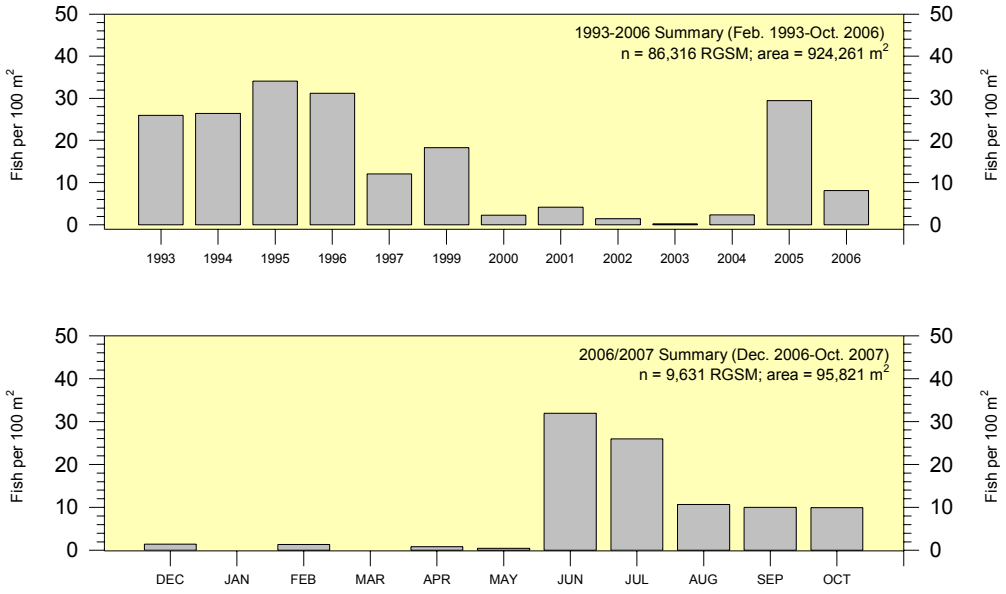
Rio Grande silvery minnow
Population Monitoring Program Results from
December 2006 to October 2007

FINAL

A Middle Rio Grande Endangered Species Act
Collaborative Program Funded Research Project



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Funded through the Middle Rio Grande Endangered Species Act Collaborative Program.

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EXECUTIVE SUMMARY

Population monitoring efforts of the Middle Rio Grande fish community over the past decade have documented vast changes (i.e., order of magnitude increases and decreases) in the abundance of Rio Grande silvery minnow. Recent monitoring efforts show that the October density of Rio Grande silvery minnow was significantly lower (p<0.05) in 2007 compared to 2005. However, the October density of this species was higher (p<0.05) in 2007 than in 1996 or 2000-2004. The Angostura Reach yielded most of the Rio Grande silvery minnow in October of 2007, followed by the Isleta Reach, and the San Acacia Reach. This was in contrast to population monitoring in October of 2006, when the largest catch rates were recorded in the San Acacia Reach.

An analysis of sampling variation at all 20 sampling sites revealed that overall sampling variation for Rio Grande silvery minnow was low and consistent among sites. Values of the coefficient of variation (*CV*) were often <0.7 for individual sites and nearly always <1. The overall *CV* value for collections of this species in the Middle Rio Grande was quite low in 2006 and 2007 (0.38 and 0.35, respectively). It is likely that the population monitoring sampling protocol combined with modest numbers of Rio Grande silvery minnow during 2006 and 2007 accounted for these low and consistent *CV* values. The notable changes in densities among years (i.e., often >1,000%) greatly outweighed the reasonable value of relative precision (ca. 35-38%) observed during this intensive sampling effort. This indicates that the current sampling approach should provide a reasonable trend estimate of increasing or decreasing population size of Rio Grande silvery minnow over time.

Spatial correlation of Rio Grande silvery minnow population dynamics was calculated among sites over the project duration (1993-1997, 1999-2007). Several models were analyzed to determine the spatial correlation among Rio Grande silvery minnow densities using year and site as effects. The most parsimonious model had a compound symmetry covariance structure for year and a spatial power covariance structure for site (AICc=2,092.7, rho=0.9505, and practical range=59.01 km), indicating that correlation among sites is low enough to ignore (i.e., autocorrelation<0.05) when the distance between sites is about 60 km. This corresponds roughly to the minimum length between sites within the shortest fragmented reach (i.e., Angostura Reach sites were 59.7 km apart) and indicates that strong correlations among sites could be driven by reach-specific effects (e.g., discharge patterns, water operations, ichthyofaunal community structure etc.). Additional analyses revealed a high degree of correlation between sampling sites over time. There were 41 negative correlations (all non-significant) out of 226 comparisons and most of these (N=27) had p values of 0.7 or higher. A total of 82 of the 185 positive pair-wise correlations yielded significant values (p<0.05). Of the 40 comparisons yielding the lowest p values, 22 were sites within 50 km of each other and 37 were sites within 100 km of each other. These results suggest that Rio Grande silvery minnow populations from different sites exhibit a high degree of spatial correlation over longer distances (especially within a reach), meaning that changes in the hydraulic regime or other environmental variables are likely to impact large portions of the reach-specific population simultaneously.

Linear regression analyses of October catch rates of Rio Grande silvery minnow from 1993-2007 revealed significant associations with several hydraulic variables. At the Albuquerque gauge, catch rate increased significantly (p<0.001) with maximum spring discharge and all combinations of number of days with discharge exceeding a threshold value (i.e., density positively correlated with extended periods of high discharge). The relationship that explained the most variation (82%) in mean catch rate was number of days with discharge >3,000 cfs during spring; similar patterns were noted using San Marcial gauge data. In contrast, there was a strong negative relationship (p<0.001) between the number of low flow days in the San Acacia Reach (either days<200 cfs or days<100 cfs) and mean October catch rates. Although still a working hypothesis, the abundance of Rio Grande silvery minnow over the period of study has consistently decreased during years with low spring

discharge combined with prolonged summer low-flow/drying conditions but consistently increased following years with extended high spring flows (Dudley et al., 2007).

Despite recent increases in the abundance of Rio Grande silvery minnow, the full suite of issues that threaten the long-term persistence of this species remain. The increased abundance of Rio Grande silvery minnow in 2005 and 2007 is a positive sign but it does not eliminate the threats that currently endanger this species. While recent management strategies are essential to prevent short-term catastrophic losses, a renewed focus on issues that could lead to self-sustaining populations of Rio Grande silvery minnow in the wild (e.g., natural flow regime, river connectivity, functional floodplains etc.) will assist in achieving the ultimate goal of long-term recovery.

INTRODUCTION

Population information on Rio Grande silvery minnow and the associated Middle Rio Grande (Rio Grande between Velarde and Elephant Butte Reservoir, New Mexico) fish community has been gathered systematically since 1987. The first studies were conducted by Platania (1993a) from 1987-1992 to determine spatial and temporal changes in the Middle Rio Grande ichthyofaunal community and to provide resolution of species-specific habitat use patterns. An additional purpose of those preliminary studies was to provide information on the conservation status of Rio Grande silvery minnow. Sampling efforts during 1989-1990 revealed that Rio Grande silvery minnow population numbers had declined markedly since 1987-1988 (Platania, 1993a). Based on previous samples, reduced numbers of individuals indicated a rapid decline of this species in its already reduced range. The 90-95% reduction in the range of Rio Grande silvery minnow and threats to its continued persistence in the Middle Rio Grande were central to this species being listed as endangered by the U. S. Fish and Wildlife Service (U. S. Department of Interior, 1994).

From 1992 until the present, the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service, New Mexico Department of Game and Fish, and U. S. Army Corps of Engineers have cooperated to fund numerous ichthyofaunal studies of the Middle Rio Grande. Among these studies was the long-term monitoring of the Middle Rio Grande fish community at numerous sites between Angostura Diversion Dam and Elephant Butte Reservoir (initiated in 1993). Population monitoring efforts have documented wide fluctuations (i.e., order of magnitude increases and decreases) in the abundance of Rio Grande silvery minnow over the past decade. Although still a working hypothesis, the abundance of this species has consistently decreased during years with low spring discharge combined with prolonged summer low-flow/drying conditions but has consistently increased following years with extended high spring flows (Dudley and Platania, 2007). While Rio Grande silvery minnow was the focus of most population monitoring efforts and hypothesis testing, research activities were also designed to provide information about the associated Middle Rio Grande fish community.

The primary objective of the December 2006 to October 2007 sampling activities was to monitor the long-term and short-term trends in the abundance and status of Rio Grande silvery minnow at numerous sites throughout the Middle Rio Grande. Additional objectives included evaluating the influence of discharge patterns on population fluctuations, determining general habitat use patterns, documenting the changes in relative abundance among fish species over time, determining site-specific sampling variation, and examining spatial correlation of population dynamics over time. Seasonal and spatial differences in population structure and abundance of native and nonnative Middle Rio Grande fishes were also examined. This study should aid natural resource managers in obtaining a more thorough understanding of the current conservation status and population dynamics of Rio Grande silvery minnow, both of which are important components for the recovery of this species.

STUDY AREA

The headwaters of the Rio Grande are located in the San Juan Mountains of southern Colorado. The mainstem Rio Grande flows 750 km through New Mexico, draining an area of about 68,104 km^2 (excluding closed basins). The Rio Chama is the only major perennial tributary of the Rio Grande in New Mexico and confluences with it near the city of Española. Snowmelt from southern Colorado and northern New Mexico yields the majority of water for the Rio Grande, but transmontane diversions from the San Juan River (Colorado River Basin) supplement flow by providing water in route to downstream agricultural users and municipalities. The highest flow in the Rio Grande generally occurs shortly after spring snowmelt, while the lowest flow usually occurs in late summer and early autumn prior to the cessation of irrigation season (October 31). Summer thunderstorms

periodically augment low flow in discrete reaches, but do not ensure that the river channel will remain wetted. Precipitation in the region is low, averaging <25 cm/year (Gold and Denis, 1985).

Several large dams on the Rios Chama and Grande and numerous smaller irrigation diversion dams regulate flow in the Middle Rio Grande. A complex system of ditches, drains, and conveyance channels provides water for extensive irrigated agriculture in the Rio Grande Valley. Cochiti Dam is the primary flood control structure that regulates discharge in the mainstem Middle Rio Grande. The Middle Rio Grande has been greatly modified over the last 50 years; this has led to degradation, armoring, and narrowing of the river channel and abandonment of the floodplain in various portions of the overall reach (Lagasse, 1980; Massong et al., 2006; Makar et al., 2006).

The Middle Rio Grande is defined as the reach between Velarde, New Mexico and Elephant Butte Reservoir. The study area (Figure 1) is a segment of the Middle Rio Grande, from Angostura Diversion Dam to the inflow of Elephant Butte Reservoir, that encompasses most of the current range of Rio Grande silvery minnow (i.e., below Cochiti Dam [although additional study is required to determine if Rio Grande silvery minnow still persist upstream of Angostura Diversion Dam] to the inflow of Elephant Butte Reservoir). The Cochiti Reach of the Rio Grande (between Cochiti Dam and Angostura Diversion Dam) passes first through Cochiti Pueblo, then Santo Domingo Pueblo, and finally San Felipe Pueblo. Access is currently restricted or unreliable in the Cochiti Reach, precluding long-term fish monitoring in this area. The last comprehensive ichthyofaunal surveys of the Rio Grande in the Cochiti Reach documented the presence, at low abundance, of Rio Grande silvery minnow on Santo Domingo and San Felipe pueblos (Platania, 1995). Rio Grande silvery minnow was not found within the boundaries of Cochiti Pueblo during similar surveys (Platania, 1993b).

Sampling localities were located from Angostura Diversion Dam to just upstream of Elephant Butte Reservoir. Most of the sampling localities were selected from a list of nearly 100 Middle Rio Grande sites, which were sampled from 1987 to 1992 (Platania, 1993a); these localities have been sampled consistently since 1993. Site locations were chosen based on spatial distribution, site accessibility, relative permanence of flow (or deep pools during drought), and the presence of adequate instream habitat. While most sites have been consistently monitored over time, several localities have been added (e.g., to increase the spatial coverage within and among reaches) or removed (e.g., loss of consistent land access) over the past decade.

Reach names were derived from the diversion structure at the upper portion of the reach. The Angostura Reach (Angostura Diversion Dam to Isleta Diversion Dam) had five sampling localities and the Isleta Reach (Isleta Diversion Dam to San Acacia Diversion Dam) had six sampling sites. There were nine sampling localities in the San Acacia Reach (San Acacia Diversion Dam to inflow of Elephant Butte Reservoir). The 20 sampling sites in the Middle Rio Grande (Appendix A, Table A-1) overlap the current documented range of Rio Grande silvery minnow.

Diel and seasonal discharge varied greatly during 2006 and 2007, especially in southern reaches of the Middle Rio Grande (Figure 2). There was a general trend of lower flow at downstream locations (e.g., U. S. Geological Survey (USGS) San Acacia Gauge [#08354900] and USGS San Marcial Gauge [#08358400]) compared to upstream locations (e.g., USGS Albuquerque Gauge [#08330000]). Mean annual discharge was higher and included higher peaks in 2007 compared to 2006. From mid-March 2007 until late June 2007, flows were elevated and variable. Flow conditions in 2006 and 2007 included periodic intervals of very low discharge from July through October. Summer rains contributed little flow to the river in 2007 compared to 2006.

METHODS

This investigation was structured to monitor the population of Rio Grande silvery minnow and the associated fish community in the study area over time. Monthly sampling efforts allowed for determination of general spatial and temporal changes in population structure and species