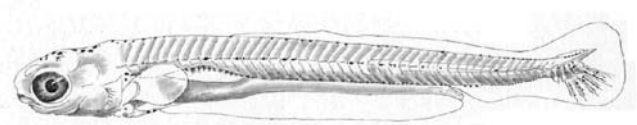
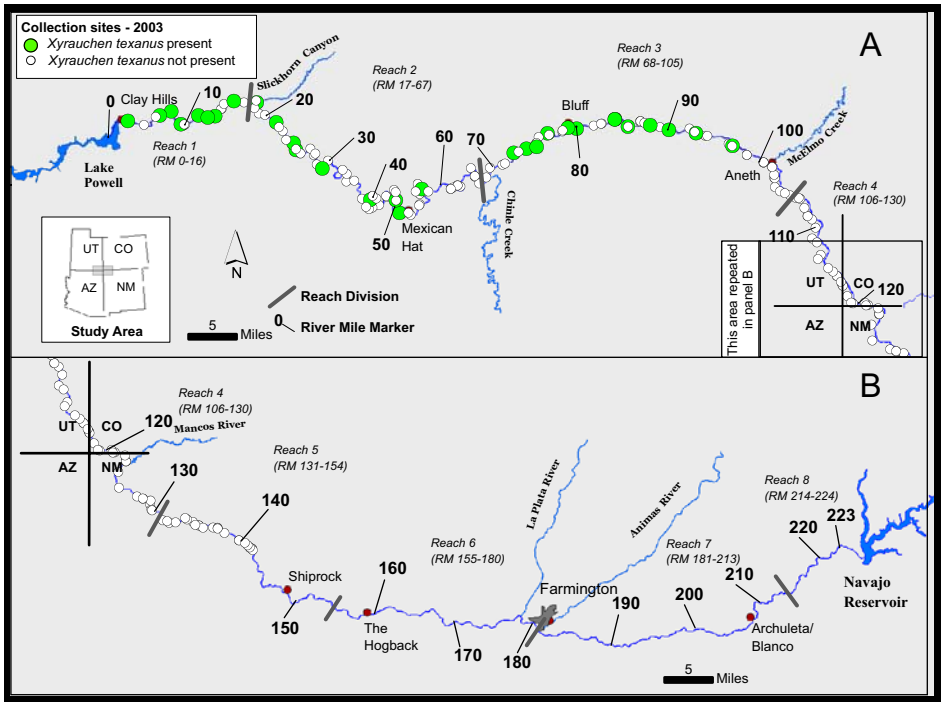
Razorback sucker larval fish survey in the San Juan River during 2003

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
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San Juan River Basin Recovery Implementation Program

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Table of Contents

List of Tables

page

List of Figures

page

Executive Summary

1. There were 208 fish collections at 173 unique sites made between river miles 141.5 and 2.9 during the 2003 razorback sucker larval fish survey.

2. The 2003 sampling effort yielded 26.5% fewer fish (n=41,181) as compared to 2002 (n=56,034), and represented a 36.1% decrease in CPUE (561.9 fish per 100 m^2 and 880.1 fish per 100 m^2, respectively .

3. The 208 samples resulted in the collection of fish representing seven families and 15 species, with all except seven samples producing fish.

4. Several species collected in 2003 were not represented in 2002 samples. Introduced fish collected in 2003, but not in 2002, were black bullhead, green sunfish, bluegill, and kokanee salmon. Native fish collected in 2003, but not in 2002, were Colorado pikeminnow.

5. Catostomids comprised 15.2% of the number of fish collected in 2003 (n= 6,275) which was a 47.7% decrease from 2002.

6. Flannelmouth sucker was the numerically dominant catostomid taxon (n= 5,088) in 2003, accounting for over 81.1% of the sucker catch, 68.4 fish per 100 m^2 sampled. Bluehead sucker comprised 114% of catostomids collected in 2003.

7. Introduced cyprinids comprised 83.6% (n=34,430) of the 2003 catch by number, 469.7 fish per 100 m^2 sampled. Red shiner was the dominant cyprinid comprising 77.1% of all cyprinids collected in 2003 (n=26,714).

8. A total of 472 larval and juvenile razorback sucker was collected during the 2003 portion of this study, 6.4 fish per 100 m^2 sampled. This is 42% decline in larval razorback sucker compared with 2002 but still more than 1998 through 2001 collections combined.

9. A total of 31 collections yielded razorback sucker, three of which contained >50 individuals, three containing 30-49 individuals, and five containing 10-29 individuals.

10. The first larval razorback sucker was collected on 16 May 2003 at RM 97.0 and the largest single sample of razorback sucker (n=99) was taken on 22 May 2003 at RM 8.1.

11. Larval and juvenile razorback sucker were collected throughout reaches 3, 2, and 1. Unlike 2002 no razorback sucker were collected in reaches 4 and 5.

12. Seven collections produced a total of nine juvenile razorback sucker. The largest specimen was 37.3 mm TL.

13. In 2003, 2.3% of all razorback sucker collected were juveniles (n= 11). This represents a 91.5% decrease in the total juvenile razorback sucker, as compared to the 2002 collection (n=129).

14. Larval razorback sucker (n=9) were collected in two of ten light-trap sampling efforts.

Introduction

Background Information

There are few historic San Juan River records of razorback sucker, *Xyrauchen texanus*, despite that this is one of three endemic Colorado River basin catostomids native to the San Juan River drainage. Jordan (1891) conveyed anecdotal reports from the late 1800s of razorback sucker occurring in the Animas River as far upstream as Durango, Colorado. However, there were 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). A 1987 U.S. Bureau of Reclamation document (U.S. Bureau of Reclamation, 1987), citing personal communication from the Utah Division of Wildlife resources, reported the 1981-1984 spring occurrence of razorback sucker in the San Juan River arm of Lake Powell. The most recent San Juan River drainage occurrence of razorback sucker was the April 1988 collection of a single adult tuberculate male in the San Juan River near Bluff, Utah (Roberts and Moretti, 1989).

The extreme rarity of razorback sucker in the San Juan River drainage necessitated the experimental stocking of a small number of individuals so that information on their habitat use, potential spawning areas, and survival and growth rates could be obtained. In 1994 personnel from the U.S. Fish and Wildlife Service's Colorado River Fishery Project (CRFP; Grand Junction, Colorado) stocked the first series of razorback sucker (n=672) in the San Juan River. Those fish, whose mean length and mass at the time of stocking were about 400 mm TL and 710 g, respectively, were released between Hogback, New Mexico and Bluff, Utah. In 1995, numerous individuals from the 1994 stocking effort were recaptured including 13 tuberculate males with six of those individuals being ripe. Four razorback sucker recaptured in 1995 were determined to be female but, unlike the males, none were sexually mature. By 1996, a total of 939 razorback sucker, all of which were progeny of paired matings between San Juan River arm of Lake Powell adults, had been stocked in the San Juan River. In their 1995 report of activities, Ryden and Pfeifer (1996) suggested that the majority of experimentally stocked 1994 San Juan River razorback sucker would achieve sexual maturity by 1996 thereby providing the potential for spawning during 1997-1998. The success of the experimental stocking study resulted in the development of a full-scale augmentation program for razorback sucker in the San Juan River.

At the November 1996 San Juan River Basin Biology Committee integration meeting, it was suggested that the Colorado pikeminnow, *Ptychocheilus lucius*, larval fish drift study be expanded in an attempt to document spawning of razorback sucker. The MSB-NMGF larval fish drift study, which was designed to determine spawning period, identify approximate location of spawning sites, and assess the effects of annual hydrology (and temperature) on Colorado pikeminnow reproductive activities, was also successful in providing similar information for other members of the ichthyofaunal community (i.e., speckled dace, *Rhinichthys osculus*, and channel catfish, *Ictalurus punctatus*). However, because reproduction by razorback sucker (March-May) occurred considerably earlier than Colorado pikeminnow (June-July), separate investigations of spawning periodicity and magnitude were deemed necessary for each of the aforementioned species.

The most important difference between the established Colorado pikeminnow study and proposed razorback sucker study, besides temporal, was that the razorback sucker larval fish study was attempting to provide the first documentation of reproduction by stocked members of this species in the San Juan River. Sampling for larval razorback sucker was to be conducted with no assurance that the stocked population of adult razorback sucker would spawn in this system. Conversely, previous studies demonstrated that Colorado pikeminnow reproduction had and was still occurring in the San Juan River. This certainty allowed the Colorado pikeminnow larval fish sampling efforts to be different (i.e., monitoring) than those for razorback sucker (searching).

Numerous Upper Colorado River basin researchers identified light-traps as one of the most efficient means of collecting larval razorback sucker. The 1994-1995 National Park Service - San Juan

River fish investigation employed light-traps near the San Juan River-Lake Powell confluence as a larval fish collecting technique. That study produced a large number of larval fish (ca. 25,000 per year) from a modest number of samples (n=20). Red shiner numerically dominated (>98%) the light-trap catch during both years but neither Colorado pikeminnow nor razorback sucker were collected. The success of Upper Basin researchers and potentially large number of fish that could be collected using this technique led to the selection of light-traps as the sampling device during the first year (calendar year 1997) of San Juan River larval razorback sucker study.

Numerous locations adjacent to U.S. Hwy 163 and Utah State Hwy 262 (which paralleled the San Juan River between Aneth and Bluff) that appeared suitable for sampling with light-traps were identified during March 1997. Light-traps were set nightly in low-velocity habitats between Aneth and Mexican Hat from late March through mid-June 1997. Traps were distributed at dusk and retrieved about four hours later with any fish taken in those samples preserved in the field. Sampling success during the 1997 razorback sucker larval fish study was poor. While there were over 200 light-trap sets, those sampling efforts produced only 297 fish. Of those, about 200 (66%) were larval sucker (either flannelmouth sucker or bluehead sucker). Larval razorback sucker were not present in the 1997 sampling survey.

While there were probably several variables that accounted for the poor light-trap catch rate, a principal factor was limited access to suitable habitats. Light-traps are most effective when set in habitats with little or no water velocity. Unfortunately, increased April-June flow in the San Juan River eliminated virtually all low velocity habitats identified in March 1997. Further reconnaissance from an automobile (April - May) of the snowmelt enhanced river failed to yield additional locations suitable for light-traps. One of the results of the 1997 study was the realization that being bound to specific collecting sites was an inefficient means of collecting the large number of larval fish necessary to document reproduction of a rare species.

In 1998 the razorback sucker larval fish sampling technique was modified to allow for collections over a larger portion of the San Juan River and capture of a considerably larger number of larval fish. An inflatable raft, which was used to travel on the river, provided the opportunity to sample habitats that were formerly either inaccessible or unobservable under the constraints of the 1997 sampling protocol. Collecting trips were conducted at approximately bi-weekly intervals from mid-April until early-June along the river reach between Four Corners and Bluff. Both active and passive sampling techniques were employed to collect larval fish. The primary 1998 collecting method was sampling low-velocity habitats with a fine mesh seine. Light-traps were also employed in 1998 but set only when appropriate aquatic mesohabitats were located adjacent to that evenings' campsite. The seining technique yielded more larval sucker in a single sample than were taken cumulatively in 1997 light-trap samples. The only major change in sampling protocol between 1998 and 1999 was an expansion of the study area. In 1999 the reach of river sampled was increased from the 46 river mile reach between Four Corners to Bluff to a 123 river segment between Four Corners and Clay Hills.

The changes in sampling protocol and study reach that were instituted in 1998 proved effective. Two larval razorback sucker were collected in the San Juan River during 1998 thereby providing the first unequivocal documentation of reproduction in the San Juan River by members of a razorback sucker cohort which had been stocked as part of the San Juan River Basin Recovery Implementation Program. In 1999, seven additional larval razorback sucker were collected between river mile (RM) 96.2 (near Aneth, Utah) and RM 11.5 (near Clay Hills Crossing, Utah). The increase in the number of larval razorback sucker collected between 1998 and 1999 was probably the result of many factors including an increase in the number of stocked razorback sucker that had recruited to the adult cohort (i.e., able to reproduce). As this developmental segment (adult) of the razorback sucker population increases, so should the number and spatial distribution of collections of larval razorback sucker.

There was a dramatic increase between 1999 and 2000 in the catch of larval razorback sucker. The 2000 sampling effort produced 129 larval razorback sucker in 21 separate collections from 9 May

2000 to 2 June 2000. Razorback sucker ranged from 9.4 to 18.1 mm TL with all except one being at the mesolarval developmental stage. The apparent distribution of larval razorback sucker in 2000 expanded from RM 96.2 upstream to RM 124.8 and downstream from RM 11.5 to RM 8.1. About two-thirds of the 2000 catch of larval razorback sucker was from a single collection made on 26 May 2000 at RM 8.1 (n=86). While larval razorback sucker were generally distributed throughout the study area in 2000, they were notably rarest in the uppermost portion of the upper sampling reach.

In 2001 the study area was expanded upstream an additional fourteen miles to includes nearly half of reach 5. A total of 50 larval razorback sucker was taken during the 2001 sampling effort. These collections were made between 16 May 2001 and 14 June 2001, with two being taken in light-traps on 17 May 2001. The distribution of larval razorback sucker remained the same in 2001, between RM 8.1 and RM 124.8, with the greatest numbers (>90%) being collected below Bluff, Utah. Razorback sucker collected during the first sampling trip were the smallest (10.1 to 15.5 mm TL) and least developed (all were mesolarvae) of the 2001 survey, while later collections included larger (13.0 to 28.8 mm TL) and more developed (metalarvae and juvenile) specimens.

Collecting protocols remained the same in 2002 as the previous year. There were 152 collections made between 15 April 2002 through 29 June 2002. Although the 2002 sampling efforts yielded 40% fewer fish compared to 2001, there was a 93.8% increase in the number of larval and juvenile razorback sucker collected compared with 2001. A total of 67 collections yielded razorback sucker. Collections were made in 2002 that produced much larger juveniles than have been observed in previous years, the largest specimen was 62.4 mm TL. Juvenile razorback sucker comprised 15.9% of all razorback sucker collected. Rather than a clumped distribution of razorback sucker as seen in 2001, razorback sucker were collected uniformly throughout the study area from river mile 134.5 down to 2.8, with the greatest concentrations found in reaches three, two and one. Light traps were successful in collecting 31 razorback sucker in 2002.

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 predominantly 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 reduction 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

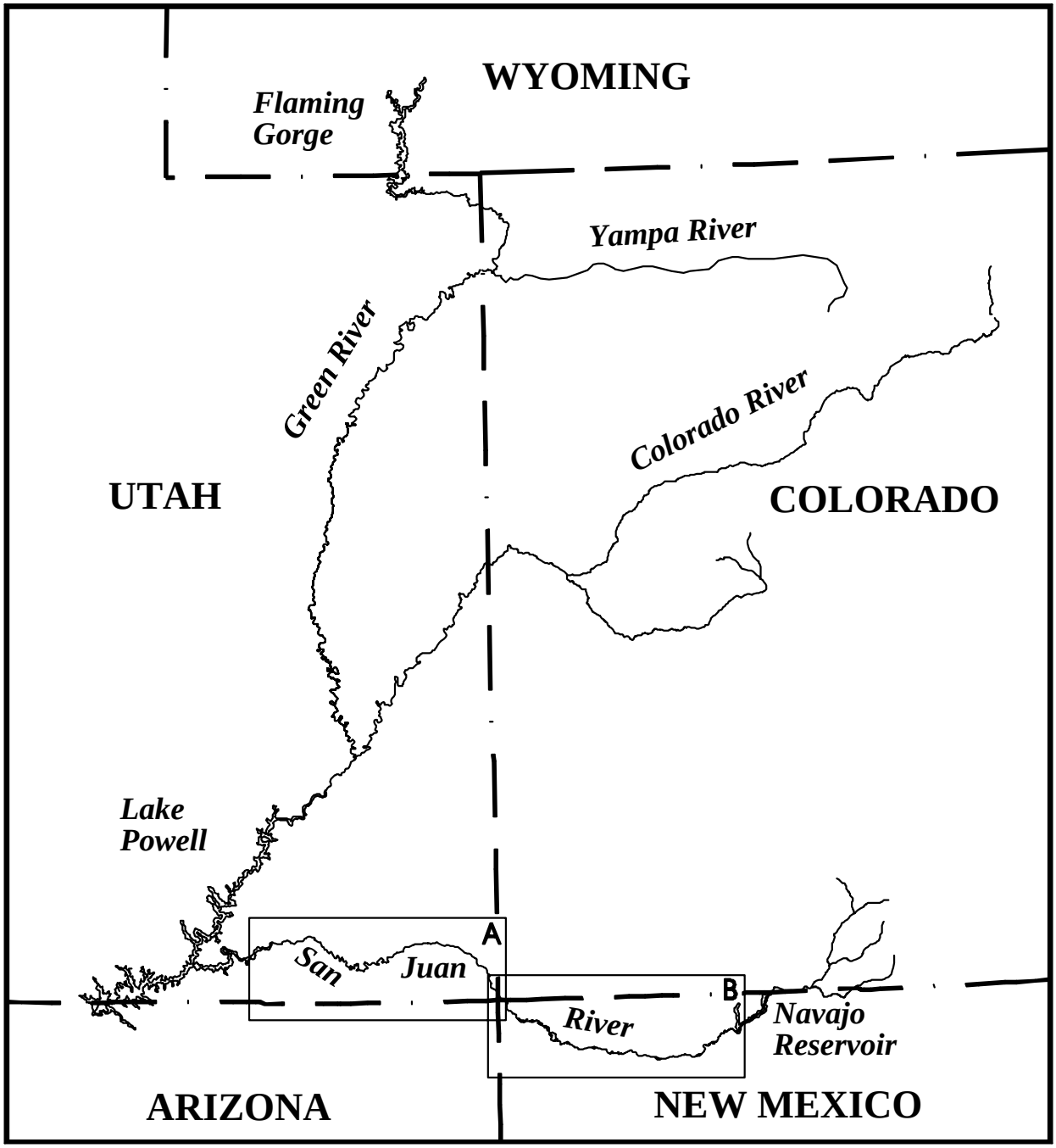

Figure 1. Location of the San Juan River within the Upper Colorado River Basin. The study area is outlined and labelled "A" and "B" with reference to subsequent maps in this report.

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. 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). 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 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 106 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's hypolimnetic release design, this area experiences much colder summer and warmer winter water temperatures. These cool, clear water conditions have allowed development of an intensively managed blue-ribbon trout fishery to the exclusion of native species in the uppermost portion of the reach.

The study area for the razorback survey remained the same between 2001 and 2003 and encompassed reaches 1 through approximately 43% of reach 5 (Figure 2). In 2003 three razorback sucker larval fish collection trips were made between 15 April and 18 June 2003. These trips were not broken into upper and lower reaches as was done in previous years but rather the entire study area was sampled in each trip. This change was made in accordance with a new protocol for reporting on annual monitoring activities that 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 larval San Juan River razorback sucker survey 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 larval San Juan River razorback sucker survey project did not attempt to sample the entire study area under a single, continuous sample event until 2003. 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 larval San Juan River razorback sucker survey project was still functioning primarily as a "search and capture" versus "monitoring" project. Given the marked increase in the number of razorback sucker taken in 2002 and the need to formalize the sampling protocol of this project with the other monitoring surveys, beginning in 2003, the entire larval razorback sucker study area was 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 spawning periodicity of catostomids between mid-April and early June and examine potential correlations with temperature and discharge
- Attempt to validate the presumed spawning period of San Juan River catostomids.
- Determine if reproduction by razorback sucker occurred in the San Juan River (upstream of Mexican Hat, Utah).
- Provide a comparative analysis of the reproductive effort of catostomids
- Determine the relative annual reproductive success of razorback sucker (1a).
- 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).

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

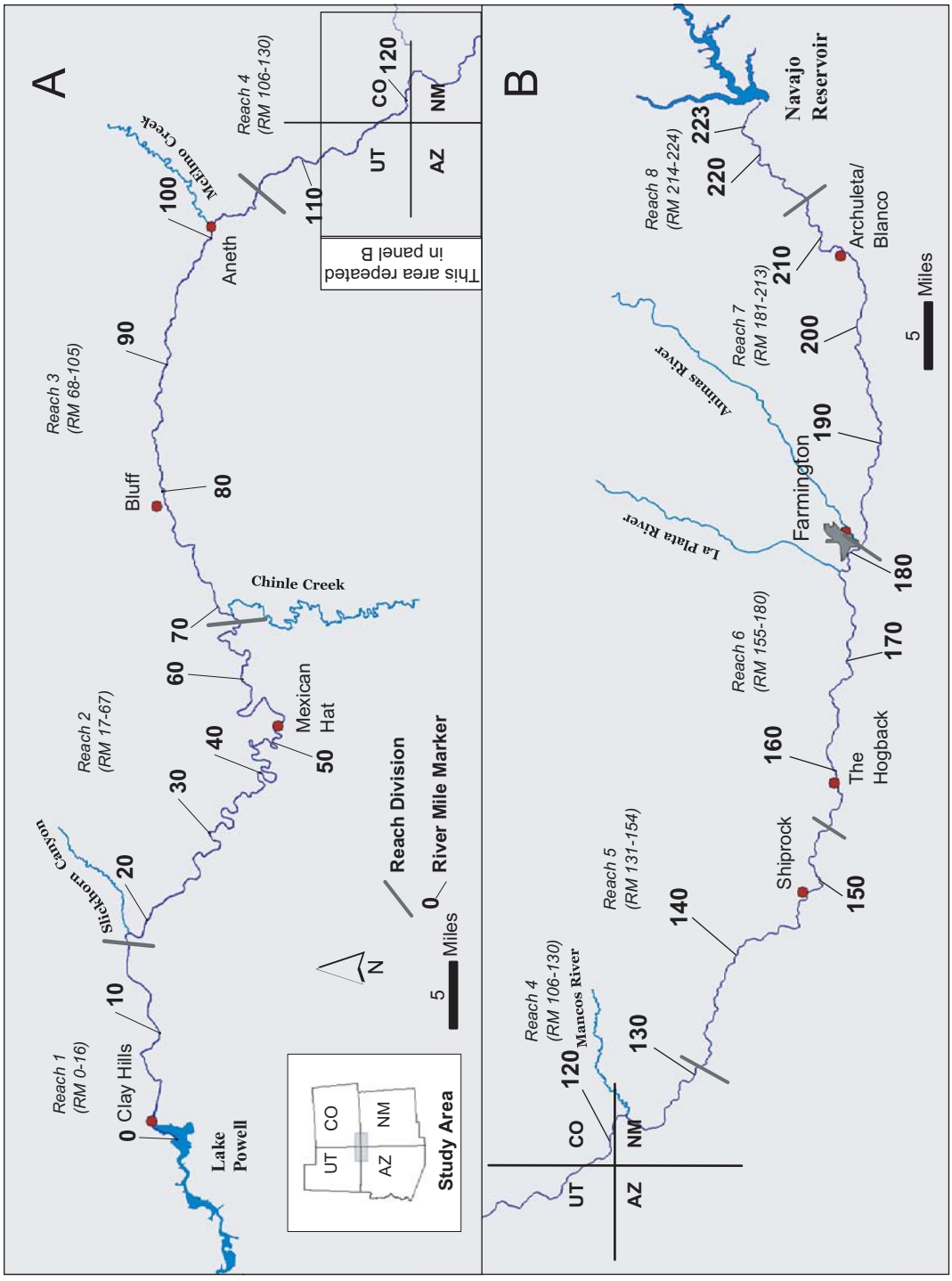

Figure 2. Map of the San Juan River study area.

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 pools and backwaters.

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, substrate, turbidity (using a secchi disk), water quality (dissolved oxygen, conductivity, salinity, and temperature), and a digital photograph were recorded for each collection. For seine collections, the length of each seine haul was determined in addition to 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-trap.

River Mile was determined to tenth of a mile using the 2003 standardized aerial maps 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) 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 lab 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, specimens identified to species, 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). 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 the tables in this report. For razorback sucker, a measure of total length (TL) was recorded for each individual in addition to standard length (SL). This was done in an effort to provide a higher degree of consistency and comparability with information presented from the San Juan River Basin and Upper Colorado River Basin programs. Throughout this report, length of YOY razorback sucker are presented as TL.

Specimens were identified to species by MSB personnel with expertise in San Juan River Basin larval fish identification. The term young-of-year (YOY) 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. 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 2003 fish collection data was formatted and submitted for inclusion in the San Juan River integrated database being developed at UNM.

This study was annually initiated prior to spring runoff and completed a few weeks before the cessation of spring run-off. Daily mean discharge during the study period was acquired from U.S. Geological Survey Gauge (# 09371010) at Four Corners, Colorado (Figure 3).

Table 1. 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 2003 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	catfishes	
Ameiurus melas	black bullhead	(AMEMEL)
Ictalurus punctatus	channel catfish	(ICTPUN)
Order Salmoniformes		
Family Salmonidae	trouts	
Oncorhynchus nerka	kokanee salmon	(ONCNER)
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)

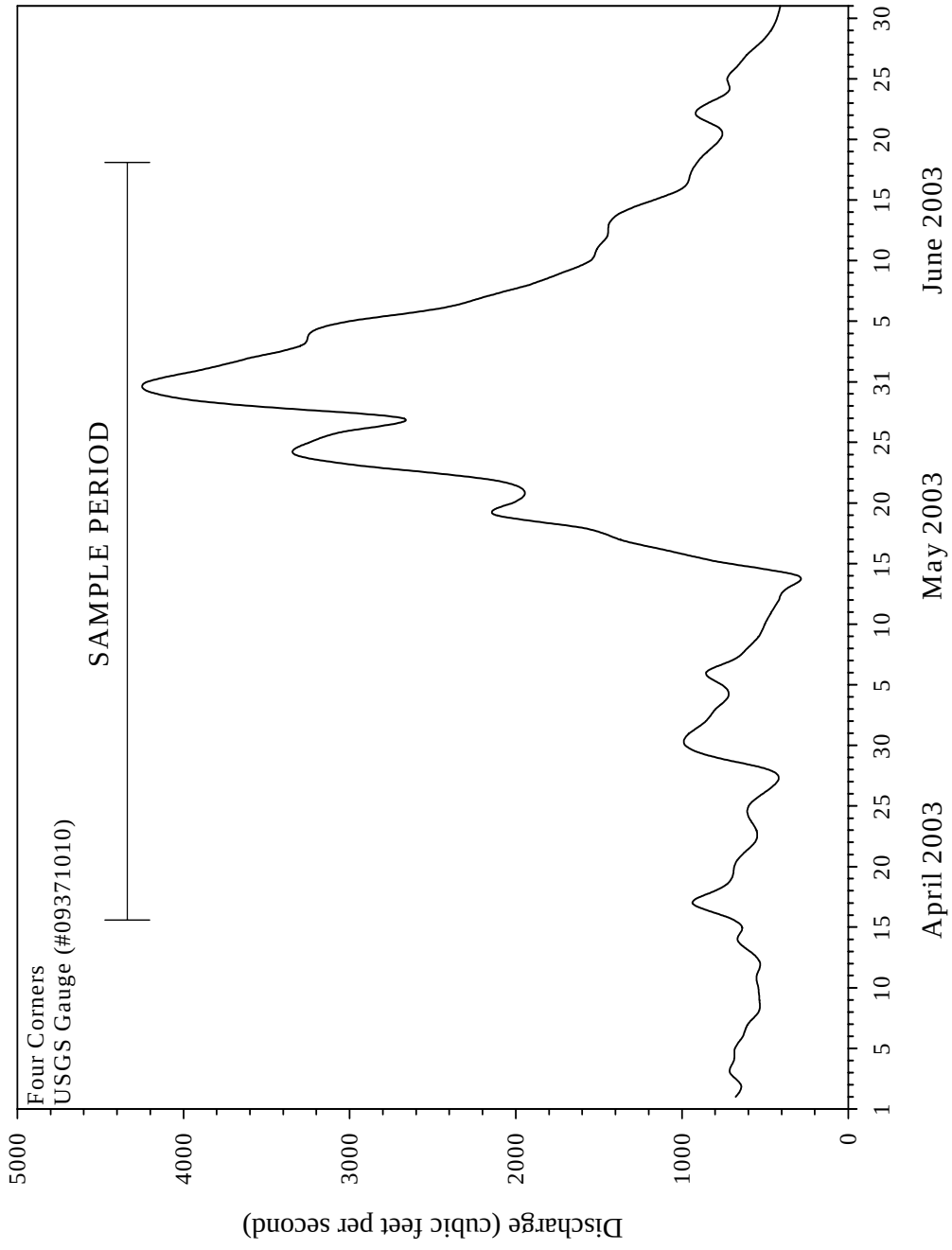

Figure 3. Hydrograph of the San Juan River at Four Corners, Colorado during the 2003 sampling period.

Results

2003 Survey

The razorback sucker survey was conducted in single monthly trips between 15 April and 18 June 2003. Each trip encompassed the downstream half of reach 5 (43.8% of reach 5), starting at river mile 141.5 (six miles downstream of Shiprock, NM) through reach 1, ending at river mile 2.9 (Clay Hills, UT). There was an approximately 26.5% decrease in the total number of fish collected in 2003 (n=41,181) as compared to 2002 (n=56,034). This decline is also reflected in the catch per unit effort (CPUE) [561.9 fish per 100 m^2 and 880.1 fish per 100 m^2, respectively] despite that there was an increase of 984 m^2 area sampled in 2003. Trip 3 produced the most fish (n=14,703) in 2003, while the lowest number of fish was collected in trip 2 (n=12,833).

A total of 208 collections were made between 173 unique sites over the course of the survey (Figure 4). Of the 208 collections, seven did not produce any fish. The remaining 201 collections represented seven families and 15 species (Table 2). Several species were collected in 2003 that were not represented in 2002, among these were Colorado pikeminnow, black bullhead, *Ameiurus melas*, kokanee salmon, *Oncorhynchus nerka*, and green sunfish, *Lepomis cyanellus*. The Colorado pikeminnow ranged in size from 35 to 75 mm SL. It is suspected, due to the size of the specimens and time of collection, that all of the Colorado pikeminnow that were collected in 2003 were fish that were previously stocked in 24 October 2002. Other than the Colorado pikeminnow all of the aforementioned species are not native to the San Juan River. Roundtail chub, a native to the San Juan River, were collected in 1998 and 1999 samples but were not collected between 2000 and 2003.

Catostomids comprised 15.2% (n= 6,275) of all fish collected in 2003 and accounted for 15.2 % of the total CPUE (85.6 fish per 100 m^2 sampled). There was a 47.7% decline in catostomids collected in 2003 compared with 2002 (n= 12,000). Flannelmouth sucker, *Catostomus latipinnis*, as has been documented since 1998, was the dominant catostomid taxon, accounting for 81.1% of the total sucker catch, 68.4 fish per 100 m^2 sampled in 2003 . Flannelmouth sucker was the first sucker taxon to spawn in 2003. This spawning pattern has been documented since the project's inception in 1997. Bluehead sucker, *Pantosteus discobolus*, comprised 11.4% of the total catostomid catch, 9.8 fish per 100 m^2 sampled, in 2003. This is an 80% decrease in abundance from 2002. Larval bluehead sucker were most abundant in reaches 3 and 4, comprising nearly 90% of the entire bluehead sucker catch. Razorback sucker was not as abundant in 2003 relative to the previous year, yet more razorback sucker were collected in 2003 than 1998 to 2001 combined. Unlike 2002, razorback sucker were not collected in reaches 4 and 5. Reach 3 provided the greatest number of razorback sucker (n=200) accounting for 42.4% of the total number of razorback collected. Reach 1, which is 46% shorter than reach 3, provided nearly as many specimens (n=190) and accounted for 40.2% of the total razorback sucker catch. River-wide, razorback sucker comprised 7.5% of the total catch of catostomids collected in 2003.

Native cyprinids accounted for only 0.7% of the total catch, 3.2 fish per 100 m^2 sampled, in 2003. Speckled dace (n=160) were 95% less abundant in 2003 than the previous year. Of the speckled dace collected, approximately half were larval fish. Speckled dace were most abundant in reaches 3 and 4. Seventy-five Colorado pikeminnow were collected in 2003. All of these fish were stocked by U.S. Fish and Wildlife Service on 24 October 2003. Greater numbers of Colorado pikeminnow were collected in reaches 4, 3, and 2. All juvenile or adult native fishes with positive field identifications were measured (SL) and released in the same meso-habitat in which they were collected.

Non-native cyprinids comprised the majority of the 2003 catch, accounting for 83.6% of the total catch, 469.7 fish per 100 m^2 sampled, in 2003. Red shiner, *Cyprinella lutrensis*, was not only the most abundant cyprinid in 2003, but also the most dominant fish species accounting for 64.9% of the total catch in 2003 and 77.1% of all the cyprinids. In 2003 there was a 28.0% increase in the number of red shiner as compared with 2002, yet still 69.1% fewer red shiner than those collected in 2001. Red shiner was the dominant fish species throughout all the reaches sampled in 2003. Reach 3 accounted for 53.3% of all

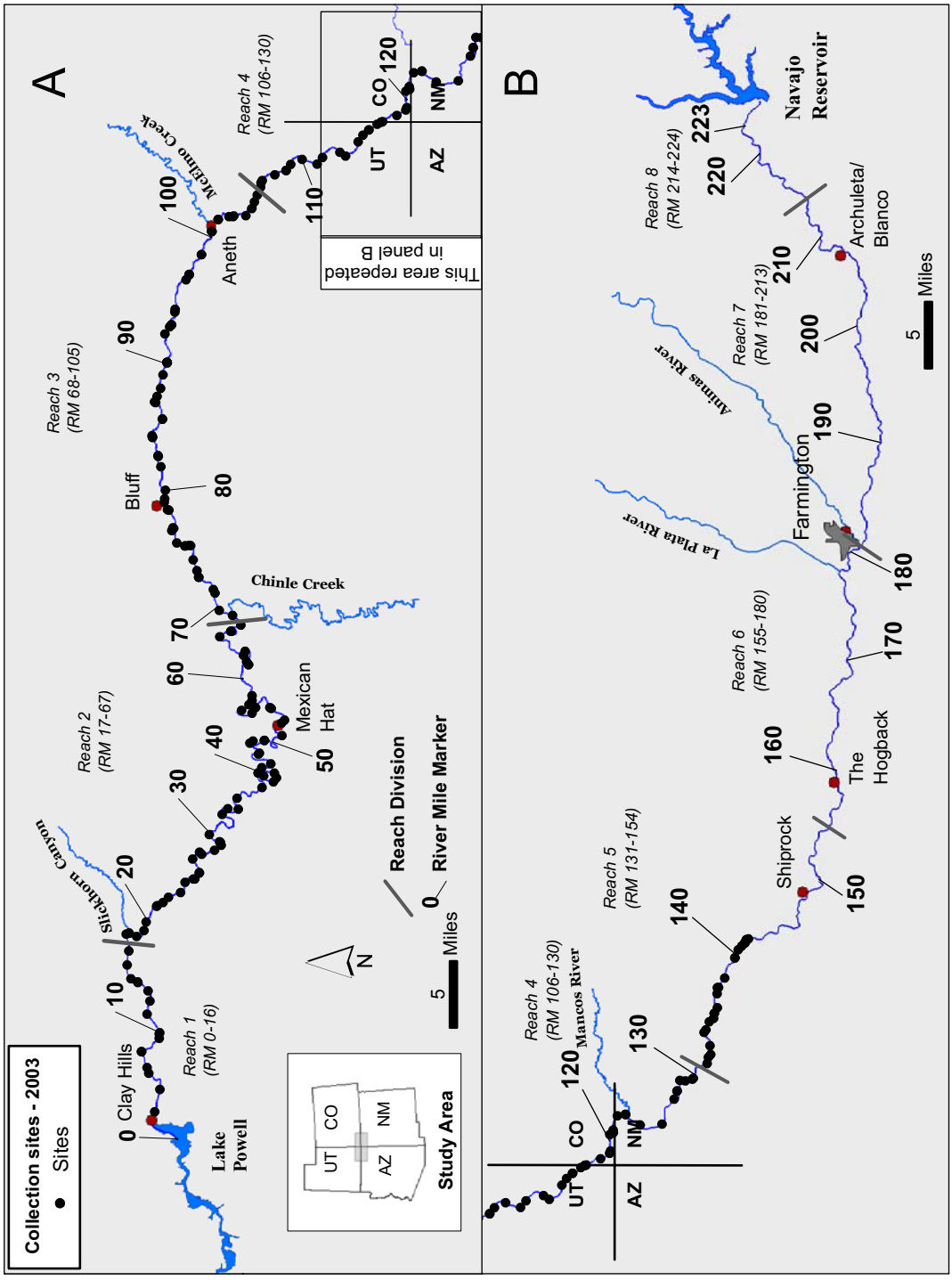

Figure 4. Map of San Juan River localities sampled during the 2003 larval razorback sucker survey (15 April - 18 June 2003)

Table 2. Summary of the 2003 San Juan River larval razorback sucker project fish collections. Effort = 7,329.5 m^2.

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	26,714	64.9	191	91.8
common carp	I	2	*	2	1.0
roundtail chub	N	-	-	-	-
fathead minnow	I	7,714	18.7	130	62.5
Colorado pikeminnow	N	75	0.2	36	17.3
speckled dace	N	160	0.4	49	23.6
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	5,088	12.3	130	62.5
bluehead sucker	N	715	1.7	72	34.6
razorback sucker	N	472	1.1	31	14.9
undetermined Catostomidae		-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	1	*	1	0.5
channel catfish	I	22	0.1	12	5.8
TROUT					
kokanee salmon	I	1	*	1	0.5
KILLIFISHES					
plains killifish	I	43	0.1	28	13.5
LIVEBEARERS					
western mosquitofish	I	153	0.4	29	13.9
SUNFISHES					
green sunfish	I	1	*	1	0.5
bluegill	I	-	-	-	-
largemouth bass	I	20	0.1	11	5.3
TOTAL		41,181			

[1] N = native; I = introduced

[2] Frequency and % frequency of occurrence are based on n=208 samples.

* Value is less than 0.05%

the red shiner collected in 2003. Fathead minnow, *Pimephales promelas*, comprised 18.7% of the entire fish catch in 2003. The total number of fathead minnows collected in 2003 were 60.4% less than the total catch in 2002. Reach 3 produced 82.0% of all fathead minnows collected in 2003.

Light-traps were employed ten times during the 2003 razorback survey, once in reach 5, three times each in reaches 4, 3 and 2. Light-trap collections accounted for 0.6% of the total catch (n=270) in 2003. Catostomids constituted 38.1% of the specimens collected. Of the 103 catostomids 8.7% were razorback sucker (Table 3). Non-native cyprinids comprised 54.1% of the total light-trap catch, with red shiner accounting for 80.2% of the cyprinids. The 2003 survey represents the fourth year since the project began in 1997 that light-traps proved successful in collecting larval razorback sucker.

The first 2003 collecting effort took place between 15 and 23 April 2003 (Figure 5). Although this trip produced the second greatest number of fish collected in 2003 (n=13,645) and the highest CPUE (612.5 fish per 100 m^2 sampled), larval catostomids comprised only 0.15% of the total catch, 0.9 fish per 100 m^2 (Table 4). The first larval catostomid (flannelmouth sucker) was documented in reach 2 (river mile 55.4) on 20 April 2003. An additional thirteen specimens were subsequently collected downstream. Only one larval catostomid was collected in reach 1 during the first trip of 2003. Conversely non-native cyprinids comprised 99.3% of the entire catch during the trip 1, 607.6 fish per 100 m^2 sampled. None of these fish were represented by larval cyprinids. Cyprinid spawning did not begin until later in the spring. Reach 3 produced the greatest numbers of cyprinids (n= 6337), primarily red shiner. Colorado pikeminnow (stocked fish) were collected in reaches 3 and 2, with the highest number of specimens (n= 26) collected in reach 2.

The second trip conducted between 13 and 22 May 2003 saw a slight decrease in the total catch (n=12,833; Table 5) and had the second highest CPUE of the three trips (547.8 fish per 100 m^2 sampled). Larval catostomids were much more abundant than the previous trip. Catostomids were collected throughout all of the reaches and comprised almost 60% of the entire catostomid catch in 2003 (n=3701), 158.0 fish per 100 m^2 sampled. Flannelmouth sucker constituted 84.4% of all the larval catostomids collected during trip 2, 133.3 fish per 100 m^2 sampled. The largest numbers of flannelmouth sucker were collected in reaches 4 and 3. Interestingly, the second most abundant catostomid was razorback sucker which comprised 9.8% (n=363) of the catostomid catch during the second trip (Figure 6), 15.5 fish per 100 m^2 sampled. All of the razorback sucker were collected within reaches 3, 2, and 1 (Figure 7), with the highest number (n=184) collected in reach 1, accounting for 50.0% of the total razorback sucker catch on the second trip. Colorado pikeminnow (stocked fish) were collected in every reach except 5 with the highest numbers occurring in reach 2, closely followed by reach 1 (n=10 and n=7). Speckled dace were captured in every reach with the highest numbers found in reach 3 (n= 30). Native cyprinids comprised 0.5% of the total CPUE of trip 2 (2.9 fish per 100 m^2). On 15 May 2003, in reach 4, the first larval speckled dace was collected (river mile 111.1) as well as the first larval fathead minnow. Larval fathead minnow were collected in many subsequent locations downstream. Non-native cyprinids accounted for 70.5% of the total catch in the second trip, 385.9 fish per 100 m^2 sampled. Of the non-native cyprinids, 92.5% were represented by red shiner, with the highest numbers collected in reach 3 (n= 5,414). Red shiners collected in trip 2 were still represented by non-larval fish.

The third and final trip occurred from 9 to 18 June 2003. More fish were collected on this trip than either of the previous trips (n=14,703; Table 6), yet trip 3 had the lowest CPUE of all the trips (532.9 fish per 100 m^2). Reach 3 accounted for 70.9% of all fish collected in the third trip. Catostomids comprised 17.4% of the total fish catch, 92.5 fish per 100 m^2 sampled. Thirty-one percent fewer catostomids were collected in the third trip as compared to the second trip. Several catostomids captured had developed into larger juveniles and were identified in the field, measured and released. If the identification was questionable then the specimen was preserved and returned to the lab for further inspection. Flannelmouth sucker comprised 76.2% of the catostomid catch on the third trip, 70.5 fish per 100 m^2 sampled. Reach 3 accounted for the majority of flannelmouth sucker (n=1,295), while they were least abundant in reach 1 (n=18). Bluehead sucker was second in catostomid abundance, accounting for

Table 3. Summary of 2003 San Juan River larval razorback sucker 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	134	49.6	5	50.0
common carp	I	-	-	-	-
roundtail chub	N	-	-	-	-
fathead minnow	I	12	4.4	2	20.0
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	21	7.8	3	30.0
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	73	27.0	5	50.0
bluehead sucker	N	21	7.8	4	40.0
razorback sucker	N	9	3.3	2	20.0
undetermined Catostomidae	N	-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
TROUT					
kokanee salmon	I	-	-	-	-
KILLIFISHES					
plains killifish	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	-	-	-	-
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		270			

[1] N = native; I = introduced

[2] Frequency and % frequency of occurrence are based on n=10 samples.

* Value is less than 0.05%

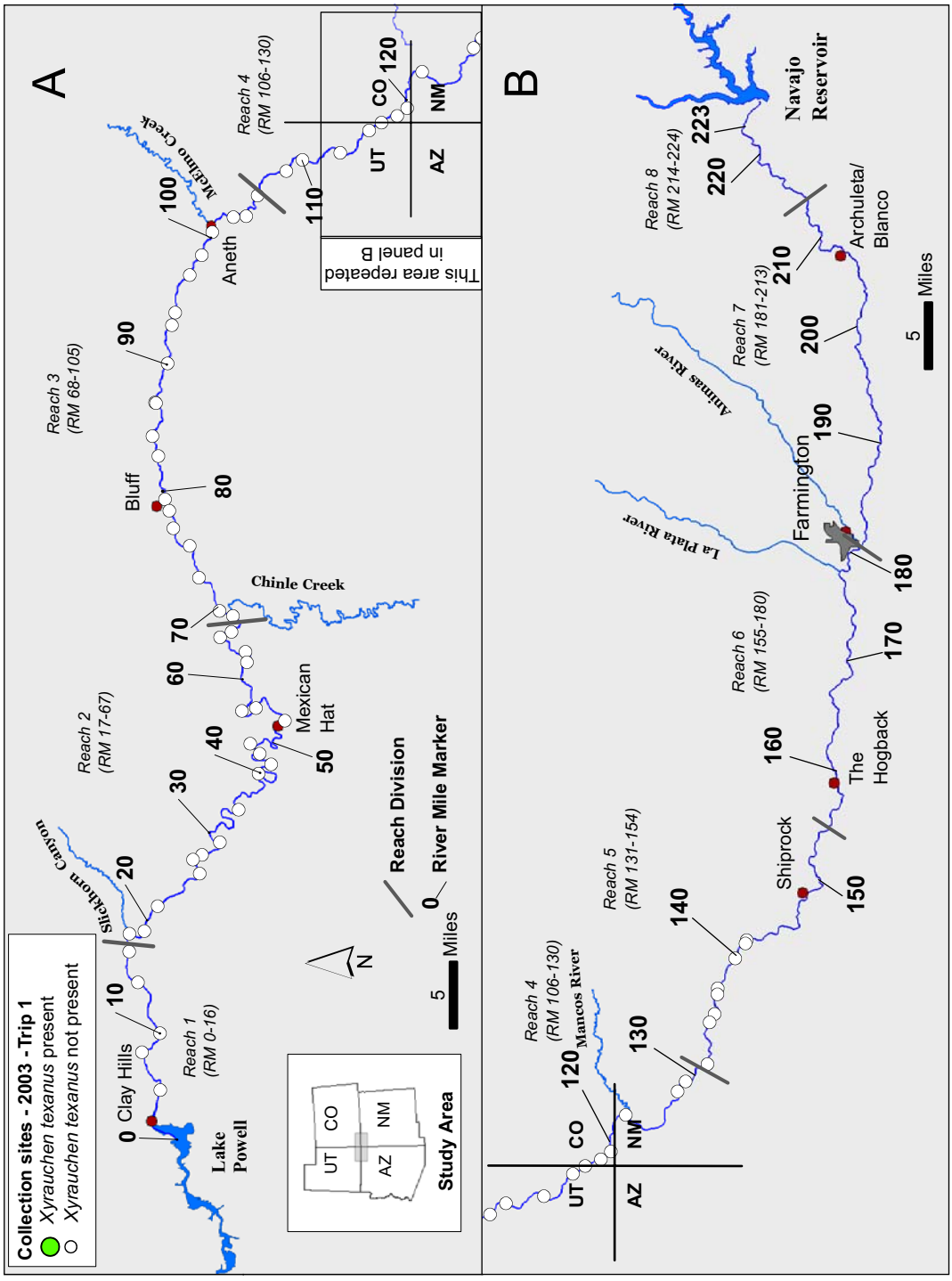

Figure 5. Map of localities sampled during the 1st San Juan River larval razorback sucker project fish collection (15 - 23 April, 2003). There were no razorback sucker collected.

Table 4. Summary of the 1st San Juan River larval razorback sucker project collections (15 - 23 April, 2003). Effort = 2,227.7 m^2.

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	13,154	96.4	59	95.2
common carp	I	-	-	-	-
roundtail chub	N	-	-	-	-
fathead minnow	I	398	2.9	38	61.3
Colorado pikeminnow	N	38	0.3	14	22.6
speckled dace	N	18	0.1	8	12.9
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	20	0.1	9	14.5
bluehead sucker	N	1	*	1	1.6
razorback sucker	N	-	-	-	-
undetermined Catostomidae		-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	2	*	2	3.2
TROUT					
kokanee salmon	I	1	*	1	1.6
KILLIFISHES					
plains killifish	I	7	0.1	6	9.7
LIVEBEARERS					
western mosquitofish	I	5	*	4	6.5
SUNFISHES					
green sunfish	I	1	*	1	1.6
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		13,645			

[1] N = native; I = introduced

[2] Frequency and % frequency of occurrence are based on n=62 samples.

* Value is less than 0.05%

Table 5. Summary of the 2nd San Juan River larval razorback sucker project fish collections (13 - 22 May, 2003). Effort = 2,342.6 m^2.

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	8,362	65.2	65	89.0
common carp	I	-	-	-	-
roundtail chub	N	-	-	-	-
fathead minnow	I	679	5.3	33	45.2
Colorado pikeminnow	N	24	0.2	13	17.8
speckled dace	N	44	0.3	20	27.4
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	3,123	24.3	65	89.0
bluehead sucker	N	215	1.7	34	46.6
razorback sucker	N	363	2.8	22	30.1
undetermined Catostomidae		-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	10	0.1	6	8.2
TROUT					
kokanee salmon	I	-	-	-	-
KILLIFISHES					
plains killifish	I	8	0.1	5	6.8
LIVEBEARERS					
western mosquitofish	I	5	*	1	1.4
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		12,833			

[1] N = native; I = introduced

[2] Frequency and % frequency of occurrence are based on n=73 samples.

* Value is less than 0.05%

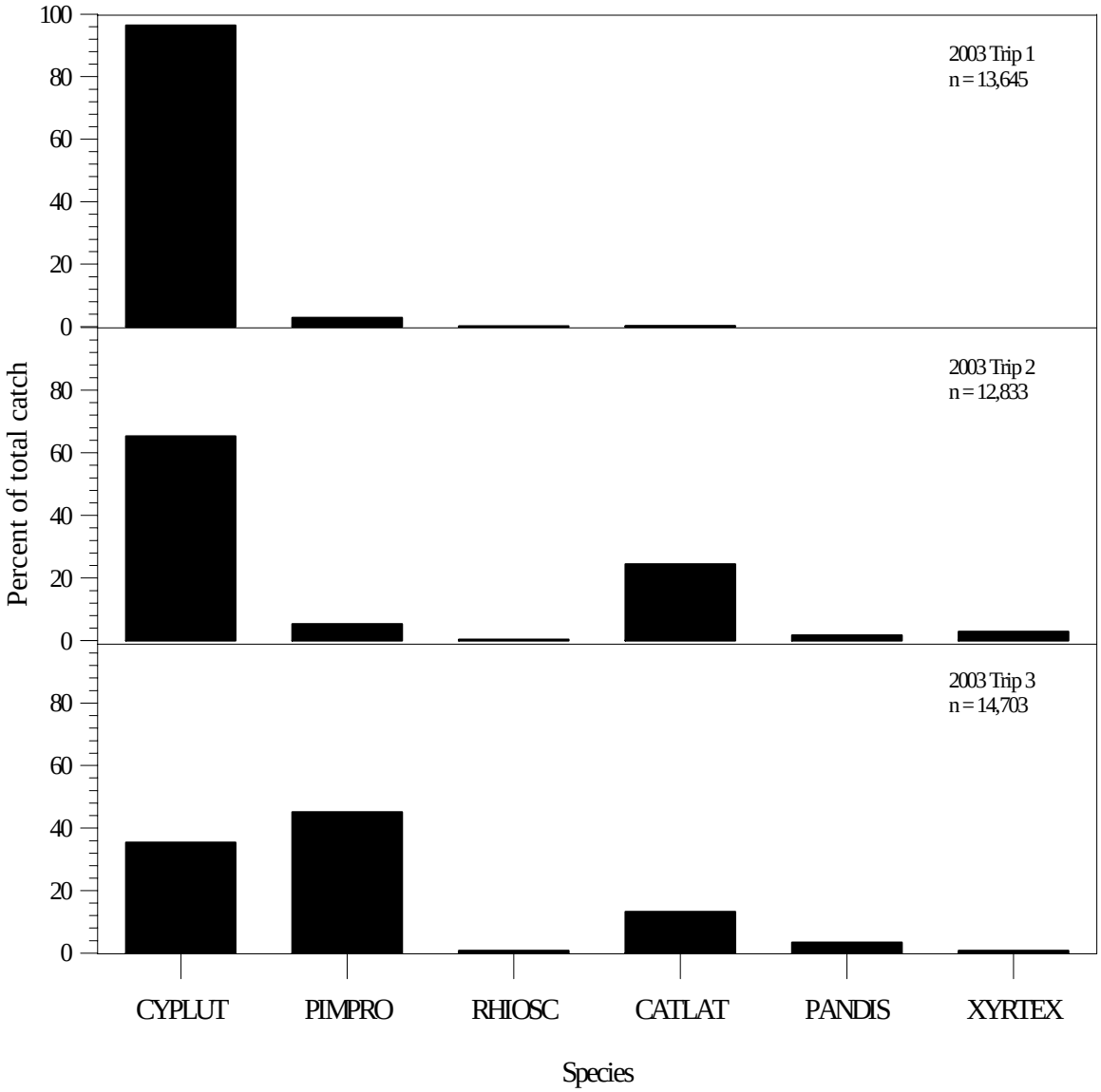

Figure 6. Ichthyofaunal composition of the most abundant species in 2003 sampling efforts by trip.

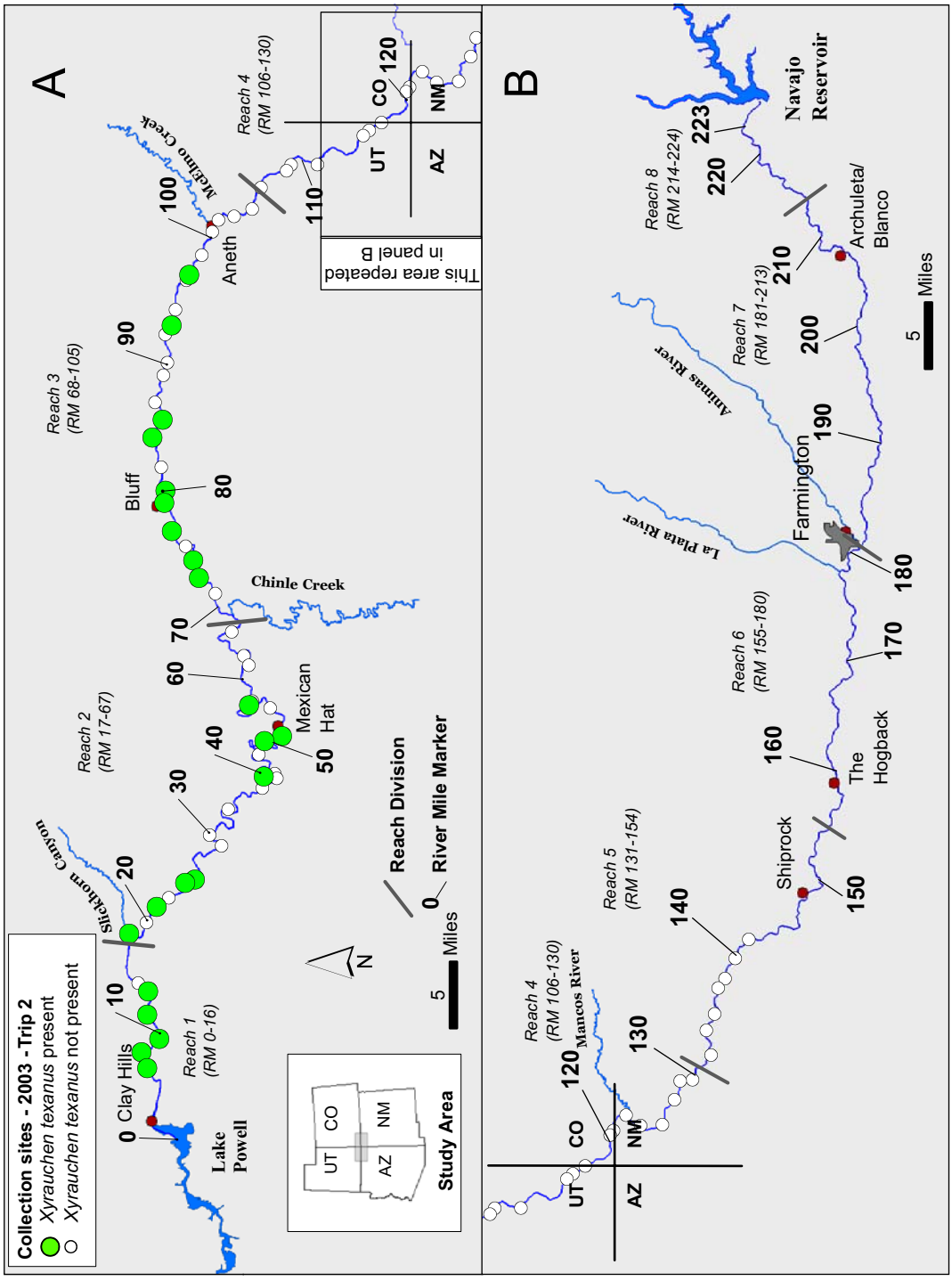

Figure 7. Map of localities sampled during the 2nd San Juan River larval razorback sucker fish collection (13 - 22 May, 2003).

Table 6. Summary of the 3rd San Juan River larval razorback sucker project fish collections (9 - 18 June, 2003). Effort = 2,759.2 m^2.

SPECIES	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OF OCCURRENCE[2]
CARPS AND MINNOWS					
red shiner	I	5,198	35.4	67	91.8
common carp	I	2	*	2	2.7
roundtail chub	N	-	-	-	-
fathead minnow	I	6,637	45.1	52	71.2
Colorado pikeminnow	N	13	0.1	9	12.3
speckled dace	N	98	0.7	21	28.8
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	1,945	13.2	56	76.7
bluehead sucker	N	499	3.4	37	50.7
razorback sucker	N	109	0.7	9	12.3
undetermined Catostomidae		-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	1	*	1	1.4
channel catfish	I	10	0.1	4	5.5
TROUT					
kokanee salmon	-	-	-	-	-
KILLIFISHES					
plains killifish	I	28	0.2	17	23.3
LIVEBEARERS					
western mosquitofish	I	143	1.0	24	32.9
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	20	0.1	11	15.1
TOTAL		14,703			

[1] N = native; I = introduced

[2] Frequency and % frequency of occurrence are based on n=73 samples.

* Value is less than 0.05%

19.5% of the total catostomid catch, 18.1 fish per 100 m^2 sampled. Bluehead sucker was most abundant in reach 4 (n= 282) accounting for 56.5% of the bluehead sucker catch for trip 3. The least abundant reach for bluehead sucker was reach 1 (n=2). Ninety-three percent of all the razorback sucker collected on the third trip were collected in reach 3 (Figure 8). Reaches 2 and 1 provided the remaining eight razorback sucker specimens for a total CPUE of 4.0 fish per 100 m^2 sampled during trip 3. Native cyprinids accounted for 0.8% of the total catch from trip 3. Although the percentage is low, this trip had the highest number of native cyprinids collected during 2003 and the highest CPUE (4.0 fish per 100 m^2). Larval speckled dace accounted for 88.3% of the native cyprinid catch in trip 3. Non-native cyprinids comprised 80.5% of the total catch from trip 3, 429.8 fish per 100 m^2 sampled. Fathead minnow comprised 56.0% of the non-native cyprinid catch. Ninety-one percent of fathead minnows were collected in reach 3 (n= 6,047). Red shiner was collected throughout all of the reaches with the greatest numbers found in reaches 3 and 2 (n=2,658 and n= 972, respectively). On 12 June 2003 at the confluence of McElmo Creek the first larval red shiners were collected. Virtually all of the non-native cyprinids collected in trip 3 were represented by larval specimens.

Reach analysis

The least productive reach in the 2003 razorback sucker survey was reach 1 (Table 7), and it also had the lowest CPUE, 189.9 fish per 100 m^2. In part, this can be explained by the shortness of the reach, compared to the other reaches, and the lack of backwaters, due to the low water levels experienced in 2003. Despite being the least productive reach for ichthyofauna it produced the third highest CPUE for catostomids (39.6 fish per 100 m^2). Seventy-seven percent of catostomids collected in reach 1 were larval razorback sucker, the second highest number of razorback sucker for any reach, accounting for 40% of the total razorback sucker catch and the highest razorback sucker CPUE of any reach (30.5 fish per 100 m^2). Reach 1 had the lowest CPUE for native cyprinids (1.4 fish per 100 m^2) of any reach.

Nearly equal numbers of collections were made in reach 2 and reach 3 (n=65 and n=63 respectively), yet reach 2 produced 78.2% fewer fish than reach 3 and had the second lowest CPUE (288.8 fish per 100 m^2) of all the reaches. Catostomids comprised 7.8% of the total catch in reach 2 (Table 8), and had the second lowest CPUE (22.4 fish per 100 m^2) of any reach. Flannelmouth sucker comprised 70.3% of all the catostomids collected in reach 2 and had the highest CPUE of the catostomids collected in reach 2 (15.7 fish per 100 m^2). Razorback sucker accounted for 20.0% of the total catostomid catch in reach 2. Non-native cyprinids had the highest CPUE (261.1 fish per 100 m^2) of all ichthyofauna in reach 2. Red shiner accounted for 86.9% of the total catch in reach 2 (Figure 9).

Reach 3 produced 59.2% of the total fish catch in 2003 (n=24,376), and had the highest CPUE of any reach (995.2 fish per 100 m^2). Fifty-eight percent of fish collected in reach 3 were represented by red shiner, while 14.8% of the catch was represented by catostomids (Table 9). Flannelmouth sucker comprised 85.2% of the total catostomid catch in reach 3 and accounted for the highest CPUE (125.5 fish per 100 m^2) of any reach for that species. Reach 3 produced the greatest number of razorback sucker taken in 2003 (n=200) accounting for 42.4% of all razorback sucker collected in 2003 and had a CPUE of 8.2 fish per 100 m^2. The CPUE for non-native cyprinids in reach 3 was by far the highest of any given reach (839.8 fish per 100 m^2).

Reach 4 was the second most productive reach for ichthyofauna and had the second highest CPUE (496.8 fish per 100 m^2) however, it produced 68% fewer fish than reach 3, and comprised only 19.0% of the overall catch in 2003 (Table 10). Catostomids accounted for 24.8% of the total fish collected in reach 4 and had the second highest CPUE of all reaches (123.4 fish per 100 m^2). Flannelmouth sucker were the most abundant catostomid taxon in reach 4 comprising 83.9% of the catostomid catch and had the highest CPUE of all catostomids (103.5 fish per 100 m^2). No razorback sucker were collected in reach 4. Non-native cyprinids comprised 73.7% of the catch in reach 4 and constituted the majority of the total CPUE (366.3 fish per m^2). Reach 4 had the highest CPUE for native cyprinids of any reach (4.7 fish per 100 m^2).

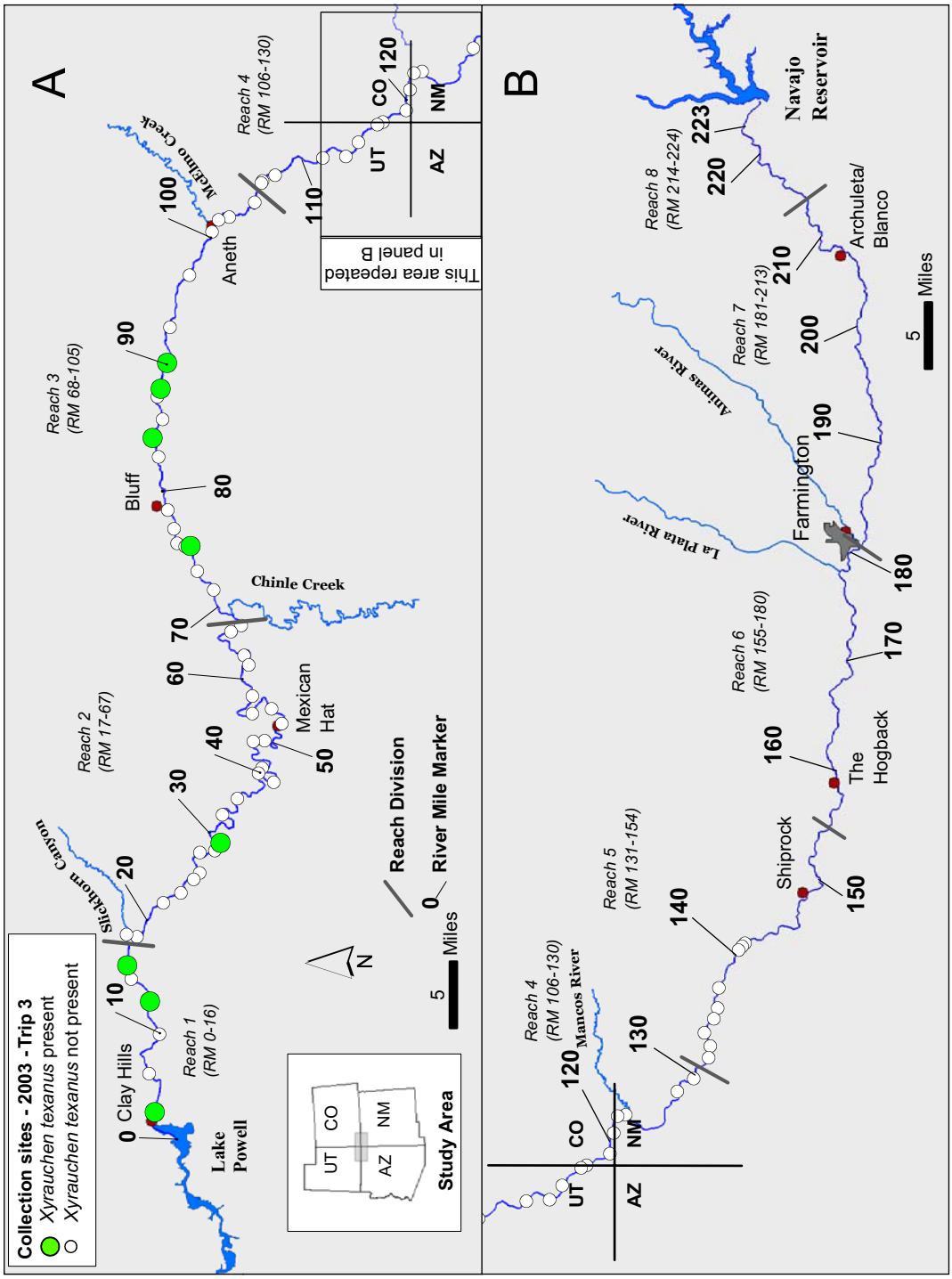

Figure 8. Map of localities sampled during the 3rd San Juan River larval razorback sucker fish collection (9 - 18 June, 2003).

Table 7. Summary of Reach 1 (RM 0-16) 2003 San Juan River larval razorback sucker project fish collections. Effort = 623.1 m^2.

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	725	61.3	16	94.1
common carp	I	-	-	-	-
roundtail chub	N	-	-	-	-
fathead minnow	I	197	16.7	12	70.6
Colorado pikeminnow	N	7	0.6	4	23.5
speckled dace	N	2	0.2	2	11.8
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	52	4.4	12	70.6
bluehead sucker	N	5	0.4	3	17.6
razorback sucker	N	190	16.1	8	47.1
undetermined Catostomidae	N	-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	2	0.2	1	5.9
TROUT					
kokanee salmon	I	-	-	-	-
KILLIFISHES					
plains killifish	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	-	-	-	-
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-.	-	-	-
largemouth bass	I	3	0.3	2	11.8
TOTAL		1,183			

[1] N = native; I = introduced

[2] Frequency and % frequency of occurrence are based on n=17 samples.

* Value is less than 0.05%

Table 8. Summary of Reach 2 (RM 17-67) 2003 San Juan River larval razorback sucker project fish collections. Effort = 1,835.9 m^2.

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	4,610	87.0	60	92.3
common carp	I	-	-	-	-
roundtail chub	N	-	-	-	-
fathead minnow	I	184	3.5	37	56.9
Colorado pikeminnow	N	42	0.8	14	21.5
speckled dace	N	22	0.4	14	21.5
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	289	5.5	36	55.4
bluehead sucker	N	40	0.8	11	16.9
razorback sucker	N	82	1.5	10	15.4
undetermined Catostomidae	N	-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	19	0.4	10	15.4
TROUT					
kokanee salmon	I	1	*	1	1.5
KILLIFISHES					
plains killifish	I	1	*	1	1.5
LIVEBEARERS					
western mosquitofish	I	7	0.1	3	4.6
SUNFISHES					
green sunfish	I	1	*	1	1.5
bluegill	I	-	-	-	-
largemouth bass	I	4	0.1	3	4.6
TOTAL		5,302			

[1] N = native; I = introduced

[2] Frequency and % frequency of occurrence are based on n=65 samples.

* Value is less than 0.05%

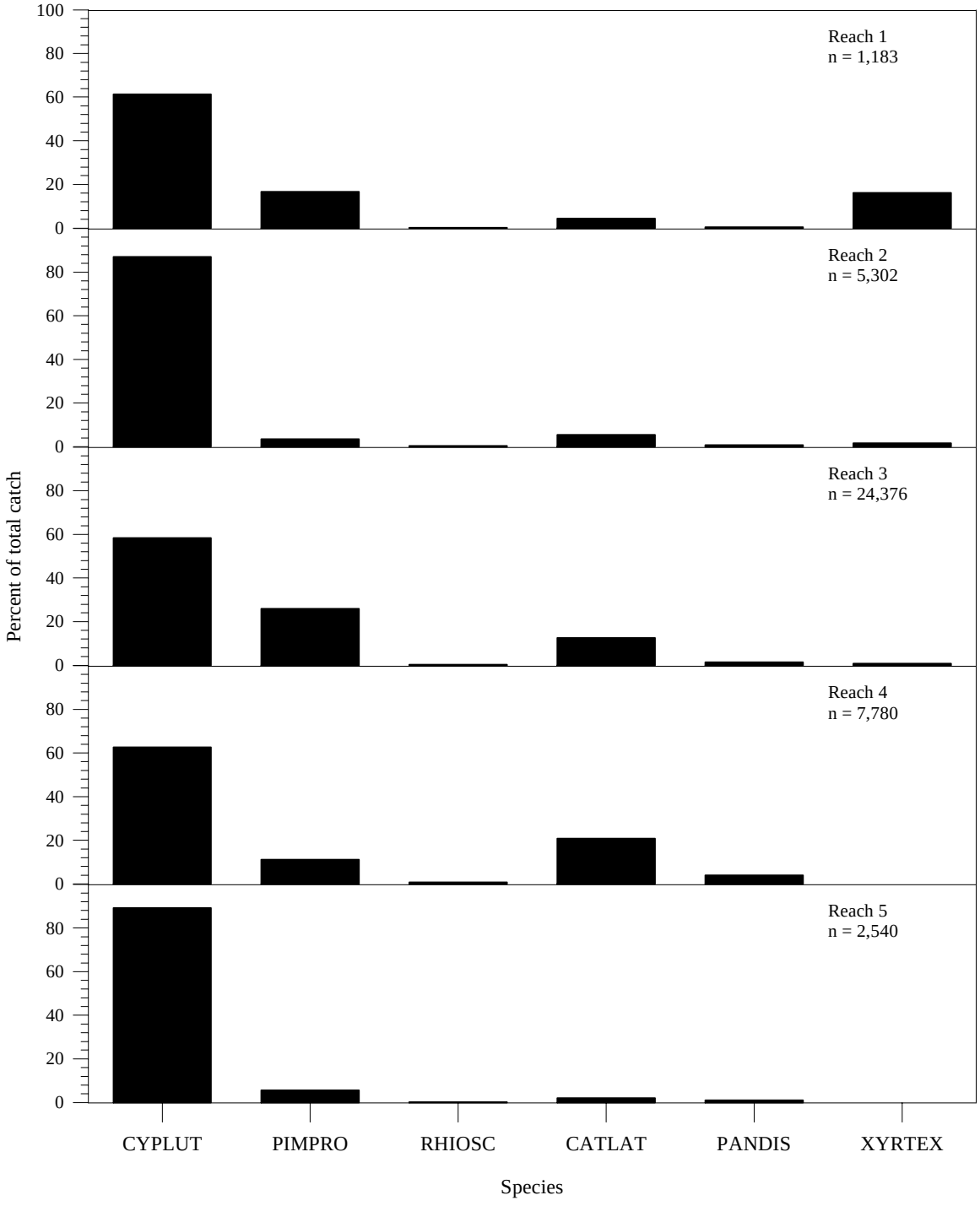

Figure 9. Ichthyofaunal composition of the most abundant species in 2003 sampling efforts by reach.

Table 9. Summary of Reach 3 (RM 68-105) 2003 San Juan River larval razorback sucker project fish collections. Effort = 2,449.3 m^2.

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	14,243	58.4	61	96.8
common carp	I	2	*	2	3.2
roundtail chub	N	-	-	-	-
fathead minnow	I	6,325	25.9	41	65.1
Colorado pikeminnow	N	10	*	8	12.7
speckled dace	N	66	0.3	20	31.7
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	3,073	12.6	45	71.4
bluehead sucker	N	333	1.4	33	52.4
razorback sucker	N	200	0.8	13	20.6
undetermined Catostomidae	N	-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	1	*	1	1.6
channel catfish	I	1	*	1	1.6
TROUT					
kokanee salmon	I	-	-	-	-
KILLIFISHES					
plains killifish	I	21	0.1	15	23.8
LIVEBEARERS					
western mosquitofish	I	92	0.4	13	20.6
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	9	*	3	4.8
TOTAL		24,376			

[1] N = native; I = introduced

[2] Frequency and % frequency of occurrence are based on n=63 samples.

* Value is less than 0.05%

Table 10. Summary of Reach 4 (RM 106-130) 2003 San Juan River larval razorback sucker project fish collections. Effort = 1,566.1 m^2.

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	4,872	62.6	35	89.7
common carp	I	-	-	-	-
roundtail chub	N	-	-	-	-
fathead minnow	I	865	11.1	23	59.0
Colorado pikeminnow	N	9	0.1	5	12.8
speckled dace	N	64	0.8	9	23.1
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	1,621	20.8	24	61.5
bluehead sucker	N	311	4.0	20	51.3
razorback sucker	N	-	-	-	-
undetermined Catostomidae		-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
TROUT					
kokanee salmon	I	-	-	-	-
KILLIFISHES					
plains killifish	I	13	0.2	9	23.1
LIVEBEARERS					
western mosquitofish	I	23	0.3	6	15.4
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	2	*	1	2.6
TOTAL		7,780			

[1] N = native; I = introduced

[2] Frequency and % frequency of occurrence are based on n=39 samples.

* Value is less than 0.05%

Approximately half (43.8%) of reach 5 was included in the razorback survey. Reach 5 and reach 2 had nearly identical CPUE (297.0 fish per 100 m^2 and 282.3 fish per 100 m^2 respectively). Reach 5 produced the greatest percentage of non-native cyprinids for any given reach (94.8%), accounting for most of the CPUE in reach 5 (281.5 fish per 100 m^2). Catostomids only comprised 3.1% of the total catch in reach 5 (Table 11), and accounted for the lowest CPUE of any of the reaches (9.2 fish per 100 m^2). Flannelmouth sucker comprised 67.1% of all catostomids collected in reach 5. There were no razorback sucker collected in reach 5.

Razorback sucker 2003

A total of 472 larval and juvenile razorback sucker were taken during the 2003 larval razorback sucker survey. A total of 31 collections yielded razorback sucker, five collections contained between ten and 29 individuals, three collections contained between 30 and 49 individuals, and three collections contained 50 or more individuals. The largest single collection of razorback sucker (n=99) was collected in reach 1 at river mile 8.1. This site is characterized as a large backwater on river right which produced 16 specimens in 2001 and 86 individuals in 2000. The first larval razorback sucker (n=6) were collected in reach 3 (river mile 97.0) on 16 May 2003, trip 2. The least developed specimens (protolarvae) collected during the 2003 razorback survey were collected on 17 May 2003 in reach 3 between river miles 94.2 - 77.1.

Larval razorback sucker were collected from reaches 3, 2, and 1 during the 2003 survey. In 2002 there was a broader spatial distribution of larval razorback sucker including reach 4, and a single individual taken in reach 5. In 2003 reach 3 produced 200 razorback sucker larvae at 13 locations. This accounted for 42.4% of the total razorback sucker catch in 2003. The most upstream collection of razorback sucker larvae was at river mile 97.0, which happened to be the first collection to produce larval razorback in 2003. Razorback sucker were collected throughout the remaining 78% of reach 3. Reach 2 accounted for 17.4% of the entire razorback sucker catch in 2003, where 82 specimens were collected in ten locations. Reach 1 accounted for 40.2% of the entire razorback sucker catch with 190 specimens collected at eight locations. Two of the eight collections that produced razorback sucker in reach 1 accounted for 78.4% (n= 99 and 50) of all of the razorback sucker collected in reach 1.

Of the thirty-one collections which produced razorback sucker in 2003 seven collections produced a total of eleven juvenile individuals, the largest of which was 37.3 mm total length (Figures 10 and 11). There were 91.2% fewer juvenile razorback sucker collected in 2003 compared to 2002. There was less evidence of a shift in habitat use by juvenile razorback sucker as compared to larval razorback sucker in 2003 compared to what was observed in 2002. All of the juvenile fish in 2003 were collected in low to zero velocity habitats and were associated with larval fish rather than being found in higher velocity shoreline habitats which was observed in 2002.

Summary

A large portion of the approximately 1,000 razorback sucker introduced to the San Juan River since the 1994 initiation of the experimental stocking effort are believed to have survived. If this assumption is true, the number of stocked razorback sucker that recruit to the adult cohort (i.e., able to reproduce) should continue to increase annually. It follows that as this segment of the population increases, so should the number and spatial distribution of collections of larval razorback sucker.

The 1998 sampling protocol resulted in the collection of over 13,000 specimens, the majority of which were larval catostomids. This 43-fold increase in number of specimens taken, compared to 1997, provided the opportunity to determine, with a higher degree of confidence (than in 1997) if razorback sucker reproduction occurred in the San Juan River during the study period. The high number of larval fish collected in combination with the large reach of river sampled also resulted in substantially better

Table 11. Summary of Reach 5 (RM 131-154) 2003 San Juan River larval razorback sucker project fish collections. Samples werecollected between RM 141.5-131 representing the lower 43.8% of Reach 5. Effort = 855.1 m^2.

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	2,264	89.1	20	83.3
common carp	I	-	-	-	-
roundtail chub	N	-	-	-	-
fathead minnow	I	143	5.6	17	70.8
Colorado pikeminnow	N	7	0.3	5	20.8
speckled dace	N	6	0.2	4	16.7
undetermined Cyprinidae		-	-	-	-
SUCKERS					
flannelmouth sucker	N	53	2.1	13	54.2
bluehead sucker	N	26	1.0	5	20.8
razorback sucker	N	-	-	-	-
undetermined Catostomidae		-	-	-	-
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
TROUT					
kokanee salmon	I	-	-	-	-
KILLIFISHES					
plains killifish	I	8	0.3	3	12.5
LIVEBEARERS					
western mosquitofish	I	31	1.2	7	29.2
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	2	0.1	2	8.3
TOTAL		2,540			

[1] N = native; I = introduced

[2] Frequency and % frequency of occurrence are based on n=24 samples.

* Value is less than 0.05%

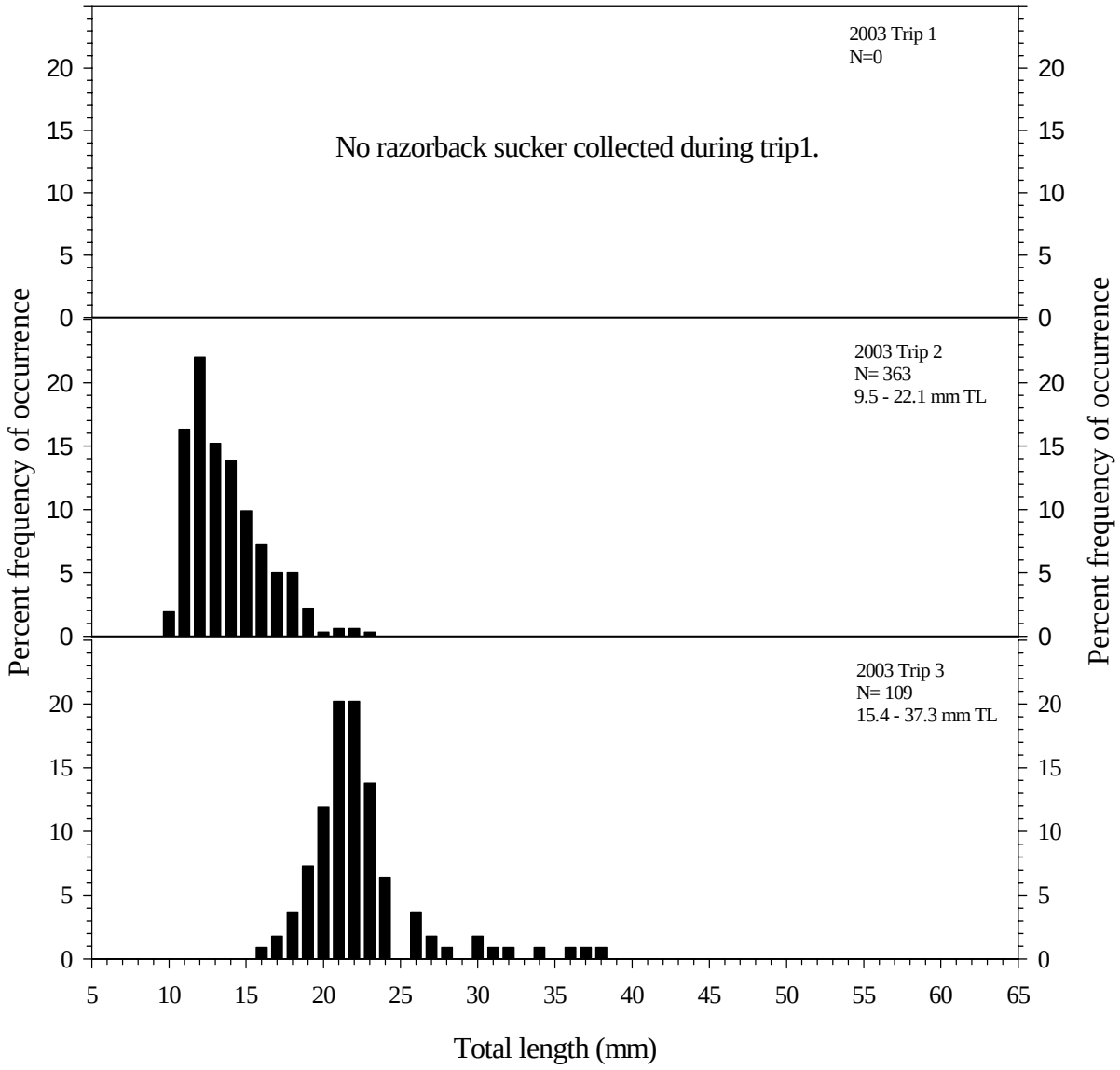

Figure 10. Length frequency histograms for razorback sucker collected from the San Juan River in 2003, by trip.

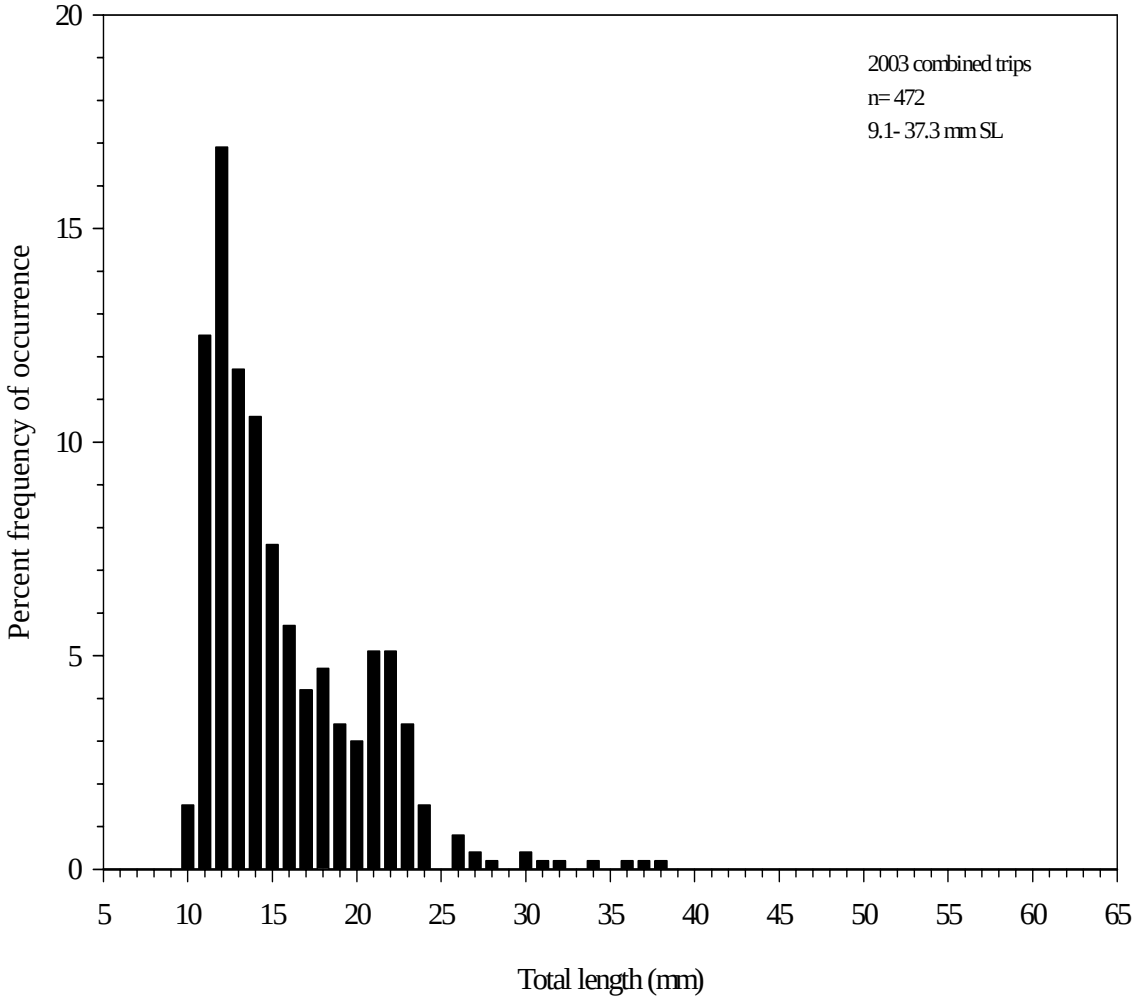

Figure 11. Length frequency histogram for all razorback suckers collected from the San Juan River in 2003.

resolution of spawning periodicity of all San Juan River catostomids. The 1998-1999 results of the larval razorback sucker study provided unequivocal documentation of reproduction in the San Juan River by members of a razorback sucker cohort that had been stocked as part of the San Juan River Basin Recovery Implementation Program.

The initial collection of larval razorback sucker in 1998 (n=2) occurred during a single sampling effort (19 - 22 May) with the specimens being taken in relatively close proximity to each other (ca. 8 river miles). The effort (1998 sampling) demonstrated that targeting sampling to collect relatively large numbers of larval sucker was an effective means of acquiring information on razorback sucker reproductive activity. Unlike the 1997 light-trap sampling project, this effort yielded a sufficient number of larval sucker so that a biologically meaningful interpretation of the data could be developed.

There were two important discoveries that resulted from the 1999 larval razorback sucker study. The first was the collection of razorback sucker larvae (n=3) from the lower portion of the San Juan River (between RM 10 - 20). As this reach of river was not sampled for larval razorback sucker in 1998, no conclusions could be made regarding expansion of the range of this species in this ontogenetic stage. The second noteworthy 1999 finding was the first collection of larval razorback sucker in light-traps. This sampling technique (light-trapping) has been successfully employed in the Upper Colorado River Basin as a mechanism by which larval razorback sucker can be monitored. The aforementioned San Juan River collection suggests that this passive collecting technique may, one day, be suitable for monitoring the San Juan River population of razorback sucker.

The 2000 project catch produced more than 14 times the number of larval razorback sucker than had been taken in 1998 and 1999 combined. The 129 larval razorback sucker collected in 2000 were taken in 21 separate collections from 9 May 2000 to 2 June 2000. Larval razorback sucker were collected at sites from RM 124.8 to RM 8.1. The 2000 collections also documented an upstream extension in the range of larval razorback sucker of 28.6 river miles and a 3.4 river mile downstream range extension. About two-thirds of the 2000 catch of larval razorback sucker was from a single collection made on 26 May 2000 at RM 8.1. The number of larval razorback sucker taken in that sample (n=86) was greater than the cumulative total of all razorback sucker larvae that had been taken prior to 2002 (n=50).

The 2001 collections provided continued documentation of reproduction by razorback sucker. Although their numbers had decreased from the 2000 collections, it is likely that the reduced number of larval razorback sucker taken in 2001 was within the normal boundaries of sample variation that would be experienced in annual fish collections of such a magnitude. The most apparent and notable result of the 2002 study was the collection of over four times as many YOY razorback sucker than had been taken overall (1998-2001) during the tenure of this study. There were several other extremely important findings in 2002 besides the large number of individuals taken. The 2002 study documented an increase in both the longitudinal distribution and abundance of naturally spawned razorback sucker and provided preliminary data on growth and habitat association of YOY razorback sucker. Likewise, the 2002 collection of numerous late metalarval and juvenile razorback sucker suggested an ontogenetic shift in habitat association and may yield insights to important distribution patterns of early life-history stages of this species. If the level of reproduction by razorback sucker continues to increase, the validity of the hypotheses will be able to be investigated during subsequent years.

For the sixth consecutive year razorback sucker reproduction was documented in the San Juan River. Although there was a 41.9% decrease in larval razorback sucker collected in 2003 compared with 2002, there were 60.2% more individuals collected in 2003 than 1998 through 2001 combined. The distribution of razorback sucker in 2003 was reduced from previous years to reaches 3, 2, and 1, with reaches 3 and 1 producing the greatest numbers of individuals.

This study continues to provide unequivocal documentation of reproduction in the San Juan River by members of a razorback sucker cohort that had been stocked as part of the San Juan River Recovery Implementation Program. There has been a relatively steady increase in the number of larval razorback

sucker taken in the San Juan River. The large number of larval razorback sucker collected in 2002 and 2003 (n=813 and 472, respectively) provides credible evidence indicative of continuing reproductive success of the augmented adult population.

As the number of stocked razorback sucker that recruit to the adult cohort (i.e., able to reproduce) continues to increase, so should the number and spatial distribution of collections of larval razorback sucker. Future studies of larval razorback sucker distribution and abundance will provide extremely important information on the level of reproduction of this species and direction necessary to achieve recovery.

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Appendix I. Summary of larval razorback sucker collected in the San Juan River.

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
1998	**TOTAL**	**2**					
WHB98-143	42207	1	12.7	mesolarva	21 May 1998	88.8	larval fish seine
WHB98-147	42218	1	12.1	mesolarva	22 May 1998	80.2	larval fish seine
1999	**TOTAL**	**7**					
WHB99-075	44201	1	11.2	mesolarva/yolk	04 May 1999	82.5	larval fish seine
WHB99-105	44254	1	14.1	mesolarva	12-13 May 1999	96.2	light-trap
WHB99-106	44257	1	10.2	mesolarva	12-13 May 1999	96.2	light-trap
WHB99-112	44269	1	11.2	protolarva/yolk	13 May 1999	82.5	larval fish seine
WHB99-167	44421	1	17.9	mesolarva	14 June 1999	16.5	larval fish seine
WHB99-169	44428	1	20.7	metalarva	14 June 1999	13.1	larval fish seine
WHB99-170	44435	1	13.8	mesolarva	14 June 1999	11.5	larval fish seine
2000	**TOTAL**	**129**					
WHB00-104	47770	1	10.4	mesolarva	09 May 2000	104.6	larval fish seine
WHB00-108	47779	2	10.6 - 11.3	mesolarvae	10 May 2000	99.7	larval fish seine
WHB00-109	47784	1	10.9	mesolarva	10 May 2000	99.4	larval fish seine
WHB00-115	47805	5	10.4 - 11.3	mesolarvae/yolk	10 May 2000	89.2	larval fish seine
WHB00-116	47808	1	11.1	mesolarva	10 May 2000	88.8	larval fish seine
WHB00-118	47814	3	10.5 - 10.8	mesolarvae	11 May 2000	85.6	larval fish seine
WHB00-119	47819	5	10.6 - 11.8	mesolarvae	11 May 2000	84.1	larval fish seine
WHB00-121	47824	1	10.6	mesolarva	11 May 2000	82.3	larval fish seine
WHB00-122	47829	6	10.4 - 13.2	mesolarvae	11 May 2000	79.4	larval fish seine
WHB00-130	47855	1	15.2	mesolarva	23 May 2000	69.5	larval fish seine
WHB00-133	47864	1	10.0	mesolarva	23 May 2000	59.8	larval fish seine
WHB00-139	47878	1	14.9	mesolarva	24 May 2000	40.5	larval fish seine
WHB00-143	47882	2	9.3 - 18.6	mesolarvae	25 May 2000	23.3	larval fish seine
WHB00-149	47896	1	16.1	mesolarva	26 May 2000	15.4	larval fish seine
WHB00-150	47902	1	17.6	mesolarva	26 May 2000	14.0	larval fish seine
WHB00-152	47910	6	15.3 - 17.9	mesolarvae	26 May 2000	13.0	larval fish seine
WHB00-154	47918	1	12.2	mesolarva	26 May 2000	10.0	larval fish seine
WHB00-155	47924	2	13.6 - 16.4	mesolarvae	26 May 2000	8.8	larval fish seine
WHB00-156	47930	86	9.4 - 18.1	meso - metalarvae	26 May 2000	8.1	larval fish seine
WHB00-158	47937	1	16.4	mesolarva	01 June 2000	124.8	larval fish seine
WHB00-168	47978	1	12.0	mesolarva	02 June 2000	104.5	larval fish seine
2001	**TOTAL**	**50**					
WHB01-123	48806	2	15.5 - 16.0	mesolarvae	16 May 2001	62.1	larval fish seine
WHB01-133	48832	1	13.8	mesolarva	17 May 2001	21.1	light-trap
WHB01-134	48834	1	13.5	mesolarva	17 May 2001	21.0	light-trap
WHB01-137	48843	1	11.3	mesolarva	18 May 2001	16.5	larval fish seine
WHB01-138	48846	1	15.5	mesolarva	18 May 2001	16.4	larval fish seine
WHB01-145	48873	11	10.1 - 14.8	mesolarvae	18 May 2001	9.5	larval fish seine
WHB01-146	48879	4	11.7 - 14.8	mesolarvae	18 May 2001	8.5	larval fish seine
WHB01-157	48918	1	14.3	mesolarva	30 May 2001	124.8	larval fish seine
WHB01-172	48978	1	17.5	metalarva	31 May 2001	89.2	larval fish seine
WHB01-173	48984	1	13.0	mesolarva	31 May 2001	88.8	larval fish seine
WHB01-175	48992	1	19.4	metalarva	1 June 2001	80.2	larval fish seine
WHB01-200	49078	4	22.0 - 26.3	metalarvae	14 June 2001	13.0	larval fish seine
WHB01-201	49082	1	17.2	metalarva	14 June 2001	11.9	larval fish seine
WHB01-203	49096	4	16.0 - 18.5	meso - metalarvae	14 June 2001	10.0	larval fish seine
WHB01-205	49108	16	16.1 - 28.8	metalarvae/juvenile	14 June 2001	8.1	larval fish seine
TOTAL (1998-2001)		**188**					

Appendix I. Summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
2002 TOTAL		**812**					
WHB02-028		2	10.2- 11.0	protolarvae	29 April 2002	76.1	larval fish seine
WHB02-029		1	10.8	protolarva	29 April 2002	75.5	larval fish seine
WHB02-032		1	10.8	protolarva	29 April 2002	68.3	larval fish seine
WHB02-033		18	10.2- 11.5	proto - mesolarvae/yolk	29 April 2002	66.8	larval fish seine
WHB02-037		2	11.0- 11.1	mesolarvae	30 April 2002	58.2	larval fish seine
WHB02-039		1	10.5	mesolarva	30 April 2002	54.5	larval fish seine
WHB02-040		6	10.5- 12.8	proto - mesolarvae	30 April 2002	52.3	larval fish seine
WHB02-043		27	9.7- 12.3	proto - mesolarvae/yolk	1 May 2002	43.0	larval fish seine
WHB02-046		1	12.9	mesolarva	1 May 2002	25.0	larval fish seine
WHB02-047		12	10.9- 11.9	proto - mesolarvae	1 May 2002	23.5	larval fish seine
WHB02-048		91	10.0- 13.8	proto - mesolarvae/yolk	1 May 2002	21.2	larval fish seine
WHB02-051		1	10.7	mesolarva	2 May 2002	12.9	larval fish seine
WHB02-052		18	10.7- 13.3	mesolarvae	2 May 2002	11.6	larval fish seine
WHB02-053		2	11.3- 13.2	mesolarvae	2 May 2002	9.2	larval fish seine
WHB02-054		89	10.1- 13.9	mesolarvae	2 May 2002	8.7	larval fish seine
WHB02-055		24	10.1- 14.1	mesolarvae	2 May 2002	5.2	larval fish seine
WHB02-064		2	12.1- 13.7	mesolarvae	16 May 2002	129.1	larval fish seine
WHB02-066		3	12.4- 13.9	mesolarvae	16 May 2002	124.8	larval fish seine
WHB02-067		7	12.5- 15.5	mesolarvae	16 May 2002	122.6	larval fish seine
WHB02-070		5	11.0- 12.6	mesolarvae	16 May 2002	116.2	light-trap
WHB02-073		3	13.0- 13.6	mesolarvae	17 May 2002	110.1	larval fish seine
WHB02-078		5	13.5- 14.6	mesolarvae	17 May 2002	97.1	light-trap
WHB02-079		39	12.8- 18.3	meso - metalarvae	18 May 2002	95.8	larval fish seine
WHB02-080		1	18.7	metalarva	18 May 2002	93.7	larval fish seine
WHB02-081		36	12.6- 19.8	meso - metalarvae	18 May 2002	93.0	larval fish seine
WHB02-082		1	15.3	mesolarva	18 May 2002	88.8	larval fish seine
WHB02-083		2	13.4- 17.6	meso - metalarvae	18 May 2002	87.8	larval fish seine
WHB02-084		1	11.0	mesolarva	18 May 2002	85.8	larval fish seine
WHB02-085		3	13.4- 18.8	meso - metalarvae	18 May 2002	82.8	larval fish seine
WHB02-086		21	11.5- 18.8	meso - metalarvae	18 May 2002	78.9	light-trap
WHB02-087		4	11.9- 21.5	meso - metalarvae	19 May 2002	77.2	larval fish seine
WHB02-088		14	15.5- 26.4	meso - metalarvae	29 May 2002	75.7	larval fish seine
WHB02-090		4	17.8- 30.7	metalarvae - juvenile	29 May 2002	71.9	larval fish seine
WHB02-091		51	14.9- 26.8	meso - metalarvae	29 May 2002	71.3	larval fish seine
WHB02-093		19	16.8- 29.7	mesolarvae - juvenile	29 May 2002	60.6	larval fish seine
WHB02-094		1	20.3	metalarva	30 May 2002	58.2	larval fish seine
WHB02-096		71	12.4- 26.6	meso - metalarvae	30 May 2002	52.5	larval fish seine
WHB02-097		4	14.8- 24.3	meso - metalarvae	30 May 2002	50.7	larval fish seine
WHB02-098		1	20.6	metalarva	30 May 2002	48.0	larval fish seine
WHB02-100		11	10.9- 26.5	meso - metalarvae	30 May 2002	41.7	larval fish seine
WHB02-101		2	20.1- 26.7	metalarvae	31 May 2002	38.9	larval fish seine
WHB02-104		2	18.6- 21.0	metalarvae	31 May 2002	29.0	larval fish seine
WHB02-105		7	17.4- 29.7	meso - metalarvae	31 May 2002	25.2	larval fish seine
WHB02-106		50	14.5- 33.4	mesolarvae - juvenile	31 May 2002	23.4	larval fish seine
WHB02-107		1	33.3	juvenile	31 May 2002	17.6	larval fish seine
WHB02-109		1	14.6	mesolarva	1 June 2002	11.5	larval fish seine
WHB02-110		3	20.8- 25.3	metalarvae	1 June 2002	9.6	larval fish seine
WHB02-111		13	12.6- 35.4	mesolarvae - juvenile	1 June 2002	7.3	larval fish seine
WHB02-112		4	14.7- 24.3	meso - metalarvae	1 June 2002	2.8	larval fish seine
WHB02-118		1	35.8	juvenile	11 June 2002	134.5	larval fish seine
WHB02-121		1	33.1	juvenile	11 June 2002	128.1	larval fish seine
WHB02-126		2	29.4- 35.3	metalarvae - juvenile	12 June 2002	116.2	larval fish seine
WHB02-128		1	30.9	juvenile	12 June 2002	109.8	larval fish seine
WHB02-130		2	37.2- 49.0	juvenile	12 June 2002	103.2	larval fish seine
WHB02-133		3	32.4- 43.4	juvenile	13 June 2002	94.0	larval fish seine
WHB02-134		23	29.7- 55.2	metalarvae - juvenile	13 June 2002	93.0	larval fish seine
WHB02-135		48	20.4- 50.8	metalarvae - juvenile	13 June 2002	91.6	larval fish seine
WHB02-137		2	37.0- 38.1	juvenile	13 June 2002	84.6	larval fish seine

Appendix I. Summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
2002 (cont.)							
WHB02-138		14	31.7 - 40.3	juvenile	13 June 2002	82.6	larval fish seine
WHB02-139		4	33.9 - 52.0	juvenile	13 June 2002	79.7	larval fish seine
WHB02-140		8	18.1 - 46.7	mesolarvae - juvenile	13 June 2002	77.1	larval fish seine
WHB02-141		1	53.1	juvenile	27 June 2002	75.4	larval fish seine
WHB02-142		2	35.6 - 49.3	juvenile	27 June 2002	74.9	larval fish seine
WHB02-146		1	51.1	juvenile	28 June 2002	68.7	larval fish seine
WHB02-148		2	59.5 - 62.4	juvenile	28 June 2002	62.3	larval fish seine
WHB02-149		8	41.8 - 54.4	juvenile	28 June 2002	61.3	larval fish seine
WHB02-150		1	39.8	juvenile	28 June 2002	60.2	larval fish seine
2003	**TOTAL**	**472**					
WHB03-096		6	12.6 - 15.8	mesolarvae	16 May 2003	97	larval fish seine
WHB03-099		33	9.5 - 14.6	proto - mesolarvae	17 May 2003	94.2	larval fish seine
WHB03-104		7	9.8 - 12.4	proto - mesolarvae	17 May 2003	85.6	larval fish seine
WHB03-105		19	10.1 - 14.5	proto - mesolarvae	17 May 2003	84.2	larval fish seine
WHB03-107		8	10.0 - 12.0	proto - mesolarvae	17 May 2003	80.2	light-trap
WHB03-108		7	9.9 - 14.1	proto - mesolarvae	18 May 2003	79.3	larval fish seine
WHB03-109		6	10.7 - 14.1	mesolarvae	18 May 2003	77.1	larval fish seine
MAF03-007		11	9.1 - 14.3	mesolarvae	18 May 2003	73.8	larval fish seine
MAF03-008		2	12.7 - 12.8	mesolarvae	18 May 2003	72.5	larval fish seine
MAF03-014		1	12.1	mesolarva	19 May 2003	57.9	larval fish seine
MAF03-016		31	10.2 - 13.9	mesolarvae	19 MAy 2003	50.9	larval fish seine
MAF03-017		3	11.2 - 11.8	mesolarvae	19 May 2003	48.3	larval fish seine
MAF03-021		1	12	mesolarva	20 May 2003	40.4	larval fish seine
MAF03-026		1	11.7	mesolarva	20 May 2003	24.5	larval fish seine
MAF03-027		5	10.2 - 13.2	mesolarvae	21 May 2003	23.8	light-trap
MAF03-029		4	10.1 - 13.6	mesolarvae	21 May 2003	21	larval fish seine
MAF03-031		34	10.6 - 19.2	meso - metalarva	21 May 2003	17.7	larval fish seine
MAF03-033		5	9.5 - 18.0	mesolarvae	22 May 2003	13.1	larval fish seine
MAF03-034		19	13 - 17.8	mesolarvae	22 May 2003	11.4	larval fish seine
MAF03-035		11	10.3 - 19.0	proto - mesolarvae	22 May 2003	9.6	larval fish seine
MAF03-036		99	10.2 - 22.1	meso - metalarvae	22 May 2003	8.1	larval fish seine
MAF03-037		50	10 - 21.1	meso - metalarvae	22 May 2003	6.9	larval fish seine
WHB03-141		16	18.3 - 23.7	meso - metalarvae	13 June 2003	90.1	larval fish seine
WHB03-142		1	33.1	juvenile	13 June 2003	88.1	larval fish seine
WHB03-145		81	15.4 - 29.4	mesolarvae - juvenile	13 June 2003	84.1	larval fish seine
WHB03-151		3	22.8 - 35.3	metalarva - juvenile	14 June 2003	75.1	larval fish seine
WHB03-168		1	26.0	juvenile	16 June 2003	33.5	larval fish seine
WHB03-169		1	26.7	juvenile	16 June 2003	28.8	larval fish seine
WHB03-178		3	26.9 - 36.1	juvenile	17 June 2003	15.4	larval fish seine
WHB03-180		2	30.2 - 37.3	juvenile	17 June 2003	12.3	larval fish seine
WHB03-183		1	22.4	mesolarvae	18 June 2003	3.3	larval fish seine
TOTAL (1998 - 2003)		**1,472**					

Appendix II. Detailed summary of larval razorback sucker collected in the San Juan River.

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
1998	**TOTAL**	**2**					
WHB98-143	42207	1	12.7	mesolarva	21 May 1998	88.8	larval fish seine
WHB98-147	42218	1	12.1	mesolarva	22 May 1998	80.2	larval fish seine
1999	**TOTAL**	**7**					
WHB99-075	44201	1	11.2	mesolarva/yolk	04 May 1999	82.5	larval fish seine
WHB99-105	44254	1	14.1	mesolarva	12-13 May 1999	96.2	light-trap
WHB99-106	44257	1	10.2	mesolarva	12-13 May 1999	96.2	light-trap
WHB99-112	44269	1	11.2	protolarva/yolk	13 May 1999	82.5	larval fish seine
WHB99-167	44421	1	17.9	mesolarva	14 June 1999	16.5	larval fish seine
WHB99-169	44428	1	20.7	metalarva	14 June 1999	13.1	larval fish seine
WHB99-170	44435	1	13.8	mesolarva	14 June 1999	11.5	larval fish seine
2000	**TOTAL**	**129**					
WHB00-104	47770	1	10.4	mesolarva	09 May 2000	104.6	larval fish seine
WHB00-108	47779	2	10.6	mesolarva	10 May 2000	99.7	larval fish seine
			11.3	mesolarva	10 May 2000	99.7	larval fish seine
WHB00-109	47784	1	10.9	mesolarva	10 May 2000	99.4	larval fish seine
WHB00-115	47805	5	10.4	mesolarva/yolk	10 May 2000	89.2	larval fish seine
			10.0	mesolarva	10 May 2000	89.2	larval fish seine
			10.2	mesolarva	10 May 2000	89.2	larval fish seine
			10.3	mesolarva	10 May 2000	89.2	larval fish seine
			11.3	mesolarva	10 May 2000	89.2	larval fish seine
WHB00-116	47808	1	11.1	mesolarva	10 May 2000	88.8	larval fish seine
WHB00-118	47814	3	10.5	mesolarva	11 May 2000	85.6	larval fish seine
			10.8	mesolarva	11 May 2000	85.6	larval fish seine
			10.8	mesolarva	11 May 2000	85.6	larval fish seine
WHB00-119	47819	5	10.6	mesolarva	11 May 2000	84.1	larval fish seine
			10.8	mesolarva	11 May 2000	84.1	larval fish seine
			10.9	mesolarva	11 May 2000	84.1	larval fish seine
			11.1	mesolarva	11 May 2000	84.1	larval fish seine
			11.8	mesolarva	11 May 2000	84.1	larval fish seine
WHB00-121	47824	1	10.6	mesolarva	11 May 2000	82.3	larval fish seine
WHB00-122	47829	6	10.4	mesolarva	11 May 2000	79.4	larval fish seine
			10.7	mesolarva	11 May 2000	79.4	larval fish seine
			11.2	mesolarva	11 May 2000	79.4	larval fish seine
			11.2	mesolarva	11 May 2000	79.4	larval fish seine
			11.6	mesolarva	11 May 2000	79.4	larval fish seine
			13.2	mesolarva	11 May 2000	79.4	larval fish seine
WHB00-130	47855	1	15.2	mesolarva	23 May 2000	69.5	larval fish seine
WHB00-133	47864	1	10.0	mesolarva	23 May 2000	59.8	larval fish seine
WHB00-139	47878	1	14.9	mesolarva	24 May 2000	40.5	larval fish seine
WHB00-143	47882	2	9.3	mesolarva	25 May 2000	23.3	larval fish seine
			18.6	mesolarva	25 May 2000	23.3	larval fish seine
WHB00-149	47896	1	16.1	mesolarva	26 May 2000	15.4	larval fish seine
WHB00-150	47902	1	17.6	mesolarva	26 May 2000	14.0	larval fish seine
WHB00-152	47910	6	15.3	mesolarva	26 May 2000	13.0	larval fish seine
			15.8	mesolarva	26 May 2000	13.0	larval fish seine
			16.1	mesolarva	26 May 2000	13.0	larval fish seine
			17.0	mesolarva	26 May 2000	13.0	larval fish seine
			17.3	mesolarva	26 May 2000	13.0	larval fish seine
			17.9	mesolarva	26 May 2000	13.0	larval fish seine

Appendix II. Detailed summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
WHB00-154	47918	1	12.2	mesolarva	26 May 2000	10.0	larval fish seine
WHB00-155	47924	2	13.6	mesolarva	26 May 2000	8.8	larval fish seine
			16.4	mesolarva	26 May 2000	8.8	larval fish seine
WHB00-156	47930	86			26 May 2000	8.1	larval fish seine
		(6)	9.4 - 10.1	mesolarvae/yolk	26 May 2000	8.1	larval fish seine
		(6)	10.0 - 11.7	mesolarvae	26 May 2000	8.1	larval fish seine
		(58)	11.8 - 15.4	mesolarvae	26 May 2000	8.1	larval fish seine
		(15)	15.5 - 17.4	mesolarvae	26 May 2000	8.1	larval fish seine
		(1)	18.1	metalarva	26 May 2000	8.1	larval fish seine
WHB00-158	47937	1	16.4	mesolarva	01 June 2000	124.8	larval fish seine
WHB00-168	47978	1	12.0	mesolarva	02 June 2000	104.5	larval fish seine
2001	**TOTAL**	**50**					
WHB01-123	48806	2	15.5 - 16.0	postflexion mesolarvae	16 May 2001	62.1	larval fish seine
WHB01-133	48832	1	13.8	postflexion mesolarva	17-18 May 2001	21.1	light-trap
WHB01-134	48834	1	13.5	postflexion mesolarva	17-18 May 2001	21.1	light-trap
WHB01-137	48843	1	11.3	flexion mesolarva	18 May 2001	16.5	larval fish seine
WHB01-138	48846	1	15.5	postflexion mesolarva	18 May 2001	16.4	larval fish seine
WHB01-145	48873	11			18 May 2001	9.5	larval fish seine
		(2)	10.1 - 10.2	preflexion mesolarvae	18 May 2001	9.5	larval fish seine
		(5)	10.8 - 13.0	flexion mesolarvae	18 May 2001	9.5	larval fish seine
		(4)	14.0 - 14.8	postflexion mesolarvae	18 May 2001	9.5	larval fish seine
WHB01-146	48879	4			18 May 2001	8.5	larval fish seine
		(1)	11.7	flexion mesolarva	18 May 2001	8.5	larval fish seine
		(3)	13.9 - 14.8	postflexion mesolarvae	18 May 2001	8.5	larval fish seine
WHB01-157	48918	1	14.3	postflexion mesolarva	30 May 2001	124.8	larval fish seine
WHB01-172	48978	1	17.5	metalarva	31 May 2001	89.2	larval fish seine
WHB01-173	48984	1	13	flexion mesolarva	31 May 2001	88.8	larval fish seine
WHB01-175	48992	1	19.4	metalarva	1 June 2001	80.2	larval fish seine
WHB01-200	49078	4	22.0 - 26.3	metalarvae	14 June 2001	13.0	larval fish seine
WHB01-201	49082	1	17.2	metalarva	14 June 2001	11.9	larval fish seine
WHB01-203	49096	4			14 June 2001	10.0	larval fish seine
		(2)	16.0 - 16.4	postflexion mesolarvae	14 June 2001	10.0	larval fish seine
		(2)	16.8 - 18.5	metalarvae	14 June 2001	10.0	larval fish seine
WHB01-205	49108	16			14 June 2001	8.1	larval fish seine
		(1)	16.1	postflexion mesolarva	14 June 2001	8.1	larval fish seine
		(13)	17.7 - 25.8	metalarvae	14 June 2001	8.1	larval fish seine
		(2)	26.8 - 28.8	juvenile	14 June 2001	8.1	larval fish seine
2002	**TOTAL**	**812**					
WHB02-028		2	10.2 - 11.0	protolarvae	29 April 2002	76.1	larval fish seine
WHB02-029		1	10.8	protolarva	29 April 2002	75.5	larval fish seine
WHB02-032		1	10.8	protolarva	29 April 2002	68.3	larval fish seine
WHB02-033		18			29 April 2002	66.8	larval fish seine
		(11)	10.1 - 11.1	protolarvae	29 April 2002	66.8	larval fish seine
		(6)	10.5 - 11.2	preflexion mesolarvae	29 April 2002	66.8	larval fish seine
		(1)	11.5	flexion mesolarvae	29 April 2002	66.8	larval fish seine
WHB02-037		2	11.0 - 11.1	preflexion mesolarvae	30 April 2002	58.2	larval fish seine
WHB02-039		1	10.5	preflexion mesolarva	30 April 2002	54.5	larval fish seine
WHB02-040		5			30 April 2002	52.3	larval fish seine
		(1)	10.5	protolarvae	30 April 2002	52.3	larval fish seine
		(2)	10.8 - 10.8	preflexion mesolarvae	30 April 2002	52.3	larval fish seine
		(3)	12.1 - 12.8	flexion mesolarvae	30 April 2002	52.3	larval fish seine

Appendix II. Detailed summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
WHB02-043		27			1 May 2002	43.0	larval fish seine
		(10)	9.7 - 10.3	protolarvae	1 May 2002	43.0	larval fish seine
		(12)	10.1 - 11.0	preflexion mesolarvae	1 May 2002	43.0	larval fish seine
		(1)	10.3	postflexion mesolarvae	1 May 2002	43.0	larval fish seine
		(4)	10.7 - 12.3	flexion mesolarvae	1 May 2002	43.0	larval fish seine
WHB02-046		1	12.9	flexion mesolarva	1 May 2002	25.0	larval fish seine
WHB02-047		12			1 May 2002	23.5	larval fish seine
		(7)	10.9 - 11.5	preflexion mesolarvae	1 May 2002	23.5	larval fish seine
		(2)	10.9 - 11.1	protolarvae	1 May 2002	23.5	larval fish seine
		(3)	11.8 - 11.9	flexion mesolarvae	1 May 2002	23.5	larval fish seine
WHB02-048		91			1 May 2002	21.2	larval fish seine
		(23)	10.0 - 11.5	protolarvae	1 May 2002	21.2	larval fish seine
		(34)	10.2 - 12.0	preflexion mesolarvae	1 May 2002	21.2	larval fish seine
		(32)	10.6 - 13.4	flexion mesolarvae	1 May 2002	21.2	larval fish seine
		(2)	12.7 - 13.8	postflexion mesolarvae	1 May 2002	21.2	larval fish seine
WHB02-051		1	10.7	preflexion mesolarva	2 May 2002	12.9	larval fish seine
WHB02-052		18			2 May 2002	11.6	larval fish seine
		(15)	10.7 - 13.3	flexion mesolarvae	2 May 2002	11.6	larval fish seine
		(1)	10.9	preflexion mesolarva	2 May 2002	11.6	larval fish seine
		(2)	12.7 - 13.2	postflexion mesolarvae	2 May 2002	11.6	larval fish seine
WHB02-053		2			2 May 2002	9.2	larval fish seine
		(1)	11.3	flexion mesolarva	2 May 2002	9.2	larval fish seine
		(1)	13.2	postflexion mesolarva	2 May 2002	9.2	larval fish seine
WHB02-054		89			2 May 2002	8.7	larval fish seine
		(69)	10.1 - 13.1	flexion mesolarvae	2 May 2002	8.7	larval fish seine
		(13)	10.2 - 11.2	preflexion mesolarvae	2 May 2002	8.7	larval fish seine
		(7)	12.5 - 13.9	postflexion mesolarvae	2 May 2002	8.7	larval fish seine
WHB02-055		24			2 May 2002	5.2	larval fish seine
		(1)	10.1	preflexion mesolarva	2 May 2002	5.2	larval fish seine
		(20)	10.5 - 13.0	flexion mesolarvae	2 May 2002	5.2	larval fish seine
		(3)	12.8 - 14.1	postflexion mesolarvae	2 May 2002	5.2	larval fish seine
WHB02-064		2			16 May 2002	129.1	larval fish seine
		(1)	12.1	flexion mesolarva	16 May 2002	129.1	larval fish seine
		(1)	13.7	postflexion mesolarva	16 May 2002	129.1	larval fish seine
WHB02-066		3			16 May 2002	124.8	larval fish seine
		(2)	12.4 - 13.9	postflexion mesolarvae	16 May 2002	124.8	larval fish seine
		(1)	12.7	flexion mesolarvae	16 May 2002	124.8	larval fish seine
WHB02-067		7			16 May 2002	122.6	larval fish seine
		(6)	12.5 - 15.5	postflexion mesolarvae	16 May 2002	122.6	larval fish seine
		(1)	12.6	flexion mesolarva	16 May 2002	122.6	larval fish seine
WHB02-070		5			16-17 May 2002	116.2	light-trap
		(3)	11.0 - 12.4	flexion mesolarvae	16-17 May 2002	116.2	light-trap
		(2)	12.0 - 12.6	postflexion mesolarvae	16-17 May 2002	116.2	light-trap
WHB02-073		3	13.0 - 13.6	postflexion mesolarvae	17 May 2002	110.1	larval fish seine
WHB02-078		5	13.5 - 14.6	postflexion mesolarvae	17-18 May 2002	97.1	light-trap
WHB02-079		39			18 May 2002	95.8	larval fish seine
		(4)	12.8 - 13.3	flexion mesolarvae	18 May 2002	95.8	larval fish seine
		(32)	13.5 - 18.0	postflexion mesolarvae	18 May 2002	95.8	larval fish seine
		(3)	17.6 - 18.3	metalarvae	18 May 2002	95.8	larval fish seine
WHB02-080		1	18.7	metalarva	18 May 2002	93.7	larval fish seine
WHB02-081		36			18 May 2002	93.0	larval fish seine
		(1)	12.6	flexion mesolarvae	18 May 2002	93.0	larval fish seine
		(30)	12.8 - 18.0	postflexion mesolarvae	18 May 2002	93.0	larval fish seine
		(5)	18.7 - 19.8	metalarvae	18 May 2002	93.0	larval fish seine
WHB02-082		1	15.3	postflexion mesolarva	18 May 2002	88.8	larval fish seine
WHB02-083		2			18 May 2002	87.8	larval fish seine
		(1)	13.4	postflexion mesolarva	18 May 2002	87.8	larval fish seine
		(1)	17.6	metalarva	18 May 2002	87.8	larval fish seine
WHB02-084		1	11.0	flexion mesolarva	18 May 2002	85.8	larval fish seine

Appendix II. Detailed summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
WHB02-085		3			18 May 2002	82.8	larval fish seine
		(2)	13.4 - 14.8	postflexion mesolarvae	18 May 2002	82.8	larval fish seine
		(1)	18.8	metalarva	18 May 2002	82.8	larval fish seine
WHB02-086		21			18-19 May 2002	78.9	light-trap
		(2)	11.5 - 12.0	flexion mesolarvae	18-19 May 2002	78.9	light-trap
		(16)	12.6 - 17.0	postflexion mesolarvae	18-19 May 2002	78.9	light-trap
		(3)	17.5 - 18.8	metalarvae	18-19 May 2002	78.9	light-trap
WHB02-087		4			19 May 2002	77.2	larval fish seine
		(1)	11.9	flexion mesolarva	19 May 2002	77.2	larval fish seine
		(2)	14.8 - 14.8	postflexion mesolarvae	19 May 2002	77.2	larval fish seine
		(1)	21.5	metalarva	19 May 2002	77.2	larval fish seine
WHB02-088		14			29 May 2002	75.7	larval fish seine
		(1)	15.5	postflexion mesolarva	29 May 2002	75.7	larval fish seine
		(13)	17.6 - 26.4	metalarvae	29 May 2002	75.7	larval fish seine
WHB02-090		4			29 May 2002	71.9	larval fish seine
		(3)	17.8 - 24.8	metalarvae	29 May 2002	71.9	larval fish seine
		(1)	30.7	juvenile	29 May 2002	71.9	larval fish seine
WHB02-091		51			29 May 2002	71.3	larval fish seine
		(7)	14.5 - 17.8	postflexion mesolarvae	29 May 2002	71.3	larval fish seine
		(44)	15.0 - 26.8	metalarvae	29 May 2002	71.3	larval fish seine
WHB02-093		19			29 May 2002	60.6	larval fish seine
		(4)	16.8 - 18.1	postflexion mesolarvae	29 May 2002	60.6	larval fish seine
		(13)	18.7 - 24.8	metalarvae	29 May 2002	60.6	larval fish seine
		(2)	28.3 - 29.7	juvenile	29 May 2002	60.6	larval fish seine
WHB02-094		1	20.3	metalarva	30 May 2002	58.2	larval fish seine
WHB02-096		71			30 May 2002	52.5	larval fish seine
		(6)	12.3 - 13.2	flexion mesolarvae	30 May 2002	52.5	larval fish seine
		(14)	14.3 - 18.8	postflexion mesolarvae	30 May 2002	52.5	larval fish seine
		(51)	17.9 - 26.6	metalarvae	30 May 2002	52.5	larval fish seine
WHB02-097		4			30 May 2002	50.7	larval fish seine
		(2)	14.8 - 15.3	postflexion mesolarvae	30 May 2002	50.7	larval fish seine
		(2)	20.2 - 24.3	metalarvae	30 May 2002	50.7	larval fish seine
WHB02-098		1	20.6	metalarva	30 May 2002	48.0	larval fish seine
WHB02-100		11			30 May 2002	41.7	larval fish seine
		(1)	10.9	flexion mesolarva	30 May 2002	41.7	larval fish seine
		(3)	13.7 - 17.8	postflexion mesolarvae	30 May 2002	41.7	larval fish seine
		(7)	17.3 - 26.5	metalarvae	30 May 2002	41.7	larval fish seine
WHB02-101		2	20.1 - 26.7	metalarvae	31 May 2002	38.9	larval fish seine
WHB02-104		2	18.6 - 21.0	metalarvae	31 May 2002	29.0	larval fish seine
WHB02-105		7			31 May 2002	25.2	larval fish seine
		(1)	17.4	postflexion mesolarva	31 May 2002	25.2	larval fish seine
		(6)	22.9 - 29.7	metalarvae	31 May 2002	25.2	larval fish seine
WHB02-106		50			31 May 2002	23.4	larval fish seine
		(1)	12.9	flexion mesolarva	31 May 2002	23.4	larval fish seine
		(9)	14.5 - 18.8	postflexion mesolarvae	31 May 2002	23.4	larval fish seine
		(34)	17.7 - 27.2	metalarvae	31 May 2002	23.4	larval fish seine
		(6)	28.0 - 33.4	juvenile	31 May 2002	23.4	larval fish seine
WHB02-107		1	33.3	juvenile	31 May 2002	17.6	larval fish seine
WHB02-109		1	14.6	postflexion mesolarvae	1 June 2002	11.5	larval fish seine
WHB02-110		3	20.8 - 25.3	metalarvae	1 June 2002	9.6	larval fish seine
WHB02-111		13			1 June 2002	7.3	larval fish seine
		(8)	12.6 - 16.7	postflexion mesolarvae	1 June 2002	7.3	larval fish seine
		(4)	17.1 - 22.8	metalarvae	1 June 2002	7.3	larval fish seine
		(1)	35.4	juvenile	1 June 2002	7.3	larval fish seine
WHB02-112		4			1 June 2002	2.8	larval fish seine
		(2)	14.7 - 15.6	postflexion mesolarvae	1 June 2002	2.8	larval fish seine
		(2)	23.5 - 24.3	metalarvae	1 June 2002	2.8	larval fish seine
WHB02-118		1	35.8	juvenile	11 June 2002	134.5	larval fish seine

Appendix II. Detailed summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
WHB02-121		1	33.1	juvenile	11 June 2002	128.1	larval fish seine
WHB02-126		2			12 June 2002	116.2	larval fish seine
		(1)	29.4	metalarva	12 June 2002	116.2	larval fish seine
		(1)	35.5	juvenile	12 June 2002	116.2	larval fish seine
WHB02-128		1	30.9	juvenile	12 June 2002	109.8	larval fish seine
WHB02-130		2	37.2 - 49.0	juvenile	12 June 2002	103.2	larval fish seine
WHB02-133		3	32.4 - 43.4	juvenile	13 June 2002	94.0	larval fish seine
WHB02-134		23			13 June 2002	93.0	larval fish seine
		(1)	29.7	metalarva	13 June 2002	93.0	larval fish seine
		(22)	31.5 - 55.2	juvenile	13 June 2002	93.0	larval fish seine
WHB02-135		48			13 June 2002	91.6	larval fish seine
		(7)	20.4 - 29.0	metalarvae	13 June 2002	91.6	larval fish seine
		(41)	28.5 - 53.1	juvenile	13 June 2002	91.6	larval fish seine
WHB02-137		2	37.0 - 38.1	juvenile	13 June 2002	84.6	larval fish seine
WHB02-138		14	31.7 - 40.3	juvenile	13 June 2002	82.6	larval fish seine
WHB02-139		4	33.9 - 52.0	juvenile	13 June 2002	79.7	larval fish seine
WHB02-140		8			14 June 2002	77.1	larval fish seine
		(1)	18.1	postflexion mesolarva	14 June 2002	77.1	larval fish seine
		(7)	34.1 - 46.7	juvenile	14 June 2002	77.1	larval fish seine
WHB02-141		1	53.1	juvenile	27 June 2002	75.4	larval fish seine
WHB02-142		2	35.6 - 49.3	juvenile	27 June 2002	74.9	larval fish seine
WHB02-146		1	51.1	juvenile	28 June 2002	68.7	larval fish seine
WHB02-148		2	59.5 - 62.4	juvenile	28 June 2002	62.3	larval fish seine
WHB02-149		8	41.8 - 54.4	juvenile	28 June 2002	61.3	larval fish seine
WHB02-150		1	39.8	juvenile	28 June 2002	60.2	larval fish seine

TOTAL (1998 - 2002) 1,000

Appendix II. Detailed summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
2003 TOTAL		**472**					
WHB03-096		6			16 May 2003	97.0	larval fish seine
		(2)	12.6 -12.8	flexion mesolarvae	16 May 2003		larval fish seine
		(4)	13.5 -15.8	postflex mesolarvae	16 May 2003		larval fish seine
WHB03-099		33			17 May 2003	94.2	larval fish seine
		(4)	9.5 -10.5	protolarvae	17 May 2003		larval fish seine
		(22)	10.4 -13.6	flexion mesolarvae	17 May 2003		larval fish seine
		(7)	12.6 -14.6	postflex mesolarvae	17 May 2003		larval fish seine
WHB03-104		7			17 May 2003	85.6	larval fish seine
		(3)	9.8 -10.4	protolarvae	17 May 2003		larval fish seine
		(4)	10.6 -12.4	flexion mesolarvae	17 May 2003		larval fish seine
WHB03-105		19			17 May 2003	84.2	larval fish seine
		(5)	10.1 -10.6	protolarvae	17 May 2003		larval fish seine
		(12)	10.7 -12.8	flexion mesolarvae	17 May 2003		larval fish seine
		(2)	13.9 -14.5	postflex mesolarvae	17 May 2003		larval fish seine
WHB03-107		8			17 May 2003	80.2	light-trap
		(2)	10 -10.3	protolarvae	17 May 2003		light-trap
		(6)	10.5 -12.0	flexion mesolarvae	17 May 2003		light-trap
WHB03-108		7			18 May 2003	79.3	larval fish seine
		(2)	9.9 -10.5	protolarvae	18 May 2003		larval fish seine
		(4)	11.0 -11.9	flexion mesolarvae	18 May 2003		larval fish seine
		(1)	14.1	postflex mesolarva	18 May 2003		larval fish seine
WHB03-109		6			18 May 2003	77.1	larval fish seine
		(5)	10.7 -12.0	flexion mesolarvae	18 May 2003		larval fish seine
		(1)	14.1	postflex mesolarvae	18 May 2003		larval fish seine
MAF03-007		11			18 May 2003	73.8	larval fish seine
		(10)	9.1 -12.1	flexion mesolarvae	18 May 2003		larval fish seine
		(1)	14.3	postflex mesolarva	18 May 2003		larval fish seine
MAF03-008		2	12.7 -12.8	flexion mesolarvae	18 May 2003	72.5	larval fish seine
MAF03-014		1	12.1	flexion mesolarvae	19 May 2003	57.9	larval fish seine
MAF03-016		31			19 May 2003		larval fish seine
		(28)	10.2 -12.9	flexion mesolarvae	19 May 2003		larval fish seine
		(3)	13.1 -13.9	postflex mesolarvae	19 May 2003		larval fish seine
MAF03-017		3	11.2 -11.8	flexion mesolarvae	19 May 2003	48.3	larval fish seine
MAF03-021		1	12	flexion mesolarvae	20 May 2003	40.4	larval fish seine
MAF03-026		1	11.7	flexion mesolarvae	20 May 2003	24.5	light-trap
MAF03-027		5			21 May 2003	23.8	larval fish seine
		(4)	10.2 -12.8	flexion mesolarvae	21 May 2003		larval fish seine
		(1)	13.2	postflex mesolarva	21 May 2003		larval fish seine
MAF03-029		4			21 May 2003	21.0	larval fish seine
		(2)	10.1 -11.5	flexion mesolarvae	21 May 2003		larval fish seine
		(2)	13.4 -13.6	postflex mesolarvae	21 May 2003		larval fish seine
MAF03-031		34			21 May 2003	17.7	larval fish seine
		(12)	10.6 -12.7	flexion mesolarvae	21 May 2003		larval fish seine
		(21)	13.0 -17.2	postflex mesolarvae	21 May 2003		larval fish seine
		(1)	19.2	metalarva	21 May 2003		larval fish seine
MAF03-033		5			22 May 2003	13.1	larval fish seine
		(2)	9.5 -12.1	flexion mesolarvae	22 May 2003		larval fish seine
		(3)	15.9 -18.0	postflex mesolarvae	22 May 2003		larval fish seine
MAF03-034		19			22 May 2003	11.4	larval fish seine
		(12)	10.4 -12.7	flexion mesolarvae	22 May 2003		larval fish seine
		(7)	13.0 -17.8	postflex mesolarvae	22 May 2003		larval fish seine
MAF03-035		11			22 May 2003	9.6	larval fish seine
		(1)	10.3	protolarvae	22 May 2003		larval fish seine
		(4)	10.4 -13.2	flexion mesolarvae	22 May 2003		larval fish seine
		(6)	13.8 -19.0	postflex mesolarvae	22 May 2003		larval fish seine

Appendix II. Detailed summary of larval razorback sucker collected in the San Juan River (continued).

Field Number	MSB Catalog Number	Number of Specimens	Total Length	Larval Stage	Date Collected	River Mile	Sampling Method
MAF03-036		99			22 May 2003	8.1	larval fish seine
		(42)	10.2 -13.3	flexion mesolarvae	22 May 2003		larval fish seine
		(55)	13.0 -18.4	postflex mesolarvae	22 May 2003		larval fish seine
		(2)	18.8 -22.1	metalarvae	22 May 2003		larval fish seine
MAF03-037		50			22 May 2003	6.9	larval fish seine
		(13)	10.0 -13.2	flexion mesolarvae	22 May 2003		larval fish seine
		(32)	12.9 -18.5	postflex mesolarvae	22 May 2003		larval fish seine
		(5)	16.1 -21.1	metalarvae	22 May 2003		larval fish seine
WHB03-141		16			13 June 2003	90.1	larval fish seine
		(4)	18.3 -19.4	postflex mesolarvae	13 June 2003		larval fish seine
		(12)	19.8 -23.7	metalarvae	13 June 2003		larval fish seine
WHB03-142		1	33.1	juvenile	13 June 2003	88.1	larval fish seine
WHB03-145		81			13 June 2003	84.1	larval fish seine
		(7)	15.4 -17.9	postflex mesolarvae	13 June 2003		larval fish seine
		(73)	18.8 -27.1	metalarvae	13 June 2003		larval fish seine
		(1)	29.4	juvenile	13 June 2003		larval fish seine
WHB03-151		3			14 June 2003	75.1	larval fish seine
		(1)	22.8	metalarvae	14 June 2003		larval fish seine
		(2)	31.7 -35.3	juvenile	14 June 2003		larval fish seine
WHB03-168		1	26	juvenile	16 June 2003	33.5	larval fish seine
WHB03-169		1	26.7	juvenile	16 June 2003	28.8	larval fish seine
WHB03-178		3	26.9 -36.1	juvenile	17 June 2003	15.4	larval fish seine
WHB03-180		2	30.2 -37.3	juvenile	17 June 2003	12.3	larval fish seine
WHB03-183		1	22.4	postflex mesolarvae	18 June 2003	3.3	larval fish seine

TOTAL (1998-2003) 1,472

Appendix III. Detailed sampling and fish identification protocol.

1. Determination and access to sampling sites

a. Suitable habitats for larval fish, including areas of low velocity (isolated 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 upon return 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 12 illustrates how data were 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 13 illustrates how data were 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 Whirl-Pak 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 with 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).
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 III. Detailed sampling and fish identification protocol. (continued)

Acc 2003- IV: 24

Field No. WHB03-101 (Sample No.)
State or Country: Utah Locality: San Juan River @ RM 91.1
T R S Lat.: 12 0644604 E Long.: 4125586 N
County: San Juan Co. Drainage: San Juan
Water: large backwater and backwater like habitat complex on river left
Vegetation: algae, green algae & roots & inundated grasses
Temp: 20.9°C Air.: 27°C
Bottom: silt sand & cobble
Shore: dirt cobble bank, Russian olive & willow Current: Ø - < .1m/s
Dist. offshore: Width: .80 - 9.3m ~~Tide:~~ turbidity .18m
Depth of capture: .05 - .47m Depth of water: .01 - .47m
Method of capture: larval seine
Seine: 1m x 1m No. Hauls: 9 Area: 69.3 sq. m.
D.O.: 4.43 mg/1 Conductivity: 628/683 ~~µs µ mhos/cm~~. Salinity: 0.3ppt ‰
Shocking seconds: Voltage: Amps:
Collected by: WHBandenburg & CC McBride Date.: 17 May 2003
Orig. preserv.: 10 % formalin Time: 1137 - 1211
Photo # 0196 & 0197

This site offered a wide variety of different and complex habitat. The entire site is approximately 300m in length. The most upstream portion has a very small shallow connection with the main channel that supplies water to the rest of the area. hauls were run is low velocity channels. in backwaters (an unconnected side channel), in debris piles and open water. Larval catostomids were taken in two locations the low velocity channel and a portion upstream of the upstream connection with the main channel, a shallow pool with inundated grasses and cobble substrate. Quite a few Fundulus zebrinus were collected throughout this site. Several were males and the anal and peluic fins were bright red. Pimephales promelas were probably most common. There were lots of tadpoles among the shore line of a pool with lots of green algae, a few of them were also collected. Haul lengths were 7.4m, 7.2m, 11.4m, 9.6m, 3.1m, 6.9m, 4.5m, 5.8m & 13.4m.

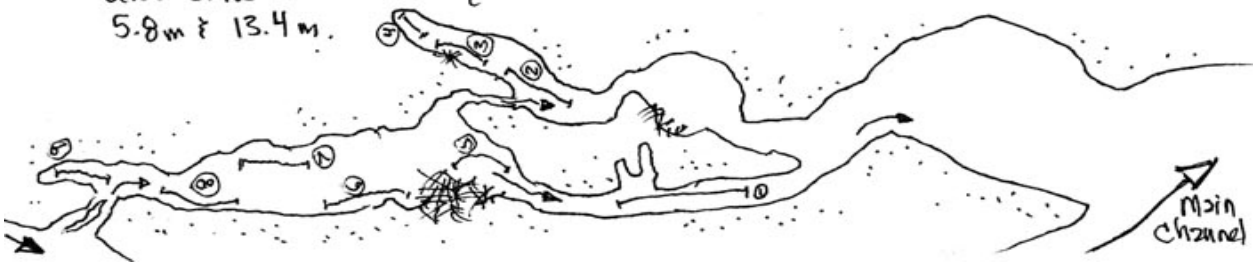

Figure 12. Field sheet used to record data at a larval seine haul site during razorback sucker sampling in the San Juan River in 2003.

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

Acc 2003-10:24

Field No. WHB03-173 (Sample No.)

State or Country: Utah Locality: San Juan River @RM 24.4

T R S Lat.: 12 0582024 E Long.: 4122396 N

County: San Juan Co. Drainage: San Juan

Water: backwater like habitat on river right

Vegetation: some algae

Temp: 26°C-20.4°C Air.: 32°-25°C

Bottom: sand, cobble & boulders

Shore: sand, cobble & boulder bank, salt cedar Current: 0-<.1 m/s

Dist. offshore: Width: 1-13.6 m Tide:

Depth of capture: Depth of water: .03-.71 m

Method of capture: light traps n=4

Seine: — No. Hauls: — Area: sq. m.

D.O.: 5.27 mg/l Conductivity: 4188/4586 ~~µ mhos/cm~~. Salinity: 0.2 ppt ‰

Shocking seconds: Voltage: Amps:

Collected by: WHBrandenburg & MAKrispinski Date.: 16-17 Jun 2003

Orig. preserv.: 10% formalin Time: 1755-0658

Photo #0362 & 0364

The light traps were set just downstream of John's canyon and John's rapid. The canyon, over time, has brought down a field of boulders which has spread across the right bank. Just down stream of these boulder large sand bars have developed creating a large low or near zero velocity areas. Water does flow from upstream yet trickles through the field of rocks so input velocites are low. the traps have been set throughout this large backwater and in a variety of habitats. All four traps collected tremendous amounts of invertebrates: ephemeroptera, tricoptera & odonata. Two of the four traps collected several tiny cyprinid larvae (4-6mm SL) [traps 3 and 4]. Last night the moon was nearly full and the canyon was well lite the majority of the night. Flows appear to have receeded again over night

Figure 13. Field sheet used to record data at a light-trap site during razorback sucker sampling in the San Juan River in 2003.

Appendix IV. Water qualitiy data for individual collection localities in the San Juan River, 2003.

Field Number	Date	RM	Dissolved Oxygen (mg/L)	Water Temp(°C)	Salinity (ppt)	Conductivity (microsiemens µs)
WHB03-003	15-Apr-03	141.2	0.4	12.3	6.6	642.0
WHB03-004	15-Apr-03	141.1	0.2	12.9	3.5	241.0
WHB03-005	15-Apr-03	139.7	0.3	12.6	3.2	426.0
WHB03-006	16-Apr-03	137.2	0.1	9.4	7.2	155.0
WHB03-007	16-Apr-03	136.8	0.4	13.0	5.8	558.0
WHB03-008	16-Apr-03	135.3	0.5	16.2	5.7	790.0
WHB03-009	16-Apr-03	134.5	1.5	17.9	5.2	2206.0
WHB03-010	16-Apr-03	131.3	0.0	21.6	4.4	79.0
WHB03-011	16-Apr-03	129.2	0.2	20.2	6.3	658.0
WHB03-012	16-Apr-03	128.1	0.4	18.6	6.5	688.0
WHB03-015	16-Apr-03	122.6	0.2	15.6	6.0	217.0
WHB03-016	17-Apr-03	119.4	0.3	11.8	6.2	487.0
WHB03-017	17-Apr-03	118.4	0.1	13.5	4.8	220.0
WHB03-018	17-Apr-03	117.2	0.2	14.0	6.7	278.0
WHB03-019	17-Apr-03	116.2	0.2	17.8	6.3	345.0
WHB03-020	17-Apr-03	113.2	0.4	22.6	5.9	731.0
WHB03-021	17-Apr-03	110.0	0.3	17.4	5.8	521.0
WHB03-022	17-Apr-03	108.5	0.1	16.4	5.2	142.0
WHB03-023	17-Apr-03	105.6	0.0	16.2	6.8	15.0
WHB03-024	18-Apr-03	103.6	0.0	7.5	2.7	48.0
WHB03-025	18-Apr-03	102.7	0.3	11.4	6.6	416.0
WHB03-026	18-Apr-03	100.5	1.4	12.6	6.0	2056.0
WHB03-027	18-Apr-03	98.6	0.1	20.0	5.2	187.0
WHB03-028	18-Apr-03	97.0	0.0	14.0	6.1	15.0
WHB03-029	18-Apr-03	94.0	0.3	14.8	6.2	509.0
WHB03-030	18-Apr-03	92.9	0.4	22.2	4.4	470.0
WHB03-031	18-Apr-03	90.0	0.2	13.4	5.9	304.0
WHB03-032	18-Apr-03	87.1	0.0	16.1	5.9	12.0
WHB03-033	18-Apr-03	87.0	0.3	11.0	5.8	489.0
WHB03-034	19-Apr-03	84.1	0.0	12.2	2.3	31.0
WHB03-035	19-Apr-03	82.8	0.2	12.4	6.0	265.0
WHB03-036	19-Apr-03	79.6	0.3	14.1	7.0	499.0
WHB03-037	19-Apr-03	78.7	0.1	14.3	6.7	101.0
WHB03-038	19-Apr-03	77.3	0.2	14.5	4.0	512.0
WHB03-039	19-Apr-03	75.2	0.3	14.6	3.2	567.0
WHB03-040	19-Apr-03	72.5	0.4	14.1	5.2	587.0
WHB03-041	19-Apr-03	69.7	0.3	15.7	5.7	498.0
WHB03-042	19-Apr-03	68.6	0.3	15.1	6.3	438.0
WHB03-043	20-Apr-03	66.2	0.3	11.4	6.7	455.0
WHB03-044	20-Apr-03	65.3	0.3	11.8	6.3	462.0
WHB03-045	20-Apr-03	62.6	0.1	12.4	6.8	195.0
WHB03-046	20-Apr-03	61.5	0.3	13.4	6.7	471.0
WHB03-047	20-Apr-03	57.2	0.3	18.3	6.0	541.0
WHB03-048	20-Apr-03	55.4	0.3	23.7	5.6	572.0
WHB03-049	20-Apr-03	52.3	0.1	20.0	5.6	114.0
WHB03-050	21-Apr-03	46.8	0.3	14.3	6.2	499.0
WHB03-051	21-Apr-03	45.9	0.3	14.3	6.2	500.0

Appendix IV. Water quality data for individual collection localities in the San Juan River, 2003.

Field Number	Date	RM	Dissolved Oxygen (mg/L)	Water Temp(°C)	Salinity (ppt)	Conductivity (microsiemens µs)
WHB03-052	21-Apr-03	43.8	0.3	16.5	5.4	533.0
WHB03-053	21-Apr-03	39.8	0.3	18.1	5.6	565.0
WHB03-054	21-Apr-03	35.2	0.3	15.5	6.8	488.0
WHB03-055	22-Apr-03	28.9	0.2	13.8	4.4	311.0
WHB03-056	22-Apr-03	27.0	0.3	14.2	6.0	512.0
WHB03-057	22-Apr-03	26.2	0.3	14.4	6.4	512.0
WHB03-058	22-Apr-03	25.1	0.2	14.7	6.7	319.0
WHB03-059	22-Apr-03	21.1	0.1	17.6	6.6	235.0
WHB03-060	22-Apr-03	19.1	0.0	17.4	6.0	1.0
WHB03-061	22-Apr-03	17.7	0.0	17.6	6.9	160.0
WHB03-062	22-Apr-03	16.3	0.1	17.5	5.1	170.0
WHB03-063	23-Apr-03	13.9	0.3	10.5	6.8	485.0
WHB03-064	23-Apr-03	10.0	0.3	10.6	7.2	475.0
WHB03-065	23-Apr-03	8.1	0.2	12.1	6.8	427.0
WHB03-066	23-Apr-03	4.8		13.0	7.2	506.0
WHB03-067	13-May-03	142.4	0.2	18.3	8.4	415.6
WHB03-068	13-May-03	141.3	0.4	20.7	8.6	740.0
WHB03-069	13-May-03	139.7	0.4	19.5	8.0	717.0
WHB03-070	13-May-03	138.1	0.2	12.6	4.0	262.0
WHB03-071	14-May-03	137.2	0.3	15.0	6.9	677.0
WHB03-072	14-May-03	135.3	0.3	16.2	7.1	438.0
WHB03-073	14-May-03	133.9	0.4	21.5	5.0	404.7
WHB03-074	14-May-03	132.0	0.4	19.6	6.6	721.0
WHB03-075	14-May-03	129.7	0.4	20.2	7.4	796.0
WHB03-076	14-May-03	128.8	0.4	19.2	7.0	799.0
WHB03-077	14-May-03	127.4	0.4	21.2	7.4	775.0
WHB03-078	14-May-03	125.3	0.6	21.2	6.4	1044.0
WHB03-079	14-May-03	123.8	0.4	16.4	5.5	711.0
WHB03-080	15-May-03	122.6	0.5	15.3	4.9	806.0
WHB03-081	15-May-03	121.0	0.4	16.5	5.5	690.0
WHB03-082	15-May-03	120.5	0.4	15.6	5.1	720.0
WHB03-083	15-May-03	117.2	0.5	20.9	5.8	860.0
WHB03-084	15-May-03	116.2	0.5	17.0	4.6	854.0
WHB03-085	15-May-03	115.7	0.4	18.3	5.0	724.0
WHB03-086	15-May-03	113.2	0.5	18.7	5.9	850.0
WHB03-087	15-May-03	111.1	0.4	18.7	5.8	741.0
WHB03-088	16-May-03	109.0	0.3	15.7	6.5	552.0
WHB03-089	16-May-03	108.5	0.3	16.5	6.2	558.0
WHB03-090	16-May-03	106.2	0.3	17.6	5.8	572.0
WHB03-091	16-May-03	104.2	0.3	18.8	5.8	590.0
WHB03-092	16-May-03	102.7	0.3	27.0	5.7	700.0
WHB03-093	16-May-03	101.5	0.4	29.3	5.0	911.0
WHB03-094	16-May-03	100.5	1.2	27.8	5.8	2313.0
WHB03-095	16-May-03	98.6	0.1	31.5	4.2	214.0
WHB03-096	16-May-03	97.0	0.4	28.6	5.5	816.0
WHB03-097	16-May-03	96.6	0.4	14.9	2.6	624.0
WHB03-098	17-May-03	94.2	0.5	15.1	5.5	851.0

Appendix IV. Water qualitiy data for individual collection localities in the San Juan River, 2003.

Field Number	Date	RM	Dissolved Oxygen (mg/L)	Water Temp(°C)	Salinity (ppt)	Conductivity (microsiemens µs)
WHB03-099	17-May-03	92.9	0.3	18.2	4.3	556.0
WHB03-100	17-May-03	92.2	0.3	18.7	5.0	592.0
WHB03-101	17-May-03	90.1	0.3	20.9	4.4	628.0
WHB03-102	17-May-03	89.1	0.4	20.0	5.3	733.0
WHB03-103	17-May-03	87.1	0.3	23.1	5.7	686.0
WHB03-104	17-May-03	85.6	0.4	23.3	4.7	772.0
WHB03-105	17-May-03	84.2	0.3	22.0	5.1	601.0
WHB03-106	17-May-03	82.0	0.3	23.2	4.8	632.0
WHB03-107	17-May-03	80.2	0.3	17.8	5.4	493.0
WHB03-108	18-May-03	79.3	0.3	17.9	4.9	424.0
WHB03-109	18-May-03	77.1	0.3	20.1	5.5	514.0
MAF03-006	18-May-03	75.5	0.3	22.9	5.4	565.0
MAF03-007	18-May-03	73.8	0.3	23.1	5.4	565.0
MAF03-008	18-May-03	72.5	0.3	22.1	4.9	588.0
MAF03-009	18-May-03	70.9	0.5	26.3	6.0	922.0
MAF03-010	19-May-03	66.2	0.3	17.3	5.8	454.0
MAF03-011	19-May-03	62.9	0.3	17.9	5.0	463.0
MAF03-012	19-May-03	61.2	0.3	18.5	5.1	469.0
MAF03-013	19-May-03	58.2	0.3	19.4	5.5	481.0
MAF03-014	19-May-03	57.9	0.3	21.0	4.9	609.0
MAF03-015	19-May-03	53.7	0.3	22.2	5.3	524.0
MAF03-016	19-May-03	50.9	0.3	21.7	4.8	526.0
MAF03-017	19-May-03	48.3	0.6	29.6	4.2	1283.0
MAF03-018	19-May-03	45.8	0.3	18.0	5.4	475.0
MAF03-019	19-May-03	41.9	0.3	18.3	5.3	474.0
MAF03-020	20-May-03	41.6	0.3	18.6	5.1	479.0
MAF03-021	20-May-03	40.4	0.3	19.1	5.2	488.0
MAF03-022	20-May-03	38.6	0.3	19.0	5.4	479.0
MAF03-023	20-May-03	34.3	0.3	20.2	5.5	491.0
MAF03-024	20-May-03	29.8	0.3	20.7	5.5	500.0
MAF03-025	20-May-03	28.6	0.3	21.0	5.4	500.0
MAF03-026	20-May-03	24.5	0.2	18.7	5.8	399.0
MAF03-027	21-May-03	23.8	0.2	19.3	5.1	406.0
MAF03-028	21-May-03	22.0	0.2	22.5	5.4	438.0
MAF03-029	21-May-03	21.0	0.0	20.5	5.5	13.0
MAF03-030	21-May-03	19.7	0.2	21.1	5.8	419.0
MAF03-031	21-May-03	17.7	0.2	21.6	2.7	430.0
MAF03-032	21-May-03	13.9	0.2	22.5	5.4	248.0
MAF03-033	22-May-03	13.1	0.2	19.6	5.8	360.0
MAF03-034	22-May-03	11.4	0.3	17.8	3.9	495.0
MAF03-035	22-May-03	9.6		20.5	4.8	12.0
MAF03-036	22-May-03	8.1	0.2	20.4	5.0	384.0
MAF03-037	22-May-03	6.9		21.2	5.4	14.0
WHB03-110	09-Jun-03	141.0	0.2	21.3	5.9	399.0
WHB03-111	09-Jun-03	140.7	0.2	20.8	6.0	366.9
WHB03-112	09-Jun-03	140.4	0.2	20.8	6.0	366.9
WHB03-113	09-Jun-03	137.3	0.2	21.0	5.4	374.8

Appendix IV. Water quality data for individual collection localities in the San Juan River, 2003.

Field Number	Date	RM	Dissolved Oxygen (mg/L)	Water Temp(°C)	Salinity (ppt)	Conductivity (microsiemens µs)
WHB03-114	10-Jun-03	135.7	0.2	18.2	6.1	359.6
WHB03-115	10-Jun-03	134.9	0.2	18.8	5.8	762.6
WHB03-116	10-Jun-03	133.7	0.2	19.4	6.3	376.0
WHB03-117	10-Jun-03	132.8	0.2	24.1	5.8	470.0
WHB03-118	10-Jun-03	131.8	0.2	20.6	6.2	379.3
WHB03-119	10-Jun-03	129.7	0.2	21.9	6.0	391.1
WHB03-120	10-Jun-03	128.1	0.2	22.1	6.0	393.3
WHB03-121	10-Jun-03	122.6	0.2	25.4	6.2	380.7
WHB03-122	10-Jun-03	122.1	0.2	16.6	6.0	347.0
WHB03-123	11-Jun-03	120.8	0.2	19.9	6.0	375.8
WHB03-124	11-Jun-03	119.2	0.2	20.2	6.2	379.7
WHB03-125	11-Jun-03	118.3	0.3	18.2	4.9	484.0
WHB03-126	11-Jun-03	116.9	0.2	20.4	6.0	385.1
WHB03-127	11-Jun-03	115.1	0.2		5.7	391.4
WHB03-128	11-Jun-03	113.7	0.2	24.1	6.0	346.5
WHB03-129	11-Jun-03	111.8	0.2	23.6	5.9	429.2
WHB03-130	12-Jun-03	107.7	0.2	17.9	6.3	358.9
WHB03-131	12-Jun-03	106.7	0.2	18.8	6.0	363.2
WHB03-132	12-Jun-03	106.5	0.2	20.3	5.8	426.3
WHB03-133	12-Jun-03	105.1	0.2	20.1	5.7	373.6
WHB03-134	12-Jun-03	102.5	0.2	23.3	5.6	398.8
WHB03-135	12-Jun-03	101.5	0.2	25.3	6.5	422.8
WHB03-136	12-Jun-03	100.5	0.9	30.4	5.8	1852.0
WHB03-137	12-Jun-03	97.0	0.2	27.4	6.5	438.8
WHB03-138	12-Jun-03	96.3	0.2	23.6	5.3	407.4
WHB03-139	13-Jun-03	92.8	0.2	19.3	5.7	375.8
WHB03-140	13-Jun-03	90.1	0.2	20.8	6.3	389.2
WHB03-141	13-Jun-03	90.1	0.2	19.8	3.5	356.2
WHB03-142	13-Jun-03	88.1	0.2	22.6	6.0	411.4
WHB03-143	13-Jun-03	87.5	0.2	25.3	6.6	419.6
WHB03-144	13-Jun-03	85.6	0.2	28.7	5.1	445.7
WHB03-145	13-Jun-03	84.1	0.2	30.4	2.9	436.7
WHB03-146	13-Jun-03	82.7	0.2	25.6	5.7	425.3
WHB03-147	14-Jun-03	78.8	0.2	20.2	6.0	384.0
WHB03-148	14-Jun-03	77.3	0.2	21.0	5.1	393.8
WHB03-149	14-Jun-03	76.1	0.2	22.5	6.1	406.5
WHB03-150	14-Jun-03	75.5	0.2	26.6	6.6	422.8
WHB03-151	14-Jun-03	75.1	0.2	24.6	5.1	428.4
WHB03-152	14-Jun-03	73.0	0.2	26.0	6.0	429.8
WHB03-153	14-Jun-03	71.2	0.2	26.9	6.8	425.5
WHB03-154	14-Jun-03	67.7	0.2	25.6	5.0	428.0
WHB03-155	14-Jun-03	66.2	0.2	26.2	5.4	431.5
WHB03-156	15-Jun-03	62.9	0.2	20.9	5.1	406.2
WHB03-157	15-Jun-03	61.2	0.2	21.7	5.0	412.7
WHB03-158	15-Jun-03	58.5	0.2	23.5	5.9	427.8
WHB03-159	15-Jun-03	55.8	0.2	24.0	6.1	432.2
WHB03-160	15-Jun-03	53.6	0.2	26.2	6.2	439.3

Appendix IV. Water quality data for individual collection localities in the San Juan River, 2003.

Field Number	Date	RM	Dissolved Oxygen (mg/L)	Water Temp(°C)	Salinity (ppt)	Conductivity (microsiemens µs)
WHB03-161	15-Jun-03	52.1	0.2	25.6	5.7	441.5
WHB03-162	15-Jun-03	48.3	0.2	26.3	5.6	441.2
WHB03-163	15-Jun-03	47.1	0.2	26.5	5.1	445.0
WHB03-164	16-Jun-03	43.0	0.2	22.9	5.4	426.0
WHB03-165	16-Jun-03	41.2	0.2	23.0	5.5	427.4
WHB03-166	16-Jun-03	39.3	0.2	23.6	5.5	432.5
WHB03-167	16-Jun-03	36.1	0.2	24.7	5.9	441.9
WHB03-168	16-Jun-03	33.5	0.2	27.4	6.5	473.0
WHB03-169	16-Jun-03	28.8	0.2	26.2	5.9	445.6
WHB03-170	16-Jun-03	28.1	0.2	26.1	5.4	447.2
WHB03-171	16-Jun-03	26.8	0.2	26.3	5.5	445.4
WHB03-172	16-Jun-03	25.1	0.2	26.6	5.5	445.8
WHB03-173	16-Jun-03	24.4	0.2	20.4	5.3	418.8
WHB03-174	17-Jun-03	22.9	0.2	21.8	4.8	461.1
WHB03-175	17-Jun-03	21.5	0.2	24.1	5.6	457.8
WHB03-176	17-Jun-03	18.2	0.2	24.4	5.8	460.6
WHB03-177	17-Jun-03	17.5	0.2	24.3	6.6	446.2
WHB03-178	17-Jun-03	15.4	0.2	25.8	5.3	462.0
WHB03-179	17-Jun-03	14.4	0.2	26.0	5.5	460.4
WHB03-180	17-Jun-03	12.3	0.2	28.2	4.7	470.0
WHB03-181	17-Jun-03	9.9	0.2	27.2	5.9	460.2
WHB03-182	18-Jun-03	6.5	0.2	23.0	5.1	450.6
WHB03-183	18-Jun-03	3.3	0.2	26.5	5.1	464.0