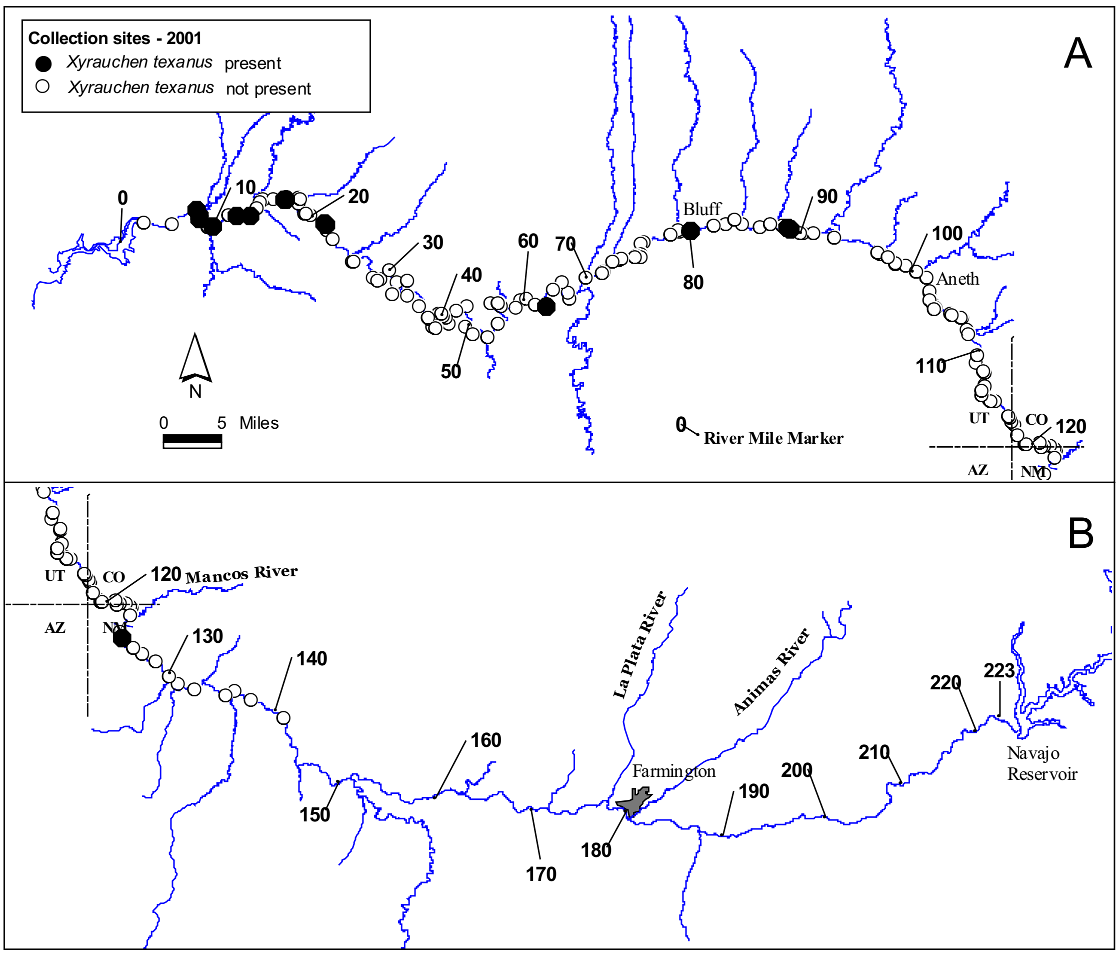
Razorback sucker larval fish survey
San Juan River

2001

DRAFT FINAL REPORT



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SAN JUAN RIVER RECOVERY IMPLEMENTATION PROGRAM

Razorback sucker larval fish survey in the San Juan River during 2001

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submitted to:

San Juan River Biology Committee
under the direction of the
San Juan River Recovery Implementation Program

31 March 2002

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Executive Summary

There were 206 fish collections (largest number of samples taken during this project to date) made between river miles 142.0 and 3.0 (=Clay Hills Crossing) under the 2001 razorback sucker larval fish study. The 2001 sampling effort yielded over twice as many fish (n=95,628) than were taken during 1998, 1999, and 2000 combined (n=45,429). Three of the seven 2001 sampling trips produced between 13,000-16,000 specimens while one of the 2001 sampling efforts in the lower reach of the study area resulted in the take of over 35,000 individuals. Likewise, a single 2001 site produced over 8,500 specimens while two additional 2001 samples (combined) during that same trip accounted for almost 8,800 individuals. Conversely, the entire first 2001 sampling effort (n=20 sites) yielded only 1,079 specimens.

The 206 samples resulted in the collection of fish representing seven families and 13 species with all except five samples producing fish. The only fish taxon present in year 2001 samples but absent from 2000 collections was plains killifish while largemouth bass, taken in 2000, was absent from 2001 samples. Neither of these two species are native to the San Juan River. Roundtail chub and Colorado pikeminnow, both native fish species, were taken in 1998-1999 samples but were not taken during either 2000 or 2001.

A total of 50 larval razorback sucker were taken during the 2001 portion of this study and for the first time since 1999, larval razorback sucker (n=2) were again collected in light-traps. Two of the 15 collections that yielded larval razorback sucker contained more than 10 individuals while four samples each contained between two and four specimens. The first 2001 larval razorback sucker were taken on 16 May 2001 at river mile 62.1 (n=2). Razorback sucker taken on that trip were also the smallest and least developed (earliest developmental stages) of the 2001 survey.

In 2001 larval razorback sucker exhibited a clumped distribution pattern with most individuals being collected in a very small reach of the study area. Of the 2001 total razorback sucker collected, 88% were taken in a 13-river mile portion of the lower study area between RM 13.1 and 8.1. The most upstream 2001 collection of larval razorback sucker was, as in 2000, at RM 124.8. This was the only 2001 larval record of this species upstream of RM 90.0.

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 was a steady increase in the number of larval razorback sucker taken in the San Juan River between 1998 and 2000. The large number of larval razorback sucker collected in 2000 (n=129) provide credible evidence indicative of continuing reproductive success of the augmented adult population. The increased number of 2000 larval razorback sucker specimens was likely indicative of both an increase in the number of augmented razorback sucker recruited to the spawning cohort and greater success among previously spawning adults.

That there was a decline in the overall catch of larval razorback sucker in 2001 should not be interpreted as an indication of a change in the trajectory of 1998-2000 sucker reproduction as it was within the of normal boundaries of sample variation. 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.

Introduction

There are few historic San Juan River records of razorback sucker 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 records of razorback sucker in the San Juan River was in 1976 when two adult specimens were collected at an irrigation pond near Bluff, Utah (in 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 by Tom Chart (formerly of the Utah Division of Wildlife Resources) in the San Juan River near Bluff, Utah.

The extreme rarity of razorback sucker in the San Juan River drainage necessitated the experimentally 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 a full-scale augmentation program for razorback sucker in the San Juan River.

At the November 1996 San Juan River Biology Committee integration meeting, it was suggested that the Colorado pikeminnow 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, identifying approximate location of spawning sites, and assess 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., longnose dace and channel catfish). 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 both 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 an extremely 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 lead 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 quite 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 snow-melt 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 longer portion of the San Juan River and capture of a considerably larger number of larval fish. An inflatable raft, which was used to travel 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. This former 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 former 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 quite 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 Recovery Implementation Program. In 1999, seven additional larval razorback sucker were collected between 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 in size from 9.4 to 18.1 mm TL with all except one being at the mesolarval developmental stage. The 2000 distribution of larval razorback sucker expanded their range from River Mile 96.2 upstream to River Mile 124.8 and downstream from River Mile 11.5 to River Mile 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 notable rarest in the upper-most portion of the upper sampling reach.

The primary objective of this study continues to be to determine if razorback sucker reproduction occurred in the San Juan River (during 2001) and the relative level of any such effort. Additional goals were to determine the spawning periodicity of catostomids between mid-April-early June and provide comparative analysis of the reproductive effort of San Juan River catostomids. This document reports results of the 2001 larval razorback sucker sampling effort.

Study Area

The San Juan River is a major tributary of the Colorado River and drains 99,200 km2 in Colorado, New Mexico, Utah, and Arizona (Figure 1). From its origins in the San Juan Mountains of southwestern Colorado at elevations exceeding 4,250 m, the river flows westward for about 570 km before confluencing with the Colorado River. The major perennial tributaries to the San Juan River are (from upstream to downstream) Navajo, Piedra, Los Pinos, Animas, La Plata, and Mancos rivers, and McElmo Creek. In addition there are numerous ephemeral arroyos and washes that contribute relatively little flow annually but input large sediment loads.

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

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

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

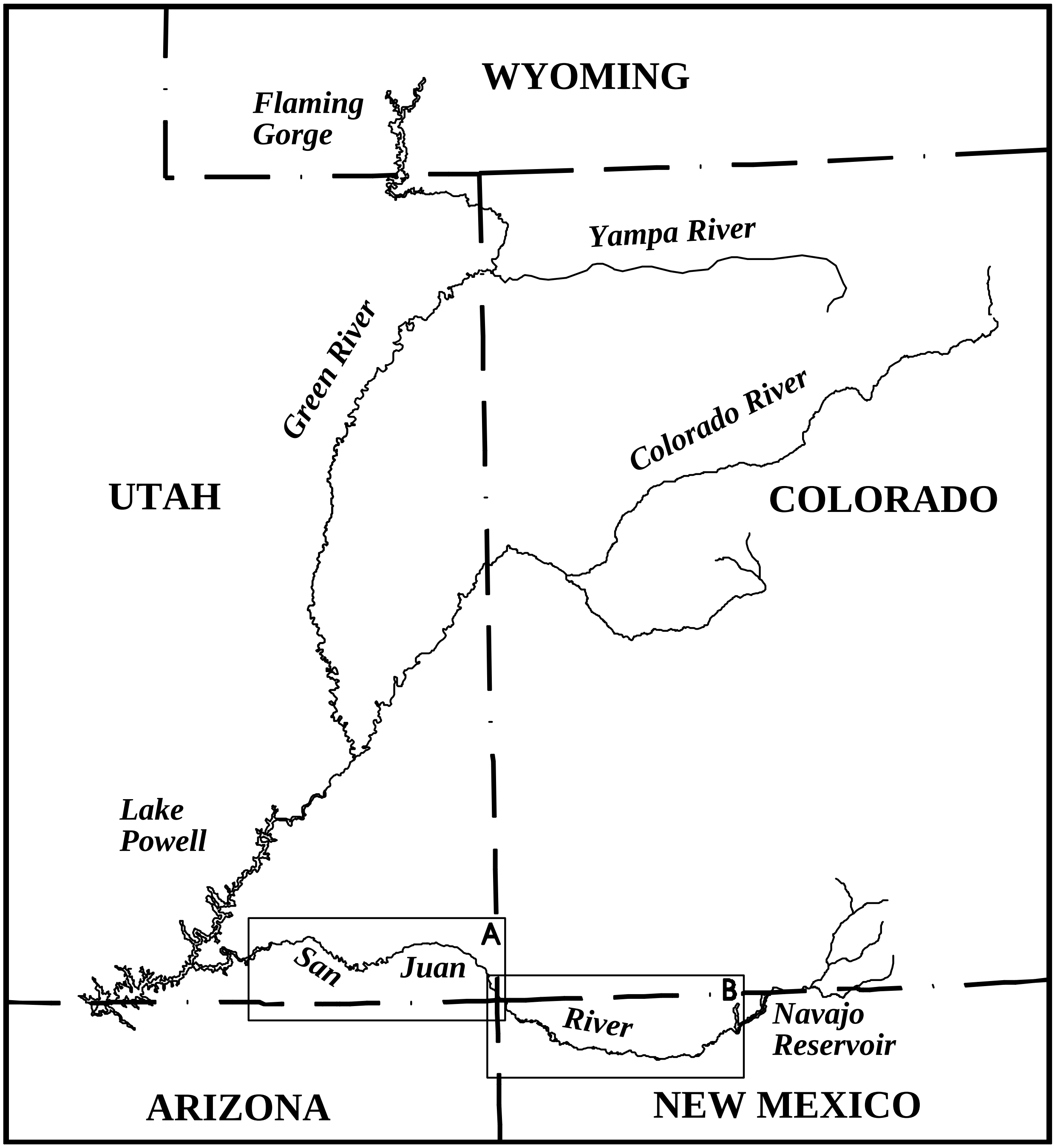


Figure 1. Location of the San Juan River within the Upper Colorado River Basin.

the river is bordered by nonnative salt cedar (*Tamarix chinensis*) and Russian olive (*Elaeagnus angustifolia*) and native cottonwood (*Populus fremontii*) and willow (*Salix* sp.). Nonnative woody plants dominated nearly all sites and resulted in heavily stabilized banks. Cottonwood and willow accounted for less than 15% of the riparian vegetation.

The characteristic annual hydrographic pattern in the San Juan River is typical of rivers in the American Southwest with large flows during spring snowmelt, followed by low summer, autumn, and winter base flows. Summer and early autumn base flows are frequently punctuated by convective storm-induced flow spikes. Prior to closure of Navajo Dam, about 73% of the total annual San Juan River drainage discharge (based on USGS Gauge # 09379500; Bluff, Utah) occurred during spring runoff (1 March through 31 July). Median daily peak discharge during spring runoff was 10,400 cfs (range = 3,810 to 33,800 cfs). Although flows resulting from summer and autumn storms contributed a comparatively small volume to total annual discharge, the magnitude of storm-induced flows exceeded the peak snowmelt discharge about 30% of the years, occasionally exceeding 40,000 cfs (mean daily discharge). Both the magnitude and frequency of these storm induced flow spikes are greater than those recorded in the Green or Colorado rivers.

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

Since 1992, Navajo Dam has been operated to mimic a “natural” San Juan River hydrograph with the volume of release during spring linked to the amount of precipitation recorded during the preceding winter. Thus in years with high spring snowmelt, reservoir releases were “large” and “small” in low runoff years. Base flows since 1992 were typically greater than during pre-dam years but less than those between 1964-1991.

The primary study area for most investigations conducted under the auspices of the San Juan River Seven Year Research Program, including that reported herein, were accomplished in the mainstem San Juan River and its immediate vicinity between Navajo Dam and Lake Powell. There is considerable human activity within the floodplain of the San Juan River between Shiprock and Navajo Dam. Irrigated agriculture is practiced throughout this portion of the San Juan River Valley and adjacent uplands. Much of the river valley not devoted to agriculture (crop production and grazing) consists of small communities (e.g., Blanco and Kirtland) and several larger towns (e.g., Bloomfield and Farmington).

The Animas River Valley is similarly developed. Small portions of the river valley and uplands from Shiprock to Bluff are farmed with dispersed livestock grazing as the primary land use. In the vicinity of Montezuma Creek and Aneth, petroleum extraction occurs in the floodplain and adjacent uplands. There are few human-caused modifications of the system from Bluff to Lake Powell.

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

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

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

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

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

Reach 5 (RM 131 to 154, the Mixer to just below Hogback Diversion) is predominantly multi-channeled with the largest total wetted area and greatest secondary channel area of any of the reaches. Secondary channels in this section tend to be longer and more stable (but fewer) than in Reach 3. Riparian vegetation is more dense in this reach than in lower reaches but less dense than in upper reaches. Cobble and gravel are more common in channel banks than sand, and clean cobble areas are more abundant than in lower reaches. This is the lowermost reach containing a diversion dam (Cudei). 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 predominately a single channel, with 50% fewer secondary channels than Reaches 3, 4, or 5. Cobble and gravel are the dominant substrata with cobble bars containing clean interstitial spaces being most abundant in this reach. There are four diversion dams that may impede fish passage in this reach. Backwater habitat abundance is low in this reach, with only Reach 2 containing fewer of these habitats. The channel has been altered by dike construction in several areas to control lateral channel movement and over-bank flow.

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

Reach 8 (RM 213 to 224, between Blanco and Archuleta and Navajo Dam) is the most directly influenced by Navajo Dam, which is situated at its uppermost end (RM 224). This reach is primarily a single channel, with only four to eight secondary channels, depending on the flow.

Cobble is the dominant substrate type, and because lateral channel movement is less confined in this reach, some loose, clean cobble sources are available from channel banks. In the upper end of the reach, just below Navajo Dam, the channel has been heavily modified by excavation of material used in dam construction. In addition, the upper 10 km of this reach above Gobernador Canyon are essentially sediment free, resulting in the clearest water of any reach. Because of Navajo Dam, this area experiences much colder summer and warmer winter water temperatures. These cool, clear water conditions have allowed development of an intensively managed blue-ribbon trout fishery to the exclusion of native species in the uppermost portion of the reach.

The upper limit of the study area was expanded between 2000 and 2001 and now encompasses reaches 1 through 5 (Figure 2). Seven razorback sucker larval fish collection trips were taken between 10 April and 14 June 2001. As in 1999 and 2000, four sampling efforts were in the upper reach and three were in the lower reach. The 1 June 2000 collection of a larval razorback sucker at River Mile 124.8 suggested the need for an upstream expansion of the 2001 study area. The first three 2001 upper-reach samples were, as in 2002, initiated at RM 127.5 while the final upstream-reach 2001 survey (29 May - 1 June 2001) was initiated at Cudei Diversion Dam (RM 142). For reporting purposes, the 2001 data were separated into upper and lower reaches with the former including collections between RM 127.5 (or RM 142) and Bluff and the latter containing collections from Bluff downstream to Clay Hills Crossing.

Methods

Access to the river and sampling localities was gained through the use a 16' inflatable raft that transported both personnel and collecting gear. There was not a predetermined number of samples per river mile or geomorphic reach for this study. Instead, an effort was made to collect in as many suitable larval fish habitats as possible within the river reach being sampled. Previous San Juan River investigations have clearly demonstrated that larval fish most frequently occur and are most abundant in low velocity habitats such as isolated pools, backwaters, and secondary channels.

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

All retained specimens were placed in plastic bags containing a solution of 5% buffered formalin and a tag inscribed with unique alpha-numeric code that was also recorded on the field data sheet. Samples were returned to the laboratory where they were sorted, specimens identified to species, enumerated, measured (minimum and maximum size [mm SL] for each species at each site), transferred to 70% ethyl alcohol, and catalogued in the Division of Fishes of the Museum of Southwestern Biology (MSB) at the University of New Mexico (UNM). Scientific and common names of fishes that are used in this report follow Robins et al. (1991) while six letter codes for species are derived from the first three letters of the genus followed by the first three letters of the species (Table 1). Common names, arranged in phylogenetic order, are presented in tables in this report.

River Mile, standardized for the San Juan River Basin Recovery Implementation Program, was used to designate the location of sampling sites. Coordinates identifying longitude and latitude were determined with a Garmin Navigation Geographic Positioning System (GPS) Instrument for each of the sampling localities and corrected for selective availability (intentionally induced error) in the laboratory. On 1 May 2000, the U.S. Government deactivated the selective availability

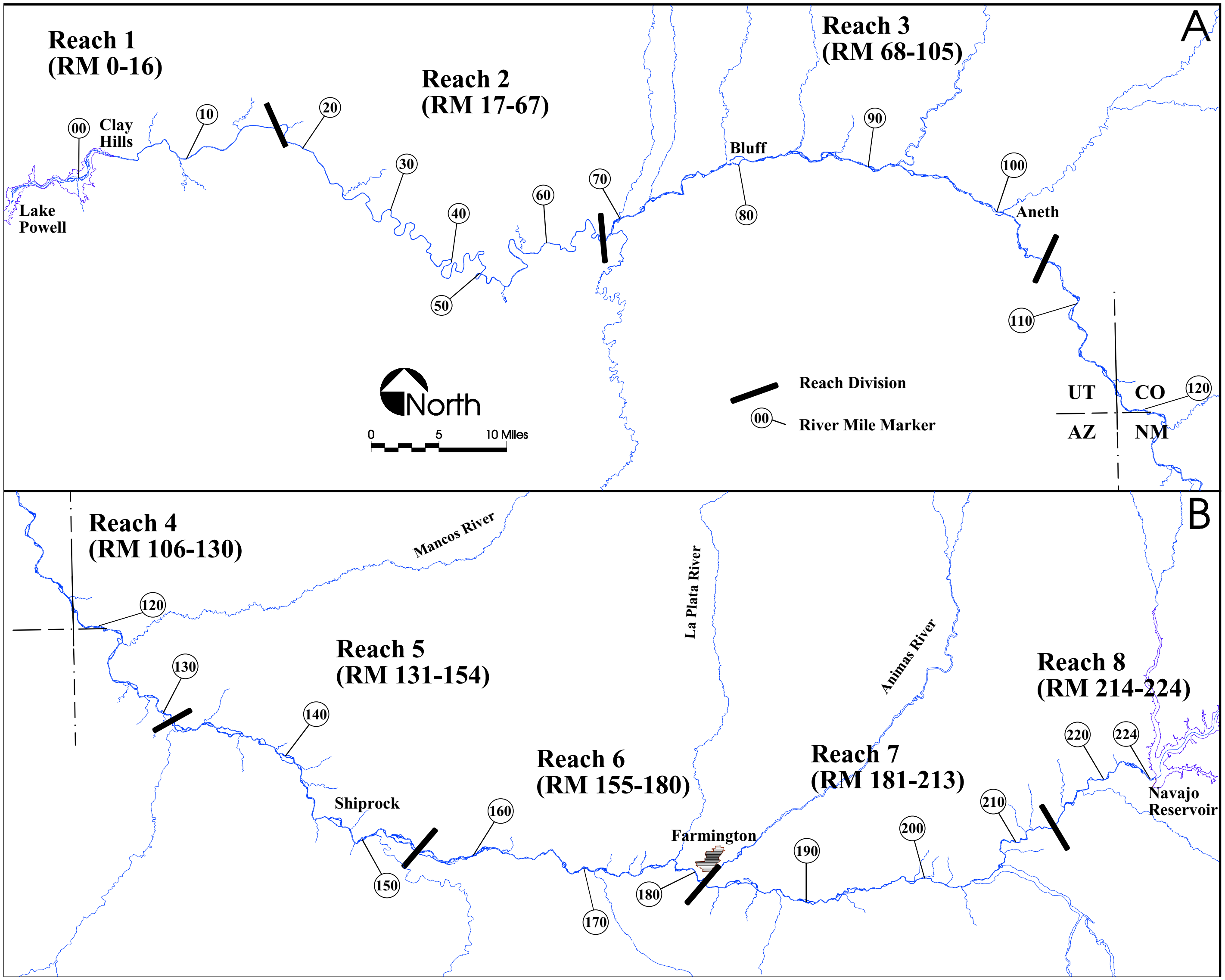


Figure 2. Map of the San Juan River study area.

Table 1. Scientific and common names and species codes of fish collected from the San Juan River during 2001.

Scientific Name	Common Name	Code
Order Cypriniformes		
Family Cyprididae	carps and minnows	
Cyprinella lutrensis	red shiner	(CYPLUT)
Cyprinus carpio	common carp	(CYPCAR)
Pimephales promelas	fathead minnow	(PIMPRO)
Rhinichthys osculus	specked dace	(RHIOSC)
Family Catostomidae	suckers	
Catostomus (Pantosteus) discobolus	bluehead sucker	(CATDIS)
Catostomus latipinnis	flannelmouth sucker	(CATLAT)
Xyrauchen texanus	razorback sucker	(XYRTEX)
Order Siluriformes		
Family Ictaluridae	bullhead catfishes	
Ameiurus melas	black bullhead	(AMEMEL)
Ictalurus punctatus	channel catfish	(ICTPUN)
Order 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)

component of the GPS system thereby providing more precise positioning information. Starting with the fourth 2000 sampling trip (8 - 11 May 2000), Universal Transverse Mercator (UTM) coordinates of sampling sites were recorded instead of longitude and latitude.

Specimens whose species-specific identity was questionable were forwarded to Darrel E. Snyder (Larval Fish Laboratory, Colorado State University) for review. In addition, all specimens identified as razorback sucker (by MSB personnel) were sent to Darrel E. Snyder for verification. An electronic copy of the 1998 -2001 fish collection data were submitted to Keller-Bliesner Engineering for inclusion in the San Juan River database.

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 determined from U.S. Geological Survey Gauge (# 09368000) at Shiprock, New Mexico (Figure 3).

Results

2001 Survey

There were over twice as many fish collected in 2001 (n=95,628) than had been taken collectively during 1998, 1999, and 2000 (n=45,429). In 2001, Trips 4, 6, and 7 each produced between 13,000-16,000 specimens while Trip 2, which was conducted in the lower reach of the study area, resulted in the take of over 35,000 individuals. A single site sampled during the Trip 2 collecting effort produced over 8,500 specimens while two additional samples (combined) during that same effort accounted for almost 8,800 individuals. Conversely, the entire first 2001 sampling effort (n=20 sites) yielded only 1,079 specimens.

The 2001 sampling effort also resulted in the largest number of samples taken during this project to date. Of the 206 localities sampled between 10 April 2001 and 14 June 2001 (Figure 4), all (97.6%) except five produced fish. There were 108 samples in the upper reach, 98 in the lower reach, and a total of 15 collections which employed light-traps as the sampling method. The 206 samples resulted in the collection of fish representing seven families and 13 species (Table 2). The only fish taxon present in year 2001 samples but absent from 2000 collections was plains killifish while largemouth bass, taken in 2000, was absent from 2001 samples. Neither of these two species are native to the San Juan River. Roundtail chub and Colorado pikeminnow, both native fish species, were taken in 1998-1999 samples but were not taken during either 2000 or 2001.

Flannelmouth sucker was the numerically dominant catostomid taxon accounting for over 95% of the sucker catch. Bluehead sucker was present in less than 25% of the samples and was only 4.2% of the sucker catch. Collectively, the three native sucker taxa comprised only 8.4% of the total catch. That sucker were sucker were such a low percent of the total catch was primarily due to the large number of larval red shiner taken in 2001.

As reported in previous years of this study, red shiner was both the most frequently encountered species and most abundant taxon. Red shiner were taken in over 95% of the 2001 samples and were 87% of the total catch. There was a marked increase in red shiner between 2000 and 2001 as during the former year red shiner were only 26% of the total catch.

There were only 15 light trap samples recorded during 2001 resulting in the collection of 1,426 specimens represented by six species (Table 3). The majority (91%) of fish collected by this sampling methodology were larval red shiner. The 96 sucker specimens taken in light-traps included two larval razorback sucker. The majority of light-trap collected sucker (88%) were flannelmouth sucker.

There was little difference in the cumulative sampling effort between the upper and lower reaches of the study area. A total of 108 collections were taken in the upper reach (Table 4; Figure 5) while 98 samples were taken in the lower reach (Table 5). The cumulative catch, however, was

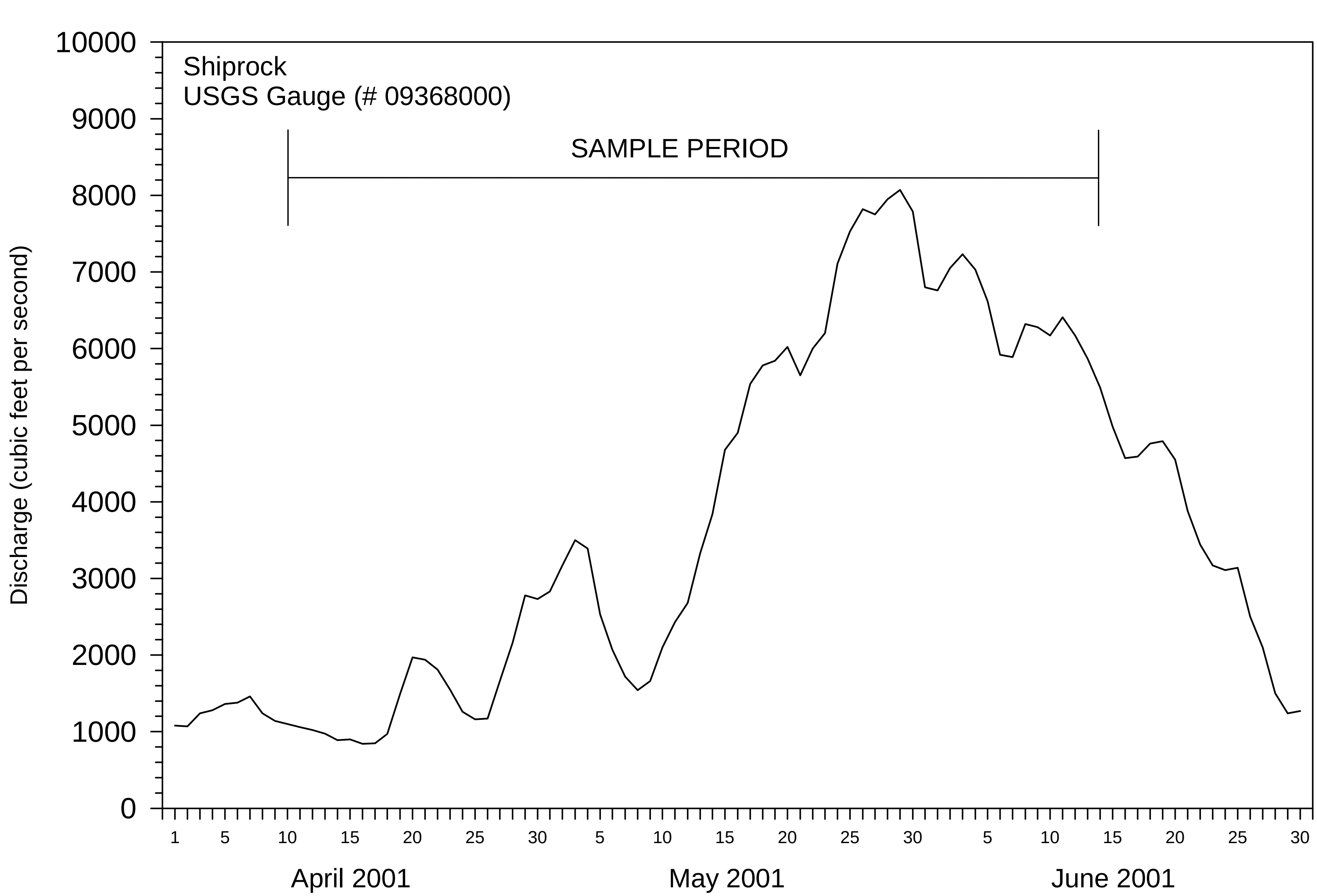


Figure 3. Hydrograph of the San Juan River at Shiprock, New Mexico during the 2001 sampling period.

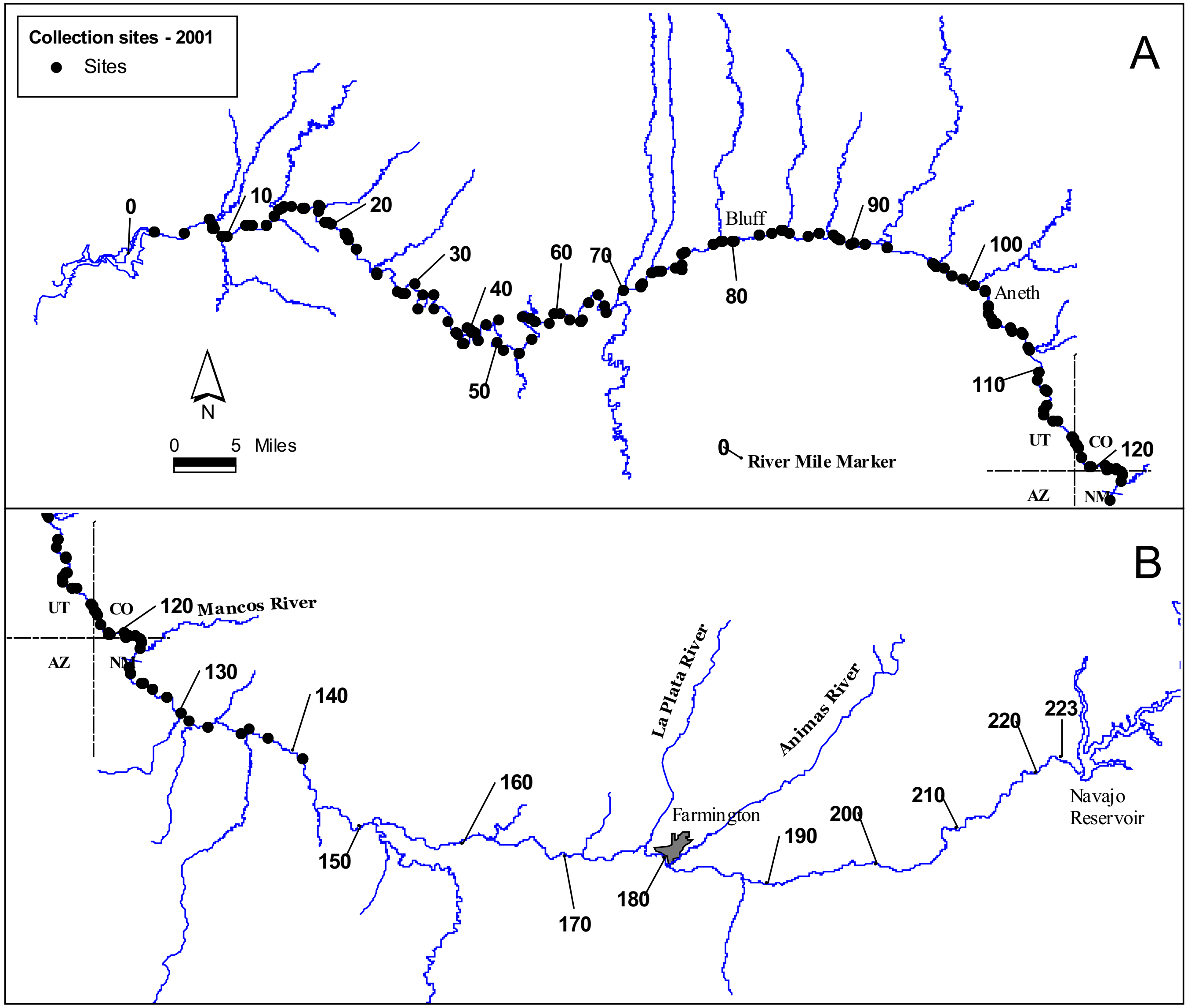


Figure 4. Distribution map of localities sampled during 2001.

Table 2. Summary of 2001 San Juan River larval razorback sucker project fish collections.

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	86,460	87.28	197	95.63
common carp	I	265	0.28	13	6.31
fathead minnow	I	3,335	3.49	132	64.08
speckled dace	N	63	0.07	36	17.48
SUCKERS					
flannelmouth sucker	N	7,642	7.99	119	57.77
bluehead sucker	N	338	0.35	48	23.30
razorback sucker	N	50	0.05	15	7.28
undetermined Catostomidae	N	1	0.00	1	0.49
BULLHEAD CATFISHES					
black bullhead	I	1	0.00	1	0.49
channel catfish	I	15	0.02	9	4.37
TROUT					
kokanee salmon	I	1	0.00	1	0.49
undetermined Salmonidae	I	1	0.00	1	0.49
KILLIFISHES					
plains killifish	I	5	0.01	4	1.94
LIVEBEARERS					
western mosquitofish	I	446	0.47	35	16.99
SUNFISHES					
green sunfish	I	4	0.00	4	1.94
bluegill	I	1	0.00	1	0.49
TOTAL		95,628			

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on n=206 samples.

Table 3. Summary of 2001 San Juan River larval razorback sucker project light-trap collections.

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	1,298	91.02	13	86.67
common carp	I	C	C	C	C
fathead minnow	I	30	2.10	5	33.33
speckled dace	N	C	C	C	C
SUCKERS					
flannelmouth sucker	N	85	5.96	11	73.33
bluehead sucker	N	9	0.63	4	26.67
razorback sucker	N	2	0.14	2	13.33
undetermined Catostomidae	N	C	C	C	C
BULLHEAD CATFISHES					
black bullhead	I	C	C	C	C
channel catfish	I	C	C	C	C
TROUT					
kokanee salmon	I	C	C	C	C
undetermined Salmonidae	I	C	C	C	C
KILLIFISHES					
plains killifish	I	C	C	C	C
LIVEBEARERS					
western mosquitofish	I	2	0.14	2	13.33
SUNFISHES					
green sunfish	I	C	C	C	C
bluegill	I	C	C	C	C
TOTAL		1,426			

1 N = native; I = introduced
2 Frequency and % frequency of occurrence are based on n=15 samples.

Table 4. Summary of 2001 San Juan River larval razorback sucker project fish collections in the upper portion of the study area (between Cudei, New Mexico and Bluff, Utah).

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	31,706	81.25	103	95.37
common carp	I	5	0.01	4	3.70
fathead minnow	I	586	1.50	70	64.81
speckled dace	N	37	0.09	21	19.44
SUCKERS					
flannelmouth sucker	N	6,377	16.34	69	63.89
bluehead sucker	N	257	0.66	27	25.00
razorback sucker	N	4	0.01	4	3.70
undetermined Catostomidae	N	C	C	C	C
BULLHEAD CATFISHES					
black bullhead	I	C	C	C	C
channel catfish	I	C	C	C	C
TROUT					
kokanee salmon	I	1	0.00	1	0.93
undetermined Salmonidae	I	1	0.00	1	0.93
KILLIFISHES					
plains killifish	I	2	0.01	2	1.85
LIVEBEARERS					
western mosquitofish	I	46	0.12	20	18.52
SUNFISHES					
green sunfish	I	1	0.00	1	0.93
bluegill	I	C	C	C	C
TOTAL		39,023			

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on n=108 samples.

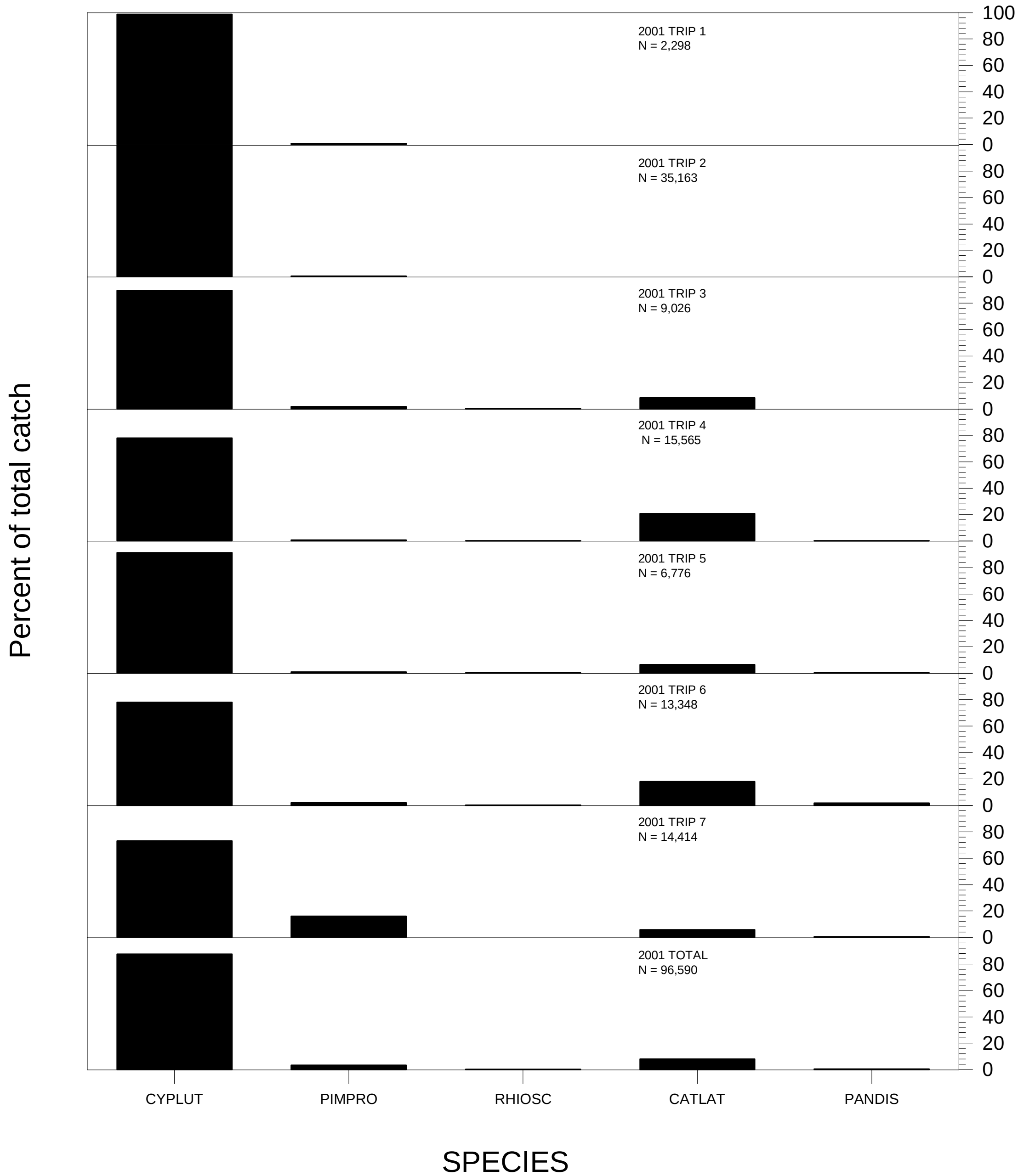


Figure 5. Ichthyofaunal composition of 2001 sampling efforts by trip.

Table 5. Summary of 2001 San Juan River larval razorback sucker project fish collections in the lower portion of the study area (between Bluff and Clay Hills, Utah).

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	51,754	91.43	94	95.92
common carp	I	260	0.46	9	9.18
fathead minnow	I	2,749	4.86	62	63.27
speckled dace	N	26	0.05	15	15.31
SUCKERS					
flannelmouth sucker	N	1,265	2.23	50	51.02
bluehead sucker	N	81	0.14	21	21.43
razorback sucker	N	46	0.08	11	11.22
undetermined Catostomidae	N	1	0.00	1	1.02
BULLHEAD CATFISHES					
black bullhead	I	1	0.00	1	1.02
channel catfish	I	1	0.00	1	1.02
TROUT					
kokanee salmon	I	C	C	C	C
undetermined Salmonidae	I	C	C	C	C
KILLIFISHES					
plains killifish	I	3	0.01	2	2.04
LIVEBEARERS					
western mosquitofish	I	400	0.71	15	15.31
SUNFISHES					
green sunfish	I	3	0.01	2	2.04
bluegill	I	1	0.00	1	1.02
TOTAL		56,605			

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on n=98 samples.

not as evenly distributed (as the number of samples) between reaches. Although 47% of the samples were from the lower reach, those collections accounted for almost 60% of the total catch. The most notable between reach difference in ichthyofaunal composition was in the relative abundance of suckers. The number of sucker specimens collected in the upper reach was over 4.5 times that taken in lower reach samples. Catostomids were about 17% of the collective upper reach catch but only 2% of the catch in the lower reach.

The first 2001 sampling effort yielded the fewest number of fish taken during this portion of the study. Red shiner numerically dominated the first 2001 samples from the upper reach of the study area occurring at 90% of the sites and comprising over 97% of the total catch (Table 6). The only two native fish species taken during this initial sampling effort (speckled dace and flannelmouth sucker) were each represented by single specimens. Other noteworthy collections included a single kokanee salmon (31 mm SL) and a salmonid egg that was not identifiable to genus or species but was also likely that of a kokanee salmon.

The second 2001 trip was between Bluff and Clay Hills and occurred from 15-19 April 2001. An extremely large number (n=35,162) of individual fish were taken during this sampling effort, however, few of the fish were larval specimens (Table 7). Red shiner comprised over 99% of the total catch with nine of the samples containing more than 1,000 individual red shiner. There were few individuals of other species, besides red shiner, present in those samples. The nine aforementioned samples collectively contained three species represented by 27,068 red shiner, but only 25 fathead minnow and three speckled dace. The first larval sucker (flannelmouth sucker; n=8) collected during 2001 were taken in a light-trap sample at river mile 9.5. Of the four light-traps set in the backwater at that site, the one in the shallowest portion of the habitat yielded larval sucker exclusively. The other three traps collected a cumulative 527 red shiner.

The next sampling effort (23-26 April 2001) was the second conducted in the upper portion of the study area and third overall. Red shiner again numerically dominated the samples occurring in 97% of the collections and comprising 90% of the total catch (Table 8). Larval sucker were present, for the first time in 2001, in relatively large numbers in the upper reach. Eleven of the 16 samples that contained larval sucker yielded more than 10 individuals while three of those samples produced over 130 individuals each. Almost all (>99%) flannelmouth sucker and all three bluehead sucker taken during this sampling event were Age 0 fish.

The forth sampling trip was conducted during 7-10 May 2001 and yielded the second largest collection of fish (n=15,570) during 2001 (Table 9). Over 12,00 red shiner were taken in 27 samples with three of those collections yielding more than 1,000 red shiner each. There was a marked increase in the abundance of larval sucker taken between the third and fourth 2001 sampling trips (both in the upper reach). Flannelmouth sucker were taken at 27 of 29 collection sites during 7-10 May 2001 and comprised 21% of the total catch. This four-fold increase in the number of individuals between trips was mirrored by a nine-fold increase in the number of larval bluehead sucker. The isolated pool at RM 82.5 that produced the largest sample of larval flannelmouth sucker (n=1,301) also yielded the largest single collection of larval bluehead sucker taken during this trip (n=12).

The fifth sampling effort occurred in the reach between Bluff and Clay Hills between 16-18 May 2001 during a period of increasing spring run-off (ca. 4,600-5,800 cfs at Shiprock). While almost 7,000 fish were taken, that number represented the second fewest specimens during the 2001 sample effort. Ten species of fish were collected during this segment of the project including all three native sucker taxa (Table 10). Red shiner remained the numerically dominant taxon again comprising over 90% of the catch. The 473 catostomids taken between 16-18 May 2001 were all Age 0 fish and were represented more razorback sucker (n=21) than bluehead sucker (n=18). A 16.2 mm TL mesolarvae that could not be identified to species (very possibly a small flannelmouth sucker or sucker hybrid; D. E. Snyder, personal communication) was instead reported herein as an

Table 6. Summary of the 1st 2001 San Juan River larval razorback sucker project fish collection (10-12 April 2001; Four Corners to Bluff).

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	1,050	97.31	18	90.00
common carp	I	C	C	C	C
fathead minnow	I	18	1.67	6	30.00
speckled dace	N	1	0.09	1	5.00
SUCKERS					
flannelmouth sucker	N	1	0.09	1	5.00
bluehead sucker	N	C	C	C	C
razorback sucker	N	C	C	C	C
undetermined Catostomidae	N	C	C	C	C
BULLHEAD CATFISHES					
black bullhead	I	C	C	C	C
channel catfish	I	C	C	C	C
TROUT					
kokanee salmon	I	1	0.09	1	5.00
undetermined Salmonidae	I	1	0.09	1	5.00
KILLIFISHES					
plains killifish	I	1	0.09	1	5.00
LIVEBEARERS					
western mosquitofish	I	6	0.56	3	15.00
SUNFISHES					
green sunfish	I	C	C	C	C
bluegill	I	C	C	C	C
TOTAL		1,079			

1 N = native; I = introduced
2 Frequency and % frequency of occurrence are based on n=20 samples.

Table 7. Summary of 2nd 2001 San Juan River larval razorback sucker project fish collection (15-19 April 2001; Bluff to Clay Hills).

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	35,014	99.58	36	97.30
common carp	I	1	0.00	1	2.70
fathead minnow	I	122	0.35	22	59.46
speckled dace	N	14	0.04	8	21.62
SUCKERS					
flannelmouth sucker	N	9	0.03	2	5.41
bluehead sucker	N	1	0.00	1	2.70
razorback sucker	N	C	C	C	C
undetermined Catostomidae	N	C	C	C	C
BULLHEAD CATFISHES					
black bullhead	I	C	C	C	C
channel catfish	I	C	C	C	C
TROUT					
kokanee salmon	I	C	C	C	C
undetermined Salmonidae	I	C	C	C	C
KILLIFISHES					
plains killifish	I	C	C	C	C
LIVEBEARERS					
western mosquitofish	I	1	0.00	1	2.70
SUNFISHES					
green sunfish	I	C	C	C	C
bluegill	I	C	C	C	C
TOTAL		35,162			

1 N = native; I = introduced
2 Frequency and % frequency of occurrence are based on n=37 samples.

Table 8. Summary of 3rd 2001 San Juan River larval razorback sucker project fish collection (23-26 April 2001; Four Corners to Bluff).

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	8,088	89.61	29	96.67
common carp	I	C	C	C	C
fathead minnow	I	160	1.77	21	70.00
speckled dace	N	13	0.14	7	23.33
SUCKERS					
flannelmouth sucker	N	753	8.34	16	53.33
bluehead sucker	N	3	0.03	2	6.67
razorback sucker	N	C	C	C	C
undetermined Catostomidae	N	C	C	C	C
BULLHEAD CATFISHES					
black bullhead	I	C	C	C	C
channel catfish	I	C	C	C	C
TROUT					
kokanee salmon	I	C	C	C	C
undetermined Salmonidae	I	C	C	C	C
KILLIFISHES					
plains killifish	I	C	C	C	C
LIVEBEARERS					
western mosquitofish	I	9	0.10	6	20.00
SUNFISHES					
green sunfish	I	C	C	C	C
bluegill	I	C	C	C	C
TOTAL		9,026			

1 N = native; I = introduced
2 Frequency and % frequency of occurrence are based on n=30 samples.

Table 9. Summary of 4th 2001 San Juan River larval razorback sucker project fish collection (7-10 May 2001; Four Corners to Bluff).

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	12,146	78.01	27	93.10
common carp	I	C	C	C	C
fathead minnow	I	132	0.85	20	68.97
speckled dace	N	11	0.07	8	27.59
SUCKERS					
flannelmouth sucker	N	3,233	20.76	27	93.10
bluehead sucker	N	29	0.19	8	27.59
razorback sucker	N	C	C	C	C
undetermined Catostomidae	N	C	C	C	C
BULLHEAD CATFISHES					
black bullhead	I	C	C	C	C
channel catfish	I	C	C	C	C
TROUT					
kokanee salmon	I	C	C	C	C
undetermined Salmonidae	I	C	C	C	C
KILLIFISHES					
plains killifish	I	1	0.01	1	3.45
LIVEBEARERS					
western mosquitofish	I	18	0.12	4	13.79
SUNFISHES					
green sunfish	I	C	C	C	C
bluegill	I	C	C	C	C
TOTAL		15,570			

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on n=29 samples.

Table 10. Summary of 5th 2001 San Juan River larval razorback sucker project fish collection (16-18 May 2001; Bluff to Clay Hills).

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	6,195	91.44	28	93.33
common carp	I	26	0.38	1	3.33
fathead minnow	I	53	0.78	15	50.00
speckled dace	N	7	0.10	4	13.33
SUCKERS					
flannelmouth sucker	N	433	6.39	22	73.33
bluehead sucker	N	18	0.27	6	20.00
razorback sucker	N	21	0.31	7	23.33
undetermined Catostomidae	N	1	0.01	1	3.33
BULLHEAD CATFISHES					
black bullhead	I	C	C	C	C
channel catfish	I	11	0.16	6	20.00
TROUT					
kokanee salmon	I	C	C	C	C
undetermined Salmonidae	I	C	C	C	C
KILLIFISHES					
plains killifish	I	C	C	C	C
LIVEBEARERS					
western mosquitofish	I	9	0.13	5	16.67
SUNFISHES					
green sunfish	I	1	0.01	1	3.33
bluegill	I	C	C	C	C
TOTAL		6,775			

1 N = native; I = introduced
2 Frequency and % frequency of occurrence are based on n=30 samples.

undetermined catostomidae. Razorback sucker were taken in seven separate collections from river miles 62.1 to 8.5 with between one and nine specimens collected per site. Two larval razorback sucker were collected in light-traps set at river miles 21.1 and 21.0. This was first time since 1999 that this sampling method has produced the target species.

The final upper reach sampling effort (sixth trip) was conducted from 29 May - 1 June 2001 and encompassed the reach from Cudei Diversion Dam (RM 142) downstream to Bluff (RM 82). Sampling occurred during the peak of the 2001 spring-runoff (ca. 7,000-8,000 cfs) as measured at the Shiprock gauge. Red shiner were taken at each of the 29 sampling localities resulting in a catch of over 10,000 individuals which was 78% of the total catch (Table 11). Although there were fewer larval sucker collected during this sampling trip than had been taken during the previous effort in this reach (n=3,262), the number was relatively substantial (n=2,619) for this project. Flannelmouth sucker were 18% of the total catch and larval bluehead sucker peaked in both number (n=225) and percent of the catch (1.7%). Four larval razorback sucker were also collected during this collecting effort. Individual specimens were taken at four separate sampling sites from river mile 124.8 downstream to 80.2.

The seventh and final 2001 sampling trip occurred from 11 June - 14 June 2001 in the reach between Bluff and Clay Hills. At the time of this survey, spring-runoff in the San Juan River had already peaked and was in a gradual decline (ca. 6,500 cfs). Red shiner was taken at 30 of the 31 sampling localities and comprised 72% of the total catch (Table 12). The second most abundant species was fathead minnow which were 18% (n=2,574) of the catch and were taken at 81% of the sampling localities. There were more fathead minnow taken during this sampling effort than in the cumulative previous six 2001 samples. The overall catch of larval sucker had declined since the last lower reach effort (16 - 18 May 2001) however, the number of larval bluehead sucker collected was greater than any of the previous three lower reach sampling efforts. In addition, this survey yielded the largest catch of larval razorback sucker (n=25) during the 2001 sampling effort. Individuals (razorback sucker) were taken in four separate collections between river miles 13.0 and 8.1 and ranged in developmental stage from late-mesolarvae (16.0 mm TL) to juvenile (28.8 mm TL).

Razorback sucker - 2001

A total of 50 larval razorback sucker were taken during the 2001 portion of this study and for the first time since 1999, larval razorback sucker (n=2) were again collected in light-traps. Two of the 15 collections that yielded larval razorback sucker contained more than 10 individuals while four samples each contained between two and four specimens. The first 2001 larval razorback sucker were taken on 16 May 2001 at river mile 62.1 (n=2) during the second lower reach (fifth overall) sampling trip. Razorback sucker taken on that trip were also the smallest and least developed (earliest developmental stages) of the 2001 survey.

In 2001 larval razorback sucker exhibited a clumped distribution pattern with most individuals being collected in a very small reach of the study area (Figure 6). Of the 2001 total razorback sucker collected, 88% (n=44) were taken in a 13-river mile portion of the lower study area between RM 13.1 and 8.1. In the intermediate (more upstream) reach of the study area, there were collections of larval razorback sucker at river miles 62.1 (n=2), 80.2 (n=1), and 88.8 and 89.1 (n=2). The most upstream 2001 collection of larval razorback sucker was, as in 2000, at RM 124.8. This was also the only 2001 larval record of this species upstream of RM 90.0.

There were four samples from the final sampling trip (14 June 2001) that contained a cumulative total of 25 larval razorback sucker. Those individuals, taken between river miles 13.0 and 8.1 ranged in length from 16.0 mm TL to 28.8 mm TL (Figure 7) and in developmental stage from late-mesolarvae to juvenile (respectively). Two of the 25 fish were juveniles (26.8 - 28.8 mm

Table 11. Summary of 6th 2001 San Juan River larval razorback sucker project fish collection (29 May - 1 June 2001; Cudei to Bluff).

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	10,422	78.08	29	100.00
common carp	I	5	0.04	4	13.79
fathead minnow	I	276	2.07	23	79.31
speckled dace	N	12	0.09	5	17.24
SUCKERS					
flannelmouth sucker	N	2,390	17.91	25	86.21
bluehead sucker	N	225	1.69	17	58.62
razorback sucker	N	4	0.03	4	13.79
undetermined Catostomidae	N	C	C	C	C
BULLHEAD CATFISHES					
black bullhead	I	C	C	C	C
channel catfish	I	C	C	C	C
TROUT					
kokanee salmon	I	C	C	C	C
undetermined Salmonidae	I	C	C	C	C
KILLIFISHES					
plains killifish	I	C	C	C	C
LIVEBEARERS					
western mosquitofish	I	13	0.10	7	24.14
SUNFISHES					
green sunfish	I	1	0.01	1	3.45
bluegill	I	C	C	C	C
TOTAL		13,348			

1 N = native; I = introduced
2 Frequency and % frequency of occurrence are based on n=29 samples.

Table 12. Summary of 7th 2001 San Juan River larval razorback sucker project fish collection (11-14 June 2001; Bluff to Clay Hills).

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	10,545	71.89	30	96.77
common carp	I	233	1.59	7	22.58
fathead minnow	I	2,574	17.55	25	80.65
speckled dace	N	5	0.03	3	9.68
SUCKERS					
flannelmouth sucker	N	823	5.61	26	83.87
bluehead sucker	N	62	0.42	14	45.16
razorback sucker	N	25	0.17	4	12.90
undetermined Catostomidae	N	C	C	C	C
BULLHEAD CATFISHES					
black bullhead	I	1	0.01	1	3.23
channel catfish	I	4	0.03	3	9.68
TROUT					
kokanee salmon	I	C	C	C	C
undetermined Salmonidae	I	C	C	C	C
KILLIFISHES					
plains killifish	I	3	0.02	2	6.45
LIVEBEARERS					
western mosquitofish	I	390	2.66	9	29.03
SUNFISHES					
green sunfish	I	2	0.01	2	6.45
bluegill	I	1	0.01	1	3.23
TOTAL		14,668			

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on n=31 samples.

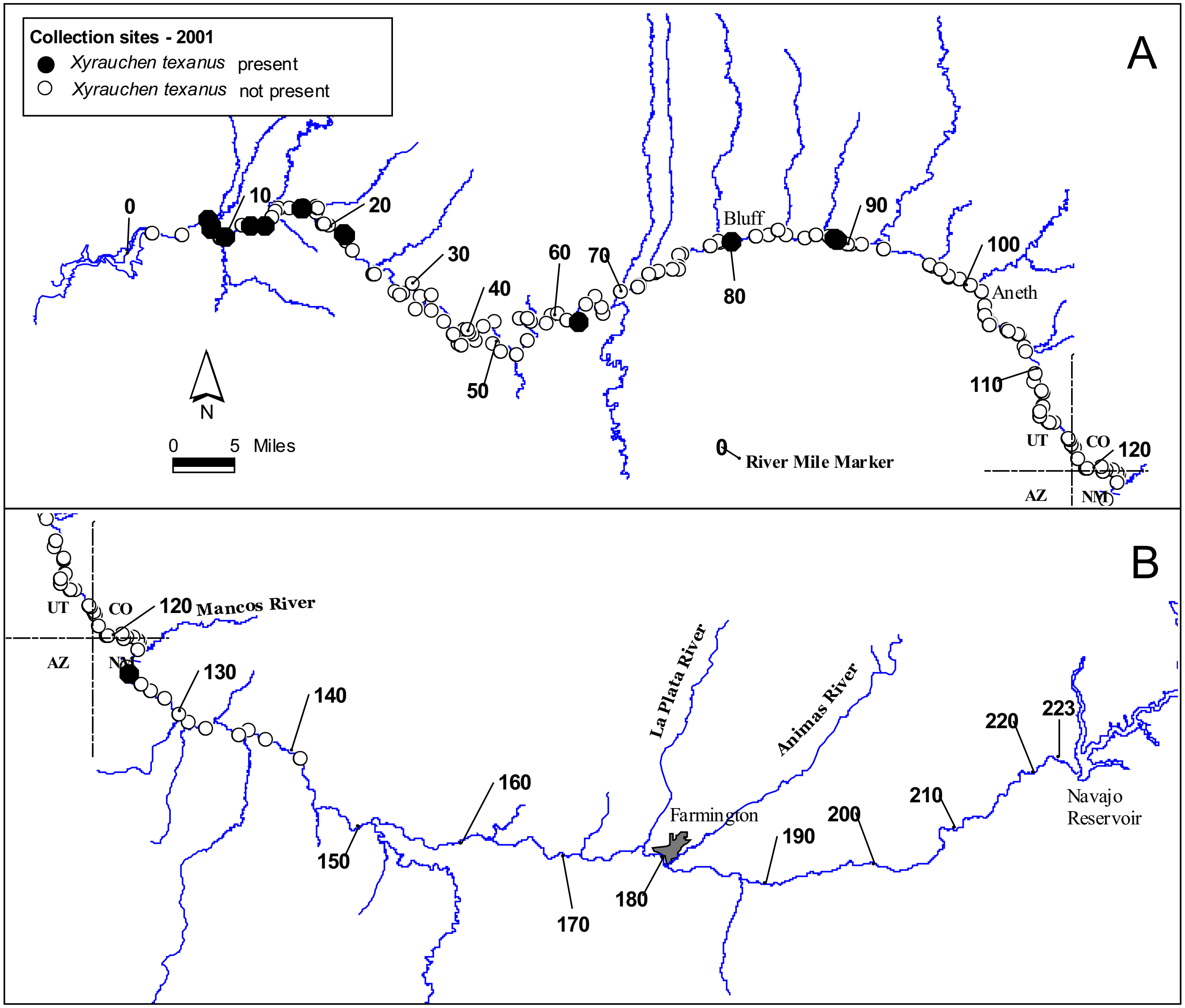
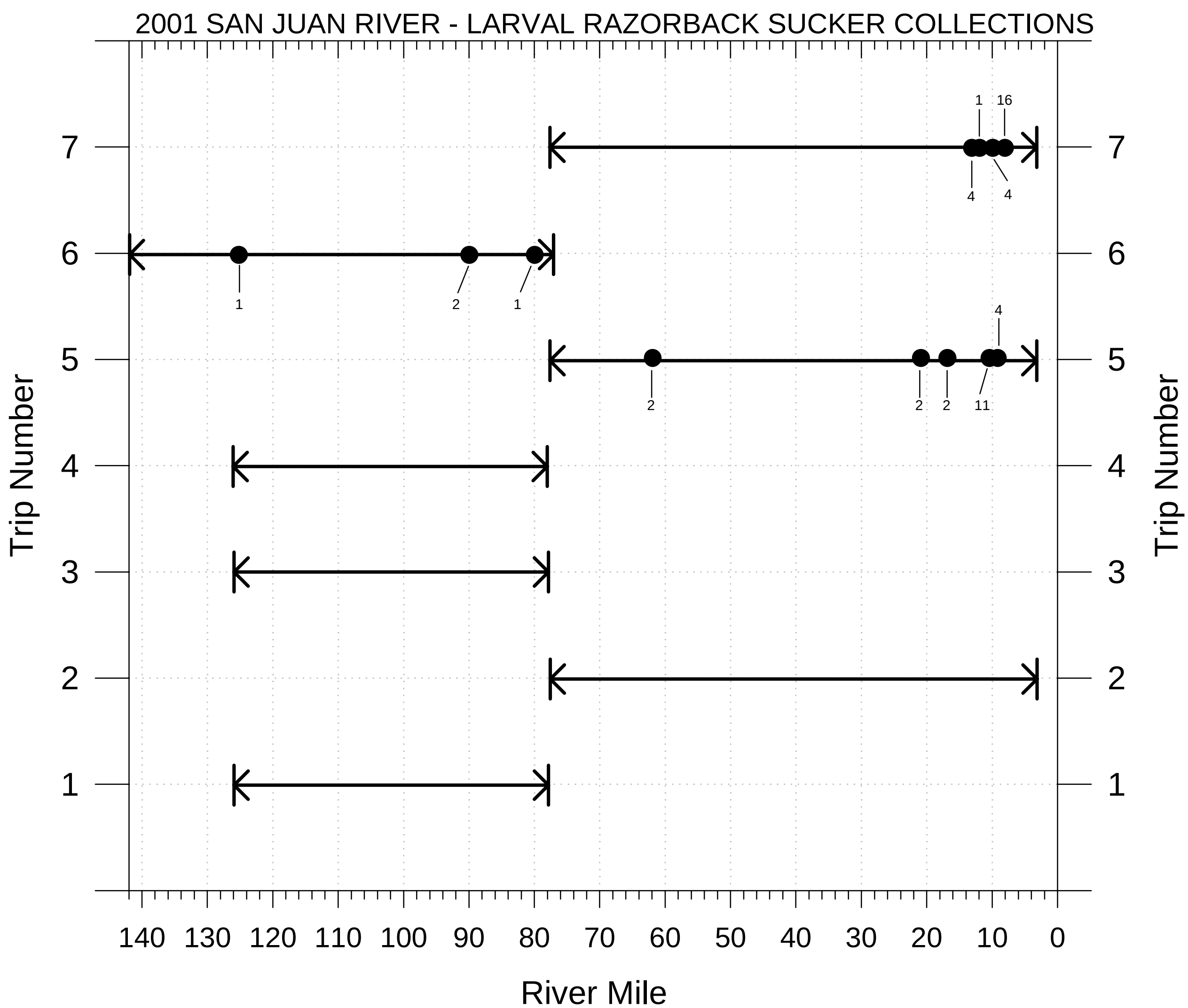


Figure 6. Distribution map of localities that yielded larval razorback sucker during 2001.



Trip Number	START DATE	END DATE	● = larval razorback sucker
1	10 APR 01	12 APR 01	
2	15 APR 01	19 APR 01	
3	23 APR 01	26 APR 01	
4	07 MAY 01	10 MAY 01	
5	16 MAY 01	18 MAY 01	● n = 21
6	29 MAY 01	01 JUN 01	● n = 4
7	11 JUN 01	14 JUN 01	● n = 25

Figure 7. Diagrammatic representation of 2001 sampling effort.

TL), 20 were metalarvae (16.8 - 26.3 mm TL), and only three were mesolarvae (post-flexion without yolk; 16.0 - 16.4 mm TL). This was the first collection of wild juvenile razorback sucker under the San Juan River Basin Recovery Implementation Program.

The site that yielded 16 larval razorback sucker (WHB01-205) was a large isolated pool (22^{o}C) that has inundated stands of common reed (*Phragmites* sp.). This collection was within 20 specimens of being the largest collections of fish made during the 11-14 June sampling trip. Larval cyprinids numerically dominated the catch (82%) of this sample with flannelmouth sucker and razorback sucker being the most abundant catostomids. All exception one of the 2,240 fish collected at this site, all were Age 0 specimens.

Summary

A large portion of the approximately 1,000 razorback sucker that were introduced into the San Juan River since the 1994 initiation of the experimental stocking effort are believed to have survived. If this assumption is true, than the number of stocked razorback sucker that recruit to the adult cohort (i.e., able to reproduce) should be expected to continued 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 increase.

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 in 1998 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 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 which had been stocked as part of the San Juan River Recovery Implementation Program.

The initial collection of larval razorback sucker in 1998 (n=2) occurred during a single sampling effort and (19 - 22 May) with the specimens being taken and 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 at acquiring information on razorback sucker reproductive efforts. Unlike the 1997 light-trap sampling project, this effort yielded a sufficient number of larval sucker so that 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 individuals (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 by this ontogenetic stage. The second noteworthy find in 1999 was the collection of larval razorback sucker in a single backwater (RM 96.2) 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 of 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 collectively. 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 to date (n=50).

That there was a decline in the overall catch of larval razorback sucker in 2001 should not be interpreted as an indication of a change in the trajectory of 1998-2000 sucker reproduction. It is likely that the reduced number of larval razorback sucker taken in 2001 was within the of normal boundaries of sample variation that would be experienced in annual fish collections of such a magnitude. The inclusion of a single sample, such as taken in 2000 (n=86), would have resulted in the continued annual increase in the number of larval razorback sucker collected. The results from the 2002 larval razorback sucker sampling effort will be important to either validate this assumption or to suggest a change in overall sucker spawning effort and success. If this hypothesis is valid, than the number of larval razorback sucker collected in 2002 could be marked larger than that taken in both 2000 and 2001.

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 steady increase in the number of larval razorback sucker taken in the San Juan River between 1998 and 2000. The large number of larval razorback sucker collected in 2000 (n=129) provide credible evidence indicative of continuing reproductive success of the augmented adult population. The increased number of 2000 larval razorback sucker specimens is likely indicative of both an increase in the number of augmented razorback sucker recruited to the spawning cohort and greater success among previously spawning adults.

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 1. 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	mesolarvae	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	17.7 - 28.8	metalarvae/juvenile	14 June 2001	8.1	larval fish seine
TOTAL (1998-2001)		**188**					

Appendix 2. 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
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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 2. 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
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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

TOTAL (1998-2000) **138**