Final Report
Fish Surveys and Habitat Assessment in the Rio Chama and Rio Grande Upstream of Cochiti Lake

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Introduction

The Rio Grande silvery minnow (silvery minnow, *Hybognathus amarus*) is federally listed as endangered. It is also listed as endangered in the states of New Mexico and Texas, and the Republic of Mexico. It was historically one of the most abundant and widespread fishes in the Rio Grande Basin, occurring from Española, New Mexico, downstream to the Gulf of Mexico (Bestgen and Platania 1991). The silvery minnow was also found in the Pecos River, a major tributary of the Rio Grande, from Santa Rosa, New Mexico, downstream to its confluence with the Rio Grande (Pflieger 1980). The known distribution of the silvery minnow is currently limited to the Rio Grande between Cochiti Dam and Elephant Butte Reservoir (Sublette *et al.* 1990; Bestgen and Platania 1991). The decline of the silvery minnow has been attributed to modification of the flow regime from impoundments, water diversion for agriculture, stream channelization, habitat fragmentation, and perhaps interactions with both non-native fish and decreasing water quality (Cook *et al.* 1992; Bestgen and Platania 1991; U.S. Fish and Wildlife Service (Service) 1999; Buhl 2001).

The silvery minnow is one of seven species in the genus *Hybognathus* found in the United States (Pflieger 1980). The species was first described by Girard (1856) from specimens collected in the Rio Grande near Fort Brown, Cameron County, Texas. The silvery minnow is stout with moderately small eyes and a small, slightly oblique mouth. Adults may reach 3.5 inches (in) (90 millimeters (mm)) in total length (Sublette *et al.* 1990). Its dorsal fin is distinctly pointed with the front of it located slightly closer to the tip of the snout than to the base of the tail. The fish is silver with emerald reflections. Its belly is silvery white, its fins are plain, and barbels are absent (Sublette *et al.* 1990).

The silvery minnow is a pelagic spawner that broadcasts semi-buoyant eggs in spring and early summer typically during runoff or spike flow events. As the developing eggs drift downstream, emerging larvae move into low velocity habitats, preferably over silt or sand substrate (Service 1999a). Of the five pelagic spawning minnows known to occur historically in the Rio Grande Basin, the phantom shiner (*Notropis orca*) and the Rio Grande bluntnose shiner (*Notropis simus simus*) are extinct (Nelson *et al.* 2004), and the Rio Grande shiner (*Notropis jemezanus*) and speckled chub (*Macrhybopsis aestivalis*) are extirpated in the Rio Grande of New Mexico (Bestgen and Platania 1991). The Rio Grande shiner and speckled chub still occur in the Rio Grande near Big Bend National Park, Texas, and in the Pecos River, New Mexico (J. Remshardt, pers. comm. 2004). The silvery minnow is the only pelagic spawning minnow remaining in the Rio Grande of New Mexico, though it occurs in less than five percent of its historic range.

To meet the goals set forth in the Rio Grande Silvery Minnow Recovery Plan, populations of silvery minnow must be established outside of the Middle Rio Grande, within the silvery minnow's historic range (Service 2003). The reintroduction of silvery minnows to other locations would reduce the likelihood that a catastrophic event could result in the extinction of the species, would help to ensure the long-term survival and recovery of the species, and would help alleviate jeopardy. Silvery minnow surveys and habitat assessments in the Rio Grande above Cochiti Lake would provide information necessary to determine the feasibility of releasing silvery minnow in this area. The historic range of the Rio Grande silvery minnow included the Rio Grande upstream of present-day Cochiti Lake. However, a great deal of uncertainty exists regarding whether this portion of the Rio Grande can provide the physical, chemical, and biological resources necessary to sustain the life cycle of the minnow and allow for persistence through time. Because of this uncertainty it was determined that further investigation was needed in this reach to evaluate its potential for future recovery actions.

The Rio Grande above Cochiti Lake is dominated by cool water, which may not be suitable for all life stages of the silvery minnow (Platania and Altenbach 1998). The majority of this reach is canyon bound, with substrate dominated by gravel, cobble, and boulder (Service 1999). The natural flow regime is altered seasonally because of irrigation and other agricultural needs, as well as recreational and municipal uses. This river reach is also highly manipulated by cold-water releases from El Vado and Abiquiu Reservoirs on the Rio Chama (J. Smith, pers. comm. 2001). In addition, silvery minnow populations may have been historically low in some areas of this reach, supporting only small outlier populations (Bestgen and Platania 1991). This reach is currently dominated by cool- and cold-water species (Service 1999). Because of the silvery minnows reproductive strategy, the stream length in this reach may be inadequate (i.e., less than 134 to 223 mi (216 to 360 km); Platania and Altenbach 1998) to ensure the survival of downstream drift of eggs and larvae and recruitment of adults (Service 1999). An intensive fish survey in the Rio Chama and Rio Grande above Cochiti Lake in 1984 did not find silvery minnow (Bestgen and Platania 1991). However, deeper areas were not sampled or accessible using seines during the survey (Bestgen and Platania 1991). Also, the 1984 survey did not include a quantitative assessment of available habitat.

The intent of this study is to determine the absence or presence of silvery minnow above Cochiti Lake and to evaluate the areas suitability as a potential reintroduction site. The Service, in coordination with the New Mexico Department of Game and Fish, conducted silvery minnow surveys and habitat assessment studies in the Rio Chama and Rio Grande above Cochiti Lake.

Methods

Seining techniques used for this study were identical to those used by the New Mexico Fishery Resources Office for their augmentation monitoring surveys in the Middle Rio Grande (Service 2003, Exp. Aug. and Monitoring of RGSM in the MRG, Remshardt and Davenport). However, because of differences in available low velocity habitat and available habitat types there were some differences in sampling protocol (e.g., fewer seine hauls and the addition of electrofishing). Although ten sites along the Rio Grande and the Rio Chama were originally selected for the fish surveys and habitat assessment, only five areas where access was available were sampled. These included two sites on the Rio Chama (upstream of the Highway 233 Bridge and upstream of the Highway 285 Bridge) and three sites on the Rio Grande (Alcalde, Española, and Buckman Wash).

To characterize available habitat, only discrete habitat types were seined. For each seine haul, the primary and secondary substrate type was recorded. Water quality data were collected at each sample site (dissolved oxygen, pH, salinity, total dissolved solids, specific conductance, and temperature). Most fish collected were immediately identified to species and enumerated in the field. All fish not positively identified in the field were preserved and identified in the laboratory. Smaller preserved specimens were sent to the University of New Mexico, Museum of Southwestern Biology, for verification and curation.

<u>Seine Haul Procedures:</u>
All seine hauls were conducted using a flat seine 10 feet (ft) wide, 6 ft tall, with 0.125 inch (in) mesh and a double-weighted (every 6 in) lead line. Seine hauls were conducted in all representative low and moderate velocity habitat types (e.g., backwaters, runs, pools, and embayments) available at each sample site. Seine hauls in mid-channel (or open water) habitats proceeded in the direction of flow with the seine width stretched such that the seine formed a pocket and the lead line had the greatest possible degree of contact with the substrate. Each seine haul terminated by sweeping the lead-line forward (downstream) and then lifting until both the lead and float line were out of the water, allowing the seine to create a pocket wherein the fish captured remained until identified and removed. The length of each seine haul was measured to delineate area seined.

For shoreline seine hauls, one person remained along the shoreline while the other entered the habitat. Both proceeded downstream along the shore with the lead line on the river bottom. The off-shore person proceeded ahead of the on-shore person to create a 'corral' effect (i.e., fishes were herded toward the shore by the off-shore person). At the end of each seine haul, the off-shore person pulled the seine to the shore keeping the lead line in contact with the substrate until it was pulled onto shore. The length of each seine haul was measured from the starting point of the shoreline person to the ending point of the off-shore person to delineate area seined.

Habitats with debris or overhanging vegetation within the water were encircled with the seine. Habitats were encircled from downstream in open water areas, and from off-shore in shoreline areas. Once the debris was encircled, each person kicked within the debris to frighten fish into the seine, and the seine was lifted (similar to mid-channel seine haul lifts, but typically requiring both people to pull the lead line back and out of the debris). The length of the seine haul was measured from where the approach began to where the debris was encircled.

Riffles were sampled using a 'kick seine' procedure. The seine was placed downstream of the selected portion of a riffle (while keeping the lead line in contact with the substrate) and the seine width stretched to allow a pocket to form. A third person started upstream of the seine at a given point and entered the riffle and proceeded downstream toward the seine while 'kicking' to overturn substrate and dislodge or frighten fish downstream into the seine. The length of the seine haul was measured from the point where the kicking began and ended (typically at the seine lead line).

Electrofishing Procedures

Electrofishing gear was used to sample deeper, swifter areas, and to collect additional species composition and catch rate data for fish in both the Rio Grande and the Rio Chama. In the Rio Grande, raft-mounted electrofishing gear (pulsed direct current) was used to sample from the upstream to downstream end of each sample site. Attempts were made to net all stunned fish near the front of the raft (anode). Similarly, in the Rio Chama, backpack electrofishing gear (pulsed direct current) was used to sample from the downstream to upstream end of each sample site. Two passes with the electrofishing gear were made at each sample site to sample both halves of the river. Electrofishing was used to sample areas too deep or swift to sample using seines. For each pass, the location, seconds shocked, and number by species was recorded. Catch per unit effort (CPUE) was calculated as the number of fish collected per minute of electrofishing for all species sampled. Catch data were summarized by site and by the entire area sampled.

Macro-habitat Characterization

Cross Sections:

To characterize available macro-habitat (channel morphology) transects (i.e., cross sections) were established at representative habitat types at each sample site. The location of each transect was recorded using a Global Positioning System (GPS). All point locations were recorded in UTM and/or latitude/longitude coordinates.

Discharge Measurement:

Mean water column velocity and water depth measurements were measured at points spaced every 4 ft along the cross section. For each point measurement, water column depth and mean column velocity was measured. Water column depth was measured using a top-set wading rod, marked in tenths of feet. Mean water column velocity was measured using a Marsh McBirney FLO Mate 2000 meter, and the 0.6 depth method for depths < 2.0 ft and the two-point method for depths > 2.0 ft. Angle of flow direction relative to the transect was measured for each point.

Point Measurements Along Transects and Cross Sections:
The transects established at each sample site were used to characterize the velocity-depth availability of a given site for each sampling effort. These data were used to develop habitat availability (i.e., depth and velocity) vs. flow relationships for each site. These relationships were also used to evaluate habitat suitability for silvery minnows across a range of flows.

In addition to depth and velocity, the flow angle of each measurement point was recorded. This measurement was used to calculate flow as well as assess the complexity of flow (i.e., relative braiding) at a given site. For instance, sites containing more of a braided planform at a given flow would have a more diverse range of flow angles, and sites with a single threaded channel would display a limited range in flow angle.

Transects were established across representative habitat types at each sample site. Transects were perpendicular to the bank line/high flow thalweg direction at each site. A kevlar tag line, marked in 2, 10, and 100-foot increments, was stretched bank to bank across the river channel.

Point measurements were made every 4.0 ft along each transect. For each point measurement, distance along the tag line, water column depth, mean column velocity, and flow angle were measured. Water column depth was measured using a top-set wading rod, marked in tenths of feet. Mean column velocity was measured using a pygmy current meter or Marsh McBirney FLO Mate 2000. The 0.6 depth method was used for depths < 2.0 ft and the two-point method was used for depths > 2.0 ft. Angle of flow direction to the transect line was measured for each point using a compass.

Transect data were not collected in the Rio Grande during spring sampling. This was because the volume of flow was too large to safely complete all transect measurements. Instead, seine haul point measurements were used to characterize available habitat.

<u>**Seine Haul Point Measurements:**</u>
Seine haul point measurements (i.e., depth and velocity) were used to characterize available habitat when flows were too high to collect river transect data. For mid-channel seine hauls, water depth and velocity were measured along the length and mid-line of each seine haul. For shoreline seine hauls, depth and velocity were measured two feet from shore along the length of each seine haul. All point measurements began 2 ft from the downstream boundary of each seine haul, and then every 4 ft upstream within the area seined until the point measured was within 4 ft of the beginning of the seine haul boundary. This assured that measurements represented the area effectively seined.

Depth of each point measurement was measured using a top-set wading rod, marked in tenths of feet. The six-tenths depth method was used for all mean column velocity measurements in depths up to 2.0 ft (Rantz et al., 1982). For depths >2.0 ft, the two-point (two-tenths and eight-tenths) method was used (Rantz et al., 1982). All water velocity measurements were made using a Marsh McBirney FLO Mate 2000 meter.

Results

A total of 2,731 fish representing 7 families (7 native species and 10 non-native species) were collected during seining and electrofishing surveys (Table 1). Native species (n = 1,625 specimens, 59.5 percent) were numerically more abundant than non-natives (n = 1,106 specimens, 40.5 percent) in the collections. Longnose dace (*Rhinichthys cataractae*) was the most abundant native species and white sucker (*Catostomus commersoni*) was the most abundant non-native species. There were differences observed in catch by gear type. For instance, western mosquitofish (*Gambusia affinis*) were only captured in the seining surveys, while brown trout (*Oncorhynchus mykiss*) and white bass (*Morone chrysops*) were collected only during electrofishing surveys (Tables 2 and 3). There were also differences in catch by site and season, though those data are not summarized for the purposes of this report. No silvery minnow were collected in either the seining or electrofishing surveys.

The four most abundant species collected (i.e., longnose dace, white sucker, flathead chub, and Rio Grande chub, respectively) are all cobble-dependent (i.e., epilithic) spawners. There were no collections of pelagic spawning minnows or any species with a reproductive strategy similar to the silvery minnow. The only other commonly collected species in the Rio Grande was western mosquitofish, though few were collected in the Rio Chama (Tables 2 and 3). Fathead minnow (*Pimephales promelas*) was commonly collected in the Rio Chama, but only commonly collected in the Rio Grande at Española (just downstream of the Rio Chama confluence). Red shiner (*Cyprinella lutrensis*) was only occasionally collected in the Rio Grande and was not collected in the Rio Chama.

Table 1. Fish species collected in the Rio Grande above Cochiti Lake and the Rio Chama, March, July, and September 2004. N=native species, I=introduced species.

Common Name	Scientific Name	Total
Rainbow trout (I)	*Oncorhynchus mykiss*	2
Brown trout (I)	*Salmo trutta*	27
Red shiner (N)	*Cyprinella lutrensis*	26
Common carp (I)	*Cyprinus carpio*	173
Rio Grande chub (N)	*Gila pandora*	286
Fathead minnow (N)	*Pimephales promelas*	217
Flathead chub (N)	*Platygobio gracilis*	355
Longnose dace (N)	*Rhinichthys cataractae*	702
River carpsucker (N)	*Carpiodes carpio*	38
White sucker (I)	*Catostomus commersoni*	525
Black bullhead (I)	*Ameiurus melas*	1
Channel catfish (I)	*Ictalurus punctatus*	70
Western mosquitofish (I)	*Gambusia affinis*	198
White bass (I)	*Morone chrysops*	17
Bluegill (N)	*Lepomis macrochirus*	1
Largemouth bass (I)	*Micropterus salmoides*	2
Smallmouth bass (I)	*Micropterus dolomieui*	91

Table 2. Distribution and number of fish collected in the Rio Grande above Cochiti Lake and the Rio Chama in seines, March, July, and September 2004. M = Medanales; H = Hernandez; A = Alcalde; E = Española; B = Buckman Wash sample site.

	Rio Chama sites		Rio Grande sites		
Species	M	H	A	E	B
Oncorhynchus mykiss	0	0	0	0	0
Salmo trutta	0	0	0	0	0
Cyprinella lutrensis	0	0	18	4	3
Cyprinus carpio	0	0	0	0	1
Gila pandora	50	145	0	10	0
Pimephales promelas	31	42	6	52	6
Platygobio gracilis	2	29	0	20	102
Rhinichthys cataractae	263	164	6	20	21
Carpiodes carpio	0	0	0	2	0
Catostomus commersoni	30	22	14	18	13
Ameiurus melas	0	0	1	0	0
Ictalurus punctatus	0	0	0	0	1
Gambusia affinis	1	3	93	55	46
Morone chrysops	0	0	0	0	0
Lepomis macrochirus	0	0	0	0	0
Micropterus salmoides	0	0	0	0	0
Micropterus dolomieui	0	0	1	0	0

Table 3. Distribution and number of fish collected in the Rio Grande above Cochiti Lake and the Rio Chama while electrofishing, March, July, and September 2004. M = Medanales; H = Hernandez; A = Alcalde; E = Española; B = Buckman Wash site.

	Rio Chama sites		Rio Grande sites		
Species	M	H	A	E	B
Oncorhynchus mykiss	0	0	0	0	2
Salmo trutta	1	1	12	2	11
Cyprinella lutrensis	0	0	0	1	0
Cyprinus carpio	0	0	67	93	12
Gila pandora	23	55	1	0	2
Pimephales promelas	24	43	0	8	5
Platygobio gracilis	3	22	8	11	158
Rhinichthys cataractae	108	66	6	10	38
Carpiodes carpio	0	1	21	11	3
Catostomus commersoni	27	16	135	127	123
Ameiurus melas	0	0	0	0	0
Ictalurus punctatus	0	0	12	22	35
Gambusia affinis	0	0	0	0	0
Morone chrysops	0	0	9	4	4
Lepomis macrochirus	0	0	0	0	1
Micropterus salmoides	0	0	0	1	1
Micropterus dolomieui	0	0	76	13	1

There were no persistent backwaters or other low-velocity habitat types available for sampling between trips, yet there were areas that were both shallow (e.g., < 2 ft deep) and low-velocity (e.g., 0 velocity) (Figure 1). At discharges greater than approximately 1,000 cubic feet per second (cfs), it was difficult to collect depth and velocity data at our established transect locations in the Rio Grande. During March sampling when flows were approximately 2,500 cfs we were not able to collect depth and velocity data at our established transect locations in the Rio Grande. However, using photographs of the sites and GPS data we were able to estimate transect widths. We did collect depth and velocity data at our seining sites during the March sampling. The results of the depth and velocity data from the seining reflect only where we were able to sample and not habitat availability (Figure 2). For instance, at 2,500 cfs, high velocities (i.e., ≥ 2.5 feet per second) generally limited seining to shallower depths (i.e., ≤ 2.0 feet) near shore.

To evaluate changes in stream cross-sectional profile by stream discharge, we plotted both wetted stream width and width/depth ratio versus discharge (Figure 3). There was little change in stream width with change in discharge in either the Rio Grande above Cochiti Lake or the Rio Chama, particularly when compared to the Middle Rio Grande (Figure 3a). There was also a decrease in the width/depth ratio as discharge increased (Figure 3b). These results indicate that depths and velocities change rapidly with changes in flow. Given the lack of persistent low-velocity habitats observed across a range of flows, this would indicate that fish seeking particular depths and velocities would continually need to seek new habitats with changes in flows.

During sampling water temperature at the study sites in the Rio Grande ranged from 9.2 to 12.2 °C in March, 20.2 to 20.8 °C in July, and 14.2 to 16.9 °C in September. For the Rio Chama sample sites the water temperature was 12.3 °C in March, ranged from 15.5 to 20.2 °C in July, to 12.0 to 13.1 °C in September. Dissolved oxygen (milligrams per liter (mg/l)) in the Rio Grande ranged from 10.5 to 17.7 in March, 7.4 to 8.0 in July, and 7.6 to 8.0 in September. For the Rio Chama sites dissolved oxygen was 10.5 in March, ranged from 9.8 to 10.0 in July, to 7.7 to 8.1 in September. In the Rio Grande pH levels ranged from 6.2 to 7.1 in March, 11.3 to 11.5 in July, and 7.4 to 7.6 in September. For the Rio Chama sites pH was 7.0 in March, ranged from 7.7 to 8.1 in July, to 7.6 to 7.7 in September. For all sites combined, specific conductance ranged from 0.128 to 0.338 micro-siemens/centimeter (µS/cm) and Total Dissolved Solids (TDS) ranged from 0.08 to 0.25 mg/l. Overall, water quality was generally suitable with the exception of the high dissolved oxygen (>10 mg/l) readings observed in March and the elevated pH (>9) readings in July for the Rio Grande. These elevated readings are suspect and will be compared to U.S. Geological Survey data for confirmation when they become available.

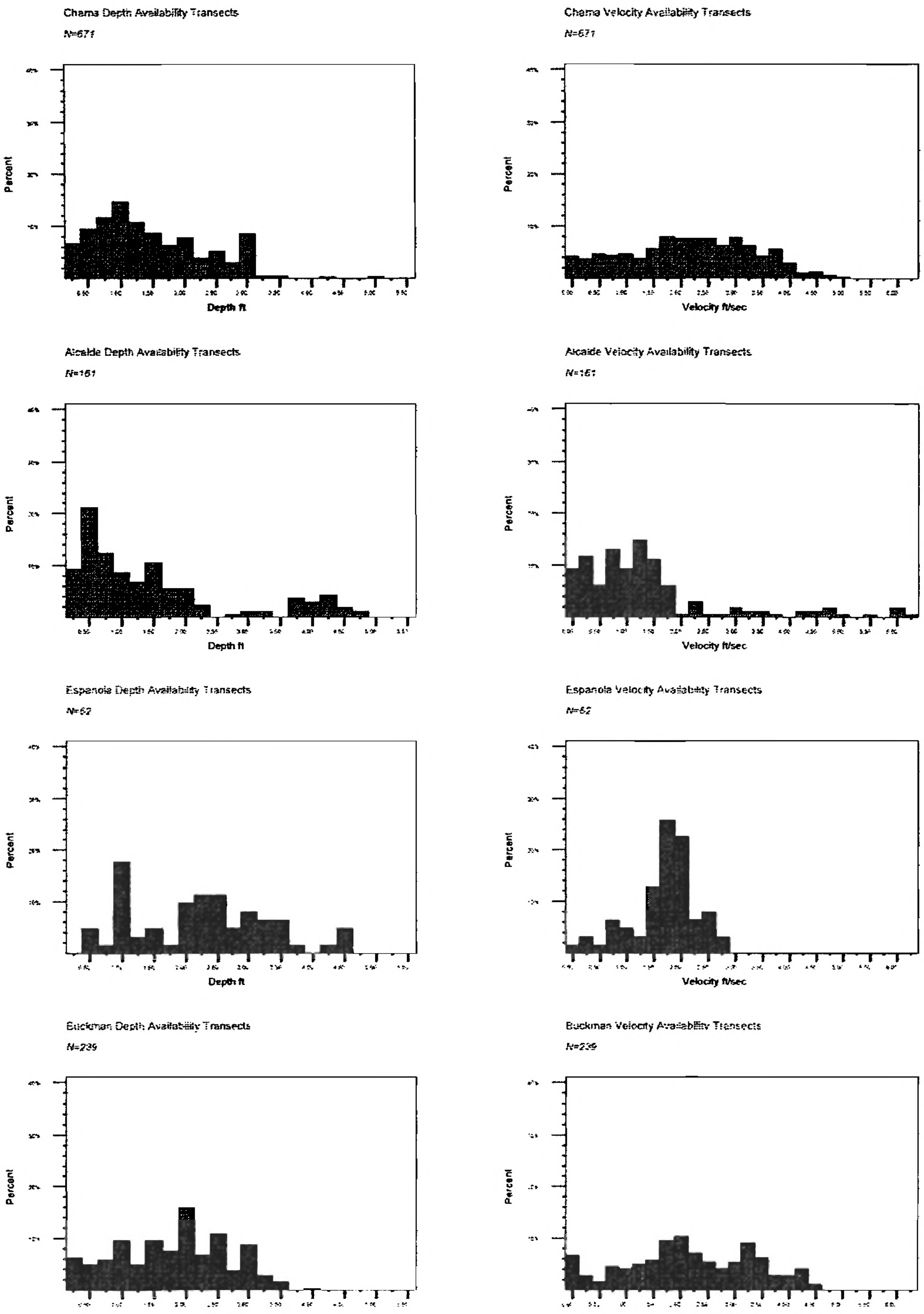


Figure 1. Frequency histogram of available water depth (ft) and water velocity (ft/sec) at the Rio Chama and Rio Grande sample sites (upstream of Cochiti Lake) during March, July, and September 2004. There were no March data collected for the Rio Grande because of high flows.

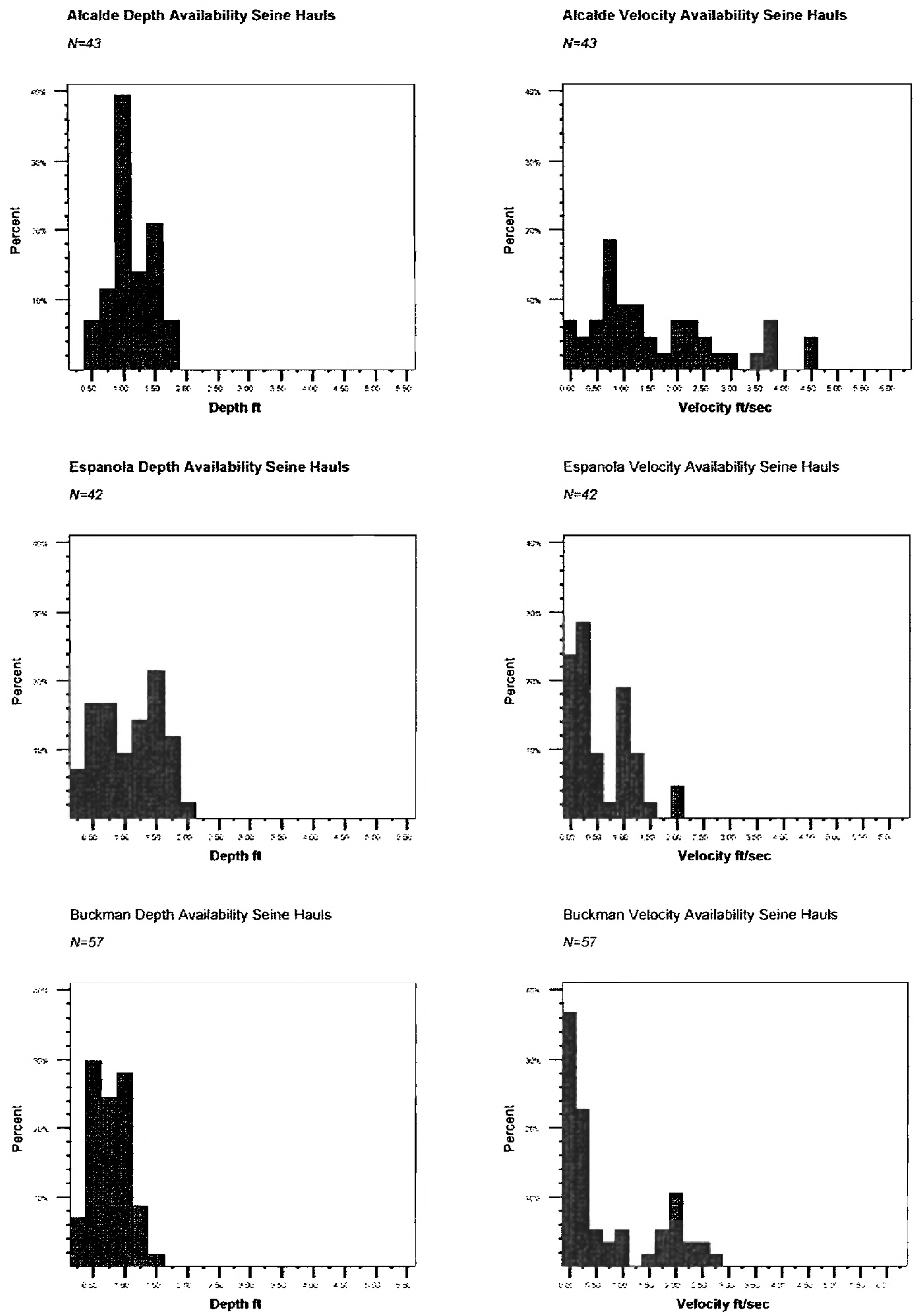
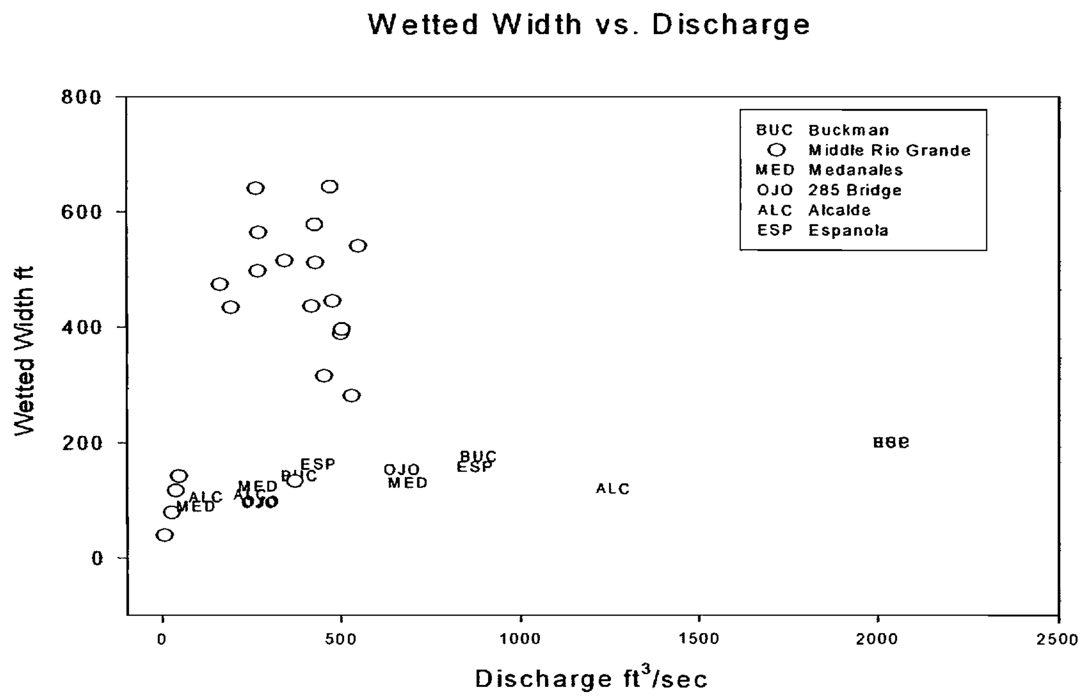


Figure 2. Frequency histogram of water depth (ft) and water velocity (ft/sec) for areas seined during March sampling of the Rio Grande, upstream of Cochiti Lake.



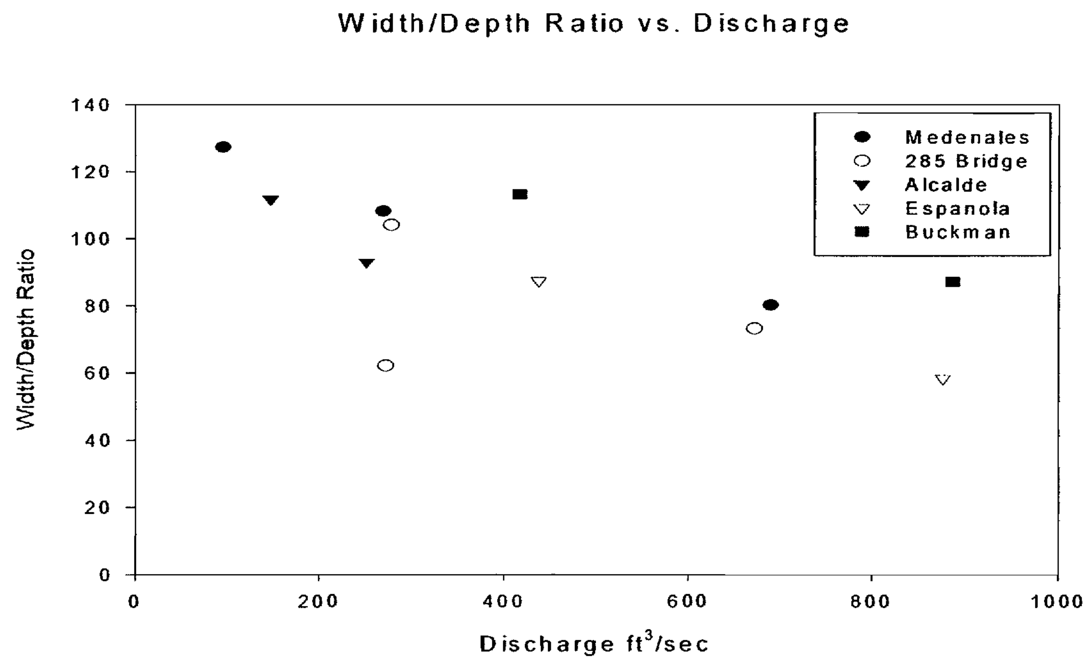


Figure 3. Plot of wetted stream width versus discharge (above) for the Middle Rio Grande, the Rio Grande above Cochiti Lake, and the Rio Chama; and a plot of width/depth ratio versus discharge (below) for the Rio Chama and the Rio Grande above Cochiti Lake.

Discussion

The fish survey data show that the species composition and relative abundance of fishes above Cochiti Lake has not changed much since 1984. The differences in catch observed between this study and that of Bestgen and Platania (1991) primarily reflect differences in the sampling gear used. Electrofishing gear was more effective at capturing larger specimens such as smallmouth bass, brown trout, and white bass, while seining was more effective at capturing smaller-bodied fishes such as red shiner and mosquitofish. However, no silvery minnow were collected in either study.

The species composition is still largely comprised of cool- and cold-water species, and the predominate species are native fishes. Many of these species are epilithic (i.e., cobble-dependent) spawners, typically more abundant in headwater streams or in deeper, swifter areas of larger rivers than are silvery minnow. For instance, the Rio Grande chub was most abundant in the Rio Chama where cold-water releases from Abiquiu Reservoir likely provide conditions similar to higher elevation streams. Flathead chub were most abundant in the Rio Grande where there was relatively more moderate to high velocity habitats. Although the species composition was comprised primarily of native species, there were relatively few specimens of fathead minnow and red shiner collected. These two species are commonly found in the Middle Rio Grande, often in low velocity habitats similar to those used by silvery minnows. In addition, there were no collections of pelagic spawning minnows or any species with a reproductive strategy similar to the silvery minnow.

Although no studies have been conducted to determine the actual distance drifting eggs and larvae are transported, relatively high water velocities during the presumed spawning period (e.g., of pelagic spawning minnows) suggest those distances are substantial (Platania and Altenbach 1998). The distance eggs and larvae are transported is also dependent on rate of development (i.e., temperature related) and river morphology. Preliminary results of our habitat assessment surveys show that as discharge increases there is little change in wetted stream width, indicating that depth and velocity increase rapidly with flows, particularly when compared to the Middle Rio Grande. In addition, the decrease in width to depth ratio versus discharge observed at the Highway 285 bridge sample site before and after summer irrigation indicates that elevated base flow releases from Abiquiu Reservoir scour the Rio Chama and reduce the availability of fine substrates such as sand-silt. Sand-silt substrate is a shared characteristic among sites where large collections of silvery minnow have been made in the Middle Rio Grande (Bestgen and Platania 1991).

Should silvery minnows be reintroduced into the Rio Chama or Rio Grande above Cochiti Lake, the influence of colder, higher (than natural) base flow releases from Abiquiu Reservoir would likely slow the development of drifting eggs and larvae and increase distance transported downstream than would occur naturally. The fact that the silvery minnow apparently disappeared from this reach within a few years (i.e., within one or two generations) after the closure of Cochiti Lake, indicate the river is functionally too short for silvery minnow to successfully complete its life cycle.

The last collection of silvery minnow in the Rio Chama was in 1949 (Service 1999a), only 14 years after the closure of the closure of El Vado Reservoir. The last collection of silvery minnow above Cochiti Lake was in the late-1970s, less than five years after the closure of the reservoir in 1975. All of the reasons why species have disappeared from the Rio Grande have not been identified, but the influence of impoundments is apparent. Fragmentation of habitats, higher and colder base flow releases for irrigation, loss of habitat from channel incising have all influenced the species composition in both the Rio Chama and the Rio Grande.

In summary, the Rio Grande above Cochiti Lake is a relatively high gradient river with a relatively simple, confined channel and limited habitat complexity. Though the fish community is similar to the Middle Rio Grande, it is comprised of more cool- and cold-water species, indicating it is a transitional area in terms of suitable habitat (for many species, including the silvery minnow). Though native fish species are still predominate above Cochiti Lake, in both the Rio Chama and the Rio Grande, there are no species present with life histories similar to the silvery minnow. Suitable habitat may be present for juvenile and adult silvery minnow, however, the lack of low velocity habitats for larvae and young-of-the-year, and the lack of contiguous sections of river for drifting eggs, would limit the ability for the species to successfully complete its life cycle. Recruitment, and therefore the ability of the silvery minnow to sustain itself, would be very limited. Thus, until there are an excess of silvery minnow available for stocking, there are other potential reintroduction areas that would have a much have a higher probability of success (e.g., the Rio Grande near Big Bend National Park, Texas).

The Service recognized in its 2003 Biological Opinion, a priori, that any releases of silvery minnow would be experimental and any potential outcomes uncertain. The results of this study indicate this is still true, and although some habitat for silvery minnow exists, it is unlikely that a self-sustaining population of silvery minnow could persist in this reach. Therefore, based on our results and previous studies, unless a "surplus" of silvery minnows are available for stocking, it is recommended that the Rio Grande near Big Bend National Park, be considered a higher priority location for silvery minnow reintroduction at this time. Because the area near Big Bend has no impoundments, and still has pelagic spawning minnows, the area would have a much higher probability for successful reintroduction. It is also recommended that an experimental stocking above Cochiti Lake not be considered until a surplus of silvery minnows is available.

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