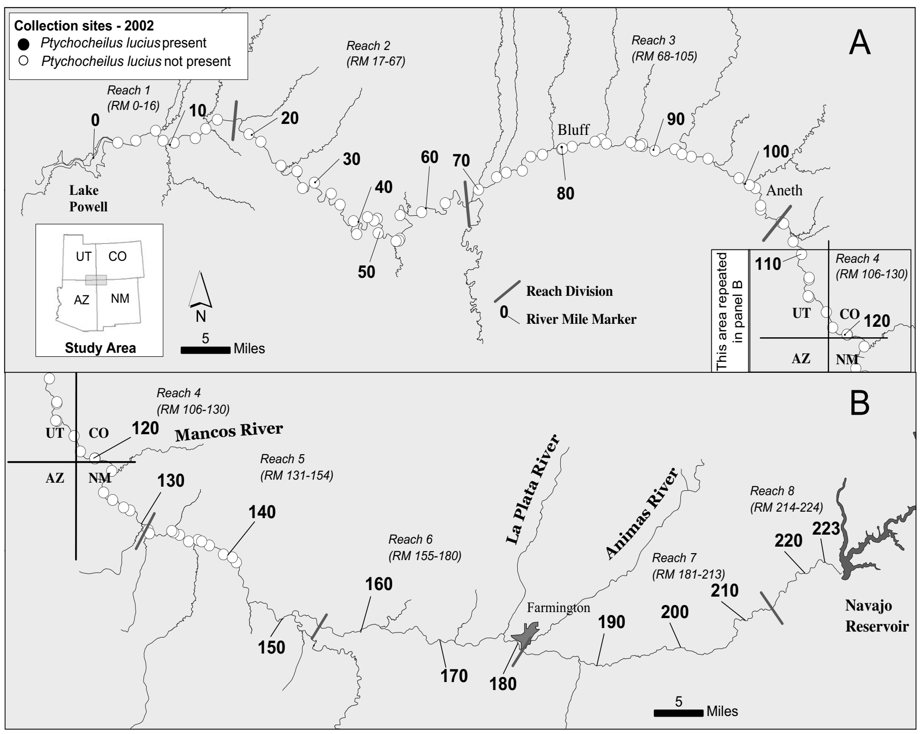
Colorado pikeminnow larval fish survey in the San Juan River during 2002

FINAL REPORT



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SAN JUAN RIVER BASIN RECOVERY IMPLEMENTATION PROGRAM

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submitted to:

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

16 December 2003

Table of Contents

List of Tables

List of Figures

Executive Summary

1. In 2002 a new sampling protocol consisting of light-traps and seining with fine mesh larval seines was used in place of stationary drift-nets.

2. There were 85 fish collections at 82 unique sites made between river miles 141.6 and 2.8 under the 2002 Colorado pikeminnow larval fish study.

3. The 2002 sampling effort yielded over four times as many fish (n=90,518) than had been taken collectively by passive drift-nets in the ten year period between 1991 and 2000 (n=20,901).

4. The 85 samples resulted in the collection of fish representing six families and 13 species, with all except two samples producing fish.

5. Introduced cyprinids accounted for 98.7% (n=89,324) of the 2002 catch by number. Red shiner was the numerically dominant (n=77,897) and most frequently encountered species, occurring in 82 of the 83 samples that produced fish.

6. Native species accounted for <0.5% (n=452) of the 2002 catch by number. Speckled dace was the numerically dominant (n=237) and most frequently encountered native species, occurring in 45 of the 83 samples that produced fish.

7. Catostomids accounted for <0.25% of the 2002 catch by number. Bluehead sucker was the numerically dominant catostomid taxon, accounting for 77.7% of all catostomids collected in 2002. Flannelmouth sucker and razorback sucker accounted for 21.4% and 0.9% of all catostomids respectively.

8. Four light-trap samples were taken in 2002, producing 130 specimens. Red shiner accounted for 99.2% (n=129) of all specimens collected by light-traps. One fathead minnow was also collected by light-trap in 2002.

9. Larval Colorado pikeminnow were not collected in 2002.

Introduction

Background Information

Colorado pikeminnow, *Ptychocheilus lucius*, is a federally endangered species (U.S. Department of the Interior, 1974) endemic to the Colorado River Basin where it was once abundant and widespread (Tyus, 1991). This species now occupies only about 20% of its historic range (Tyus, 1990). The Green River sub-basin apparently supports the majority of remaining Upper Basin individuals (Holden and Wick, 1982; Bestgen et al., 1998). Conversely, no Colorado pikeminnow have been reported in the Lower Basin since the 1960s (Minckley and Deacon, 1968; Minckley, 1973; Moyle, 1976).

A small but self-sustaining population of this species occurs in the lower-most 225 river km (between the former Cudei Diversion Dam and the inlet of Lake Powell Reservoir) of the San Juan River. The decline of this and other native fishes in the San Juan River has been attributed to flow modifications and the resultant changes to the thermal regime, instream barriers, and introduced species' predation-competition for habitat and resources. Understanding the conditions necessary for spawning in Colorado pikeminnow and other native fishes was deemed necessary to stabilize and increase the population size of this species.

Much has been reported regarding the life-history and reproductive behavior of Colorado pikeminnow (Vanicek and Kramer, 1969). Studies in the Upper Colorado River Basin (Yampa and Green rivers) have demonstrated that this species spawns as spring runoff is receding and at water temperatures between 18°C and 20°C (Haynes et al., 1984; Nesler et al., 1988). Larval Colorado pikeminnow employ drift as a dispersal mechanism and are presumed to begin this passive movement approximately five days after hatching. The five-day time-frame corresponded with the swim-up period of this fish as reported by Hamman (1981, 1986).

This life-history phase (drifting larvae), the focus of several investigations in the Upper Colorado River Basin, has been studied to provide information on spawning bar location, reproductive success, and the effects of various flow-regimes on reproduction. The collection of a juvenile (177 mm TL) Colorado pikeminnow in 1978 (Minckley and Carothers, 1979) and rediscovery of a reproducing population of Colorado pikeminnow in the San Juan River in 1987 (Meyer and Moretti, 1988; Platania and Bestgen, 1988; Platania et al., 1991) demonstrated a need for studies to ascertain information such as that obtained for this species in the Upper Colorado River Basin. Such studies would also provide comparable information on other members of the ichthyofaunal community.

In 1991, passive drift-netting for larval and young-of-year (YOY) fish was initiated in the San Juan River. The primary objectives of the passive drift-netting study were to 1) determine the temporal distribution of San Juan River ichthyoplankton in relation to the hydrograph, 2) provide comparative analysis of the reproductive success of San Juan River fishes, 3) attempt to characterize downstream movement of ichthyoplankton, and 4) attempt to validate the presumed spawning period of Colorado pikeminnow.

Passive drift-netting on the San Juan River at Mexican Hat was conducted by the Utah Division of Wildlife Resources (UDWR) during 1991-1994, samples at Four Corners were taken by New Mexico Department of Game and Fish (NMGF) during 1991-1994, and both sites were sampled by personnel at the Museum of Southwestern Biology, Division of Fishes at the University of New Mexico (UNM) during 1995-2001. Results from the 1991-1997 portion of the drift-net study were presented in a report by Platania et al. (2000) and will not be discussed in this report.

Between 1991-1999, only 18,763 specimens and five Colorado pikeminnow were collected in the passive sampling effort. In 2000 a different passive sampling device, the Moore Egg Collector (Altenbach et al., 2000), was used, with similar results to drift-nets (2,138 specimens were collected). The Moore Egg Collector (MEC) was employed in an attempt to reduce the volume of vegetative drift material being collected in sample sets. During summer spates it was not unusual for drift nets to fill with debris within five minutes of a two-hour set thereby generating more drift material in one abbreviated set than had been collected during the prior two weeks of collecting. Processing of massive amounts of drift material collected during such spates had consistently demonstrated that there were very fish associated with those large samples of drift. While the MEC eliminated this problem during periods of moderate increases in flow, this new collecting device was not capable of efficiently separating larval fish and vegative debris during the larger flow spikes common during the summer in the San Juan River.

In 1998, research personnel from the MSB initiated a project designed to determine if the augmented population of razorback sucker had spawned in the San Juan River. Intensive sampling wth larval fish seines was conducted for about eight weeks during the late spring in an effort to collect larval razorback sucker. Those investigations proved successful during the first year with two larval razorback sucker being taken among over 13,000 specimens. An important component of that investigation (larval razorback sucker project) was the recognition that the dearth of both adult and larval Colorado pikeminnow in the San Juan River necessitated a change in sampling protocol so that biologically meaningful statements could be rendered regarding the annual reproductive effort of Colorado pikeminnow. A discussion of these issues occurred at an early 2001 San Juan River Basin Biology Committee meeting at which time the committee agreed to the modification of the annual larval Colorado pikeminnow monitoring workplan. After a decade of passive sampling, these methods (with the exception of occasional use of light-traps) were discontinued in 2002 in favor of active sampling with larval seines. In 2002, over four times as many specimens were collected (n=90,518) than in the previous ten years combined. The new sampling protocol will be continued in 2003.

Study Area

The San Juan River is a major tributary of the Colorado River and drains 99,200 km^2 in Colorado, New Mexico, Utah, and Arizona (Figure 1). From its origins in the San Juan Mountains of southwestern Colorado at elevations exceeding 4,250 m, the river flows westward for about 570 km before confluencing with the Colorado River. The major perennial tributaries to the San Juan River are (from upstream to downstream) Navajo, Piedra, Los Pinos, Animas, La Plata, and 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.

Navajo Reservoir, completed in 1963, impounds and isolates the upper 124 km of the San Juan River and regulates downstream discharge. The completion of Glen Canyon Dam in 1966 and subsequent filling of Lake Powell ultimately inundated the lower 87 km of the San Juan River by the early 1980s. The San Juan River is now a 359 km lotic system bounded by two reservoirs (Navajo Reservoir near its head and Lake Powell at its mouth).

The San Juan River is canyon-bound and restricted to a single channel between its confluence with Chinle Creek (ca. 20 km downstream of Bluff, Utah) and Lake Powell. The river is predominately multi-channeled upstream of Chinle Creek with the highest density of secondary channels occurring between Bluff and the Hogback Diversion (ca. 13 km upstream of Shiprock, New Mexico). There is a general downstream decline in channel stability in the section of river between Bluff and Shiprock. Below the confluence with the Animas River near Farmington, New Mexico, the channel is less stable and more subject to floods from it largest and unregulated tributary, the Animas River. Conversely, the regulated reach of river between Farmington, New Mexico and Navajo Dam is relatively stable with few secondary channels.

From Lake Powell to Navajo Dam, the mean gradient of the San Juan River is 1.67 m/km. Examined in 30 km increments, river gradient ranges from 1.24 to 2.41 m/km but locally (i.e., <30 km reaches) can be as high as 3.5 m/km. Between Shiprock and Bluff, San Juan River substrate is primarily sand mixed among some cobble. The proportion of sand is greatest in the downstream most reaches and declines along an upstream gradient. From Farmington to Navajo Dam, the San Juan River substrate is dominated by embedded cobble. Although less embedded, cobble is also the most common substrate between Shiprock and Farmington.

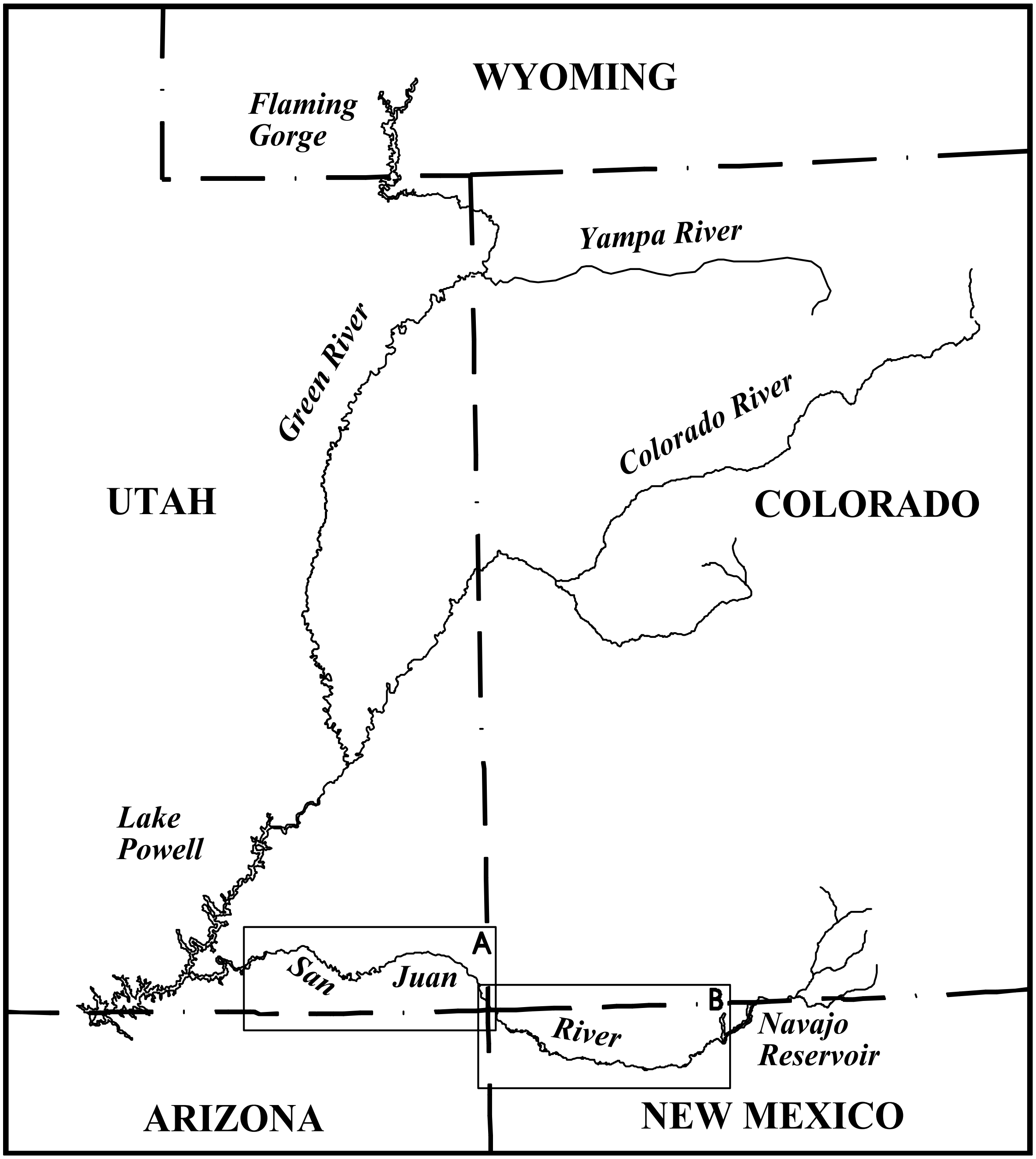

Figure 1. Location of the San Juan River within the Upper Colorado River Basin. The study area is outlined and labelled "A" and "B" with reference to subsequent maps in this report.

Except in canyon-bound reaches, the river is bordered by nonnative salt cedar, *Tamarix chinensis*, and Russian olive, *Elaeagnus angustifolia*, and native cottonwood, *Populus fremontii*, and willow, *Salix* sp. Nonnative woody plants dominated nearly all sites and resulted in heavily stabilized banks. Cottonwood and willow accounted for less than 15% 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 # 09379500; Bluff, Utah) occurred during spring runoff (1 March through 31 July). Median 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 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 hydrograph with the volume of release during spring linked to the amount of precipitation recorded during the preceding winter. Thus in years with high spring snowmelt, reservoir releases were “large” and “small” in low runoff years. Base flows since 1992 were typically greater than during pre-dam years but less than those between 1964-1991.

The primary study area for most investigations conducted under the auspices of the San Juan River Seven Year Research Program, including that reported herein, were accomplished in the mainstem San Juan River and its immediate vicinity between Navajo Dam and Lake Powell. There is considerable human activity within the floodplain of the San Juan River between Shiprock and Navajo Dam. Irrigated agriculture is practiced throughout this portion of the San Juan River Valley and adjacent uplands. Much of the river valley not devoted to agriculture (crop production and grazing) consists of small communities (e.g., Blanco and Kirtland) and several larger towns (e.g., Bloomfield and Farmington). The Animas River Valley is similarly developed. Small portions of the river valley and uplands from Shiprock to Bluff are farmed with dispersed livestock grazing as the primary land use. In the vicinity of Montezuma Creek and Aneth, petroleum extraction occurs in the floodplain and adjacent uplands. There are few human-caused modifications of the system from Bluff to Lake Powell.

A multivariate analysis of a suite of geomorphic features of the San Juan drainage was performed to segregate the river into distinct geomorphic reaches, enhance comparison between studies, and to provide a common reference for all research. This effort (Bliesner and Lamarra, 1999) resulted in the identification of eight reaches of the San Juan River between Lake Powell and Navajo Dam. A brief characterization of each reach (from downstream to upstream) follows.

Reach 1 (RM 0 to 16, Lake Powell confluence to near Slickhorn Canyon) has been greatly influenced by fluctuating reservoir levels of Lake Powell and its backwater effect. Fine sediment (sand and silt) has been deposited to a depth of about 12 m in the lowest end of this reach since the reservoir first filled in 1980. This deposition of suspended sediment into the delta-like environment of the river/reservoir transition makes it the lowest-gradient reach in the river. This portion of the river is canyon bound with an active sand bottom. Although an abundance of low-velocity habitat is present at certain flows, it is highly ephemeral, being influenced by both river flow and Lake Powell's elevation.

Reach 2 (RM 17 to 67, near Slickhorn Canyon to confluence with Chinle Creek) is also canyon bound but is upstream of the influence of Lake Powell. The gradient in this reach is greater than in either adjacent reach and the fourth highest in the system. The channel is primarily bedrock confined and influenced by debris fans at ephemeral tributary mouths. Riffle-type habitat dominates, and the only major rapids in the San Juan River occur in this reach. Backwater abundance is low in this reach, usually occurring in association with debris fans.

Reach 3 (RM 68 to 105, Chinle Creek to Aneth, Utah) is characterized by higher sinuosity and lower gradient (second lowest) than the other reaches, a broad floodplain, multiple channels, high island count, and high percentage of sand substrate. While this reach has the second greatest density of backwater habitats after peak spring runoff, it is extremely vulnerable to change during summer and autumn storm events. After these storm events, this reach may have the second lowest density of backwaters of the eight reaches. The active channel distributes debris piles throughout the reach following spring runoff, leading to the nickname "Debris Field".

Reach 4 (RM 107 to 130, Aneth, Utah, to below "the Mixer") is a transitional zone between the upper cobble substrate-dominated reaches and the lower sand substrate-dominated reaches. Sinuosity is moderate compared with other reaches, as is gradient. Island area is higher than in Reach 3 but lower than in Reach 5, and the valley is narrower than in either adjacent reach. Backwater habitats are low overall in this reach (third lowest among reaches) and there is little clean cobble.

Reach 5 (RM 131 to 154, the Mixer to just below Hogback Diversion) is predominantly multi-channeled with the largest total wetted area and greatest secondary channel area of any of the reaches. Secondary channels in this section tend to be longer and more stable (but fewer) than in Reach 3. Riparian vegetation is more dense in this reach than in lower reaches but less dense than in upper reaches. Cobble and gravel are more common in channel banks than sand, and clean cobble areas are more abundant than in lower reaches. Backwaters and spawning bars in this reach are much less subject to perturbation during summer and fall storm events than are the lower reaches.

Reach 6 (RM 155 to 180, below Hogback Diversion to confluence with the Animas River) is predominantly a single channel, with 50% fewer secondary channels than Reaches 3, 4, or 5. Cobble and gravel are the dominant substrata with cobble bars containing clean interstitial spaces being most abundant in this reach. There are four diversion dams that may impede fish passage in this reach. Backwater habitat abundance is low in this reach, with only Reach 2 containing fewer of these habitats. The channel has been altered by dike construction in several areas to control lateral channel movement and over-bank flow.

Reach 7 (RM 181 to 213, Animas River confluence to between Blanco and Archuleta, New Mexico) is similar to Reach 6 in terms of channel morphology. The river channel is very stable, consisting primarily of embedded cobble substrate as a result of controlled releases from Navajo Dam. In addition, much of the river bank has been stabilized and/or diked to control lateral movement of the channel and over-bank flow. Water temperature is influenced by the hypolimnetic release from Navajo Dam and is colder during the summer and warmer in the winter than that of the river below the Animas confluence.

Reach 8 (RM 213 to 224, between Blanco and Archuleta and Navajo Dam) is the most directly influenced by Navajo Dam, which is situated at its uppermost end (RM 224). This reach is primarily a single channel, with only four to eight secondary channels, depending on the flow. Cobble is the dominant substrate type, and because lateral channel movement is less confined in this reach, some loose, clean cobble sources are available from channel banks. In the upper end of the reach, just below Navajo Dam, the channel has been heavily modified by excavation of material used in dam construction. In addition, the upper 10 km of this reach above Gobernador Canyon are essentially sediment free, resulting in the clearest water of any reach. Because of Navajo Dam, this area experiences much colder summer and warmer winter water temperatures. These cool, clear water conditions have allowed development of an

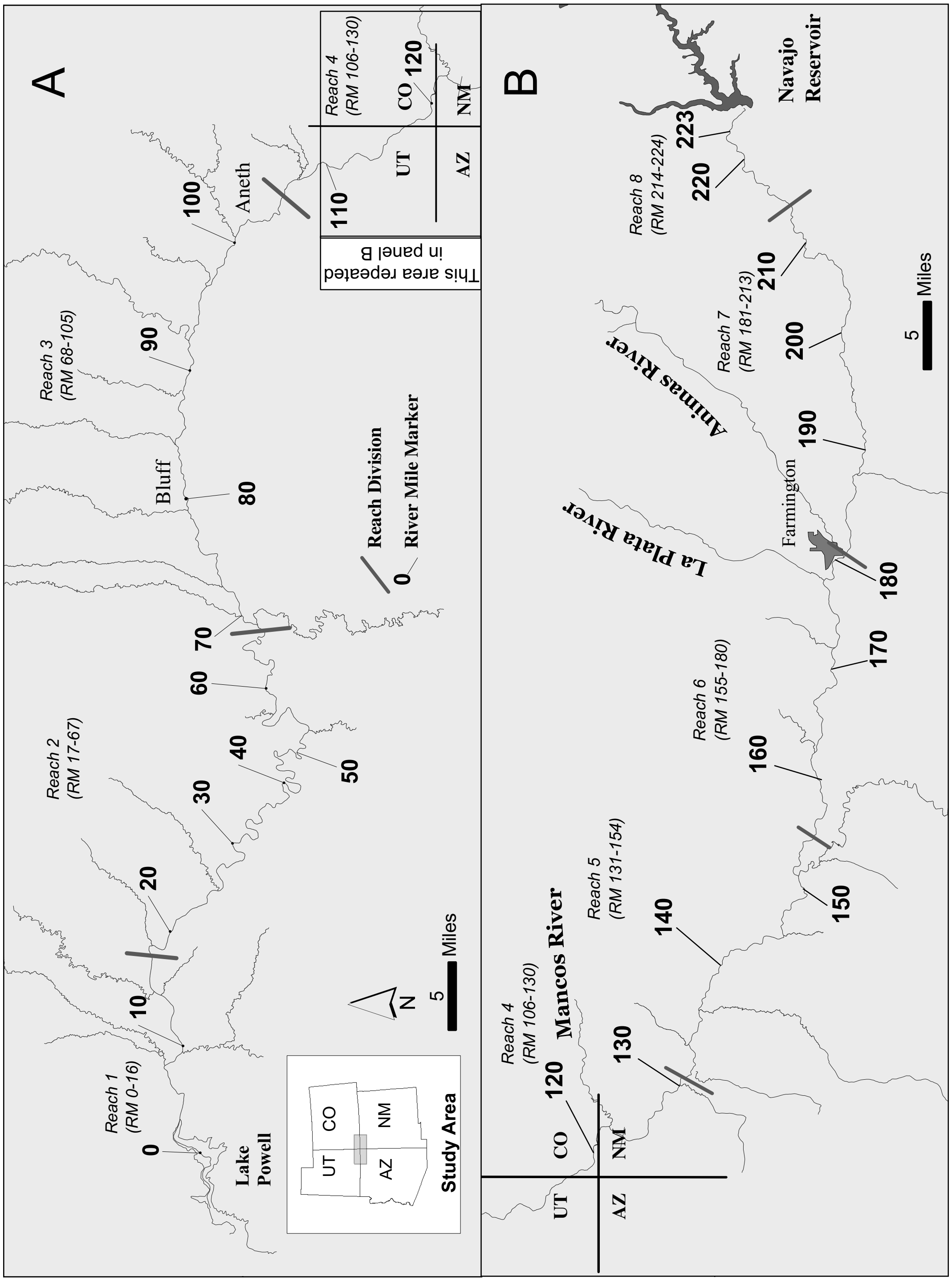

Figure 2. Map of the San Juan River study area.

intensively managed blue-ribbon trout fishery to the exclusion of native species in the uppermost portion of the reach.

The study area in 2002 encompassed reaches 1 through 5 (Figure 2). Four Colorado pikeminnow larval fish collection trips were taken between 9 July and 12 September 2002. Two of the sampling efforts were between RM 141.0 and Bluff (RM 76.4) and two were in the lower reach. For reporting purposes, the 2000 data were separated into upper and lower reaches with the former including collections between RM 141.0 and Bluff and the latter containing collections from Bluff downstream to Clay Hills Crossing (RM 2.9).

A new protocol for reporting on annual monitoring activities was agreed to by the San Juan River Basin Biology Committee and initiated beginning with 2002 reports. One component of the new reporting was that data were to be presented and analyzed along the predesignated San Juan River Reaches (delineated in Study Area). This change in reporting did not work well for the 2002 larval Colorado pikeminnow survey project as that investigation was not conducted in the same format as the other monitoring activities (i.e., small bodied fish, adult monitoring, habitat, etc). In these other well established monitoring programs, sampling of the entire river was done during a single uninterrupted effort which allowed for meaningful between reach comparisons. Conversely, the 2002 larval Colorado pikeminnow survey project did not attempt to sample the enire study area under a single, continuous sample event. Instead, the river was divided into functional reaches (upper and lower) based solely on the distance that could be sampled in five to seven days and points of access. The period between sampling events of the upper and lower reaches of the San Juan River (under this study) were often one to two weeks. This sampling protocol allowed for a more efficient sampling of the San Juan River especially given that the 2002 larval Colorado pikeminnow survey project was still functioning primarily as a "search and capture" versus "monitoring" project. Given the need to formalize the sampling protocol of this project with the other monitoring surveys, beginning in 2003, the entire larval Colorado pikeminnow survey project study area will be sampled during each individual (continuous) sampling trip.

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 the relative annual reproductive success of Colorado pikeminnow (1a).
- Provide annual summaries of monitoring results (3a).
- Provide a detailed analysis of data collected to determine progress towards endangered species recovery in three years and thence every five years (3b).
- Provide a comparative analysis of the reproductive success of San Juan River fishes.
- Attempt to validate the presumed spawning period of Colorado River pikeminnow.

Methods

Access to the river and sampling localities was gained through the use a 16' inflatable raft that transported both personnel and collecting gear. There was not a predetermined number of samples per river mile nor geomorphic reach for this study. Instead, an effort was made to collect in as many suitable larval fish habitats as possible within the river reach being sampled. Previous San Juan River investigations have clearly demonstrated that larval fish most frequently occur and are most abundant in low velocity habitats such as isolated pools, backwaters, and secondary channels.

Sampling efforts for larval fish concentrated on low velocity habitats using small mesh seines (1 m x 1 m x 0.8 mm) and light-traps. Meso-habitat type, length, maximum depth, and substrate were recorded for each sample. For seine samples, the length of each seine haul was determined in addition to

Table 1. Scientific and common names and species codes of fish collected from the San Juan River. Asterisk (*) indicates species collected in this study during previous years, but absent from 2002 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	specked 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	bullhead catfishes	
Ameiurus melas	black bullhead	(AMEMEL)
Ictalurus punctatus	channel catfish	(ICTPUN)
Order Atheriniformes		
Family Cyprinodontidae	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)
Micropterus salmoides	largemouth bass	(MICSAL)

the number of seine hauls per site. The aforementioned habitat conditions were recorded at light-trap sampling sites in addition to the time of placement and retrieval of the light-traps.

All retained specimens were placed in plastic bags 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, specimens identified to species, enumerated, measured (minimum and maximum size [mm SL] 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). Scientific and common names of fishes used in this report follow Robins et al. (1991) while six letter codes for species are those adopted by the San Juan River Basin Biology Committee (Table 1). Common names, arranged in phylogenetic order, are presented in tables in this report.

River Mile was determined to tenth of a mile using the 1988 aerial photos produced for the San Juan River Basin Recovery Implementation Program and used to designate the location of sampling sites. In addition, 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). 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.

Specimens were identified to species by MSB personnel with expertise in San Juan River Basin larval fish identification. Larval fish is a specific developmental (morphogenetic) period between the time of hatching and when larval fish transform to juvenile fish. We have chosen to follow larval fish terminology as defined by Snyder (1981). There are three distinct sequential larval developmental 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 metalarval 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. Specimens whose species-specific identity was questionable were forwarded to Darrel E. Snyder (Larval Fish Laboratory, Colorado State University) for review.

An electronic copy of the 2002 fish collection data was formatted and included in the San Juan River integrated database being developed at UNM.

This study was annually initiated in mid-summer and completed in late-summer. Daily mean discharge during the study period was acquired from U.S. Geological Survey Gauge (# 09371010) at Four Corners, Colorado (Figure 3).

Results

2002 Survey

There were over four times as many fish collected in 2002 (n=90,518) than had been taken collectively by passive drift nets in the ten year period between 1991 and 2000 (n=20,901). In 2002, Trip 1 produced over 73,000 specimens with a single site yiedling 9,200 specimens. Trips 2, 3, and 4 produced between 3,000 and 9, 000 specimens with no single site yielding >1,600 specimens. Additionally, the 28 sites sampled during Trip 1 produced 57,000 more specimens than was collectively taken at the 57 sites sampled during Trips 2, 3, and 4.

Between 9 July 2002 and 12 September 2002, a total of 85 collections was made between Cudei, New Mexico and Clay Hills, Utah (Figure 4). All except two of these collections produced fish. Fifty-two of these collections were made in the upper portion of the study area (Cudei to Bluff) which is comprised of the lower half of reach 5, all of reach 4, and the upper half of reach 3. Thirty-three

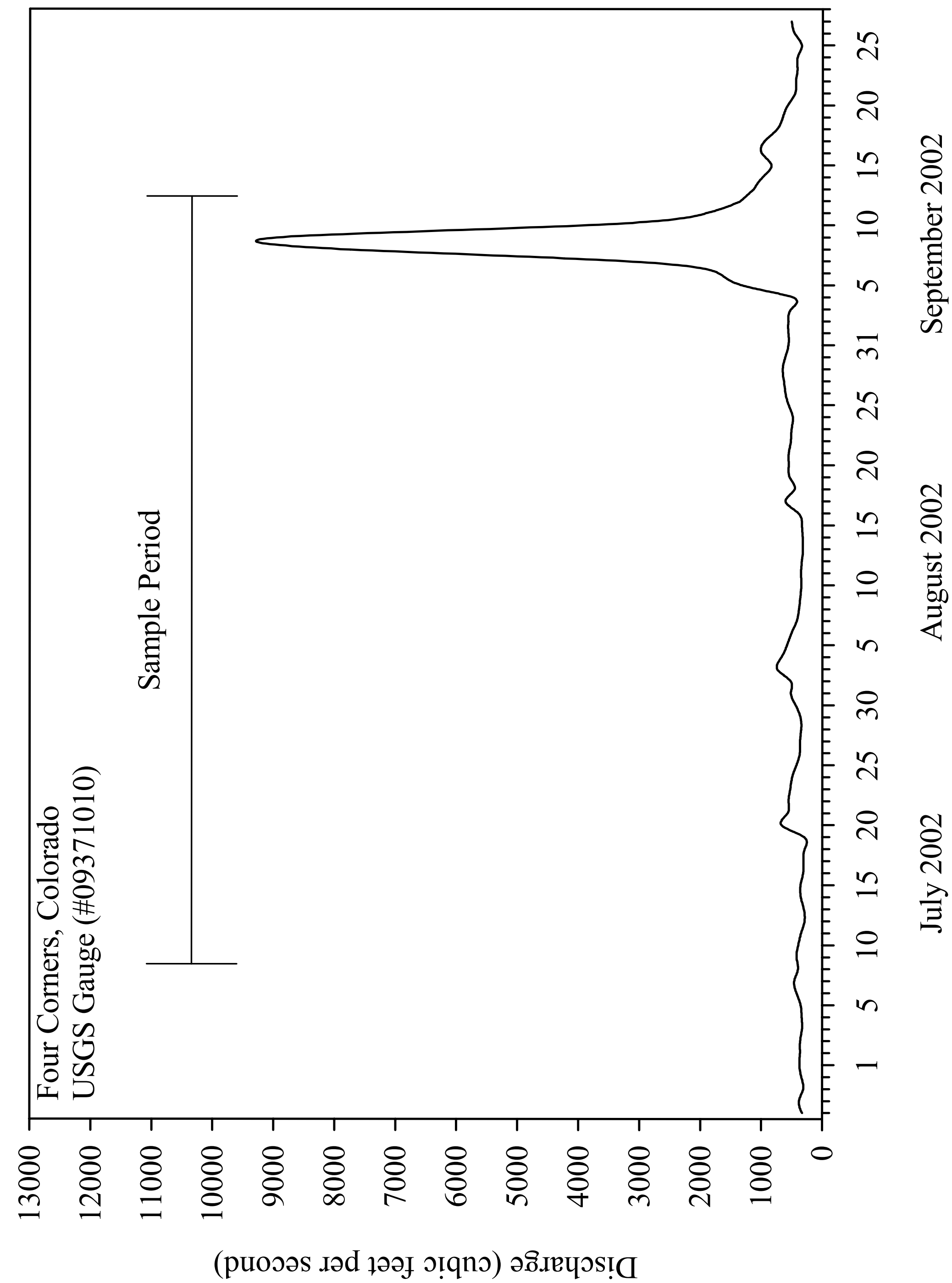

Figure 3. Hydrograph of the San Juan River at Four Corners, Colorado during the 2002 sampling period.

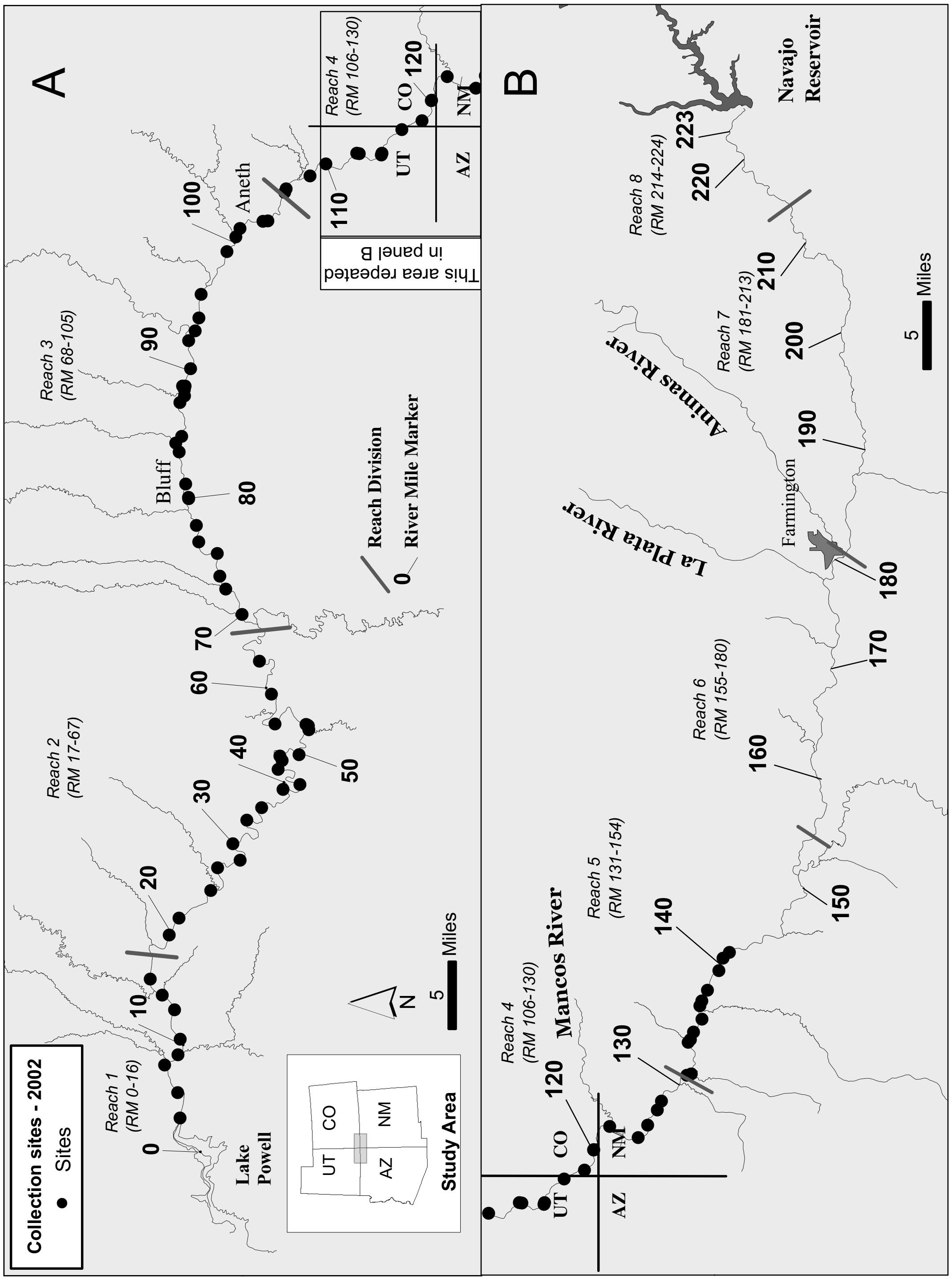

Figure 4. Map of San Juan River localities sampled during the 2002 larval Colorado pikeminnow study.

Table 2. Summary of the 2002 San Juan River larval Colorado pikeminnow project fish collections.

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	77,897	86.1	82	96.5
common carp	I	248	0.3	28	32.9
roundtail chub	N	-	-	-	-
fathead minnow	I	11,179	12.4	73	85.9
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	237	0.3	45	52.9
SUCKERS					
flannelmouth sucker	N	46	0.1	22	25.9
bluehead sucker	N	167	0.2	26	30.6
razorback sucker	N	2	*	2	2.4
BULLHEAD CATFISHES					
black bullhead	I	59	0.1	3	3.5
channel catfish	I	100	0.1	28	32.9
KILLIFISHES					
plains killifish	I	26	*	10	11.8
LIVEBEARERS					
western mosquitofish	I	547	0.6	49	57.7
SUNFISHES					
green sunfish	I	1	*	1	1.2
bluegill	I	-	-	-	-
largemouth bass	I	9	*	7	8.2
TOTAL		90,518			

1 N = native; I = introduced

2 Frequency and % frequency of occurrence are based on n=85 samples.

* Value <0.05%

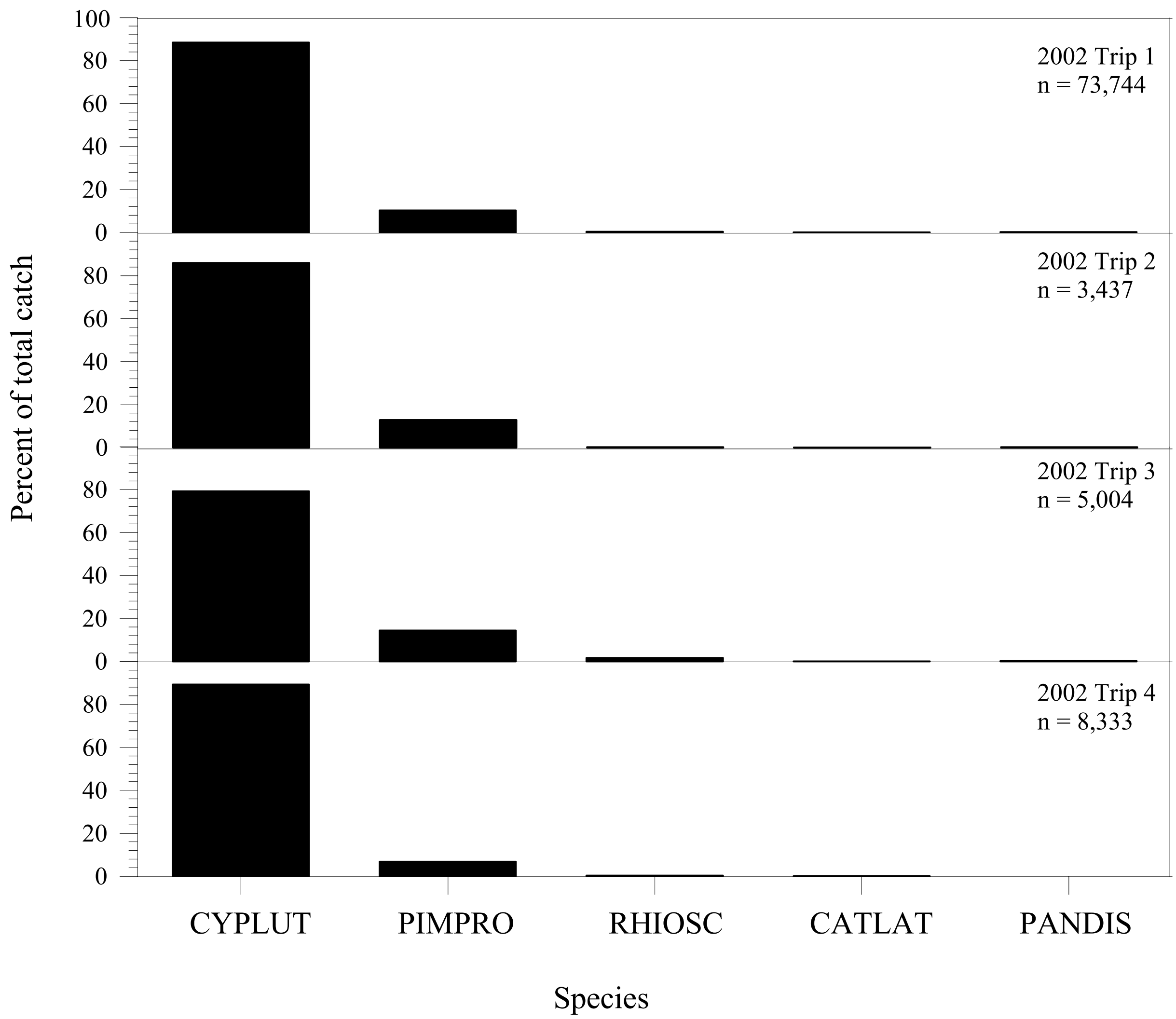

Figure 5. Ichthyofaunal composition of the most abundant species in 2002 sampling efforts by trip.

Table 3. Summary of 2002 San Juan River larval Colorado pikeminnow project light-trap collections.

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	129	99.2	3	75.0
common carp	I	-	-	-	
roundtail chub	N	-	-	-	-
fathead minnow	I	1	0.8	1	25.0
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	-	-	-	-
SUCKERS					
flannelmouth sucker	N	-	-	-	-
bluehead sucker	N	-	-	-	-
razorback sucker	N	-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
KILLIFISHES					
plains killifish	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	-	-	-	-
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		130			

[1] N = native; I = introduced

[2] Frequency and % frequency of occurrence are based on n=4 samples.

collections were made in the lower half of the study area (Bluff to Clay Hills) which included the lower half of reach 3 and all of reaches 2 and 1. The relatively small number of collections taken in the lower portion of the study area can be attributed the low flow conditions that persisted there during July and August and consequently limited access to the study area.

Red shiner, *Cyprinella lutrensis*, numerically dominated nearly every collection made in 2002 (Table 2, Figure 5) and was the species most frequently encounteredoccurring in 82 of the 83 samples that produced fish. Red shiner accounted for 86.1% of all specimens collected while the second most abundant species, fathead minnow, *Pimephales promelas*, was 12.4% of all specimens collected. Collectively, these two introduced cyprinids constituted 98.4% of the total catch for 2002. The most frequently encountered and abundant native fish collected during this study was speckled dace, *Rhinichthys osculus*. Forty-five samples contained speckled dace, however, this species constituted less than 0.3% of all specimens collected. All three of the native San Juan River catostomids were collected (bluehead sucker, *Catostomus discobolus*, flannelmouth sucker, *Catostomus latipinnis*, and razorback sucker) but even combined they constituted only about 0.2% of the 2002 larval Colorado pikeminnow total catch.

There were only four light-trap samples taken in 2002 resulting in the collection of 130 specimens (Table 3). One light-trap sample failed to produce fish and two others produced <10 fish. The majority of the specimens collected by light-traps occurred on 23 July 2002 at RM 52.5.A total of 117 fish was collected during this effort, all of which were red shiner. Of the overall 130 specimens collected by light-traps in 2002, 129 were red shiner and one was a fathead minnow.

While there was a substantial difference in the number of samples taken between the upper and lower reaches of the study area, there was little difference in the cumulative area sampled between reaches. A total area of 1,816 m^2 was sampled in the upper reach while a total area of 1,440 m^2 was sampled in the lower reach. While the area sampled for both reaches was similar, the number of specimens collected in each reach was substantially different (Tables 4, 5). The 52 samples collected in the upper reach produced 82,077 specimens (90.7% of all specimens collected) while the 33 samples collected in the lower reach produced 8,441 specimens (9.3% of all specimens collected).

The first sampling trip conducted in 2002 occurred between 9-13 July in the upper reach between Cudei and Bluff (Figure 6). This trip yielded the largest collection of specimens for any of the four sampling trips. Red shiner numerically dominated the collection (86.0% of total catch) and was present in all 28 collections made (Table 6). Native species collected during this trip include speckled dace, bluehead sucker, flannelmouth sucker, and razorback sucker. Combined, these four native species accounted for less than 1% of the total collection taken during this trip. This was the only trip that produced razorback suckers (n=2).

The second 2002 sampling trip was between Bluff and Mexican Hat and was conducted between 22-24 July (Figure 7). This trip was originally to be conducted between Bluff and Clay Hills, but low flow conditions precluded sampling below Mexican Hat. A total of ten samples was collected producing 3,437 specimens (Table 7). Over 88% of the specimens collected were red shiner (n=3,041) with all ten samples containing red shiner. Native species collected were speckled dace, flannelmouth sucker, and bluehead sucker. These three native species were collected in 7, 2, and 3 of the ten collections respectively. This trip also produced a yolked, larval channel catfish, *Ictalurus punctatus,* the first taken in 2002.

The third and final lower reach run was between Mexican Hat and Clay Hills and was conducted between 13-16 August (Figure 8). Twenty-three samples were taken yielding 5,004 specimens. Red shiner was again the numerically dominant species and was collected in 22 of 23 samples (Table 8). This is the only trip in which red shiner accounted for >85% of the total catch (79.2%). Fathead minnow was the second most abundant species collected accounting for 14.4% of the total catch (the highest recorded in 2002) and was found in 19 of the 23 samples. This trip also marked the only time in which a native species, speckled dace, was >1% of the total collection.

Table 4. Summary of the 2002 San Juan River larval Colorado pikeminnow project fish collections in the upper portion of the study area (Cudei, New Mexico to Bluff, Utah)

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	70,891	86.4	50	96.1
common carp	I	242	0.3	23	44.2
roundtail chub	N	-	-	-	-
fathead minnow	I	10,102	12.3	48	92.3
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	141	0.2	26	50.0
SUCKERS					
flannelmouth sucker	N	40	0.1	17	32.7
bluehead sucker	N	156	0.2	17	32.7
razorback sucker	N	2	*	2	3.9
BULLHEAD CATFISHES					
black bullhead	I	59	0.1	3	5.8
channel catfish	I	15	*	7	13.5
KILLIFISHES					
plains killifish	I	26	*	10	19.2
LIVEBEARERS					
western mosquitofish	I	395	0.5	30	57.7
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	8	*	5	9.6
TOTAL		82,077			

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on n=52 samples.

* Value <0.05%

Table 5. Summary of the 2002 San Juan River larval Colorado pikeminnow project fish collections in the lower portion of the study area (Bluff to Clay Hills, Utah).

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	7,006	83.0	32	97.0
common carp	I	6	0.1	5	15.2
roundtail chub	N	-	-	-	-
fathead minnow	I	1,077	12.8	25	75.8
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	96	1.1	19	57.6
SUCKERS					
flannelmouth sucker	N	6	0.1	5	15.2
bluehead sucker	N	11	0.1	9	27.3
razorback sucker	N	-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	85	1.0	21	63.6
KILLIFISHES					
plains killifish	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	152	1.8	19	57.6
SUNFISHES					
green sunfish	I	1	*	1	3.0
bluegill	I	-	-	-	-
largemouth bass	I	1	*	1	3.0
TOTAL		8,441			

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on n=33 samples.

* Value <0.05%

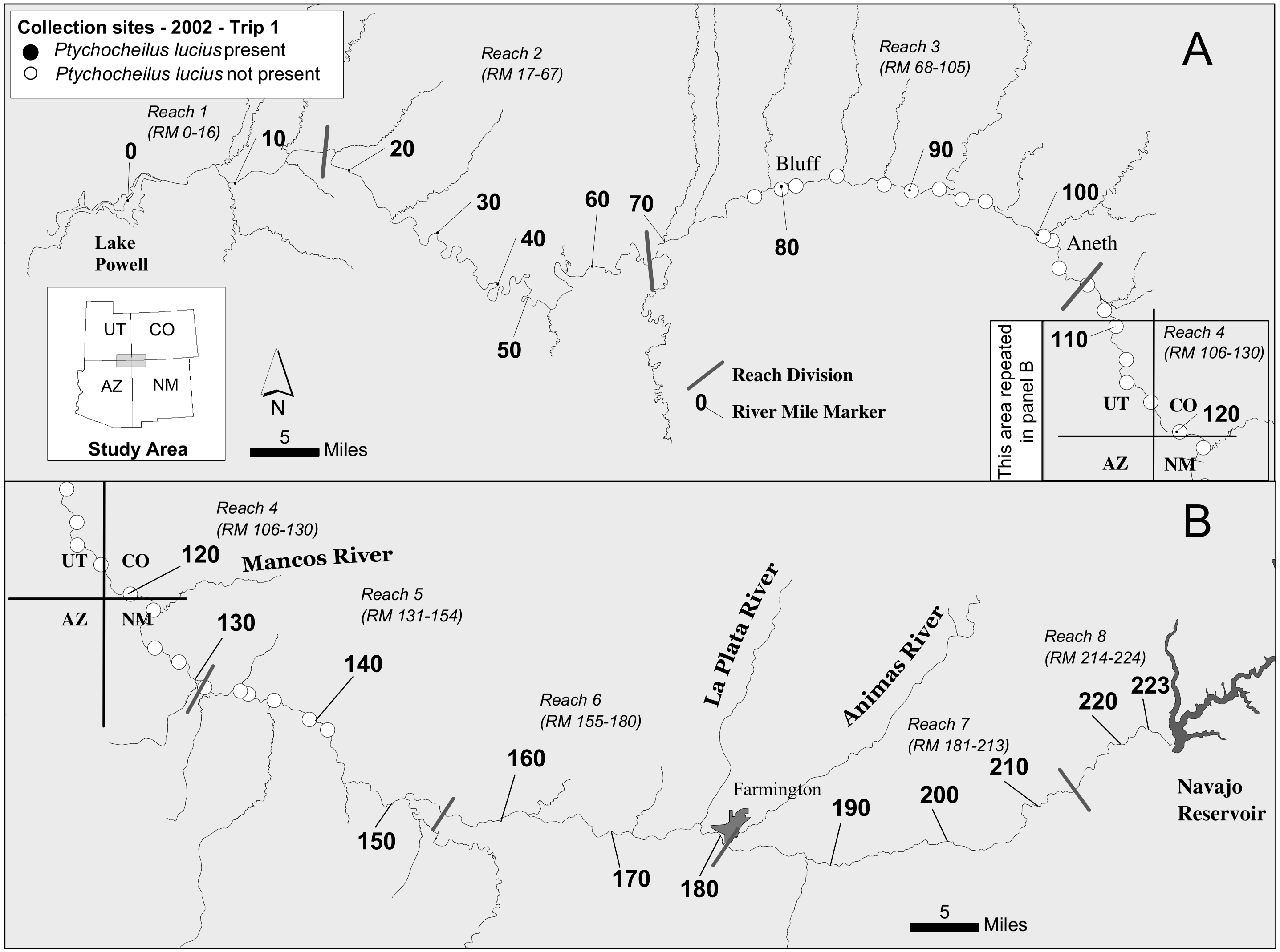

Figure 6. Map of localities sampled during the 1st 2002 San Juan River larval Colorado pikeminnow project fish collections (9-13 July 2002; Cudei to Bluff). There were no Colorado pikeminnow collected.

Table 6. Summary of the 1st 2002 San Juan River larval Colorado pikeminnow project fish collections (9-13 July 2002; Cudei to Bluff).

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	63,453	86.0	28	100.0
common carp	I	237	0.3	19	67.9
roundtail chub	N	-	-	-	-
fathead minnow	I	9,526	12.9	28	100.0
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	110	0.2	16	57.1
SUCKERS					
flannelmouth sucker	N	34	0.1	12	42.9
bluehead sucker	N	156	0.2	17	60.7
razorback sucker	N	2	*	2	7.1
BULLHEAD CATFISHES					
black bullhead	I	59	0.1	3	10.7
channel catfish	I	-	-	-	-
KILLIFISHES					
plains killifish	I	17	*	4	14.3
LIVEBEARERS					
western mosquitofish	I	143	0.2	14	50.0
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	7	*	4	14.3
TOTAL		73,744			

1 N = native; I = introduced

2 Frequency and % frequency of occurrence are based on n=28 samples.

* Value <0.05%

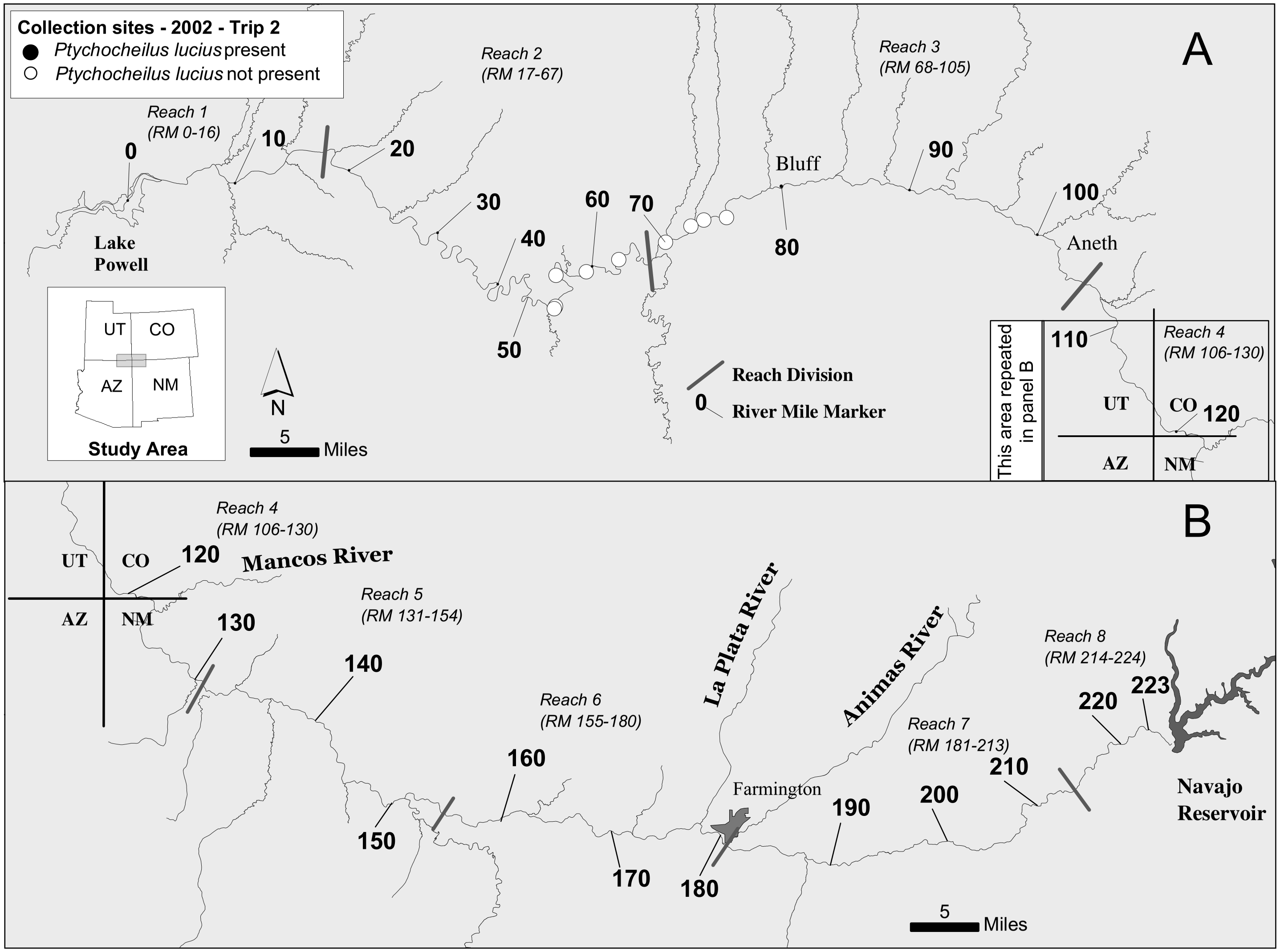

Figure 7. Map of localities sampled during the 2nd 2002 San Juan River larval Colorado pikeminnow project fish collections (22-24 July 2002; Bluff to Mexican Hat). There were no Colorado pikeminnow collected.

Table 7. Summary of the 2nd 2002 San Juan River larval Colorado pikeminnow project fish collections (22-24 July 2002; Bluff to Mexican Hat).

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	3,041	88.5	10	100.0
common carp	I	1	*	1	10.0
roundtail chub	N	-	-	-	-
fathead minnow	I	355	10.3	9	90.0
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	14	0.4	7	70.0
SUCKERS					
flannelmouth sucker	N	3	0.1	2	20.0
bluehead sucker	N	5	0.2	3	30.0
razorback sucker	N	-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	2	0.1	2	20.0
KILLIFISHES					
plains killifish	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	16	0.5	6	60.0
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		3,437			

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on n=10 samples.

* Value <0.05%

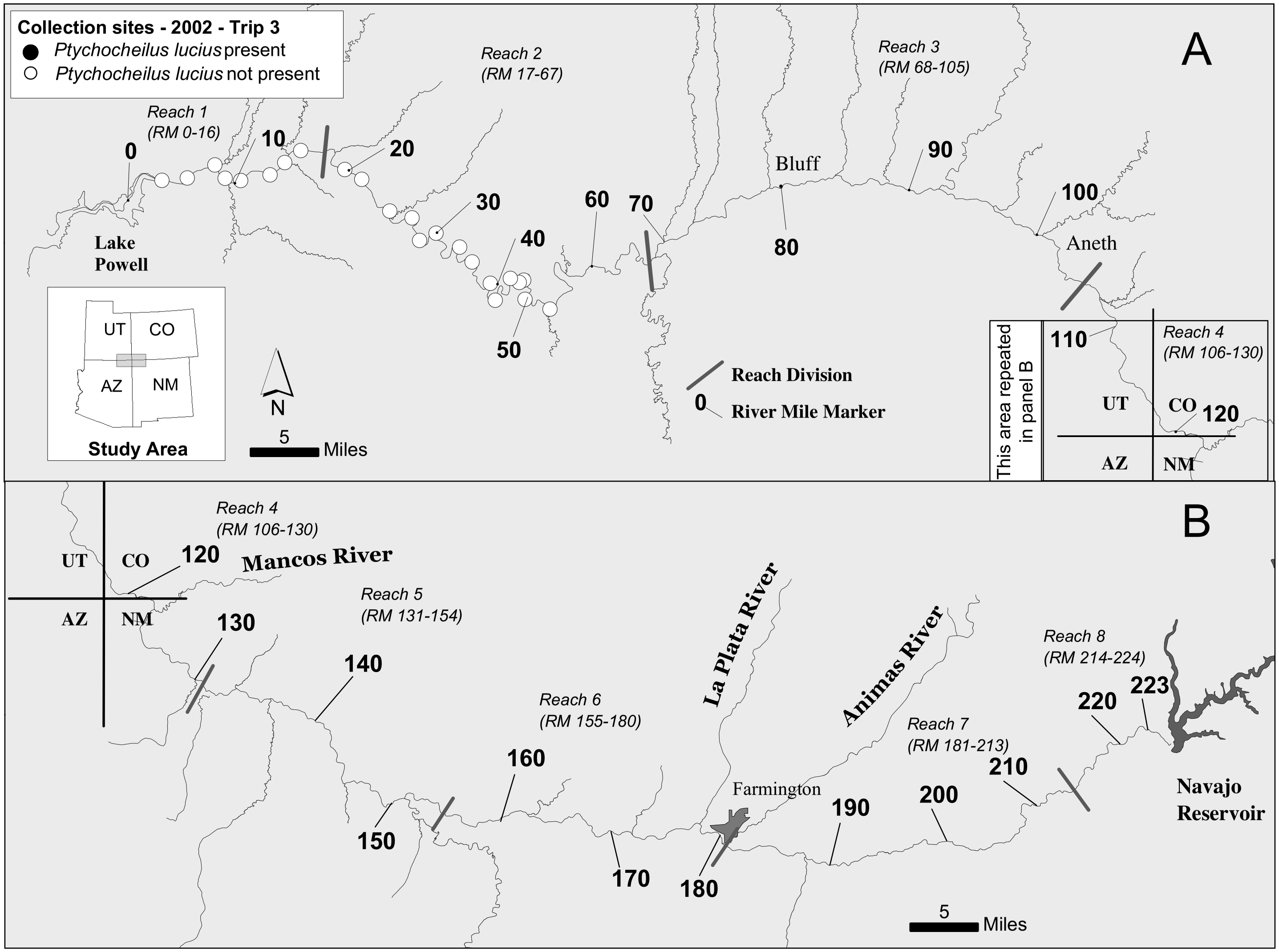

Figure 8. Map of localities sampled during the 3rd 2002 San Juan River larval Colorado pikeminnow project fish collections (13-16 August 2002; Mexican Hat to Clay Hills). There were no Colorado pikeminnow collected.

Table 8. Summary of the 3rd 2002 San Juan River larval Colorado pikeminnow project fish collections (13-16 August 2002; Mexican Hat to Clay Hills).

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	3,965	79.2	22	95.7
common carp	I	5	0.1	4	17.4
roundtail chub	N	-	-	-	-
fathead minnow	I	722	14.4	19	82.6
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	82	1.6	12	52.2
SUCKERS					
flannelmouth sucker	N	3	0.1	3	13.0
bluehead sucker	N	6	0.1	6	26.1
razorback sucker	N	-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	83	1.7	19	82.6
KILLIFISHES					
plains killifish	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	136	2.7	13	56.5
SUNFISHES					
green sunfish	I	1	*	1	4.4
bluegill	I	-	-	-	-
largemouth bass	I	1	*	1	4.4
TOTAL		5,004			

1 N = native; I = introduced
2 Frequency and % frequency of occurrence are based on n=23 samples.

* Value <0.05%

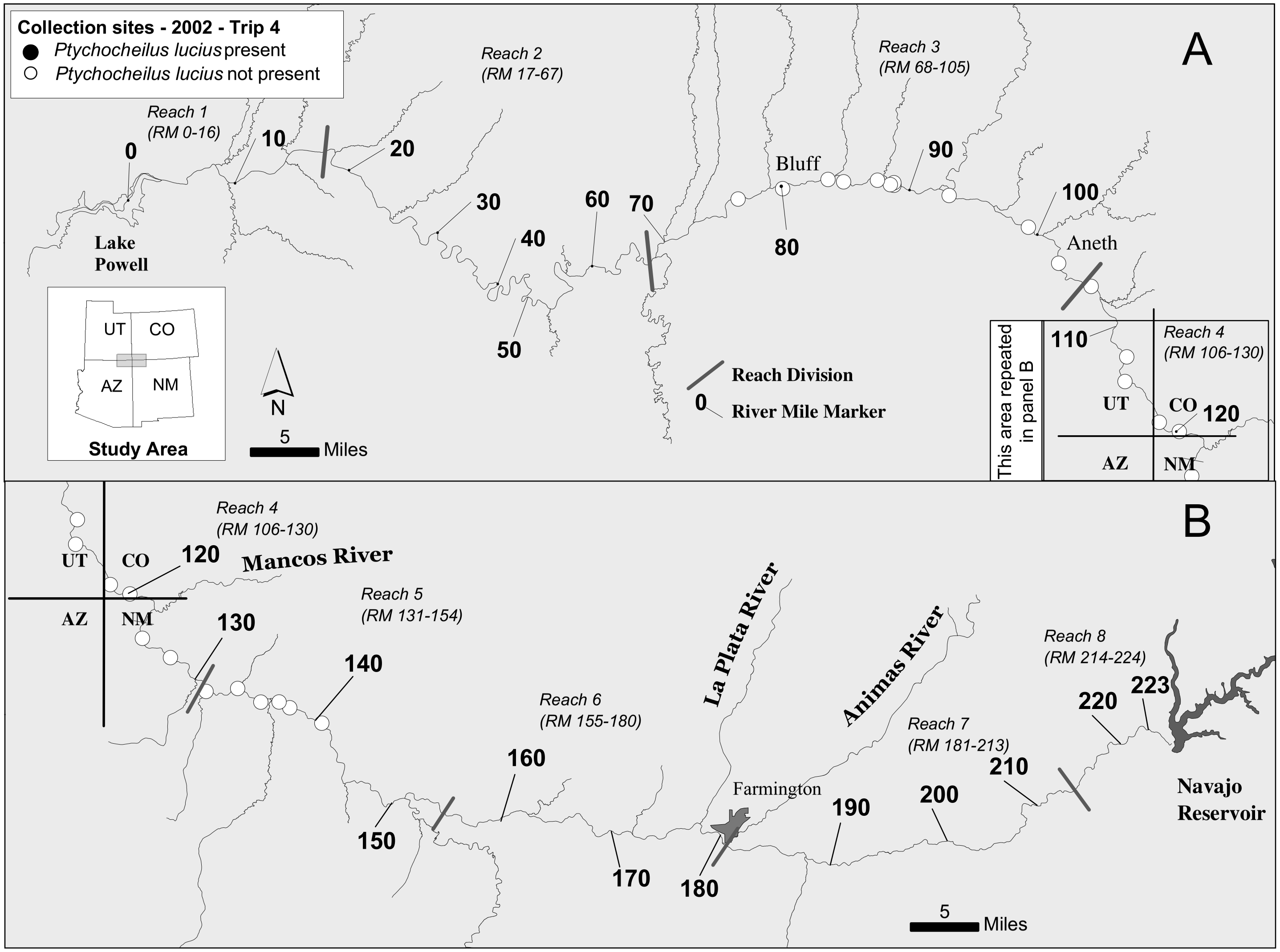

Figure 9. Map of localities sampled during the 4th 2002 San Juan River larval Colorado pikeminnow project fish collections (9-12 September 2002; Cudei to Bluff). There were no Colorado pikeminnow collected.

Table 9. Summary of the 4th 2002 San Juan River larval Colorado pikeminnow project fish collections (9-12 September 2002; Cudei to Bluff).

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	7,438	89.3	22	91.7
common carp	I	5	0.1	4	16.7
roundtail chub	N	-	-	-	-
fathead minnow	I	576	6.9	20	83.3
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	31	0.4	10	41.7
SUCKERS					
flannelmouth sucker	N	6	0.1	5	20.8
bluehead sucker	N	-	-	-	-
razorback sucker	N	-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	15	0.2	7	29.2
KILLIFISHES					
plains killifish	I	9	0.1	6	25.0
LIVEBEARERS					
western mosquitofish	I	252	3.0	16	66.7
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	1	*	1	4.2
TOTAL		8,333			

1 N = native; I = introduced
2 Frequency and % frequency of occurrence are based on n=24 samples.

* Value <0.05%

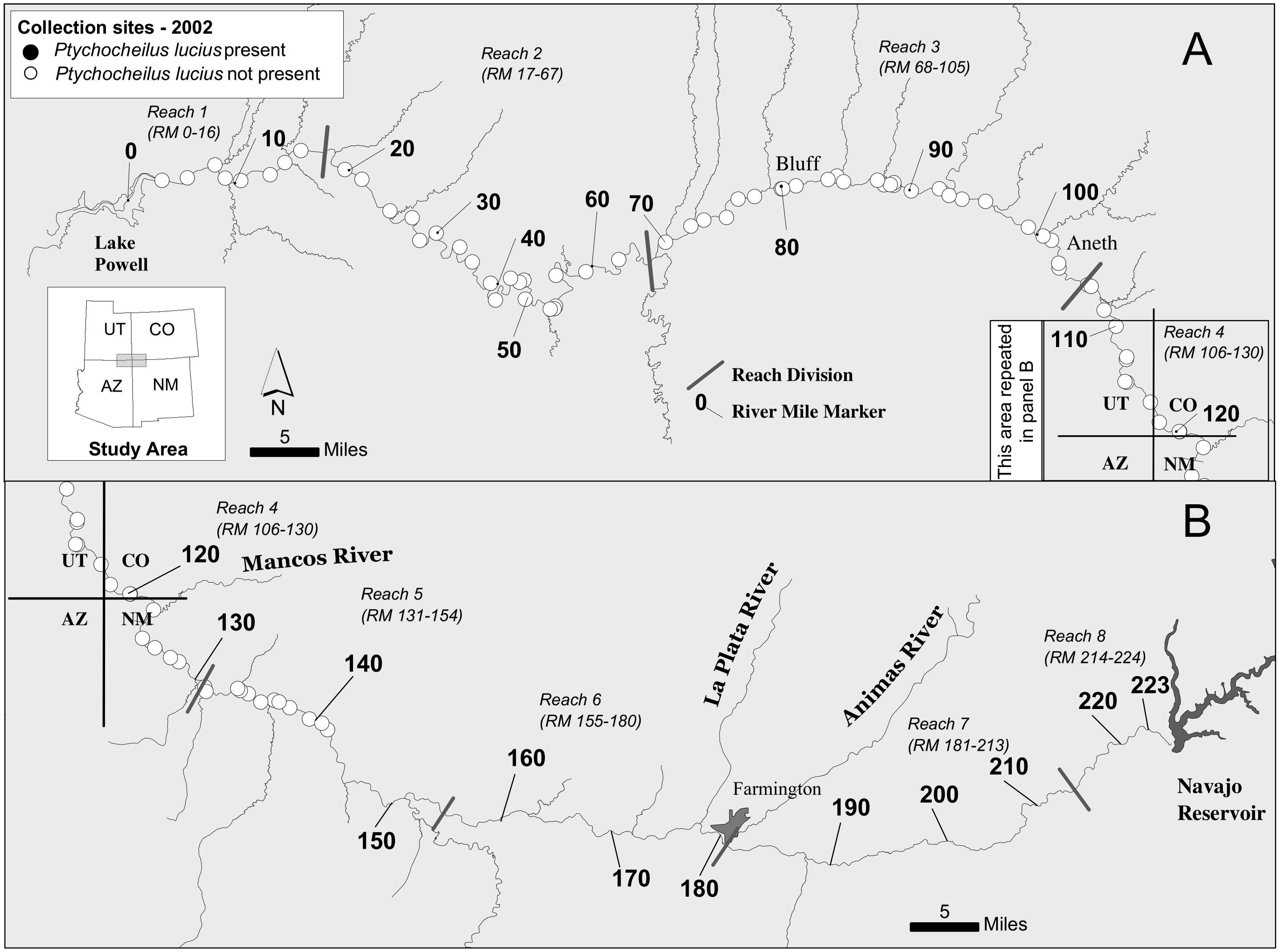

Figure 10. Map of all localities sampled during 2002 larval Colorado pikeminnow study. None yielded larval Colorado pikeminnow during 2002.

The final 2002 larval Colorado pikeminnow sampling effort was between Cudei and Bluff and occurred between 9-12 September (Figure 9). A total of 24 samples was taken producing 8,333 specimens (Table 9). This was the second largest number of specimens taken during this study and nearly equaled the total number of specimens collected for the second and third trips combined. It should be noted that a large flow spike (>17,000 cfs at Four Corners gauging station) occurred during the early morning hours of 11 September 2002. This flow spike inundated many of the backwater sites that had previously been dry. Many of these backwaters sites were sampled and produced few specimens. The only seining effort that failed to produce fish during this study occurred in a backwater site at RM 80.2 on 12 September 2002. Red shiner was collected in 22 of 24 samples and constituted 89.3% (n=7,438) of the total collection. Speckled dace and flannelmouth sucker were the only two native species collected during this trip and together constituted <0.5% of the total catch.

Larval Colorado pikeminnow 2002

Larval Colorado pikeminnow was not collected during the 2002 study period (Figure 10) despite the large number of fish taken (n=90,518) during the tenure of this project.

Acknowledgments

Numerous individuals assisted with the efforts necessary to accomplish this project. John P. Larson and Lee E. Renfro (MSB) participated in field portions of this study. This project benefited from the invaluable assistance of Ernie Teller and Paul Thompson (Bureau of Indian Affairs). Assistance with all aspects of collection and database management and curation was provided by Alexandra M. Snyder (MSB). Robert K. Dudley (MSB) and Steven P. Platania (MSB) reviewed and commented on this report. This study was approved by the San Juan River Basin Biology Committee through the San Juan River Basin Recovery Implementation Program and funded under a U. S. Bureau of Reclamation, Salt Lake City Project Office, contract administered by Thomas P. Chart (U.S. Bureau of Reclamation). The collecting of fish was authorized under scientific collecting permits provided by the Utah Division of Wildlife Resources, New Mexico Department of Game and Fish, U.S. Fish and Wildlife Service, and Navajo Nation. Finally, we thank Darrel E. Snyder, Larval Fish Laboratory, Colorado State University, for verification of specimen identification.

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Appendix I. Detailed sampling and fish identification protocol.

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 1988 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 to 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:
    $$\Sigma \textit{haul lengths (m)} \bullet \textit{seine width (m)} = \textit{effort } (m^2)$$
    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 11 illustrates data recorded at seining sites in the field.

3. Collection of larval fish samples via light-trap and associated data recorded

    a. Light-traps were set only when appropriate aquatic mesohabitats (described above) were located adjacent to that evenings' campsite.
    b. Times of placement and retrieval of the light-trap were recorded.
    c. Ecological data about each site were recorded as above. Figure 12 illustrates data recorded at light-trap 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 the sample.
    c. Specimens were identified to species by MSB personnel trained in 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. 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 I. Detailed sampling and fish identification protocol (continued).

ACC2002-VII:8

Field No. WHB02-215 (Sample No.)

State or Country: New Mexico Locality: San Juan River @ RM137.9

Z 12

T R S Lat.: 0096038E Long.: 4082920N

County: San Juan Drainage: Colorado

Water: Backwater

Vegetation: Algae, inundated grasses

Temp: 26°C Air.: 24°C

Bottom: Cobble, silt

Shore: Russian olive Current: 0

Dist. offshore: ≤3.5m Width: ≈7.0m Tide:

Depth of capture: 0.06 to 0.78m Depth of water: .78m

Method of capture: Seine

Seine: 1.0m x 1.0m No. Hauls: 4 Area: 32.6 sq. m.

D.O.: mg/1 Conductivity: µ mhos/cm. Salinity: ‰

Shocking seconds: Voltage: Amps:

Collected by: M.A. Farrington L.E. Renfro Date: 9 Sept. 2002

Orig. preserv.: +/- 10% Formalin Time: 1818 to 1831

This was a small backwater with very good depth at the mouth, but it quickly became shallow towards the backend. The backend contained lots of inundated vegetation, and hauls in this area produce very good numbers of fish, including many small Cyprinids. Most Cyprinids taken were C lutrensis, and some of the adults appeared to be in poor physical condition (lernia, blood filled cysts). The one haul near the mouth produced few fish. Seine haul lengths were as follows: 5.4, 8.8, 9.1, 10.5 m.

Figure 11. Field sheet used to record larval seine collection data at a sampling site during the Colorado pikeminnow survey in the San Juan River in 2002.

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

Acc 2002 - VII : 8

Field No. WHB02-200 (Sample No. ....)

State or Country: Utah Locality: San Juan River @ RM 29.9

T ...... R ...... S ...... Lat.: Z12 0587546 E Long.: 4120707 N

County: San Juan Co. Drainage: Colorado

Water: eddy pool on river right

Vegetation: none

Temp: 24.5° - 22°C Air.: 34° - 25°C

Bottom: mud & rock

Shore: willow & limestone cliffs Current: > .1 - .3 m/S

Dist. offshore: .02 - .5 m Width: ...... Tide: ......

Depth of capture: N/A Depth of water: .36 - .44 m

Method of capture: light traps n = 4

Seine: ...... No. Hauls: ...... Area: ...... sq. m.

D.O.: ...... mg/1 Conductivity: ...... µ mhos/cm. Salinity: ...... ‰

Shocking seconds: ...... Voltage: ...... Amps: ......

Collected by: WHBrandenburg & LERenfro Date.: 14-15 Aug. 2002

Orig. preserv.: N/A Time: 1920 – 0740

Four light traps were set along the bank in a large slow eddy The lowest velocity regions of the eddy was the downstream portions. This did not appear to be favorable larval habitat but it was the only thing around. Either unfavorable habitat or water turbidity is too high, regardless no fish were collected in any of the traps. The farthest most downstream trap was set in a pool formed between several large boulders water velocities were very low and this is where I thought we would have the most luck... nothing.

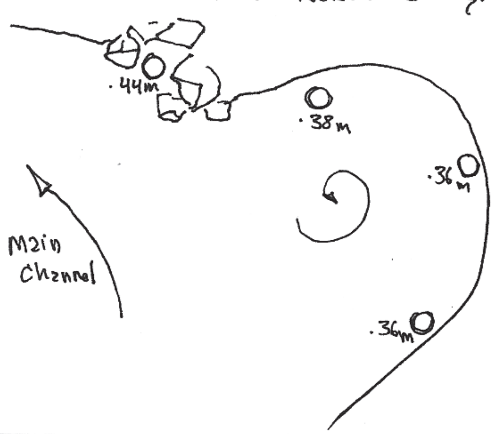

Figure 12. Field sheet used to record light-trap data at a sampling site during the Colorado pikeminnow survey in the San Juan River in 2002.