RIO GRANDE SILVERY MINNOW

EGG ENTRAINMENT IN

IRRIGATION CANALS DURING 2003

SEPTEMBER 8, 2003

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BUREAU OF RECLAMATION
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ALBUQUERQUE, NEW MEXICO

INTRODUCTION

Monitoring of the reproductive effort and egg entrainment of the Rio Grande silvery minnow (silvery minnow) is a requirement of the 29 June 2001 and March 17, 2003 Programmatic Biological Opinions for river maintenance and water management on the Middle Rio Grande, New Mexico (U.S. Fish and Wildlife Service, 2001; 2003) by the U. S. Fish and Wildlife Service (Service). This is an effort to document entrainment of the federally endangered silvery minnow in irrigation canals. This study described in this report will provide a preliminary assessment of the amount of the silvery minnow entrainment at diversion structures and provide useful information for management decisions.

Spawning appears to occur over about a 1-month period in the late spring-early summer (May-June) (Platania 1995). The peak spawning coincides with spring runoff in May, with sporadic spawning occurring over several weeks. Subsequent analysis by Reclamation indicates a narrow time frame for peak spawning of silvery minnows in mid-May (U.S. Bureau of Reclamation, 2002). The majority of spawning individuals are Age 1 fish (1-year old); older and larger Age 2 fish normally constitute less than 10% of the spawning population (Platania 1995). Reproductively mature females are typically larger than males; each female produces several clutches of eggs during spawning (Platania 1995). Age 2 females are more fecund than the smaller Age 1 fish and may ultimately release up to 6,000 eggs (Platania 1995). Following fertilization, the semi-buoyant, non-adhesive eggs drift with the current. Egg hatching time is temperature-dependent and appears to occur in 24-48 hours (more quickly in warmer water) (Platania 1995). Recently hatched larval fish are about 3.7 mm in length, and attempt to escape the river current by swimming vertically up in the water column (Platania 1995).

METHODS

Reclamation contracted with SWCA environmental consultants to deploy egg collectors at the principal diversion canals May 17-31, 2003 (Table 1; Figure 1). Folding Moore Egg Collectors (MEC) were used following the protocol described in Altenbach et al. (2000) to determine the catch rate of silvery minnow eggs passing the study sites. All sites were visited once a day but at different times (sequentially), sampling for one hour each day. Mechanical flow meters were attached to each of the MECs so that volume of water filtered could be determined. Eggs were counted and returned alive to the Rio Grande. The Service deployed MECs at several locations in the Rio Grande in the Angostura and Isleta reaches during the same time period.

Under Reasonable and Prudent Alternative B in the Biological Opinion (U.S. Fish and Wildlife Service, 2001), the Corps and Reclamation released a volume of Conservation Water to provide a one-time increase in flows (spawning spike) to cue spawning in mid-May during the 2003 spawning season. This spike flow was designed to stimulate silvery minnow spawning in the absence of a normal spring runoff. The Middle Rio Grande Conservancy District (MRGCD) at the request of the Service closed the diversion at Isleta to prevent entrainment during the peak spawn. Sampling at Angostura began on May 17th, and at Isleta (Belen highline and Peralta canals) on May 19th. San Acacia Dam was open for run of the river until May 30th. No sampling was attempted in the Socorro Main canal until diversions were initiated at San Acacia.

Table 1. Study sites for Rio Grande silvery minnow egg entrainment.

Location	River Mile	Channel Type	Agency
Angostura Canal	210	Irrigation canal	SWCA under contract to Reclamation
Peralta Canal	169	Irrigation canal	SWCA under contract to Reclamation
Belen Canal	169	Irrigation canal	SWCA under contract to Reclamation
Socorro Canal	115	Irrigation canal	US Bureau of Reclamation

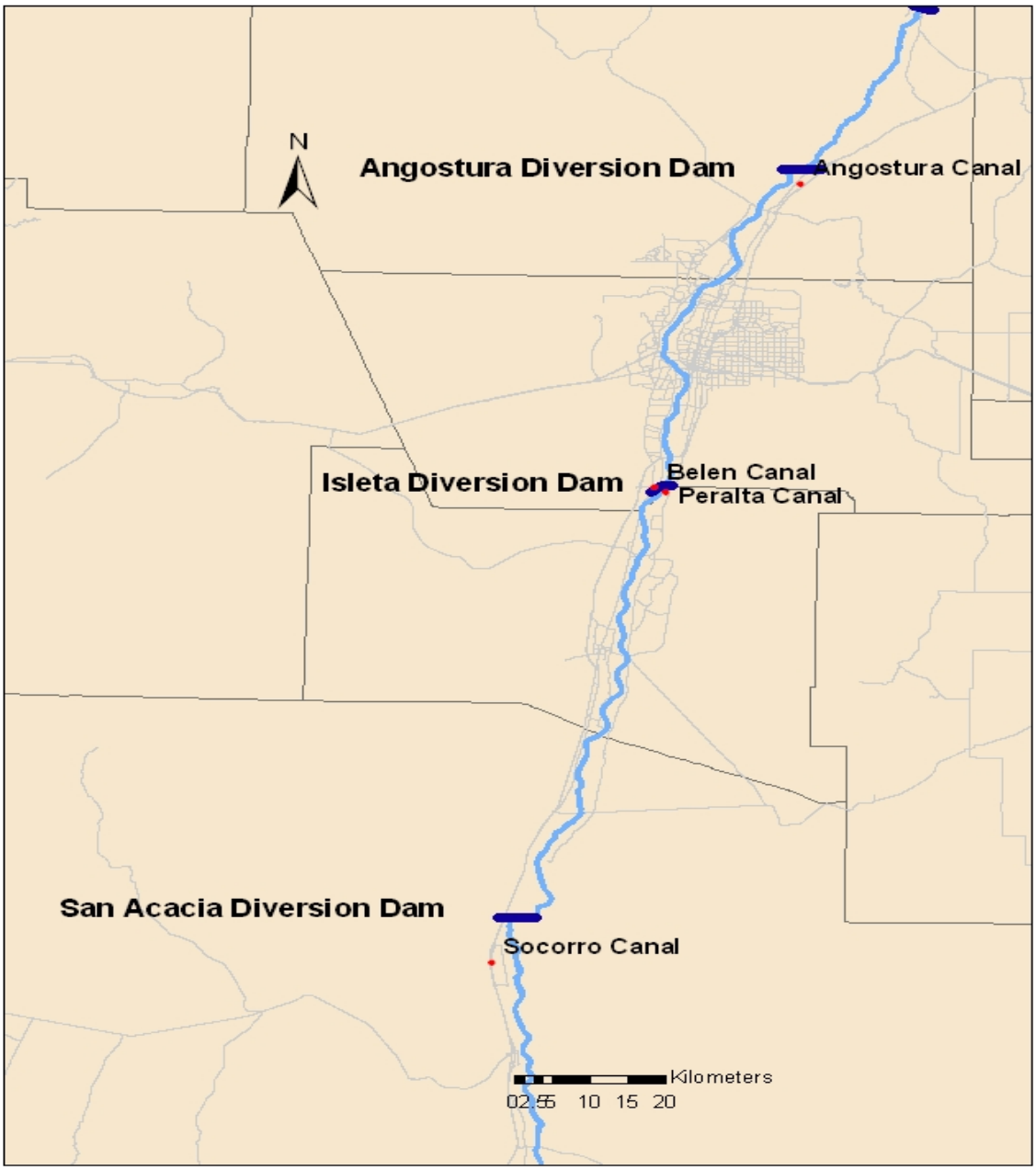

Figure 1. Location of Rio Grande silvery minnow egg sample sites.

RESULTS

Peak silvery minnow spawning occurred during the spike flow provided by Reclamation and the Corps starting May 14th. Silvery minnow eggs were collected at the Angostura canal (RM 210) twice during May (Table 2). Diversions into the Peralta and Belen Canals (RM 169) at Isleta Dam were shut off by MRCGD May 17 and 18th at the request of the Service to minimize entrainment during the peak spawn in the Albuquerque Reach. Eggs were collected in the canals below Isleta during two spawning events.

Diversion of water into the Socorro Canal (RM 115) was initiated at 14:00 on May 30th. High flows in the Socorro Main canal prevented safe deployment of the MECs. It is estimated that MECs can be safely deployed at flows less than 150 cfs in the Socorro Canal. No sampling was conducted on May 30 or 31st. Results from other sampling efforts by the Service, American Southwest Ichthyological Research Foundation and NM Game and Fish Department are not yet available.

DISCUSSION

The occurrence of silvery minnow eggs on two days in the Angostura canal indicates that a small population exists above Angostura diversion dam in the Cochiti Reach. The occurrence of eggs for three days after the main pulse of spawning had occurred May 16-18th in the Albuquerque Reach suggests that the artificial pulse was a partial spawning stimulus. The second series of eggs starting May 28th were probably spawned in response to a rain event which contributed water and sediment from Tonque Arroyo to the river. This indicates that sediment directly or indirectly is an important cue for spawning silvery minnows.

The lack of information on the habitat requirements for the critical life stages (egg to juvenile) of silvery minnows makes any conclusions regarding the effect of entrainment on recruitment speculative at best. Rio Grande silvery minnows produce semi-buoyant pelagic eggs that are dispersed by river currents (Platania and Altenbach, 1998). Reproductively mature females produce several clutches of eggs, releasing 3,000 to 6,000 eggs during the spring spawning season (Platania 1995). The number of eggs per female indicates an R reproductive strategy with expected high mortality of eggs and / or larvae during the early days of development. The expected natural mortality of R-strategy fish eggs and protolarvae is approximately 99%, with a theoretical expected survival to the juvenile stage of less than 1% (Houde, 1987). Survival of silvery minnows to the juvenile stage is probably about 1%. Current egg entrainment studies attempt to predict the impacts on recruitment (about 1%) while sampling all the eggs in the system.

Although some data has been collected, it is not possible to accurately determine the level of entrainment into the irrigation canal network at this time. At present, limitations on experienced field personnel and sampling equipment have precluded necessary data collection at the diversion dams to estimate the proportion of eggs passing through the dam in the river. Furthermore, waste-ways returning water from the canals back into the river have not been sampled. A full comprehensive study to measure egg numbers upstream and downstream of diversion dams, within the irrigation canals, as well as the return flows is required to ascertain the level of entrainment of eggs into the irrigation network.

From a statistical perspective, an unknown level of effort would be required to achieve a 95% confidence interval for the collected data. The data set from the 2003 monitoring effort, like data sets from past egg entrainment monitoring efforts are characterized by a large number of no eggs (zeros),

hence creating an inability to normalize the data. The inability to properly normalize the data via some transformation (e.g., log transformation) will reduce the sensitivity of ANOVA. This increases the likelihood of a type II error concluding that no effect exists. A pilot study with 24/7 sampling for 5-15 days is needed to estimate the level of effort to reach a statistically valid study design to estimate the level of entrainment. This type of intensive study will not, however, be able to fully assess the effects of entrainment on recruitment. Because the estimated survival of eggs to the juvenile stage is about one percent, statistical analysis of entrainment at a 95% confidence will be unable to detect effects on recruitment resulting from the entrainment of eggs. The lack of survival data from egg to the juvenile stage means that any statistical analysis only evaluating the level of entrainment will result in a default type I error, mistakenly assuming that increasing entrainment results in decreasing recruitment.

RECOMMENDATIONS

The moderate sampling effort for silvery minnow eggs in the river conducted by several agencies results in a crude estimate of reproductive effort at a cost above $200,000. Documenting the effects of water operations on silvery minnow recruitment should focus on identification of essential nursery habitat for eggs and larvae. Mapping the topography and river interactions of these habitats will lead to the development of sampling protocols to quantify egg retention, hatching and survival to a post-larval or juvenile stage. In addition, a GIS-based model of nursery habitat can be used to evaluate water operations and habitat restoration projects designed to benefit the silvery minnow. Sampling directed at nursery habitats that produce silvery minnows (~1% of reproductive effort) should allow the development of statistically sound analyses. Understanding the processes of egg retention will allow creation of these habitats above diversion dams and integrate them into waste-ways to increase recruitment. This approach will allow Reclamation and the Service to test hypotheses comparing egg entrainment effects to nursery habitat availability for understanding limiting factors for recruitment and population growth.

Table 2. Rio Grande silvery minnow egg collections in Middle Rio Grande Conservancy District irrigation canals for May 2003.

	Irrigation canals			
Date	Angostura	Peralta	Belen	Socorro
05/01/03				No diversions
05/02/03				No diversions
05/03/03				No diversions
05/04/03				No diversions
05/05/03				No diversions
05/06/03				No diversions
05/07/03				No diversions
05/08/03				No diversions
05/09/03				No diversions
05/10/03				No diversions
05/11/03				No diversions
05/12/03				No diversions
05/13/03				No diversions
05/14/03				No diversions
05/15/03	Reclamation was issued TE species collecting permit by USFWS.			
05/16/03	Permission obtained from Isleta Pueblo to begin sampling on May 19.			
05/17/03	0	No diversions at request of USFWS.		No diversions
05/18/03	0	No diversions at request of USFWS.		No diversions
05/19/03	1	4	0	No diversions
05/20/03	0	1	0	No diversions
05/21/03	0	2	0	No diversions
05/22/03	0	0	0	No diversions
05/23/03	0	1	0	No diversions
05/24/03	0	1	0	No diversions
05/25/03	0	0	0	No diversions
05/26/03	0	0	0	No diversions
05/27/03	0	0	0	No diversions
05/28/03	2	33	26	No diversions
05/29/03	0	3	0	No diversions
05/30/03	0	3	0	High flows
05/31/03	0	0	0	High flows

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