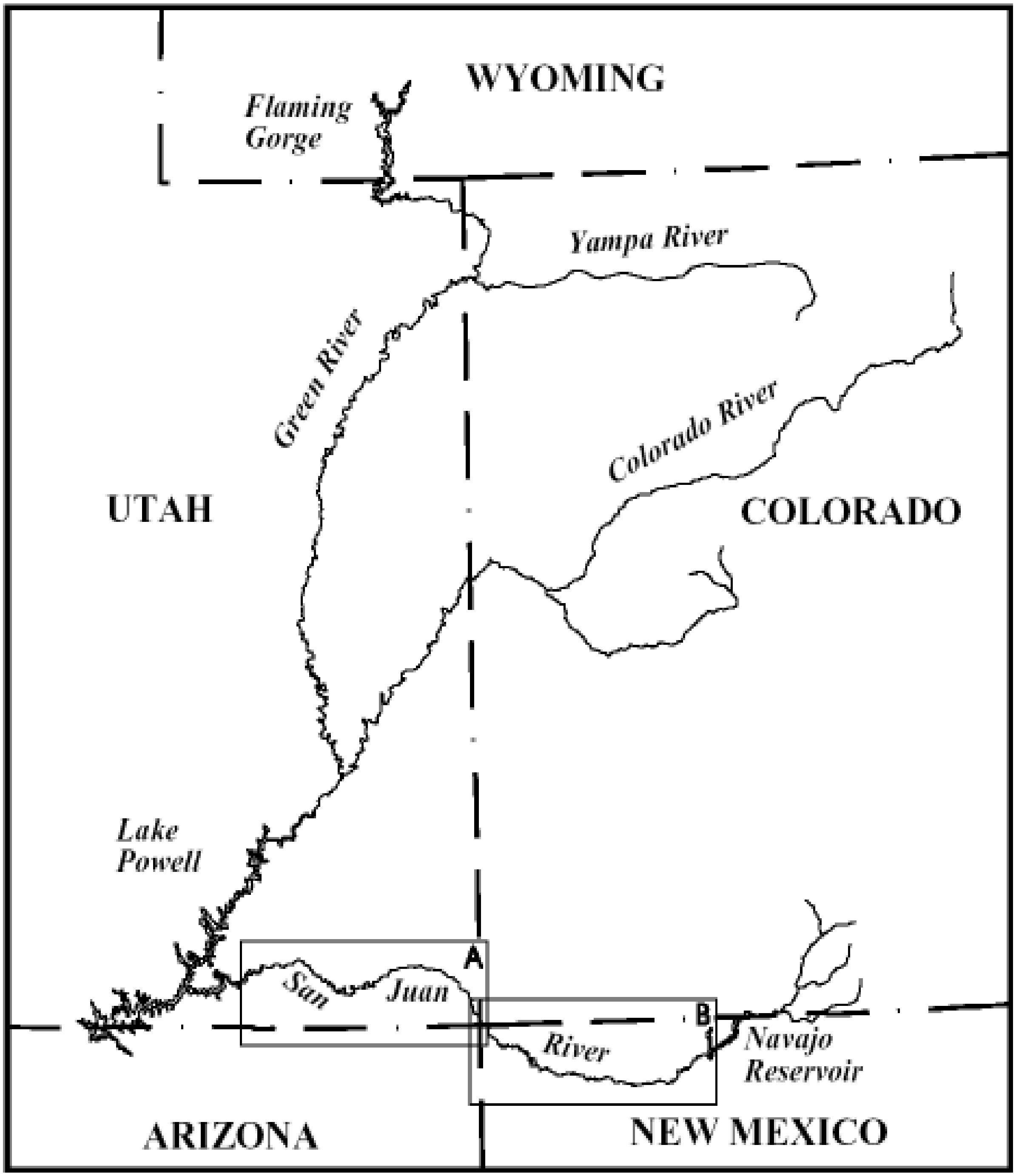


Figure 1. Location of the San Juan River within the Upper Colorado River Basin. The study area is outlined and labelled “A” and “B” with reference to subsequent maps in this report.

produced for the San Juan River Basin Recovery Implementation Program and used to designate the location of collecting sites. In addition, geographic coordinates were determined at each site with a Garmin Navigation Geographic Positioning System (GPS) unit and were recorded in Universal Transverse Mercator (UTM) Zone 12 (NAD27). In instances where coordinates could not be obtained due to poor GPS satellite signal, coordinates were determined in the laboratory using a Geographic Information System based on the recorded river mile.

All retained specimens were placed in plastic bags (Whirl-Paks) containing a solution of 10% formalin and a tag inscribed with unique alpha-numeric code that was also recorded on the field data sheet. Samples were returned to the laboratory where they were sorted and identified to species. Specimens were identified by personnel with expertise in San Juan River Basin larval fish identification. Underlit stereo-microscopes were used to aid in identification of larval individuals. Age-0 specimens were separated from age-1+ specimens using published literature to define growth rates for individual species (Snyder 1981, Snyder, Muth 2004). Both age classes were enumerated, measured (minimum and maximum size [mm standard length] for each species at each site), transferred to 70% ethyl alcohol, and catalogued in the Division of Fishes of the Museum of Southwestern Biology (MSB) at the University of New Mexico (UNM). Results reported in this document pertain to age-0 fish. Raw numbers of age-1+ fish are presented in Appendix III. Scientific and common names of fishes used in this report follow Nelson et al. (2006) while six letter codes for species are those adopted by the San Juan River Basin Biology Committee (Table 3). Total length (TL) and standard length (SL) were measured on Colorado pikeminnow and razorback sucker to be consistant with information gathered by the San Juan River Basin and Upper Colorado River Basin programs [Appendix V, VI]. Within this report, YOY lengths of these species are given as TL.

The term young-of-year can include both larval and juvenile fish. It refers to any fish, regardless of developmental stage, between hatching or parturition and the date (1 January) that they reach age 1 (i.e., YOY = age 0 fish). Larval fish is a specific developmental (morphogenetic) period between the time of hatching and when larval fish transform to juvenile fish. The larval fish terminology used in this report is defined by Snyder (1981). Larval fish develop through three distinct sequential larval stages: protolarvae, mesolarvae, and metalarvae. Fish in any of these developmental stages are referred to as larvae or larval fish. Juvenile fish are those that have progressed beyond the metalarvae stage and no longer retain traits characteristic of larval fishes. Juveniles were classified as individuals that 1) had completely absorbed their fin folds, 2) had developed the full adult complement of rays and spines, and 3) had developed segmentation in at least a few of the rays.

Differences in mean CPUE were determined by species between years using a one-way Analysis of Variance (ANOVA). A Poisson Distribution provided the best fit to the raw data. A variety of transformations (e.g., logarithmic, reciprocal, square root) were applied on the mean CPUE data for between year comparisons. A natural log transformation yielded the best variance-stabilizing qualities and produced a relatively normal distribution. Pair-wise comparisons between years (2003 – 2007) were made for each species and significance (i.e., $p<0.05$) was determined using the Tukey-Kramer HSD test. Finally, a nonparametric Analysis of Variance (Kruskal–Wallis test) was run for the various data sets to compare results to the parametric analyses.

While both ANOVA and Kruskal-Wallis were used to analyze data, data transforms enabled use of parametric analysis in all cases. The assumption of homogeneity of variances was assessed using the more conservative variance ratio criterion of <3:1 (Box, 1954), as opposed to <4:1 (Moore, 1995), among years. All species data sets met this more rigorous criterion and in most cases the variance ratio was <2:1 among years. Additionally, the significance values between parametric and nonparametric techniques were nearly identical and so only the parametric analysis will be presented.

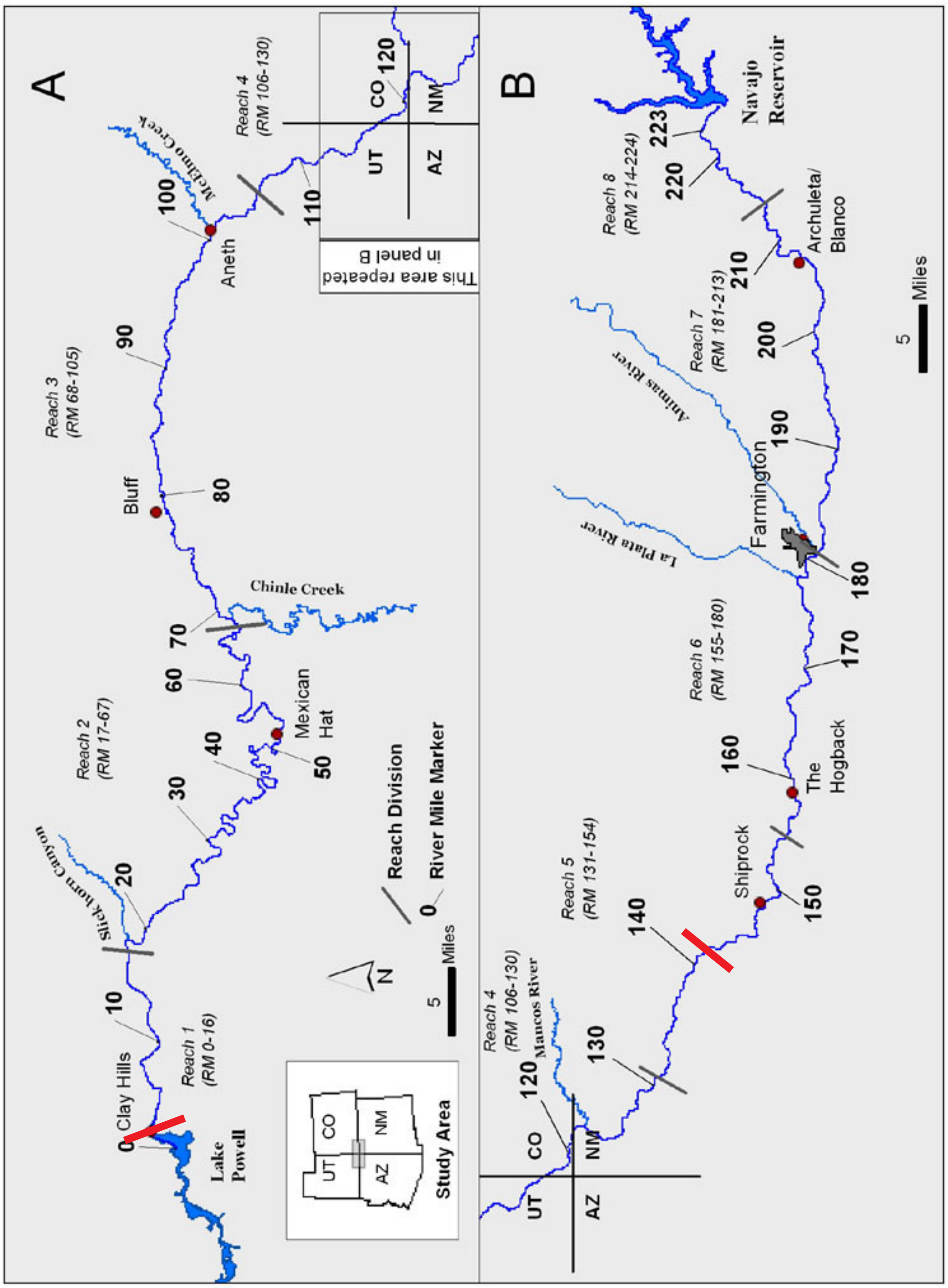


Figure 2. Map of the San Juan River. Study area is delineated by red bars (Cudei, NM river mile 141.5 and Clay Hills Crossing, UT (river mile 2.9).

Table 3. Scientific and common names and species codes of fish collected from the San Juan River. Asterisk (*) indicates species collected in previous years, but absent from 2006 samples.

Scientific Name	Common Name	Code
Order Cypriniformes		
Family Cyprinidae	carps and minnows	
Cyprinella lutrensis	red shiner	(CYPLUT)
Cyprinus carpio	common carp	(CYPCAR)
*Gila robusta**	roundtail chub	(GILROB)
Pimephales promelas	fathead minnow	(PIMPRO)
Ptychocheilus lucius	Colorado pikeminnow	(PTYLUC)
Rhinichthys osculus	speckled dace	(RHIOSC)
Family Catostomidae	suckers	
Catostomus (Pantosteus) discobolus	bluehead sucker	(CATDIS)
Catostomus latipinnis	flannelmouth sucker	(CATLAT)
Xyrauchen texanus	razorback sucker	(XYRTEX)
Order Siluriformes		
Family Ictaluridae	catfishes	
Ameiurus natalis	yellow bullhead	(AMENAT)
Ameiurus melas	black bullhead	(AMEMEL)
Ictalurus punctatus	channel catfish	(ICTPUN)
Order Salmoniformes		
Family Salmonidae	trouts	
*Oncorhynchus nerka**	kokanee salmon	(ONCNER)
Order Cyprinodontiformes		
Family Fundulidae	killifishes	
Fundulus zebrinus	plains killifish	(FUNZEB)
Family Poeciliidae	livebearers	
Gambusia affinis	western mosquitofish	(GAMAFF)
Order Perciformes		
Family Centrarchidae	sunfishes	
Lepomis cyanellus	green sunfish	(LEPCYA)
*Lepomis macrochirus**	bluegill	(LEPMAC)

Habitat designations used in this report follow those of Blisner and Lamarra (1999). For the purpose of analyzing densities of age-0 fish found within specific habitat types, sand shoals and cobbles shoals were grouped together as shoals. Rootwad pool and debris pool habitats were grouped as debris pools. Habitat association graphs were generated using riverwide CPUE of each species graphed. As such, these graphs are not meant to address habitat preference, rather they simply look at raw densities of each species within each of the given habitat types.

Hatching dates were calculated for larval Colorado pikeminnow using the formula: $-76.7105+17.4949(L)-1.0555(L)^2+0.0221(L)^3$, where L=length (mm TL). Spawning dates were then calculated by adding five days to the post-hatch ages to account for incubation time at 20 - 22°C (Nesler et al. 1988). Hatch dates of razorback sucker larvae were calculated by subtracting the average length of larvae at hatching (8.0 mm TL) from the total length at capture divided by 0.3 mm (Bestgen et al. 2002), which was the average daily growth rate of wild larvae observed by Muth et al. (1998).

Only larval specimens were used to generate larval occurrence graphs. Larval fish were separated from age-0 fish by recording the first collection of larval fish within a given year for each species as the initial occurrence. The cessation of larval occurrence was developed using the mean standard length of transformation from metalarvae to juvenile (Snyder 1981, 2003). Larval occurrence was then plotted against discharge recorded at Bluff, UT (USGS gauge #9379500) and water temperature recorded at Mexican Hat, UT to describe an approximation for the duration of spawning of individual species within the San Juan River between the years 2003 and 2007.

This study was initiated prior to spring runoff and completed near the end of the summer season (late September). Daily mean discharge during the study period was acquired from U.S. Geological Survey Gauge (# 09379500) near Bluff, Utah. Temperature data (mean, max, min) was supplied by Keller-Bliesner Engineering and taken at the state highway 160 bridge crossing in Colorado (river mile 119.2) and Mexican Hat, Utah.

Results and Discussion

2007 Survey Riverwide

Between 16 April and 9 September 2007, a total of six monthly sampling trips were conducted between Cudei, NM (river mile 141.5) and Clay Hills UT, (river mile 2.9). During the study period spring runoff flows peaked at 7,230 cfs (Bluff, UT gauge # 9379500) with mean flows at 2,418 cfs (Figure 3). Pre-spring runoff temperatures recorded at Mexican Hat, UT peaked on 30 April 2007 at 20.2 °C then in a period of five days dropped to 9.8 °C corresponding to the ascending limb of spring run-off. The mean temperature during the study period was 21.1°C.

A total of 374 collections produced 53,079 specimens during the 2007 sampling effort. Of the total specimens collected, 3,359 (6.4%) were age-1+ fish with the remaining 49,720 (93.6%) consisting of age-0 (larvae and young-of-year) fish . During the 2007 survey 13,436m^2 of habitat were sampled. Age-0 fish had a riverwide CPUE of 370.1 fish per 100m^2 (Appendix I). Riverwide CPUE for age-1+ fish was 25.0 fish per 100m^2 (Appendix III). Native species accounted for 61.0% of all age-0 fish collected, with flannelmouth sucker being the numerically dominant (n=16,539) and most frequently encountered native species (Appendix I). Non-native species accounted for 39.6% of the 2007 age-0 catch, with red shiner being the numerically dominant (n=16,800) and most frequently encountered non-native species. Three age-0 (larvae) Colorado pikeminnow were collected during trip 4 (July) of the 2007 survey. Larval Colorado pikeminnow were last collected from the San Juan River in 2004. A total of 200 age-0 (larval and juvenile) razorback sucker were collected in 2007. This marks the tenth consecutive

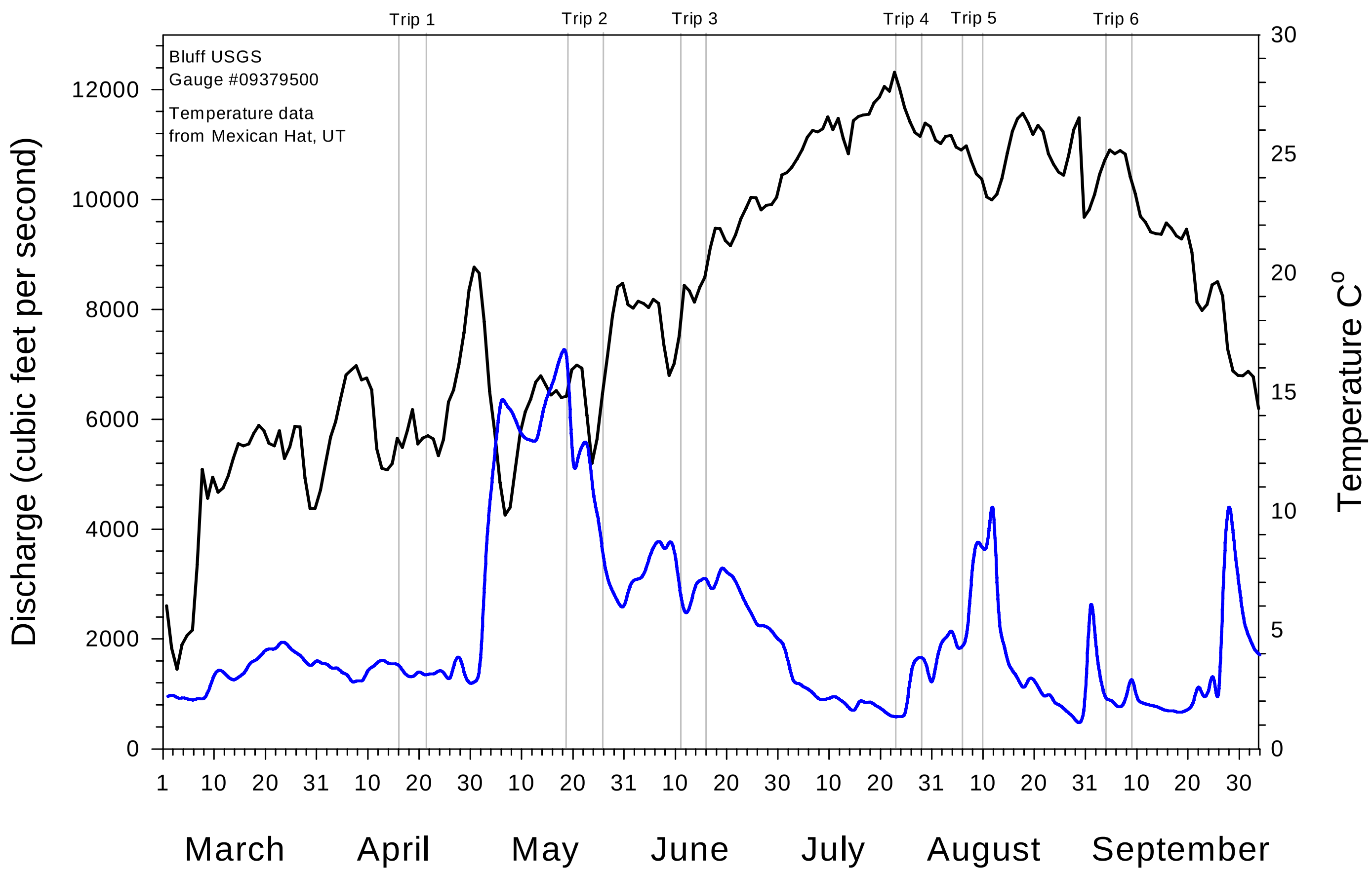


Figure 3. Discharge (cfs) at Bluff, UT (USGS gauge #9379500) and water temperature (°C) at Mexican Hat, UT in the San Juan River during the 2007 sampling period. Gray vertical bar denote individual collecting trips. The black line represents discharge and the blue line represents temperature.

year in which successful reproduction of razorback sucker has been documented in the SanJuan River.

Native Species

Flannelmouth sucker. The first larval specimens documented during the 2007 survey were flannelmouth sucker. Samples containing larval flannelmouth sucker were first collected downstream of McElmo Creek in a backwater at river mile 98.6 during trip 1 (April). Age-0 flannelmouth suckers were collected in the majority of subsequent downstream collection during trip 1 (Figure 4), and throughout the rest of the study period. Located just upstream of the first collection of larval catostomids in 2007 is the tributary, McElmo Creek (river mile 100.5). Large spawning aggregations of adult flannelmouth sucker have been observed in McElmo Creek during March sampling trips with Bio-West (2002-2005). The earliest collections of larval catostomids from 2003 - 2007 were all collected at or downstream of McElmo Creek. Beginning in 2006 three temperature loggers (StowAway Tid-biTs) were placed in three locations in the San Juan River: reach 4 (river mile 127.5, NM), in McElmo Creek, UT, and just below the boat take out at Clay Hills, UT (2.8). In 2007, these temperature loggers recorded average daily temperatures in McElmo Creek that were 1-2 degrees warmer beginning in early March than reach 4 and Clay Hills (Figure 5). These warmer temperatures, along with observation of spawning aggregations of flannelmouth sucker in McElmo creek, are evidence that McElmo Creek is an important spawning area for flannelmouth suckers. Mean CPUE was highest during trip 1 at 409.7 fish per 100m^2 (Figure 6). Trip 1 had a higher mean CPUE than the combined mean CPUE of trips 2-6. Spatially, reach 3 had the highest mean CPUE at 259.7 fish per 100m^2. Flannelmouth sucker was the numerically dominant and most frequently encountered native species in 2007. The relative abundance of flannelmouth sucker (CPUE) has generally been constant over the period of study (2003-2007), except for an increase in 2007 ($F=5.53$ $p=0.0002$) [Figure 7]. Flannelmouth suckers were collected in each of the ten habitat types sampled with backwaters having the highest CPUE (205.3 fish per 100m^2) for this species (Figure 8).

Bluehead sucker. Catch rates of bluehead sucker during trips 1and 2 were generally low (n-2) and 2 (n=50). The two individuals collected during trip 1 were collected in reach 3 while the 50 individuals collected during trip 2 were all taken in reaches 1 and 2 (Figure 9). Beginning with trip 3 (June), the number of age-0 bluehead sucker collected increased substantially and age-0 specimens were collected in all five reaches (Figure 10). Mean CPUE was 137.0 fish per 100m^2 during trip 3 and peaked at 153.2 fish per 100m^2 during trip 4 (Figure 11). The largest densities of larval bluehead sucker were collected in reaches 4 and 5 during trip 4. Mean CPUE declined substantially during trip 5 (August) and no bluehead sucker were collected during trip 6 (September). Reach 5 had the highest mean CPUE (240.3 fish per 100m^2) however catch rates were highly variable in that reach. Mean CPUE was relatively unchanged in each of the four subsequent downstream reaches. The highest densities of bluehead sucker were found in edge pools (83.7 fish per 100m^2), and bluehead sucker was the only catostomid for which backwaters were not the most productive habitat type. The relative abundance of bluehaed sucker (CPUE) has varied among years, between 2003 and 2007. Catch rates of bluehead sucker increased from 2003 to 2005. The highest catch of bluehead sucker between the five years analysed were recorded in 2005 ($F=10.36$ $p<0.0001$). Catch rates dropped in 2006 and increased in 2007 (Figure 12).

Razorback sucker. A total of 200 age-0 razorback sucker were collected in 2007. The first and only specimen collected during trip 1 was in a backwater site at river mile 81.3. Trip 2

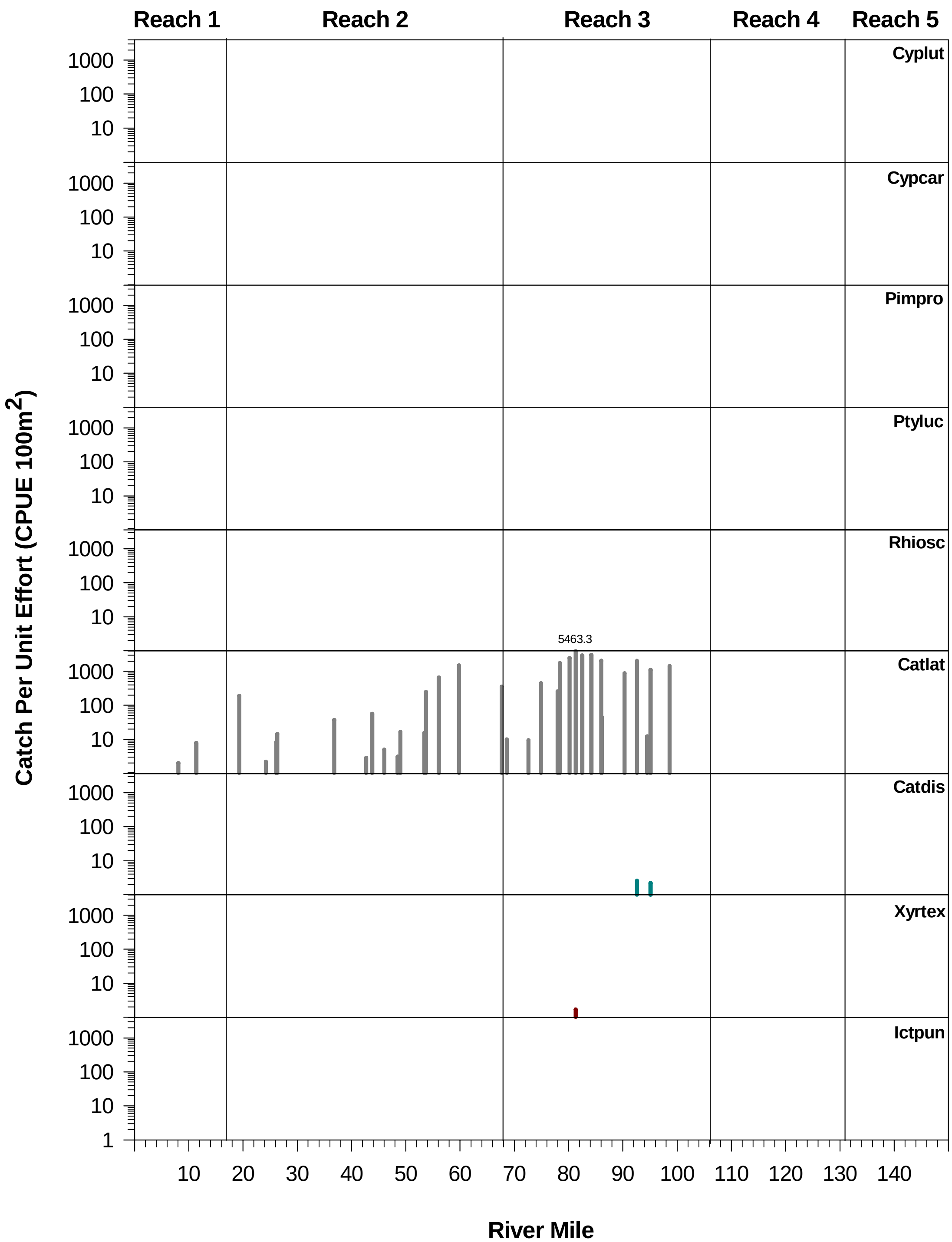


Figure 4. Catch per unit effort /100 m^2 of age-0 fish by sampling locality, Trip 1 (16 - 21 April 2007).

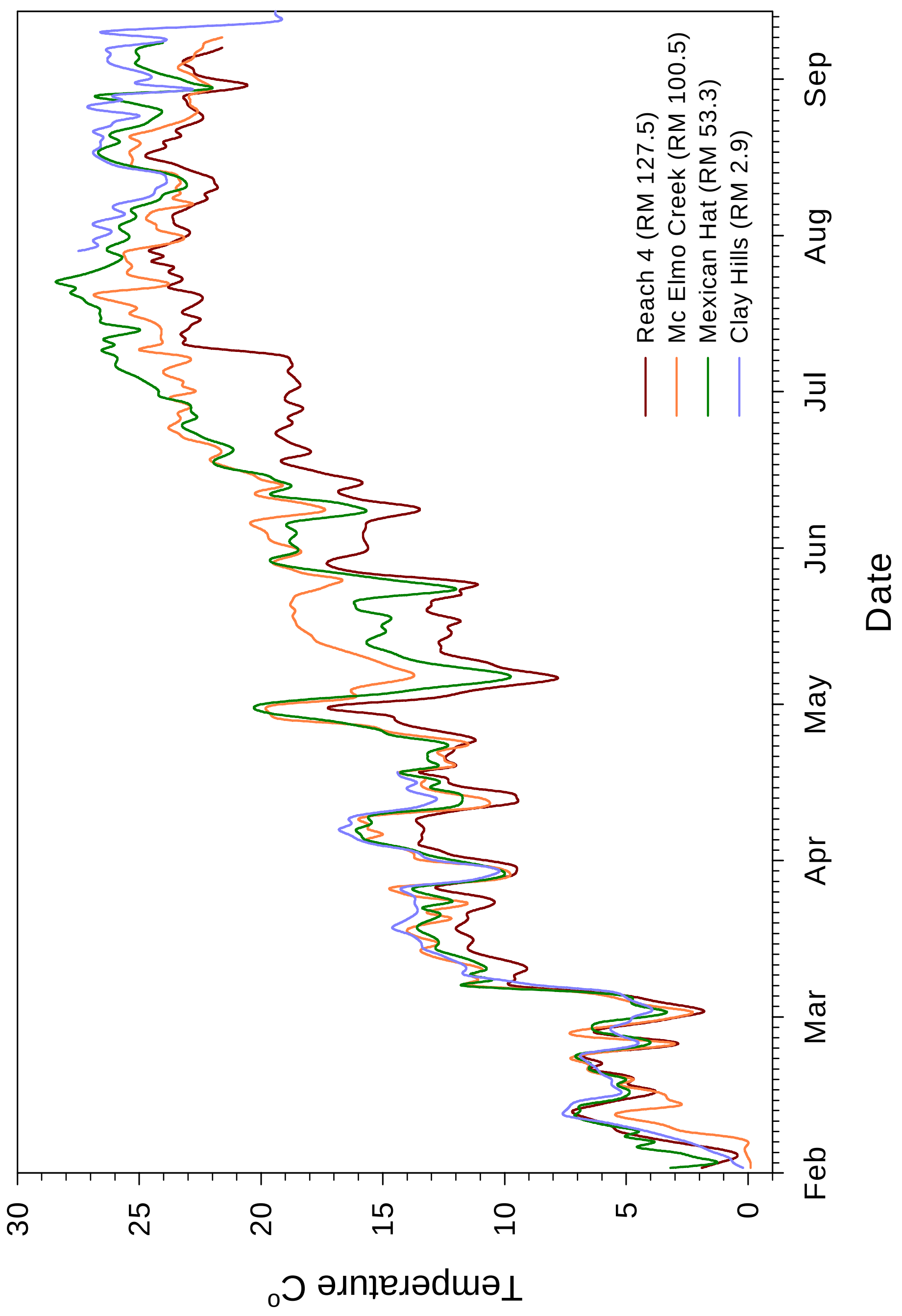


Figure 5. Water temperatures during the 2007 larval survey study period recorded in reach 4, NM, McElmo Creek, UT, Mexican Hat, UT, and Clay Hills Crossing, UT from 1 February to 30 September 2007.

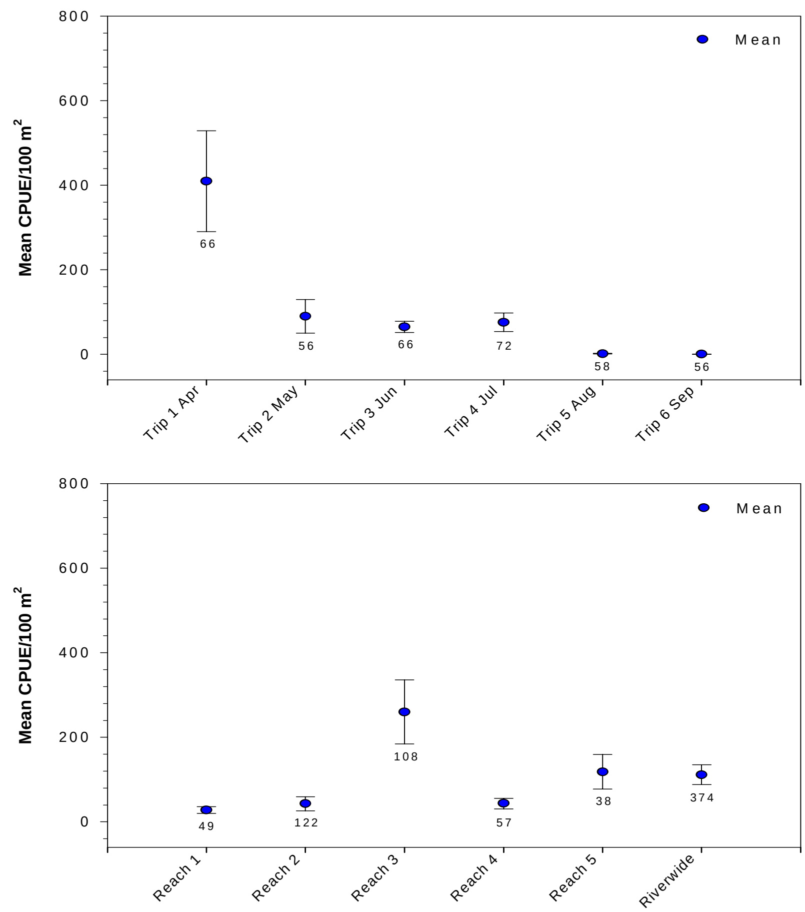


Figure 6. Mean CPUE / 100 m^2 ($\pm$1 SE) for age-0 flannelmouth sucker by trip, reach, and riverwide for 2007. Sample size reported below SE bars.

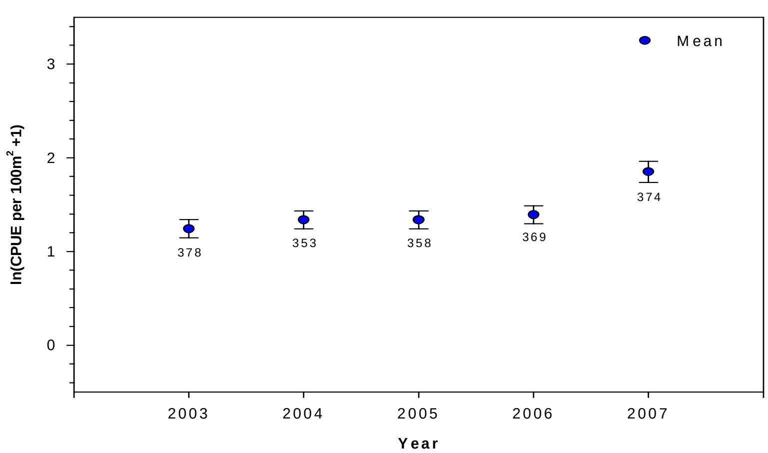
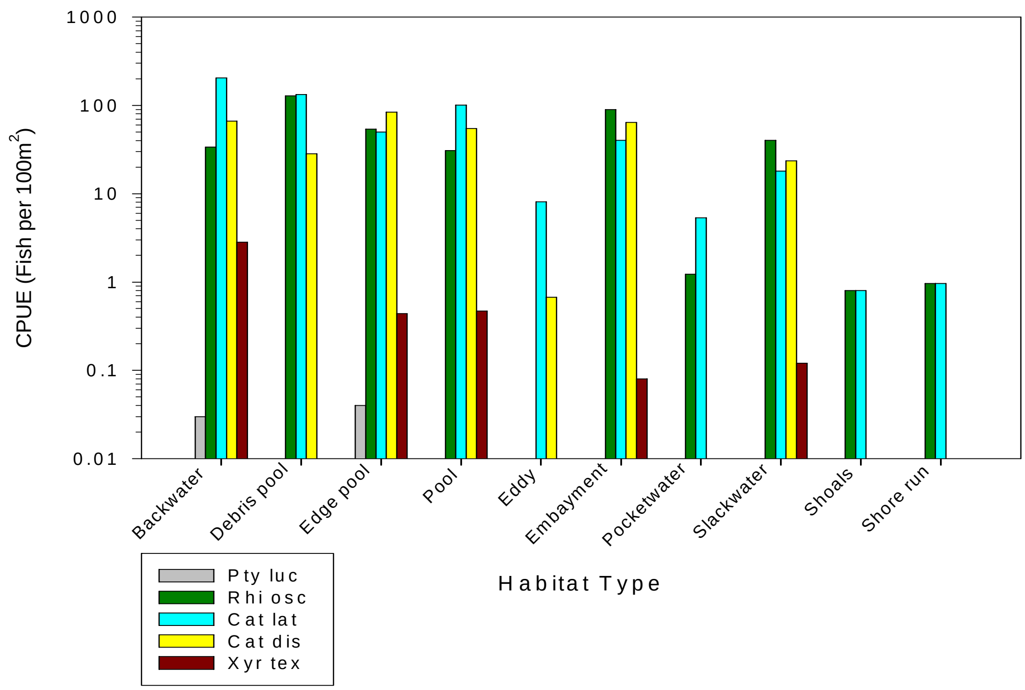


Figure 7. ln(CPUE per 100m^2 +1) [$\pm$1 SE] for age-0 flannelmouth sucker by year 2003-2007. Sample size reported below SE bars.



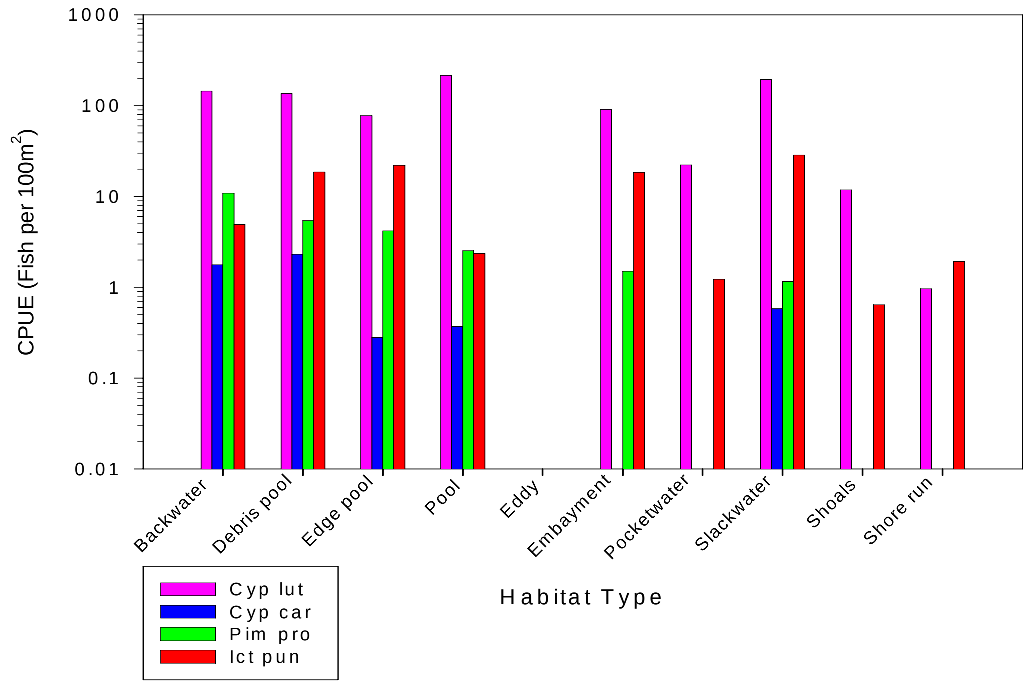


Figure 8. Riverwide species specific CPUE per 100m^2 by habitat types. Top graph represents habitat association by native fish, bottom graph represents habitat association by non-native fish.

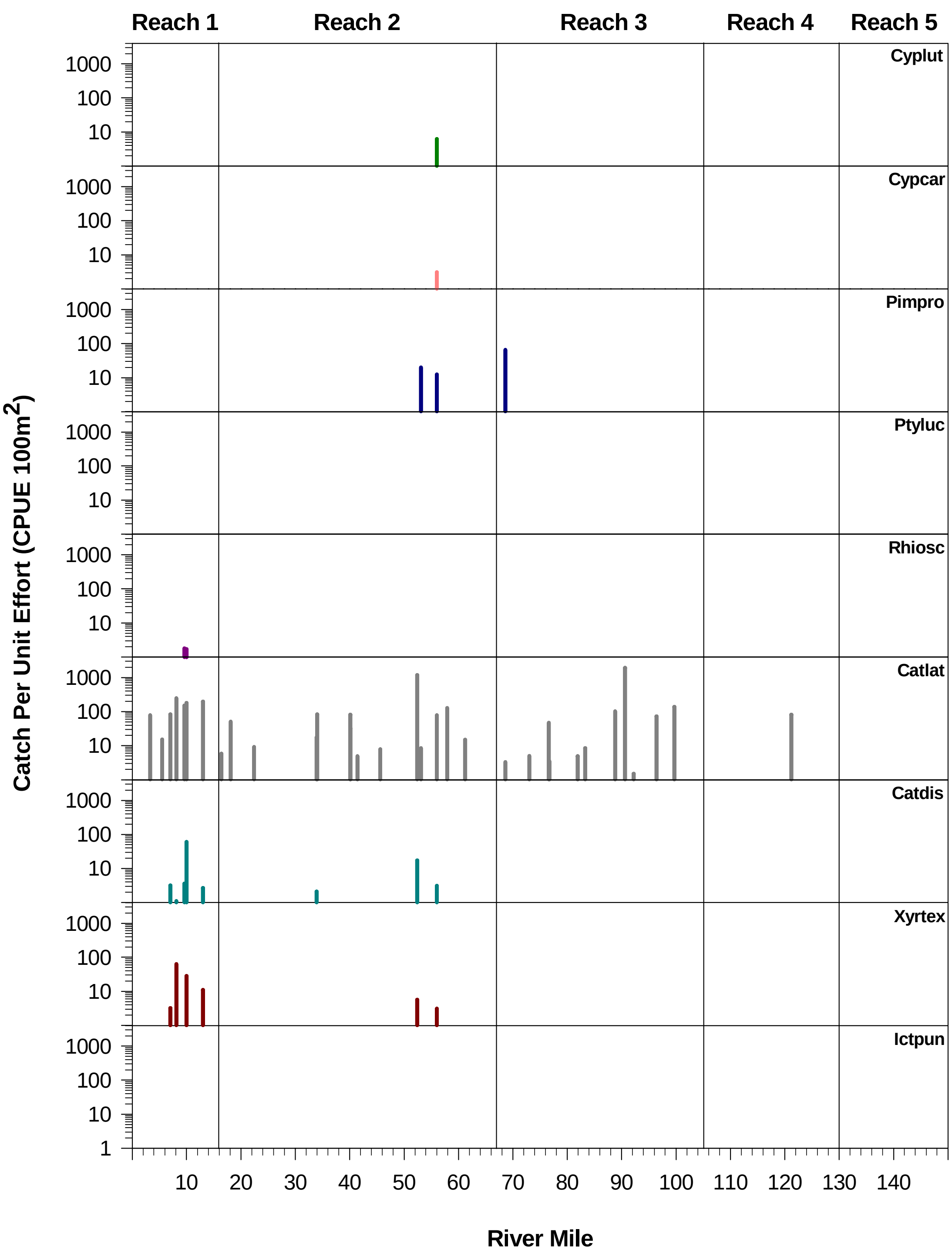


Figure 9. Catch per unit effort /100 m^2 of age-0 fish by sampling locality, Trip 2 (19 - 26 May 2007).

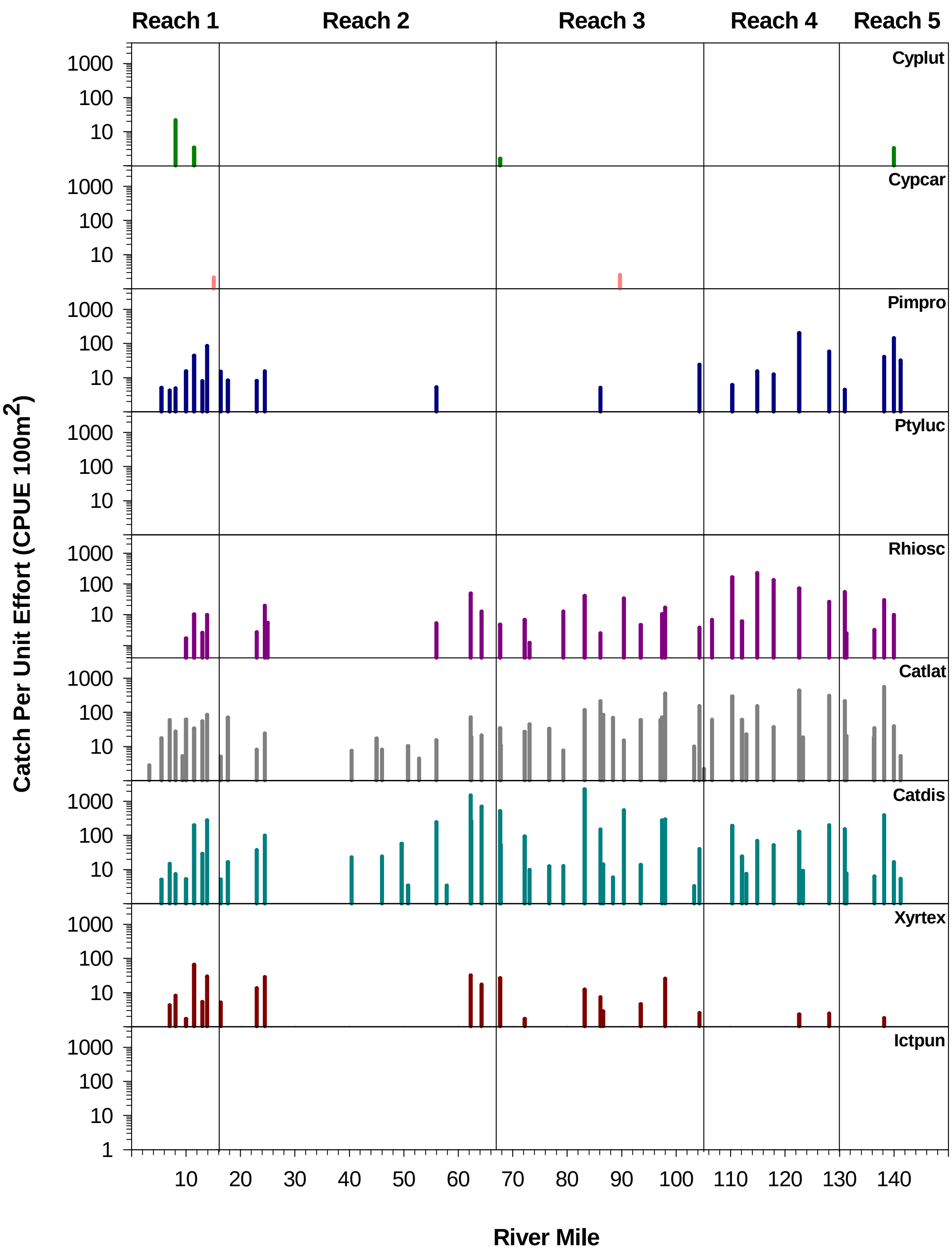


Figure 10. Catch per unit effort /100 m[2] of age-0 fish by sampling locality, Trip 3 (12 - 16 June 2007).

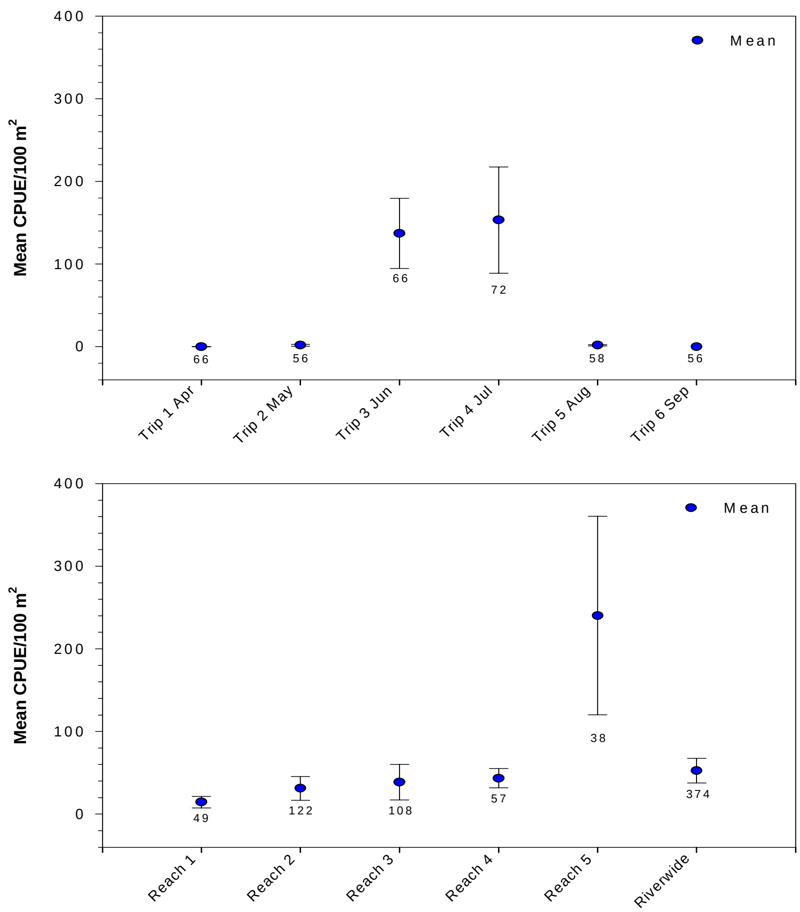


Figure 11. Mean CPUE / 100 m^2 (+1 SE) for age-0 bluehead sucker by trip, reach, and riverwide during the 2007 survey. Sample size reported below SE bars.

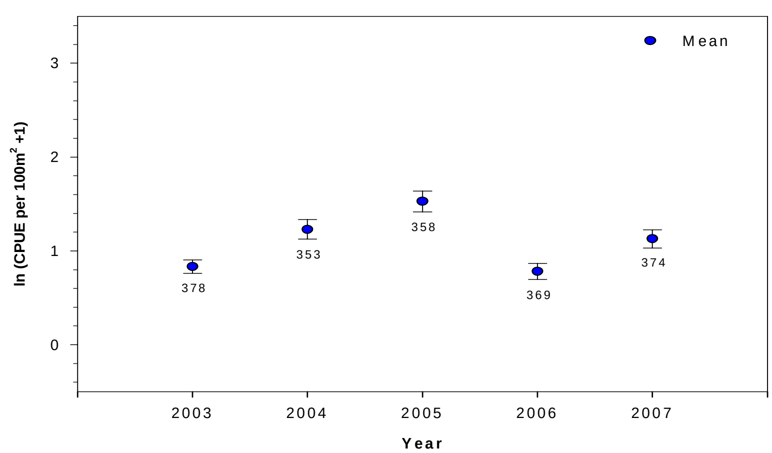


Figure 12 ln(CPUE per 100m^2 +1) [+1 SE] for age-0 bluehead sucker by year (2003-2007). Sample size reported below SE bars.

produced the single largest collection of age-0 razorback sucker with 56 individuals collected from a backwater site at river mile 8.1 (Steer Gulch). The highest catch rates of age-0 razorback sucker during trip 2 occurred in reach 1. Mean CPUE was highest during trip 3 at 5.2 fish per 100m^2 (Figure 13). During trip 3, age-0 razorback sucker were collected throughout the study area in all five reaches. Reach 1 had the highest catch rates of age-0 razorback sucker during trip 3. Additionally, four recently transformed juvenile razorback sucker were collected during trip 3 in Steer Gulch (river mile 8.1). Trip 4 produced a single razorback sucker and was the last trip in which age-0 razorback sucker were collected. Reach 1 had the highest mean CPUE (4.6 fish per 100m^2) and was nearly three times that of the other four reaches (2-5) combined (Figure 13). Razorback sucker were collected from five different habitat types in 2007, and densities were greatest in backwater habitats (2.8 fish per 100m^2). The remaining four habitat types (edge pool, pool, embayment and slackwater) had a combined CPUE of 1.1 fish per 100m^2 (Figure 8). Catch rates in 2007 did not differ significantly from most other sample years, with the exception of 2003 which had significantly greater fish densities than 2004 and 2005 ($F=4.75$ $p=0.008$) when CPUE was the highest among the five comparative years (Figure 14). Three age-1+ razorback sucker were collected in 2007. It is not known if these fish were wild or stocked specimens.

Back-calculated hatch dates for age-0 razorback sucker ranged from 26 March to 17 June 2007. The range of back-calculated hatch dates is broader in 2007 than those recorded for 2003-2006 (Figure 15). The second broadest hatching period was in 2005. Both 2007 and 2005 had mean discharge during the calculated hatching period of over 3,000 cfs. Mean temperature during the back-calculated hatching period for all five years (2003-2007) was 15.0^{o}C or greater.

All larval razorback sucker from 2003 - 2007 were staged using the criteria from Darrel E. Snyder’s larval keys. Site specific catch per unit effort were plotted by river mile for individual larval stages (Figure 16). From 2003 - 2007 protolarvae were distributed throughout all five reaches. This overall distribution is indicative of the drifting behavior of the early life stages of larval fish (Pavlov, 1994; Robinson et. al. 1998). Spawning bars can be inferred by looking at the clumped distribution of protolarvae as they are the most recently hatched individuals. Protolarvae were collected from 2004-2007 between river miles 131.0 and 123.0 suggesting a spawning bar around the area of “the mixer”, a section of river with complex habitat. A second peak in protolarvae densities occurs downstream of McElmo Creek and into reach 2. Catch rates decrease in reach 2 until about John’s Canyon (river mile 24.5). Catch rate for protolarvae increase again in reach 1. Distribution of mesolarvae is somewhat more clumped. Reach 1 has the highest catch rates with peaks at Steer Gulch (river mile 8.1). There is also a peak in catch rates of mesolarvae in reach 2 at river mile 57.9. Mesolarval razorback sucker were collected in a large backwater here in 2003, 2004, and 2006. Metalarvae are less distributed throughout the study area and the peaks in catch rates occur in reaches 3 and 1.

Colorado pikeminnow. All three of the larval Colorado pikeminnow collected in 2007 were taken during trip 4 (Figure 17). Two specimens were collected on the same day (25 July 2007), one in a pool habitat in reach 2 (river mile 33.7) and one in a backwater habitat 74 miles upstream (reach 4) in the upper section of the study area. Two days later a third larval Colorado pikeminnow was collected in the upper section at river mile 74.9 (reach 3). Both Colorado pikeminnow collected in reaches 3 and 4 were found in backwater habitats. The three larval Colorado pikeminnow ranged in length from 12.0-13.0 mm SL (14.9-17.5mm TL). These three specimens represent the first larval Colorado pikeminnow collected from the San Juan River since 2004. Because of the very low numbers of larval Colorado pikeminnow collected in each of the past five years, no significant difference in yearly CPUE exists (Figure 18). A total of 181

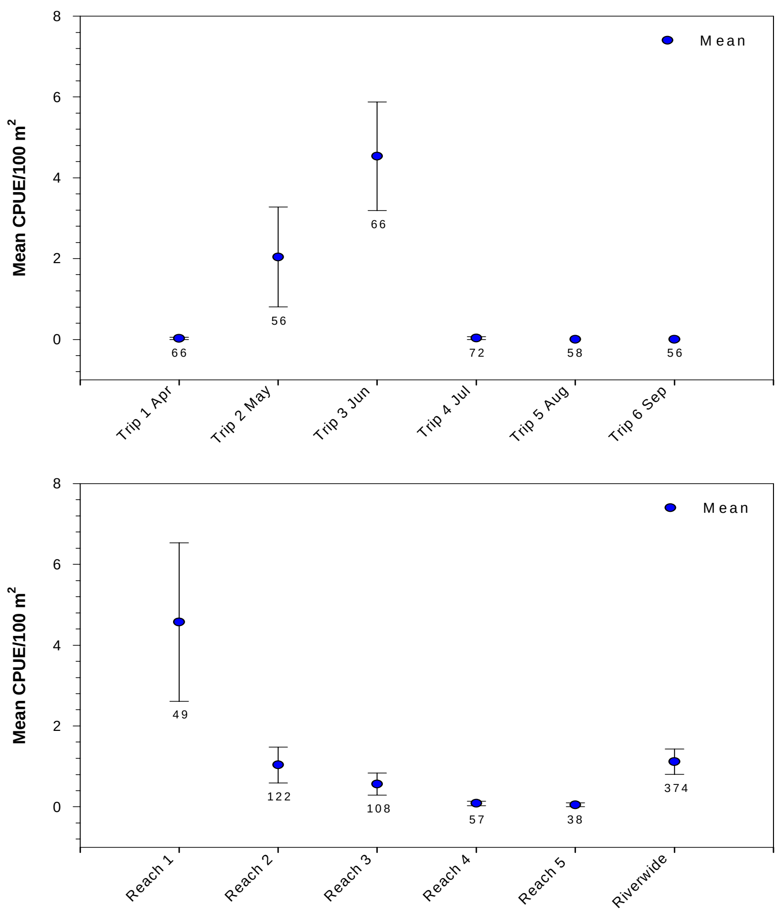


Figure 13. Mean CPUE / 100 m^2 (±1 SE) for age-0 razorback sucker by trip, reach, and riverwide during the 2007 survey. Sample size reported below SE bars.

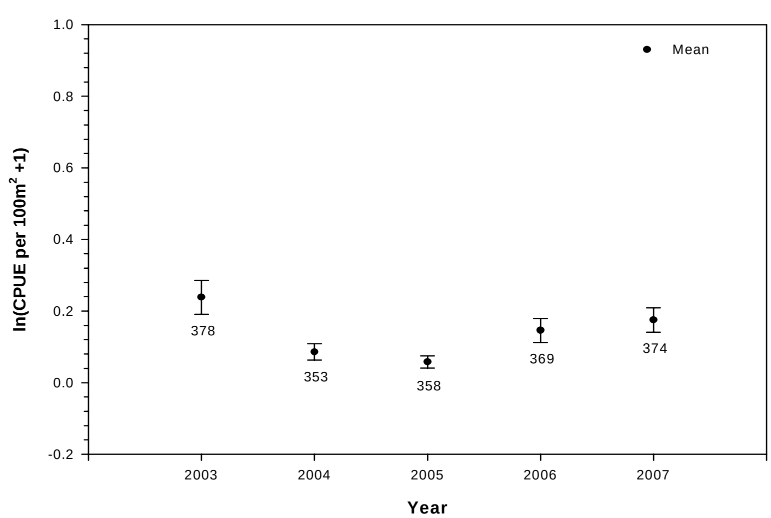


Figure 14 ln(CPUE per 100m^2 +1) [±1 SE] for age-0 razorback sucker by year (2003-2007). Sample size reported below SE bars.

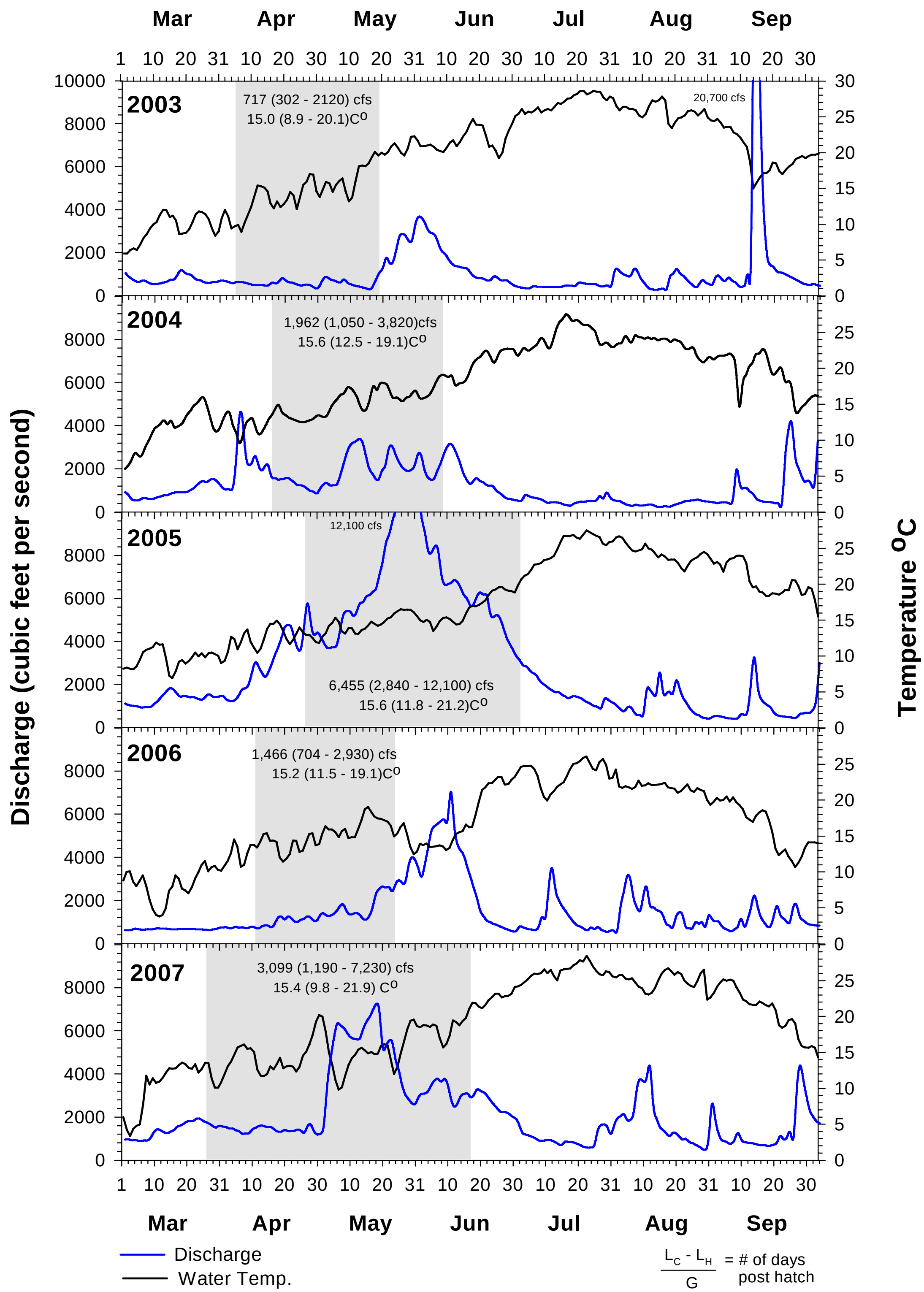


Figure 15. Back-calculated hatching dates for razorback sucker plotted against discharge (Bluff, UT USGS gauge 39379500) and water temperature (Mexican Hat, UT) from 2003 - 2007. Gray boxes delineate hatching periods.

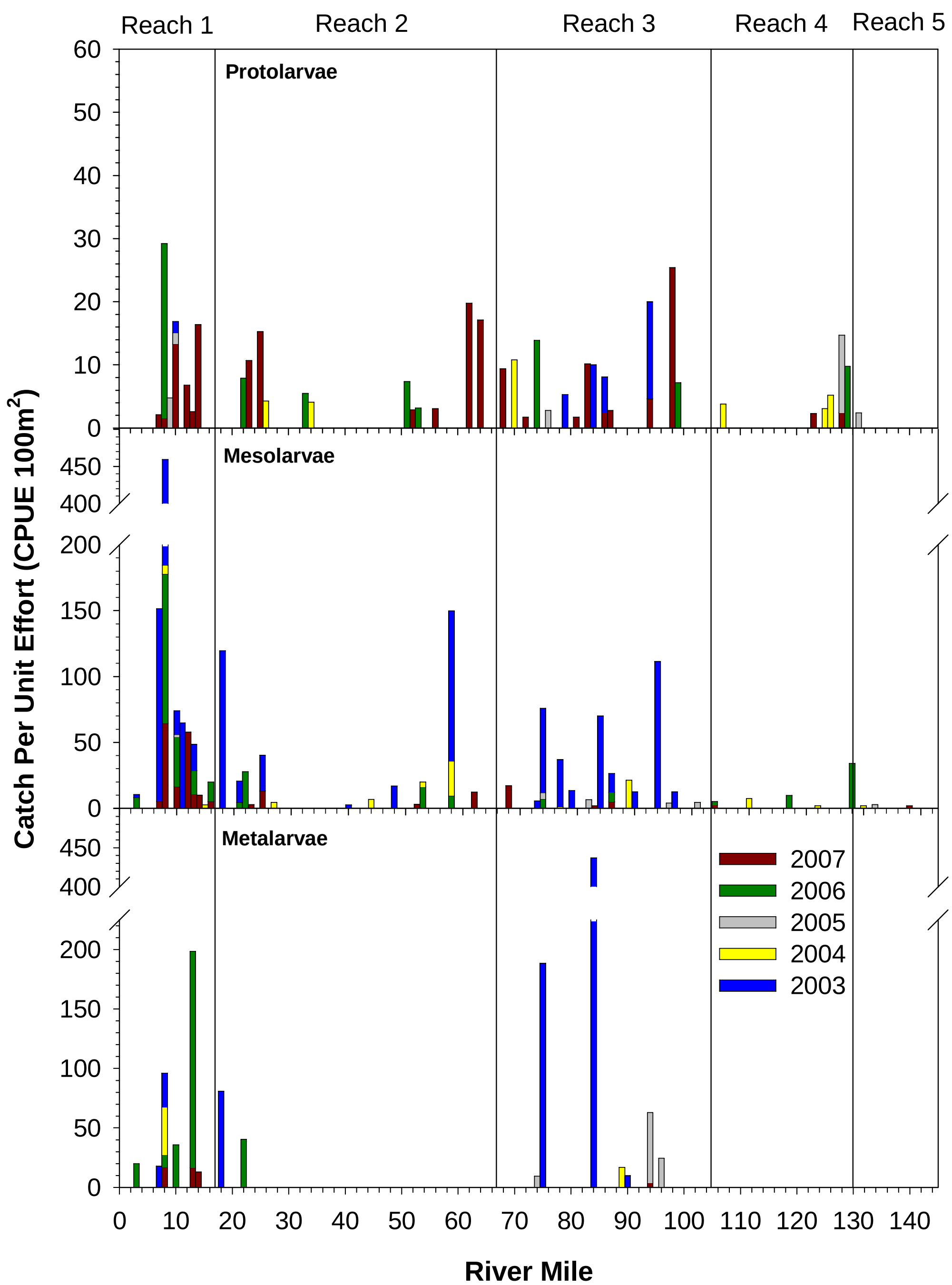


Figure 16. Catch per unit effort /100m2 of discrete larval stages (protolarvae, mesolarvae, and metalarvae) of razorback sucker by sample locality, 2003 - 2007.

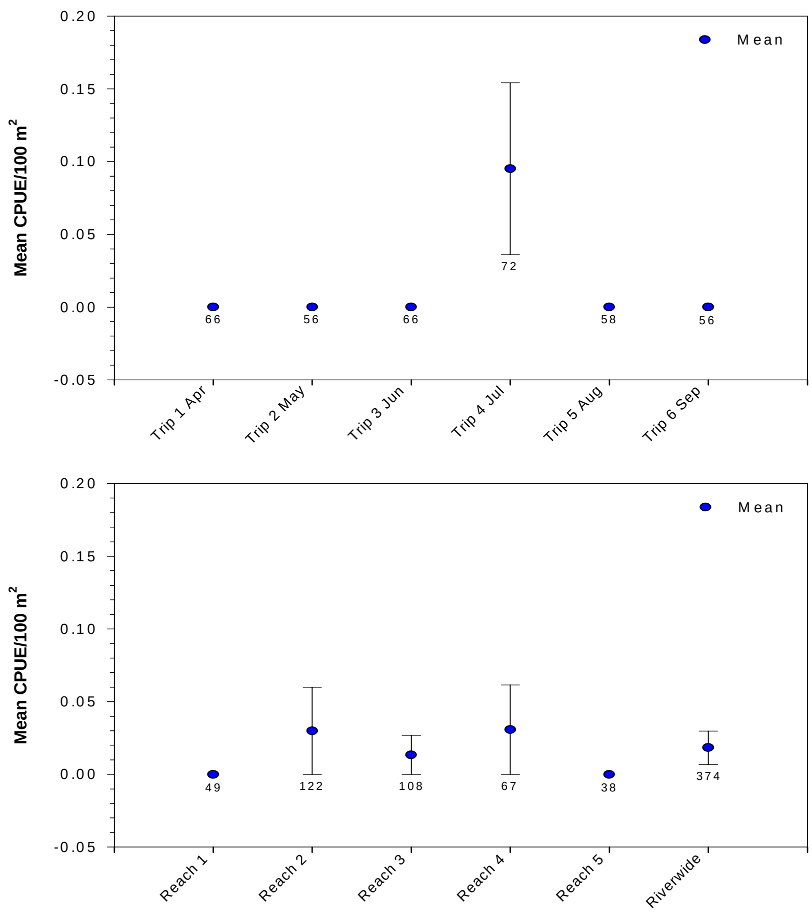


Figure 17. Mean CPUE / 100 m^2 (±1 SE) for age-0 Colorado pikeminnow by trip, reach, and riverwide during the 2007 survey. Sample size reported below SE bars.

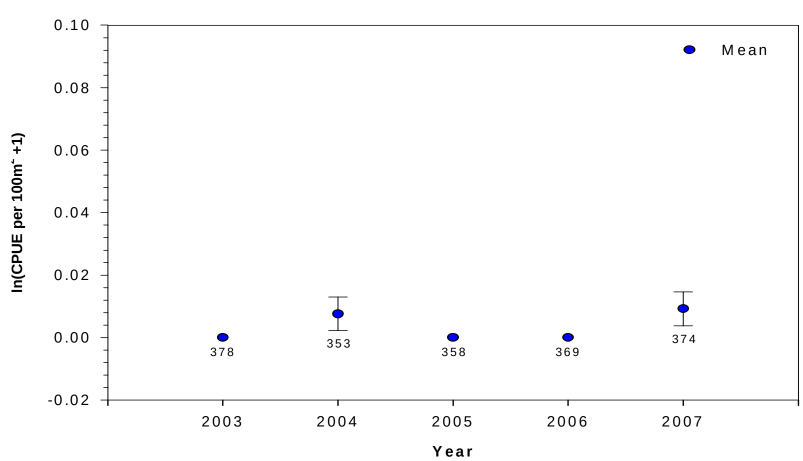


Figure 18. ln(CPUE per 100m^2 +1) [±1 SE] for age-0 Colorado pikeminnow by year (2003-2007). Sample size reported below SE bars.

age-1+ Colorado pikeminnow were collected in 2007. Each of the six trips (April-September) and all five of the reaches in the study area produced at least one age-1+ Colorado pikeminnow (Appendix II). However, the majority (n=178) were collected in the first three sampling trips and it is therefore assumed that these fish were the result of recent stocking efforts.

The back-calculated spawning date for all three 2007 Colorado pikeminnow specimens was 27 June 2007, which falls on the descending limb of the post spring runoff hydrograph. Mean flow (Bluff gauge) and temperature (Four Corners) during this period were 2120 cfs and 20.3 C^{o} respectively (Figure 19). The back-calculated spawning dates of the 2004 larval Colorado pikeminnow were 24 and 25 June 2004, when mean discharge was 781 cfs, and mean temperature at Four Corners was 22.8 C^{o}. The spawning dates for the two 2004 larval specimens were also back-calculated on the descending limb of spring-runoff.

Speckled dace. Age-0 speckled dace were first collected during trip 2 near the bottom of the study area (river mile 10.0) in reach 1 (Figure 9). Age-0 speckled dace were collected throughout the study area in each of the four subsequent trips. Riverwide, age-0 speckled dace had a mean CPUE of 43.2 fish per 100m^2 in 2007 (Figure 20). During the June sampling effort densities of larval speckled dace increased, with catch rates highest in reach 4. Mean CPUE of age-0 speckled dace peaked during trip 4 (July) at 181.0 fish per 100m^2 (Figure 20). Riverwide, reaches 4 and 5 had the highest mean CPUE at 116.4 and 122.7 fish per 100m^2, respectively (Figure 20). Mean CPUE for age-0 speckled dace dropped in each of the three subsequent downstream reaches. Of the ten habitat types sampled, debris pools had the highest CPUE (128.1 fish per 100m^2) for speckled dace while the only habitat type that did not produce speckled dace were eddies (Figure 8). After the low CPUE ($F=10.85$, $p<0.0001$), catch rates for speckled dace have remained essentially the same (Figure 21).

Non-native species

Red Shiner. Age-0 red shiner were collected in all but trip 1 in 2007 and the majority (>75%) of all red shiner were collected during the fourth sampling trip. Mean CPUE for red shiner peaked at 598.4 fish per 100m^2 during trip 4. Red shiner were the dominant fish collected in trips 4, 5, and 6 and had higher site-specific CPUE than any other species collected (Figures 22, 23 and 24). Spatially, reach 1 had the highest mean CPUE (277.0 fish per 100m^2) for red shiner. However, both reaches 4 and 5 had a mean CPUE of at least 200 fish per 100m^2 (Figure 25). Red shiner was the numerically dominant and most frequently encountered non-native species in 2007 and was found in every habitat type sampled with the exception of eddies. Pool habitat types were the most productive for this species followed closely by slackwater (216.0 and 193.4 fish per 100m^2, respectively). Significant differences exisit in CPUE between many of the five comparative years for age-0 red shiner. The year 2007 was significantly lower than 2003, 2004, and 2005 ($F=10.74$ $p<0.0001$). Catch rates peaked for red shiner in 2004, and were significantly higher than 2003 and 2006. The CPUE for 2005 was also significantly higher than that of 2006 (Figure 26).

Common carp. A total of 137 age-0 common carp collected in 2007. Like other non-native cyprinids, mean CPUE for this species peaked (4.1 fish per 100m^2) during trip 4 (Figure 27). Trip 4 produced 131 age-0 common carp, while no common carp were collected during trips 1 and 6. Mean CPUE increased between reaches 5 and 4 and again between reaches 4 and 3 where it peaked at 1.8 fish per 100m^2 (Figure 27). Catch rates in 2003 were significantly lower compared to 2004, 2005 and 2007 ($F=13.06$ $p<0.001$) [Figure 28]. Similarly, 2006 CPUE

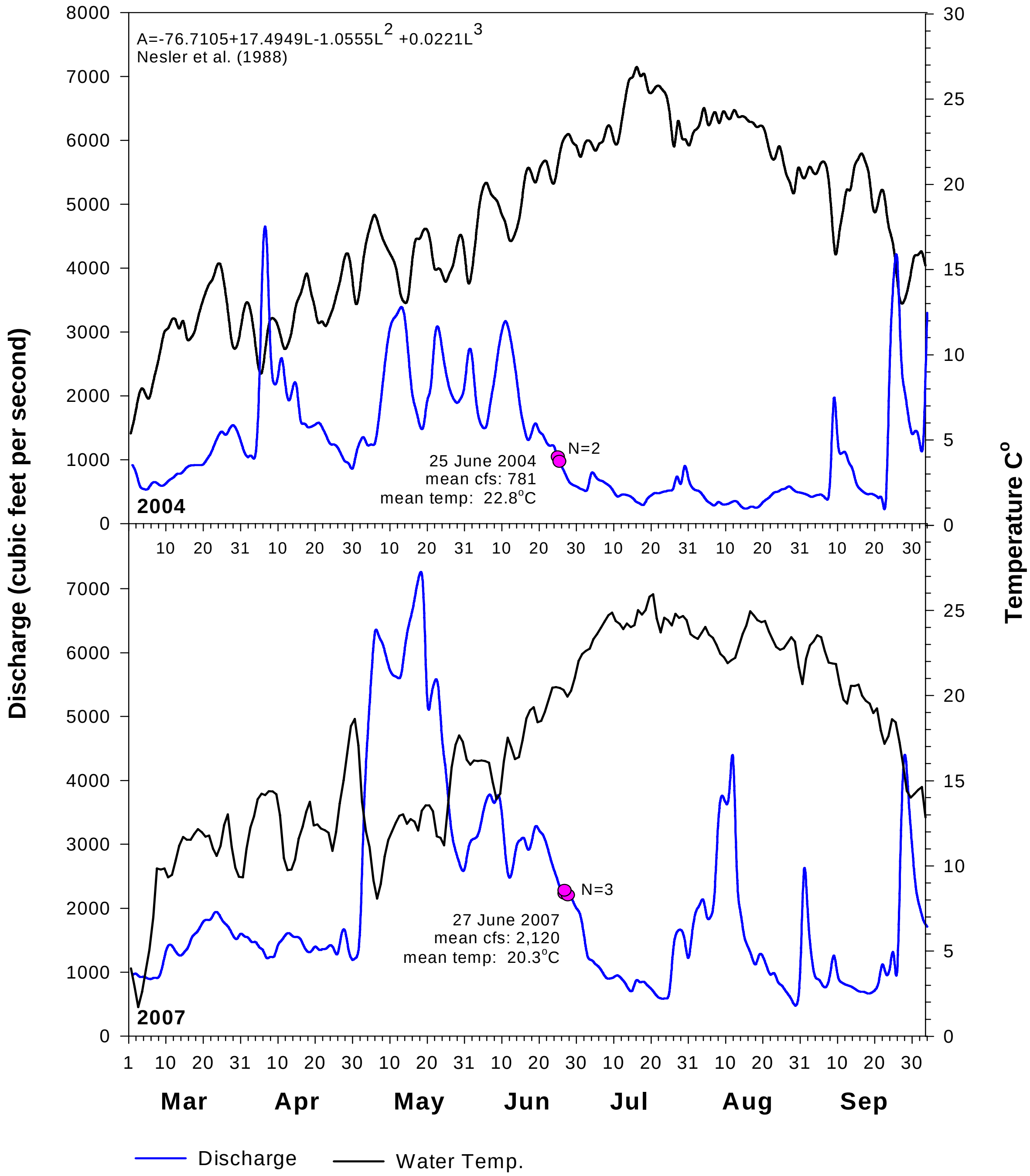


Figure 19. Back-calculated spawning dates for Colorado pikeminnow plotted against discharge (Bluff, UT, USGS gauge #9379500) and water temperature (Four Coners, CO) 2004 and 2007. Pink dot represents spawning date.

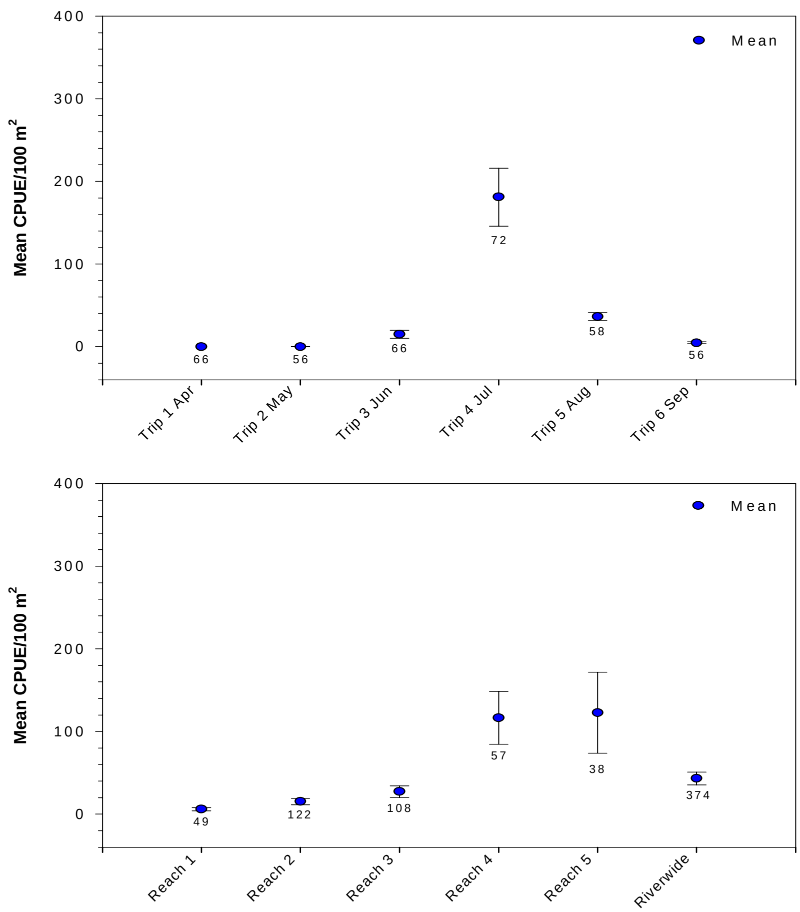


Figure 20. Mean CPUE / 100 m^2 (±1 SE) for age-0 speckled dace by trip, reach, and riverwide during the 2007 survey. Sample size reported below SE bars.

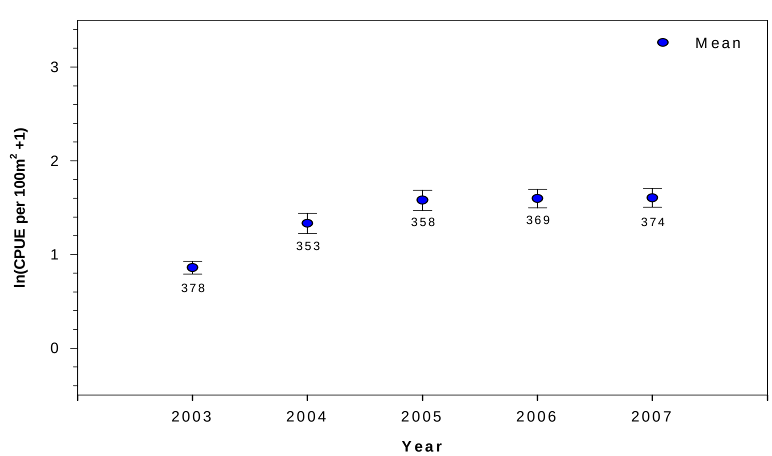


Figure 21. ln(CPUE per 100m^2 +1) [±1 SE] for age-0 speckled dace by year (2003-2007). Sample size reported below SE bars.

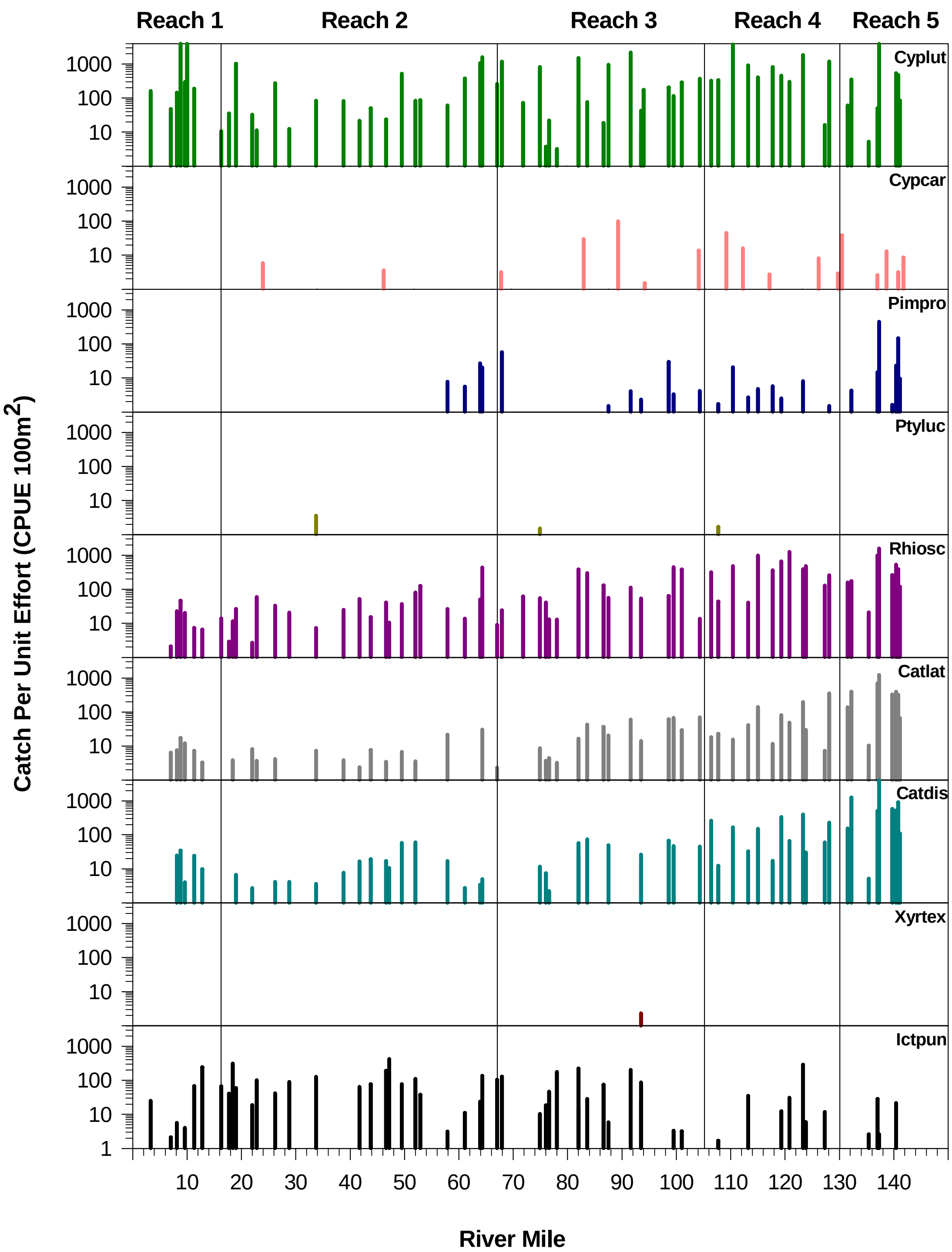


Figure 22. Catch per unit effort /100 m^2 of age-0 fish by sampling locality, Trip 4 (23-28 July 2007).

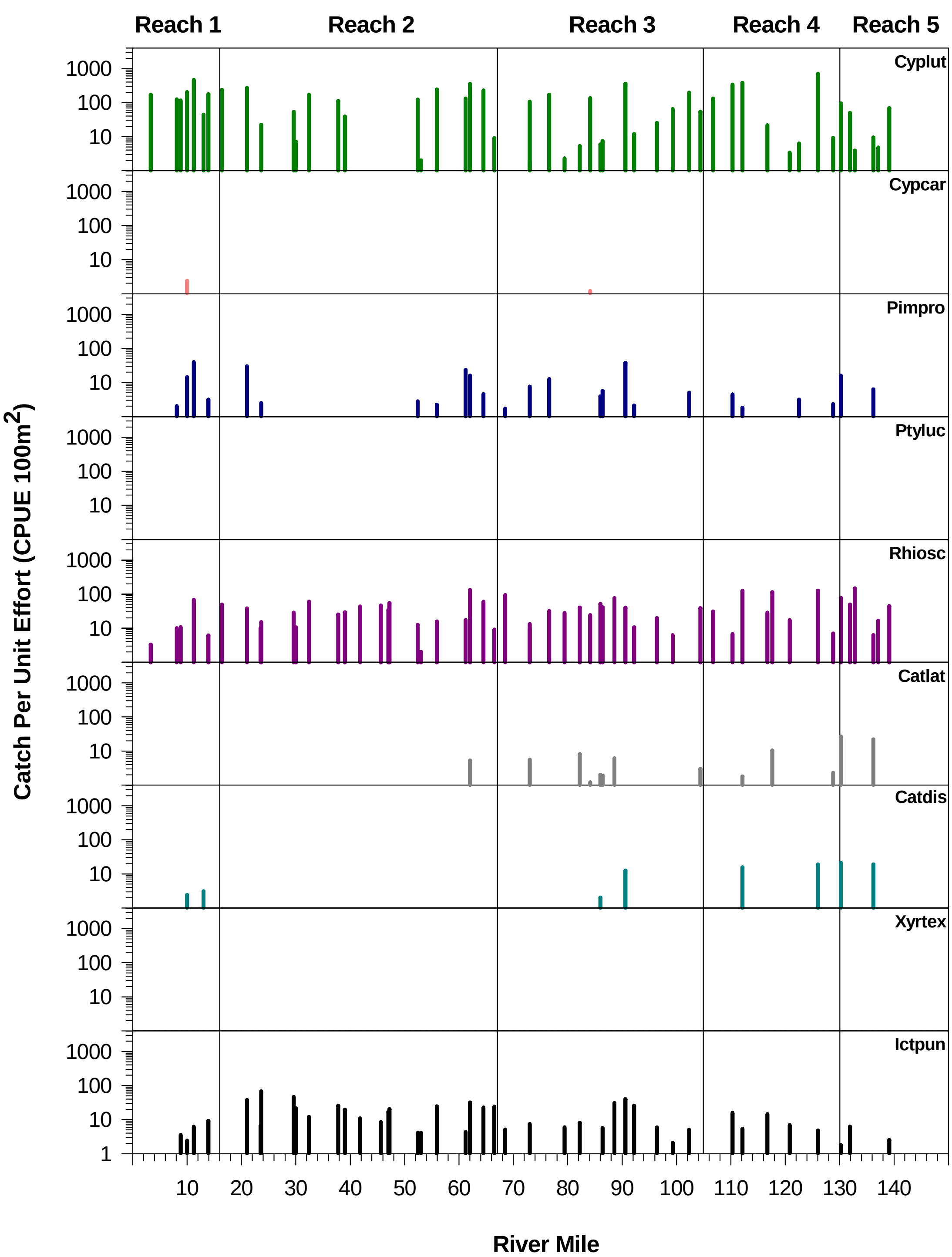


Figure 23. Catch per unit effort /100 m^2 of age-0 fish by sampling locality, Trip 5 (6 - 10 August 2007).

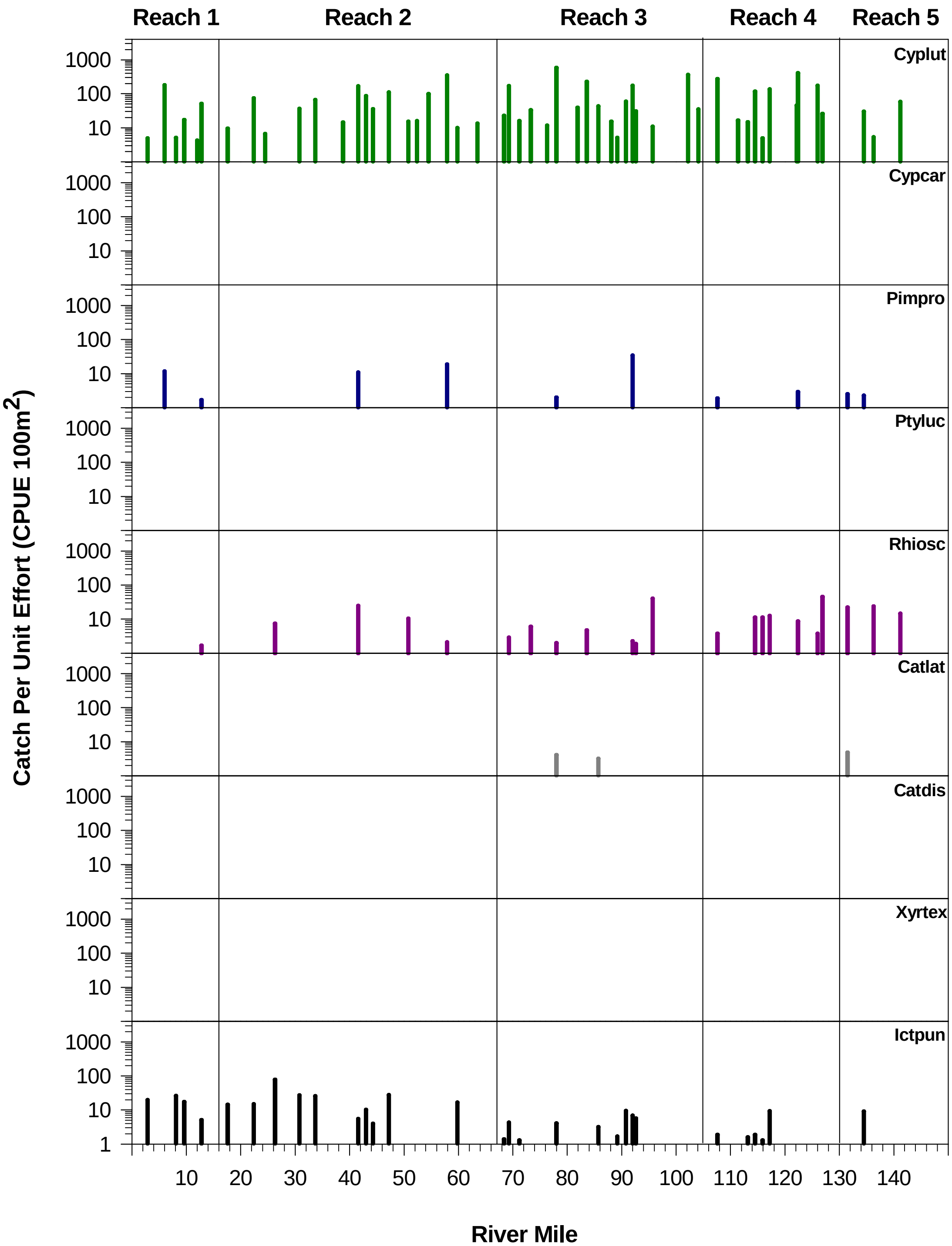


Figure 24. Catch per unit effort /100 m^2 of age-0 fish by sampling locality, Trip 6 (4 - 9 September 2007).

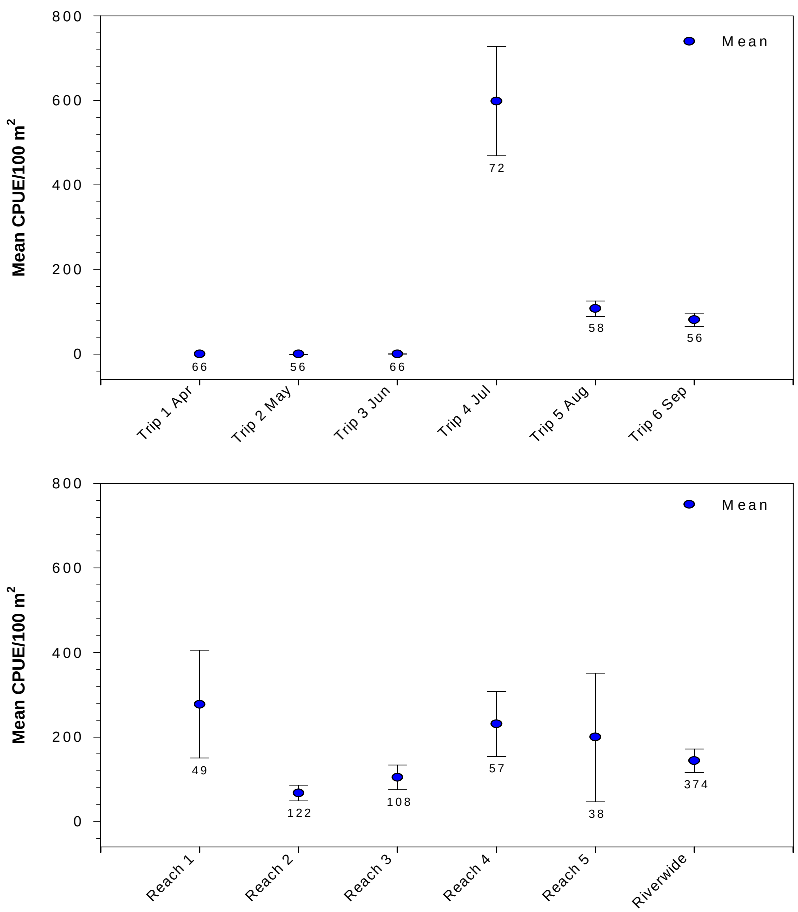


Figure 25. Mean CPUE / 100 m^2 (+1 SE) for age-0 red shiner by trip, reach, and riverwide during the 2007 survey. Sample size reported below SE bars.

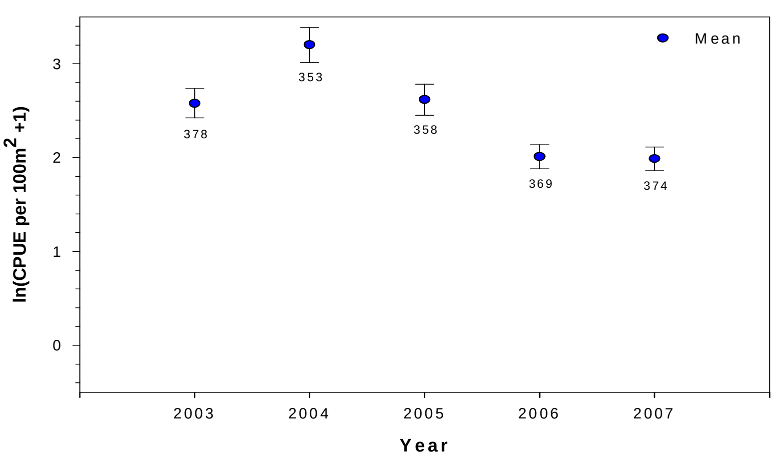


Figure 26. ln(CPUE per 100m^2 +1) [+1 SE] for age-0 red shiner by year (2003-2007). Sample size reported below SE bars.

was also significantly lower than 2004, 2005, and 2007. Catch rates for common carp were lowest during 2003 and 2006.

Fathead minnow. The first age-0 fathead minnow was collected during trip 2; fathead minnow were subsequently collected in each of the next four sampling trips. Temporally, mean CPUE for fathead minnow peaked during trips 3 and 4 at 11.5 and 11.9 fish per $100m^2$, respectively (Figure 29). The CPUE for reach 5 was greater than the other four reaches (1-4) combined (23.3 fish per $100m^2$). Backwater habitats contained the greatest densities of fathead minnow at 10.9 fish per $100m^2$. Fathead minnow CPUE was lower in 2007 than in any of the four previous years ($F=23.81$ $p<0.0001$) [Figure 30].

Channel catfish. A total of 1,416 age-0 channel catfish were collected in 2007 making channel catfish the second most abundant non-native species. The first age-0 channel catfish was collected during trip 4; the highest mean CPUE (54.6 fish per $100m^2$) also occured in trip 4 (Figure 31). Age-0 channel catfish were collected in both trips 5 and 6. Riverwide mean CPUE was the greatest in reach 2 (21.0 fish per $100m^2$) [Figure 31]. Channel catfish were found in every habitat type sampled with the exception of eddies. Slackwater contained the highest densities of channel catfish followed closely by edge pools (28.6 and 22.1 fish per $100m^2$ respectively). The CPUE for 2007 was significantly greater ($F=24.94$ $p<0.0001$) than in 2003-2006 (Figure 32).

Larval Temporal Distribution 2003 - 2007

Flannelmouth sucker were the first larval fish collected during the 2007 larval survey followed by the other two catostomid species (bluehead sucker and razorback sucker). Collection of larval catostomids occurred prior to the ascending limb of spring run-off (Figure 33). Larval flannelmouth sucker were collected through early August while collection of larval razorback sucker and bluehead sucker ceased on 16 June and 9 July, respectively. Larval collections of cyprinids occurred during late May on the descending limb of the spring hydrograph and were collected until nearly the end of the 2007 survey, with the exception of Colorado pikeminnow which were only collected between 25-27 July 2007.

The only other year which mimicked the spawning patterns of catostomids and cyprinids observed during 2007 was 2005. During this high flow year, larval flannelmouth sucker were collected beginning in mid-April in McElmo Creek. It was not until 14 May 2005 that the other two species of sucker were collected. Catostomids were all first collected on the ascending limb of spring run-off. Similar to 2007, red shiner, fathead minnow and speckled dace were first documented in early June on the descending limb of spring run-off. No larval Colorado pikeminnow were collected in 2005. Mean temperature during the period of the first larval collections of catostomids during 2005 and 2007 were 12.9°C and 13°C. Mean temperature during the collection of the first cyprinids in 2005 and 2007 were 14.4°C and 14.3°C.

In all years (2003-2007), flannelmouth sucker were the first larval specimens documented in the San Juan River (Figure 33). Mean temperature between 2003 and 2007 at time of the first capture of larval flannelmouth sucker was 12.4°C. Larval flannelmouth sucker were collected into July in all years except 2003, which was marked by low spring discharge and warmer water temperatures. During 2003, the last larval flannelmouth sucker were collected on 15 June 2003. Between 2003 and 2005 the duration of occurrence of larval bluehead sucker extended beyond the two other sucker species. The shortest duration of the occurrence of larval bluehead sucker was the year 2007. The longest duration of larval bluehead sucker collections was in 2005. This year also had the greatest peak and duration of flow

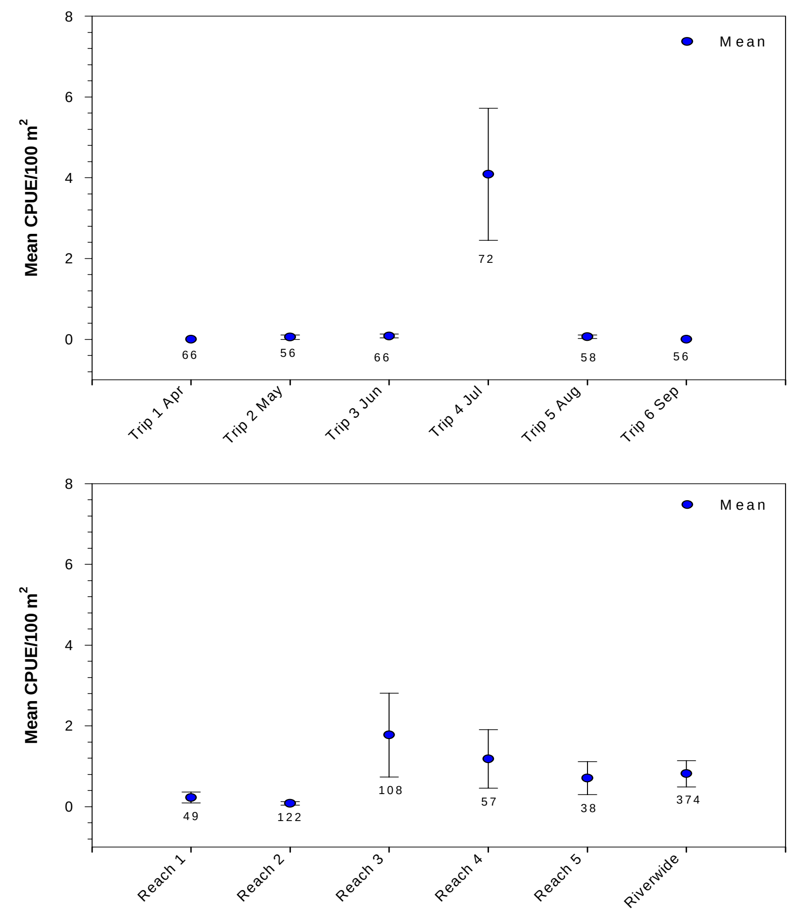


Figure 27. Mean CPUE / 100 m^2 (+1 SE) for age-0 common carp by trip, reach, and riverwide during the 2007 survey. Sample size reported below SE bars.

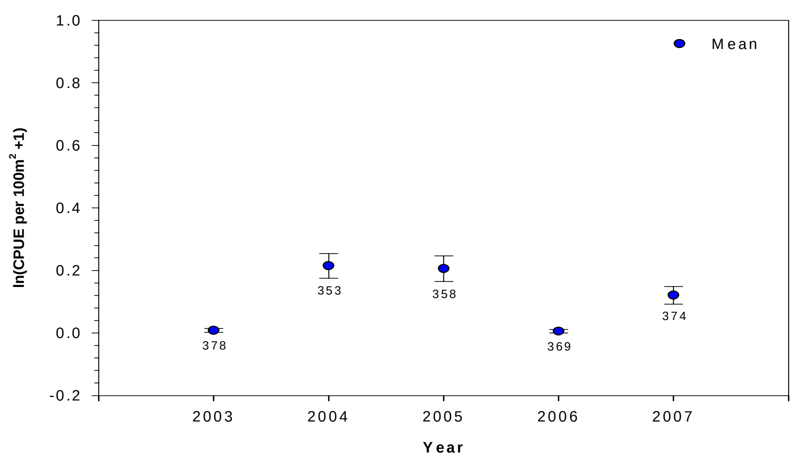


Figure 28. ln(CPUE per 100m^2 +1) [+1 SE] for age-0 common carp by year (2003-2007). Sample size reported below SE bars.

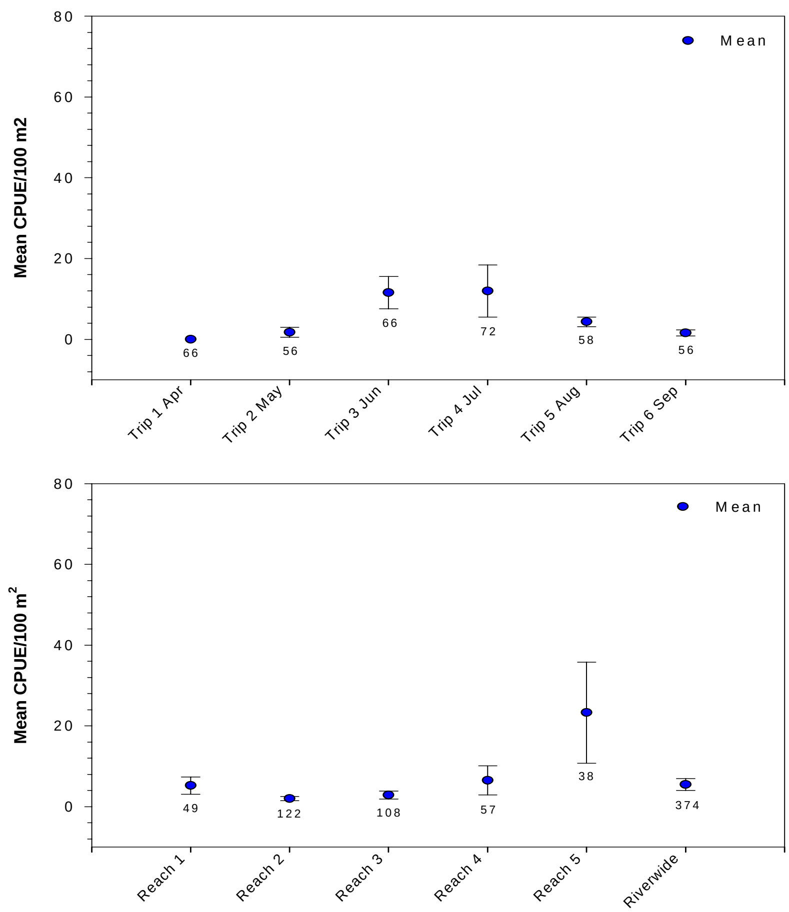


Figure 29. Mean CPUE / 100 m^2 (+1 SE) for age-0 fathead minnow by trip, reach, and riverwide during the 2007 survey. Sample size reported below SE bars.

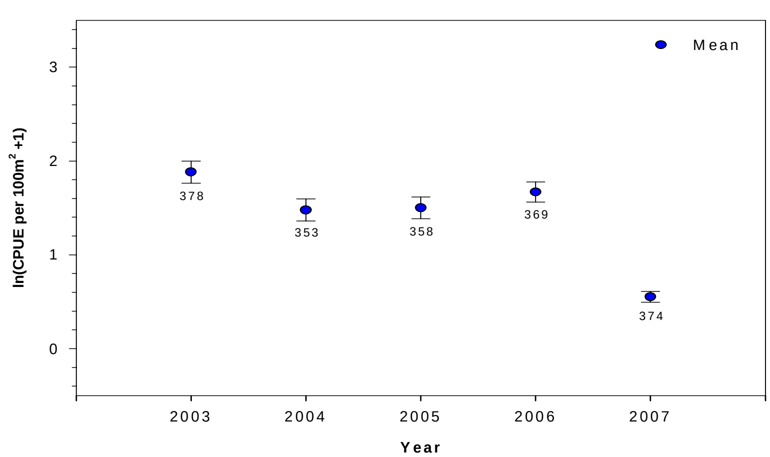


Figure 30. ln(CPUE per 100m^2 +1) [+1 SE] for age-0 fathead minnow by year (2003-2007). Sample size reported below SE bars.

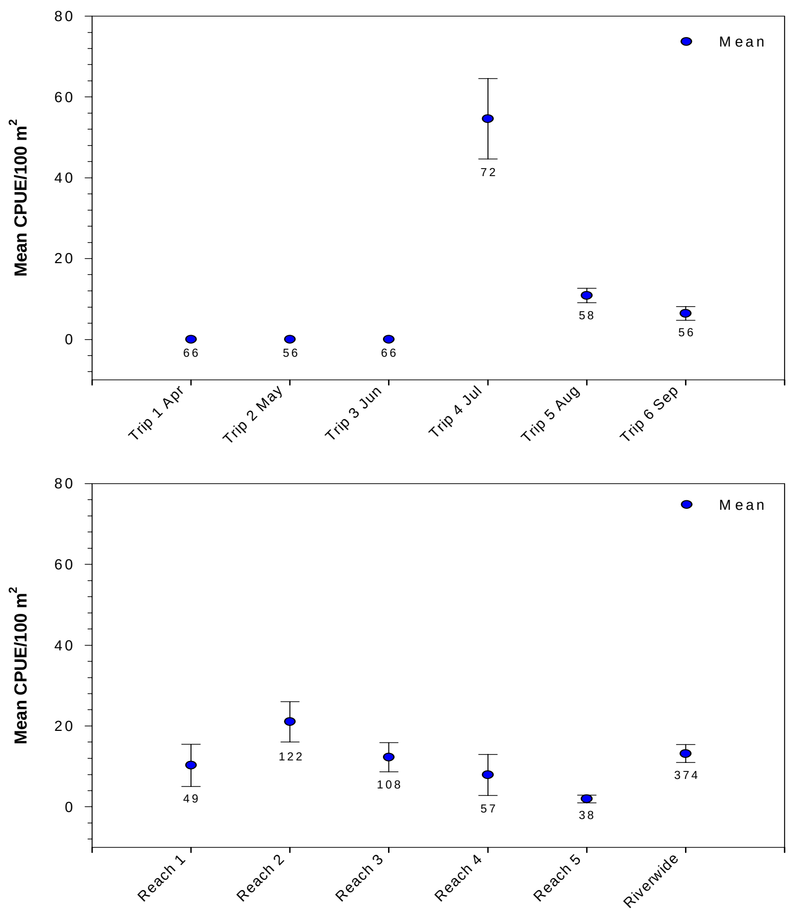


Figure 31. Mean CPUE / 100 m^2 (±1 SE) for age-0 channel catfish by trip, reach, and riverwide during the 2007 survey. Sample size reported below SE bars.

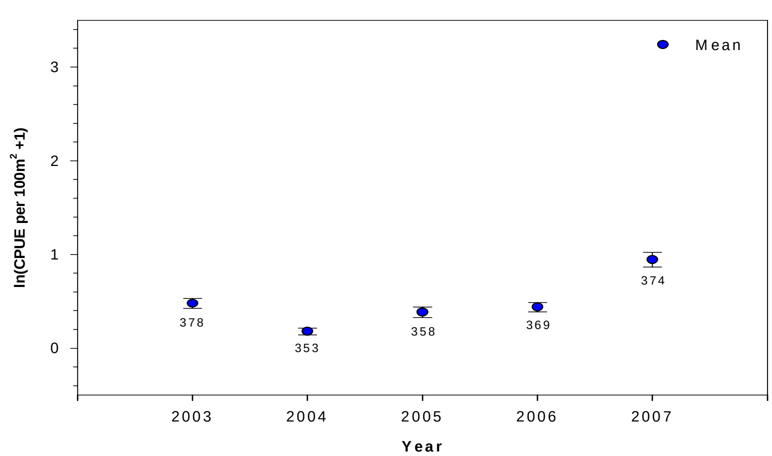


Figure 32. ln(CPUE per 100m^2 +1) [±1 SE] for age-0 channel catfish by year (2003-2007). Sample size reported below SE bars.

between the five years. The first documentation of larval razorback suckers varies from year to year between late April to mid-May. Razorback sucker larvae were documented earliest in the years 2006 and 2007.

Larval cyprinids, except for Colorado pikeminnow, are documented well into the summer season and in some years are documented through the end of the study period. Similar to what was seen with larval bluehead sucker in 2005, larval cyprinids also had their most prolonged occurrence in the San Juan River during this year. Mean discharge and temperature during the first collections of larval speckled dace between 2003-2007 was 3,184 cfs, and 15.5^{o}C. The shortest duration of larval speckled dace occurred in 2003.

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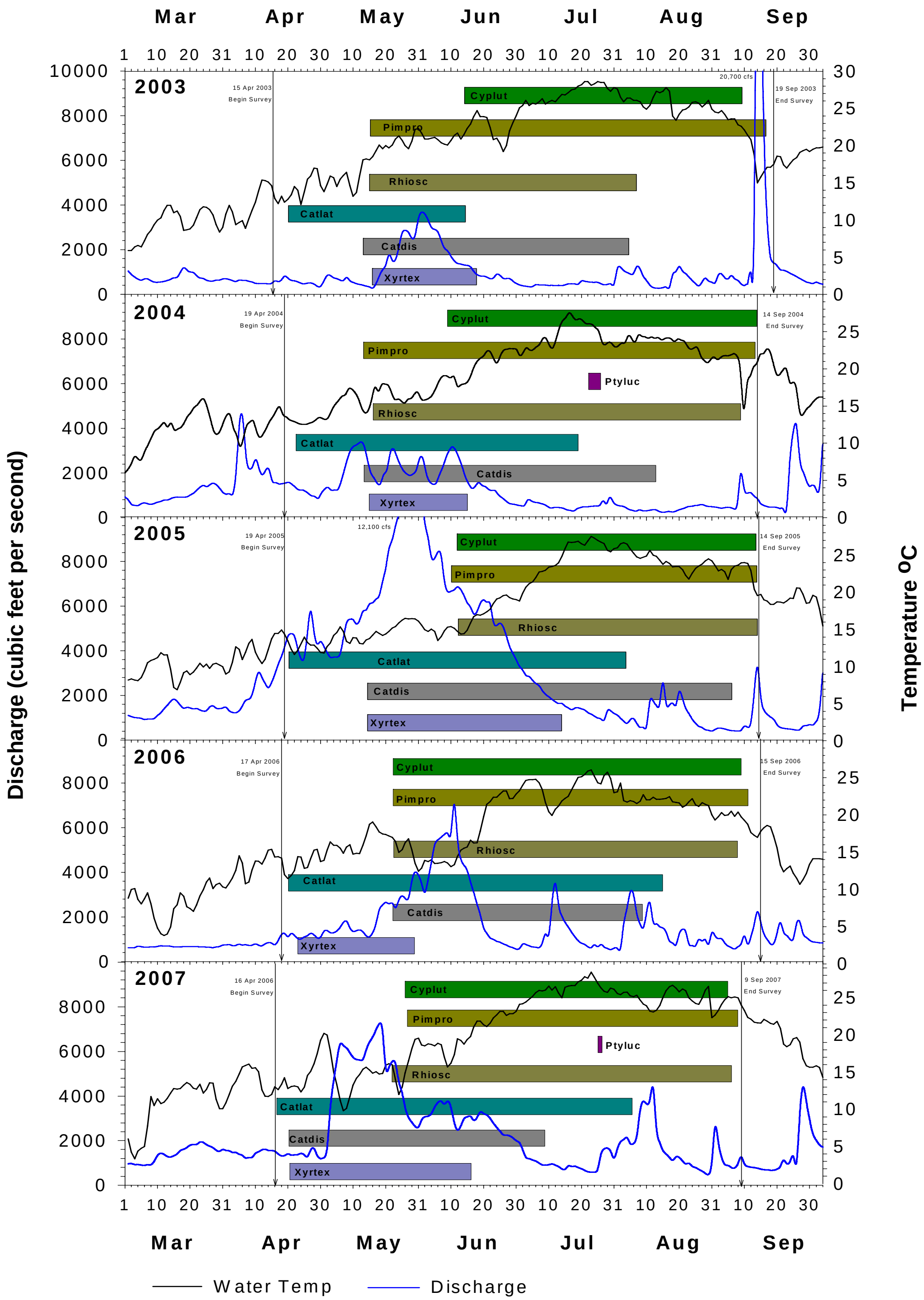

Figure 33. Occurrence of larval fishes in the San Juan River from 2003 - 2007 plotted against discharge (Bluff, UT USGS gauge #9379500) and temperature (Mexican Hat, UT). Colored bars represent the period between date of first and last collection of larvae for each species.

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Appendix I. Summary of age-0 fishes collected in the San Juan River during the 2007 larval fish survey.

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	CPUE[2]	FREQUENCY OF OCCURRENCE[3]	% FREQUENCY OF OCCURRENCE[3]
CARPS AND MINNOWS						
red shiner	I	16,800	34.3	125.0	174	46.5
common carp	I	137	0.3	1.0	23	6.1
roundtail chub	N	-	-	-	-	-
fathead minnow	I	873	1.8	6.5	88	23.5
Colorado pikeminnow	N	3	*	*	3	0.8
speckled dace	N	5,598	11.3	59.5	179	47.9
SUCKERS						
flannelmouth sucker	N	16,539	33.3	123.1	196	52.4
bluehead sucker	N	7,996	16.1	59.5	124	33.2
razorback sucker	N	200	0.4	1.5	30	8.0
BULLHEAD CATFISHES						
black bullhead	I	17	*	0.1	8	2.1
vellow bullhead	I	1	*	*	1	0.3
channel catfish	I	1,416	2.9	10.5	125	33.4
KILLIFISHES						
plains killifish	I	5	*	*	5	1.3
LIVEBEARERS						
western mosquitofish	I	60	0.1	0.4	12	3.2
SUNFISHES						
green sunfish	I	3	*	*	1	0.3
bluegill	I	-	-	-	-	-
largemouth bass	I	71	0.1	0.5	34	9.1
TOTAL		49,720		370.1		

[1] N = native; I = introduced
[2] CPUE = catch per unit effort; value based on catch per 100 m^2 (surface area) sampled
[3] Frequency and % frequency of occurrence are based on n=374 samples.

* Value is less than 0.05

Table I-4. Summary of age-0 fishes collected during the 2007 San Juan River larval Colorado pikeminnow and razorback sucker survey. (16 April - 9 September, 2007). Effort =13,436.0m^2

Appendix I. Summary of age-0 fishes collected in the San Juan River during th 2007 larval fish survey.

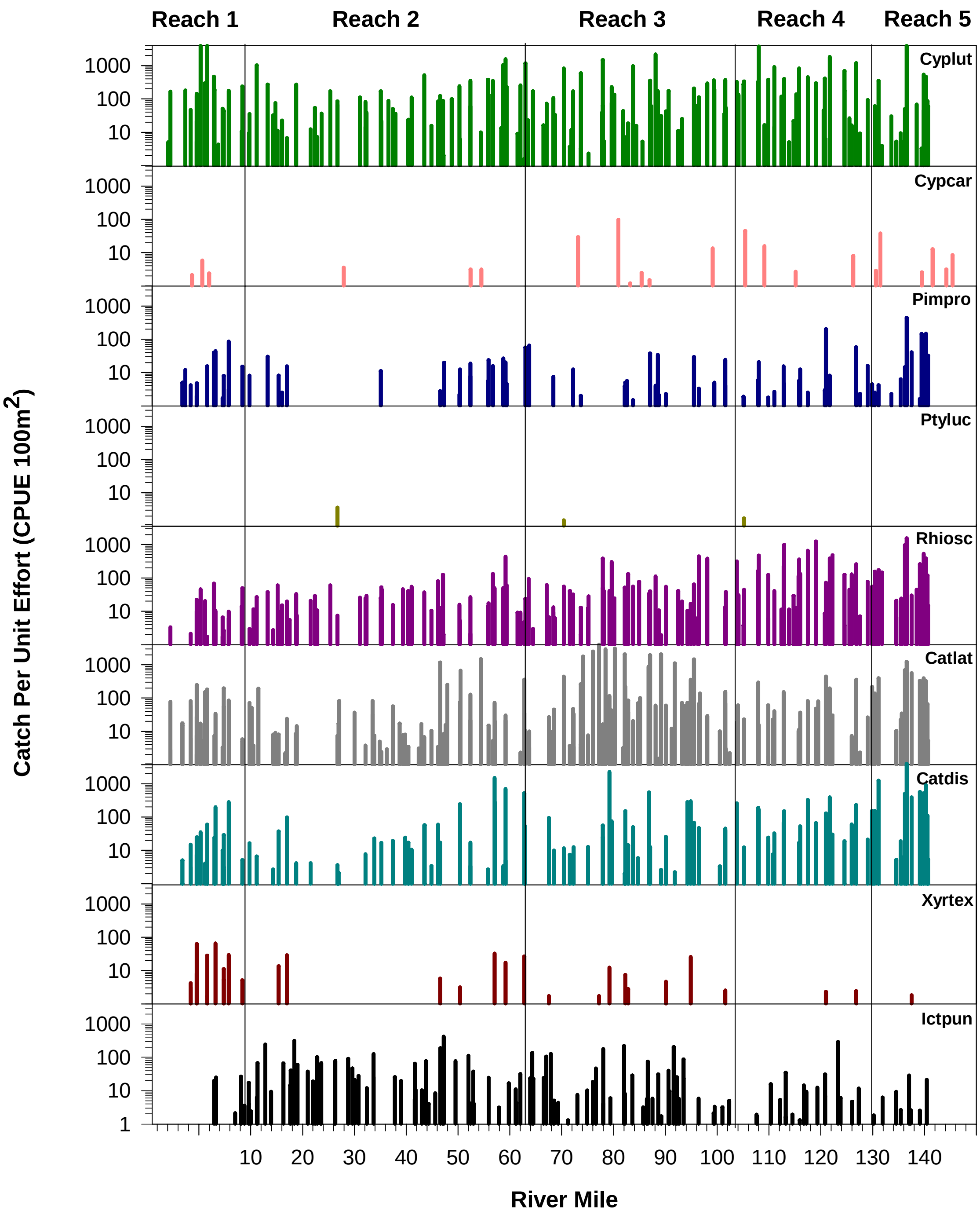

Figure I-34. Catch per unit effort /100m² of age-0 fish by sampling locality, riverwide (16 April - 9 September 2007).

Appendix I. Summary of age-0 fishes collected in the San Juan River during th 2007 larval fish survey.

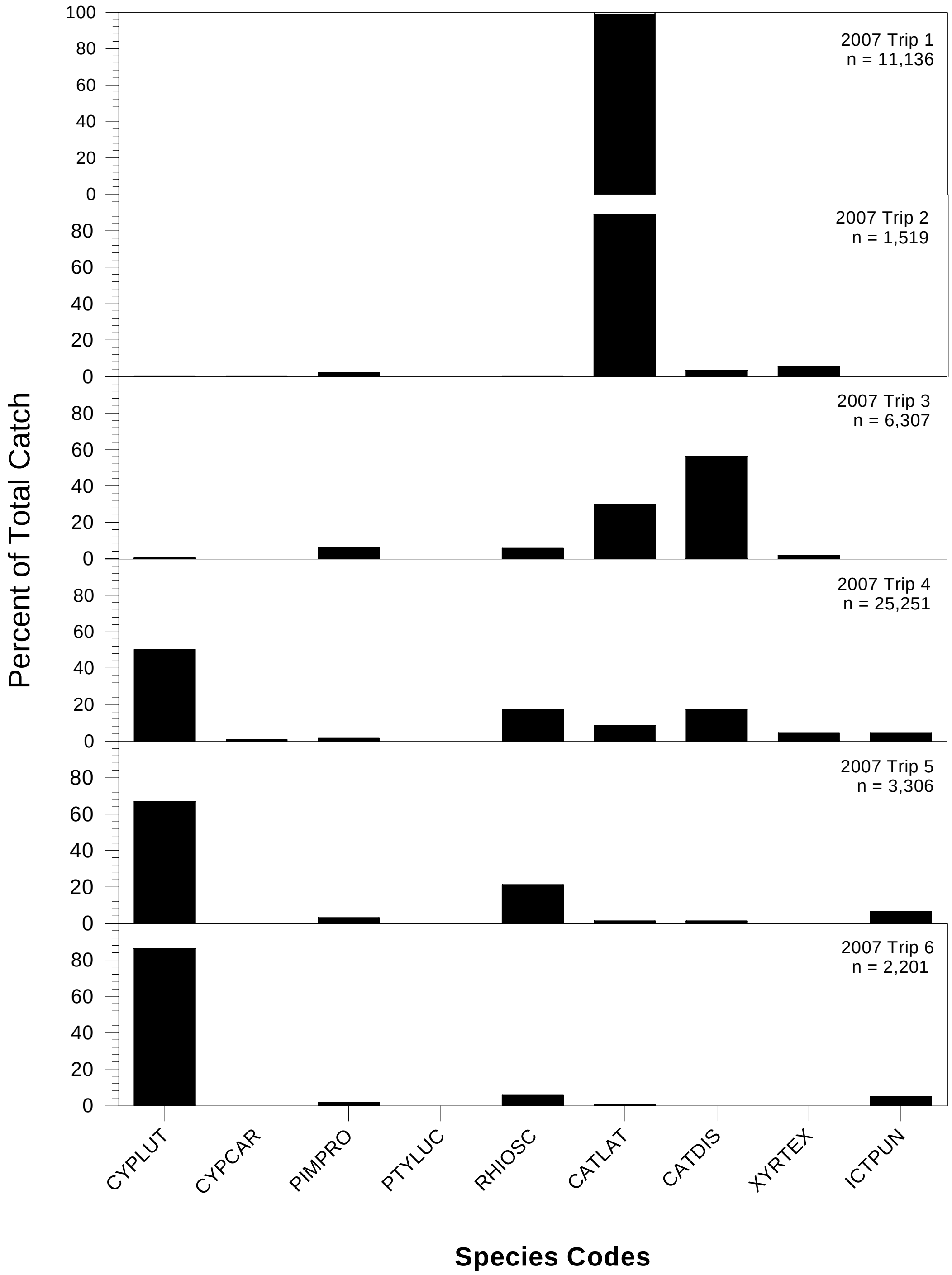

Figure I-35. Age-0 ichthyofaunal composition of native and the most abundant non-native species from the 2007 sampling efforts by trip.

Appendix I. Summary of age-0 fishes collected in the San Juan River during th 2007 larval fish survey.

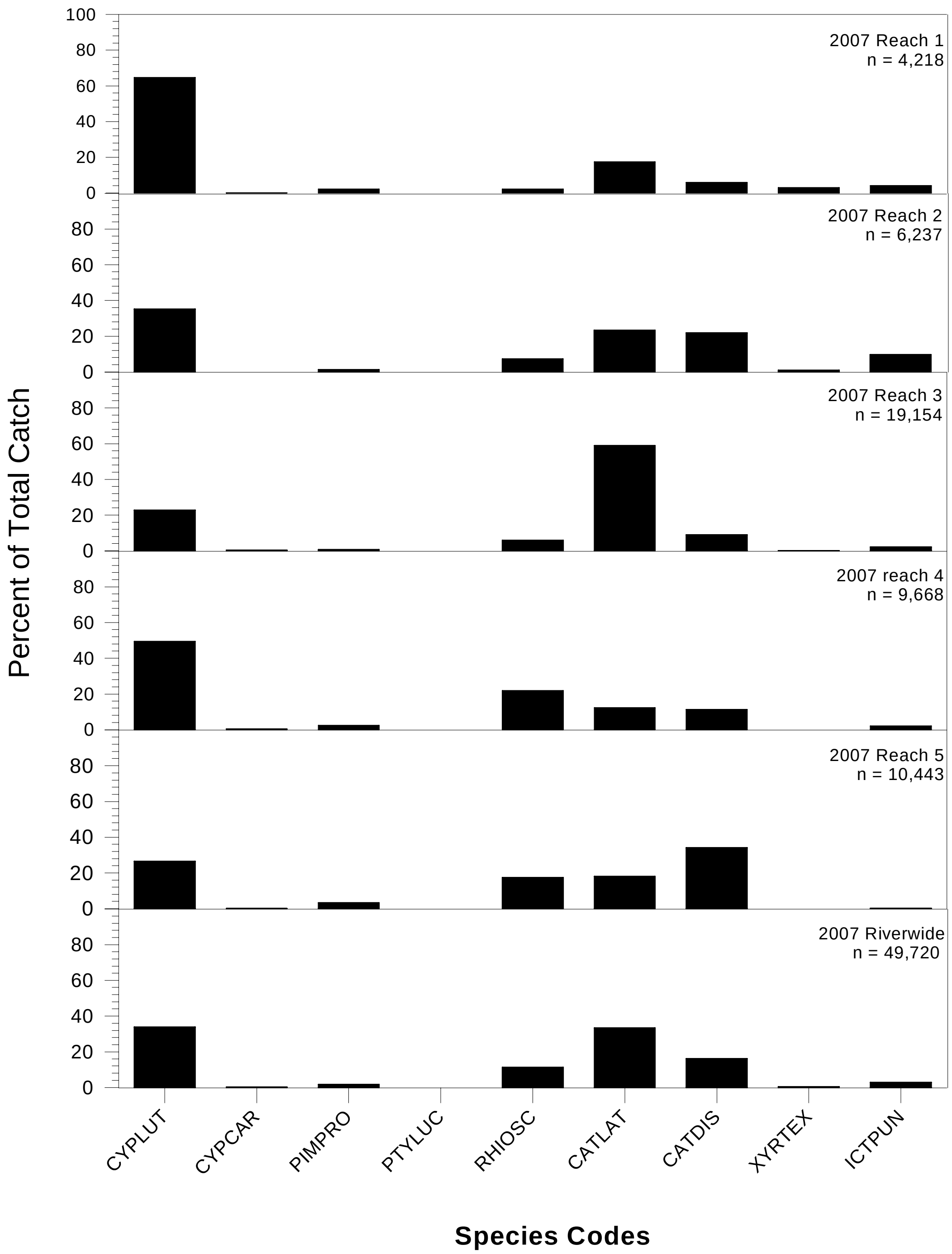

Figure I-36. Age-0 ichthyofaunal composition of native and the most abundant non-native species from the 2007 sampling efforts by reach and riverwide.

Appendix II. Summary of age-1+ fishes collected in San Juan River during the 2007 larval fish survey.

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	CPUE[2]	FREQUENCY OF OCCURRENCE[3]	% FREQUENCY OF OCCURRENCE[3]
CARPS AND MINNOWS						
red shiner	I	2,599	77.4	19.3	165	44.1
common carp	I	3	0.1	*	2	0.5
roundtail chub	N	-	-	-	-	-
fathead minnow	I	336	10.0	2.5	62	16.6
Colorado pikeminnow	N	183	5.4	1.4	53	14.2
speckled dace	N	176	5.2	1.3	52	13.9
SUCKERS						
flannelmouth sucker	N	24	0.7	0.2	19	5.1
bluehead sucker	N	-	-	-	-	-
razorback sucker	N	3	0.1	*	3	0.8
BULLHEAD CATFISHES						
black bullhead	I	-	-	-	-	-
yellow bullhead	I	-	-	-	-	-
channel catfish	I	7	0.2	0.1	7	1.9
KILLIFISHES						
plains killifish	I	1	*	*	1	0.3
LIVEBEARERS						
western mosquitofish	I	17	0.5	0.1	10	2.7
SUNFISHES						
green sunfish	I	1	*	*	1	0.3
bluegill	I	-	-	-	-	-
largemouth bass	I	9	0.3	0.1	5	1.3
TOTAL		3,359		25.0		

[1] N = native; I = introduced
[2] CPUE = catch per unit effort; value based on catch per 100 m^2 (surface area) sampled
[3] Frequency and % frequency of occurrence are based on n=374 samples.

* Value is less than 0.05

Table II-5. Summary of age-1+ fishes collected during the 2007 San Juan River larval Colorado pikeminnow and razorback sucker survey. (16 April - 9 September, 2007). Effort =13,436.0m^2

Appendix II. Summary of age-1+ fishes collected in San Juan River during the 2007 larval fish survey.

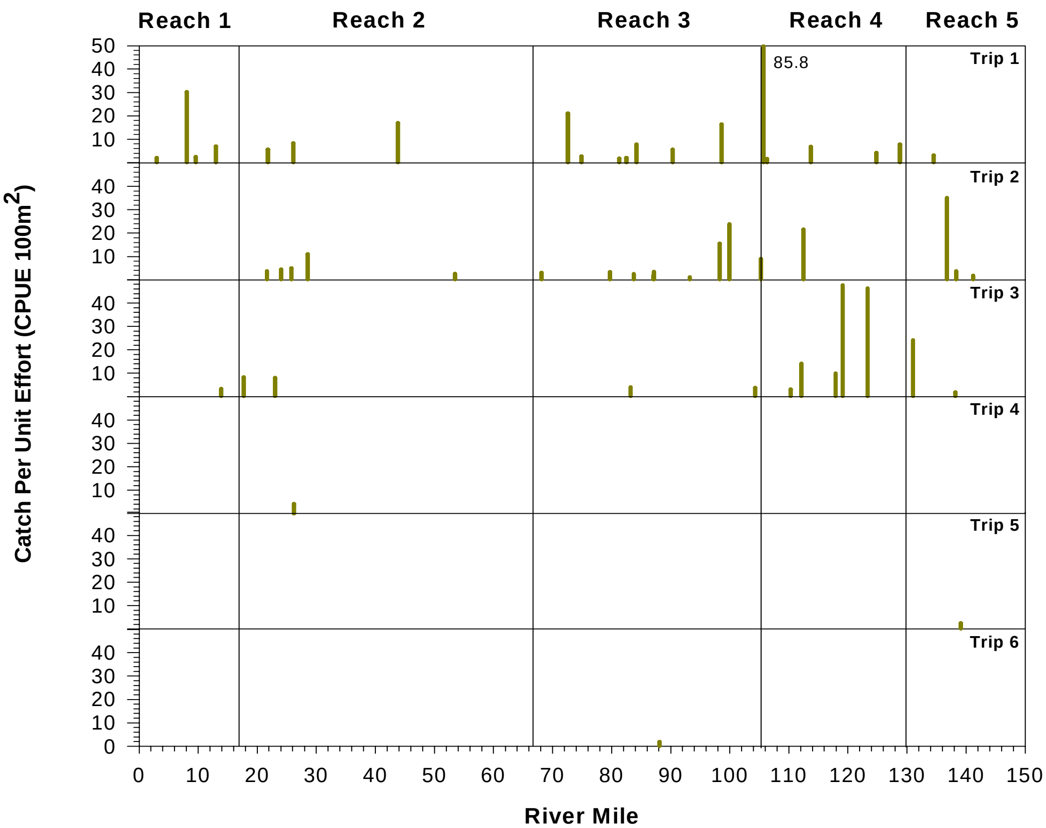

Figure II-37. Catch per unit effort /100m2 of age-1+ Colorado pikeminnow (N= 181) by sampling locality during the 2007 larval fish survey.

Table II-6. Summary of age-1+ razorback sucker collected in the San Juan River during the 2007 larval fish survey.

FIELD NUMBER	DATE	RIVER MILE	REACH	N=	LENGTH MM SL	CPUE
WHB07-062	13 Jun 2007	13.9	1	1	221	3.3
WHB07-105	7 Aug 2007	29.6	2	1	192	3.6
WHB07-131	6 Sep 2007	12.8	1	1	182	1.7
WHB07-039	21 May 2007	13.0	1	3	155 - 243	found dead

Scans found no pit tags on age 1+ razorback sucker.

Appendix III. Summary of endangered larval fishes collected in the San Juan River during the 2007 larval fish survey.

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
MAF07-030		1	12.1	protolarva	19-Apr-07	81.3	larval fish seine
WHB07-025		2	9.9, 11.8	proto - mesolarvae	19-May-07	52.4	larval fish seine
WHB07-039		4	17.3- 19.8	mesolarvae	21-May-07	13	larval fish seine
WHB07-040		17	10.4- 13.9	proto - mesolarvae	21-May-07	10	larval fish seine
WHB07-042		56	11.2- 24.8	meso - metalarvae	21-May-07	8.1	larval fish seine
WHB07-043		1	13.2	mesolarvae	21-May-07	7	larval fish seine
MAF07-076		1	11.3	protolarva	26-May-07	56	larval fish seine
MAF07-080		1	12	mesolarvae	12-Jun-07	138.2	larval fish seine
MAF07-085		1	10.5	protolarvae	13-Jun-07	128.1	larval fish seine
MAF07-087		2	9.2- 10.6	protolarvae	13-Jun-07	122.6	larval fish seine
WHB07-058		13	9.5- 12.4	proto-mesolarvae	13-Jun-07	24.5	larval fish seine
WHB07-059		5	10.1- 11.4	proto-mesolarvae	13-Jun-07	23	larval fish seine
WHB07-061		1	11.8	mesolarva	13-Jun-07	16.4	larval fish seine
WHB07-062		9	10.2 27.5	proto-mesolarvae	13-Jun-07	13.9	larval fish seine
WHB07-063		2	10.3, 29.6	proto- metalarvae	13-Jun-07	13	larval fish seine
WHB07-065		1	10.4	protolarva	14-Jun-07	10	larval fish seine
WHB07-067		10	10.3 31.9	protolarvae - juvenile	14-Jun-07	8.1	larval fish seine
WHB07-068		2	10.3, 15.1	proto- mesolarvae	14-Jun-07	7	larval fish seine
MAF07-096		2	11.4 12.6	mesolarvae	14-Jun-07	104.3	larval fish seine
MAF07-098		3	8.8 10.6	protolarvae	14-Jun-07	98	larval fish seine
WHB07-064		19	10.1 19.5	proto- mesolarvae	14-Jun-07	11.5	larval fish seine
MAF07-101		1	10.3	protolarva	15-Jun-07	93.5	larval fish seine
MAF07-104		1	10	protolarva	15-Jun-07	86.6	larval fish seine
MAF07-105		3	10.1 11.5	proto-mesolarvae	15-Jun-07	86.1	larval fish seine
MAF07-106		6	9.6 11.7	proto-mesolarvae	15-Jun-07	83.2	larval fish seine
MAF07-110		1	11.6	protolarva	16-Jun-07	72.2	larval fish seine
MAF07-112		17	10.3 12.1	proto-mesolarvae	16-Jun-07	67.7	larval fish seine
MAF07-113		4	10.6 11.4	protolarvae	16-Jun-07	64.3	larval fish seine
MAF07-115		13	10.0 11.8	proto-mesolarvae	16-Jun-07	62.3	larval fish seine
MAF07-147		1	23.2	metalarva	26-Jul-07	93.5	larval fish seine
TOTAL		**200**					
TOTAL 1998-2007		**1,935**					

Table III-7. Summary of the larval razorback sucker collected in the San Juan River during the 2007 larval fish survey.

Appendix III. Summary of endangered larval fishes collected in the San Juan River during the 2007 larval fish survey.

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
MAF04-046	53090	1	14.2	metalarva	22 July 2004	46.3	larval seine
MAF04-059	53130	1	17.0	metalarva	24 July 2004	17.0	larval seine
2004	**TOTAL**	**2**					
MAF07-139	NA	1	14.9	metalarva	25 July 2007	107.7	larval seine
MAF07-157	NA	1	17.5	metalarva	27 July 2007	74.9	larval seine
WHB07-078	NA	1	15.6	metalarva	25 July 2007	33.7	larval seine
2007	**TOTAL**	**3**					
TOTAL		**5**					

Table III-8. Summary of larval Colorado pikeminnow collected in the San Juan River during the 2004 and 2007 larval fish survey.

Appendix IV. Detailed sampling and fish identification protocol.

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1. Determination and access to sampling sites

    a. Suitable habitats for larval fish, including areas of low velocity (pools, backwaters, and secondary channels) were identified by field personnel while floating the river.
    b. Access to the habitats was gained via 16' inflatable raft.
    c. River Mile was determined to tenth of a mile using the standardized map set 2003 aerial photos produced for the San Juan River Basin Recovery Implementation Program.
    d. Geographic coordinates were determined at each site with a Garmin Navigation Geographic Positioning System (GPS) Instrument and were recorded in Universal Transverse Mercator (UTM) Zone 12 NAD27 CONUS. In instances where coordinates could not be obtained due to poor GPS satellite signal, coordinates were determined in the lab using a Geographic Information System based on the recorded river mile.

2. Collection of larval fish samples via seine and associated data recorded

    a. Small-mesh seines (1m x 1m x 0.8 mm) were drawn through the sampling site.
    b. The number of seine hauls per site was recorded along with the length of each seine haul. This information was used to calculate effort (area sampled) using the equation:
    c. Ecological data about each site were recorded, including meso-habitat type, length of habitat area, maximum depth, and substrate. A secchi disk was used to determine water clarity. Figure 16 illustrates data recorded at seining sites in the field.

4. Retention, identification, and permanent deposition of specimens

    a. Retained specimens at each site were placed in WhirlPak bags containing a solution of 10% formalin and a tag inscribed with a unique alpha-numeric code that was also recorded on the field data sheet.
    b. Samples were returned to the Division of Fishes, Museum of Southwestern Biology (MSB), University of New Mexico. The specimens were removed from the field bags, debris and silt was removed and they were transferred to glass museum jars containing a solution of 5% buffered formalin. Specimens from each site were sorted and identified to species, then the species series were enumerated, and measured for minimum and maximum size (mm SL) of that sample.
    c. Specimens were identified to species by MSB personnel with expertise in San Juan River Basin larval fish identification. Identifications were made using a polarized, underlit stereo microscope. Specimens whose species-specific identity was questionable were forwarded to Darrel E. Snyder (Larval Fish Laboratory, Colorado State University) for review.
    d. Specimens identified as razorback sucker were further examined for determination of developmental stage and minimum and maximum size (mm TL).
    e. All collections were transferred through a series of 35%, 50%, and ultimately 70% ethanol, catalogued, labeled, and placed on shelves in the in the collection archives of the MSB.

Appendix IV. Detailed sampling and fish identification protocol (continued).

Field No.: WHB07-097

Date: 7 Aug / 2007 Sample: .... Acc. No.: 2007-VII:25

State/Country: Utah / USA Locality: San Juan River RM 45.6

County: San Juan Co. Drainage: San Juan Quad.: The Goosenecks

Coordinate System: Nad 27 (N)S: 4114976 (E)W: 597062 Zone: 12 S

Shore Description: sand bank, limestone boulders, grasses & salt cedar Air Temp.: 26 °C

Water Description: ~~the~~ shore line pool

Substrate: sand Water Depth: .11 m

Aquatic Vegetation/Cover: none / none

Water Temp.: 23.0 °C Velocity (est.): .1 - .2 m/s m/s Width (est.): 2 m

Secchi Depth: Ø cm D.O.: 5.85 mg/l Conductivity: (T) 735 / 765 µS Salinity: 0.4 ppt pH: 7.92

Method of Capture: larval seine / 1m x 1m

No. Hauls: 4 Area: 24.2 m² Shocking Sec.: .... Volts: .... Amps: ....

Distance from Shore (est.): .... m Depth of Capture: .02 - .27 m

Collected by: WHBrandenburg & ALFitzgerald

Time: (start) 0858 h (stop) 0859 h Notes taken by: WHBrandenburg

Orig. Preservative: 10 % formalin Photographs: 0145

Released fishes: Yes / (No) (list separately):

The river levels rose noticeably over night. The river is still quite turbid and there is a fair amount of large debris floating past. A TV floated by while sipping morning coffee. This site must have been recently created by the higher flows. It consists of a shallow shoreline pool on river left with a small sand bar separating it from the main channel. We primarily collected juvenile Rhinichthys osculus. No larval fish were observed. This was not ideal larval habitat in appearance. Haul lengths were 3.5, 6.6, 7.4 & 6.7m. weather is clear and warm this morning.

Figure IV-38. Field sheet used to record seine collection data at a sampling site during the Colorado pikeminnow survey in the San Juan River 2007.