PROGRESS REPORT 2003

CONTRIBUTIONS TO DELISTING RIO GRANDE SILVERY MINNOW: EGG HABITAT IDENTIFICATION

U.S. Department of the Interior
Bureau of Reclamation

PROGRESS REPORT-2003

CONTRIBUTIONS TO DELISTING RIO GRANDE SILVERY MINNOW: EGG HABITAT IDENTIFICATION

September 2003

FUNDING PROVIDED BY
U.S. BUREAU OF RECLAMATION
-SCIENCE AND TECHNOLOGY PROGRAM
-ENVIRONMENT DIVISION

INTERSTATE STREAM COMMISSION

MIDDLE RIO GRANDE ESA COLLABORATIVE PROGRAM

U.S. FOREST SERVICE

PRINCIPLE INVESTIGATORS:
Michael D. Porter
Tamara M. Massong
Environment Division
Bureau of Reclamation-Albuquerque Area Office

INTRODUCTION

The Rio Grande silvery minnow (*Hybognathus amarus*) (silvery minnow) was listed as an endangered species in 1994 (U.S. Department of the Interior 1994). The declining silvery minnow population in the Rio Grande and Pecos River is thought to be due to loss of habitat following dam construction (Bestgen and Platania 1991). The current Biological Opinion (U.S. Fish and Wildlife Service, 2003) and the Middle Rio Grande Collaborative Program recognize the importance of habitat restoration in achieving, stabilizing, and recovery of the species. Knowledge of how geomorphology and hydrology affect egg retention will improve our ability to design and construct useful habitat restoration projects. The project goal is to identify simple, effective habitat features that can be applied economically at numerous sites. Fiscal year 2003 goals included: 1) using artificial eggs to examine existing channel features where egg retention is believed to occur, and 2) determine the effectiveness of creating silvery minnow egg retention habitat (nursery habitat) at two ongoing habitat restoration projects.

In fiscal year 2003, potential nursery habitats at one existing channel (North AMAFCA Channel) and two habitat restoration locations (Los Lunas and Bosque Del Apache) were sampled (Figure 1). The Los Lunas site is a habitat restoration project funded under the ESA Collaborative Program. The Bosque del Apache (BDA) site is a habitat restoration project built as mitigation for river maintenance activities in the headwaters of Elephant Butte Reservoir. The two habitat restoration sites were visited in mid-May 2003 when the silvery minnows were spawning. The third site, North AMAFCA Channel (AMAFCA), is the north storm diversion channel for the City of Albuquerque located on Sandia Pueblo. The outfall area within 100 m of the mouth was visited in July 2003, outside the normal spawning period for silvery minnows.

METHODS

Retention of real silvery minnow eggs (May) and artificial eggs (May and July) was measured at each site using a grid of quadrats throughout the site area (Figure 2A). The artificial eggs are yellow gellan beads previously used as a surrogate for striped bass eggs (Davin et al. 1999). The quadrats are square frames with window screen attached (Gammon, 1965; Kelso, 1996) for collecting eggs and other biotic materials. A quadrat consists of nylon window screen stretched over a 0.25 m^2 PVC frame. The quadrats are attached to a nylon rope approximately 0.5 meter apart. A line of quadrats consists of ten quadrats strung together with nylon rope and held in place by metal fence posts (Figure 2B). Conforming to the shape of the study site, multiple lines of quadrats were deployed to create a matrix of quadrats; 90-180 individual quadrats were deployed at each site.

Several batches of artificial eggs (yellow beads) (Davin et al. 1999) were released upstream of the all sampling sites. At Los Lunas and BDA the artificial eggs were scattered into the current from shore approximately 100 m upstream. At the AMAFCA site, the artificial eggs were scattered across the mouth of the channel 50 m from the quadrats. During the minnow spawning period, a Moore egg collector (MEC) (Altenbach et al. 2000) was deployed in the main flow of the Rio Grande. Quadrats were retrieved at 1-2 hour intervals, all eggs and artificial eggs were counted and recorded. Silvery minnow eggs were collected into a labeled container with river water and returned to the nursery habitat at the end of the day. The number of both the artificial eggs and the minnow eggs collected in the Moore egg collectors were recorded as part of the data collection.

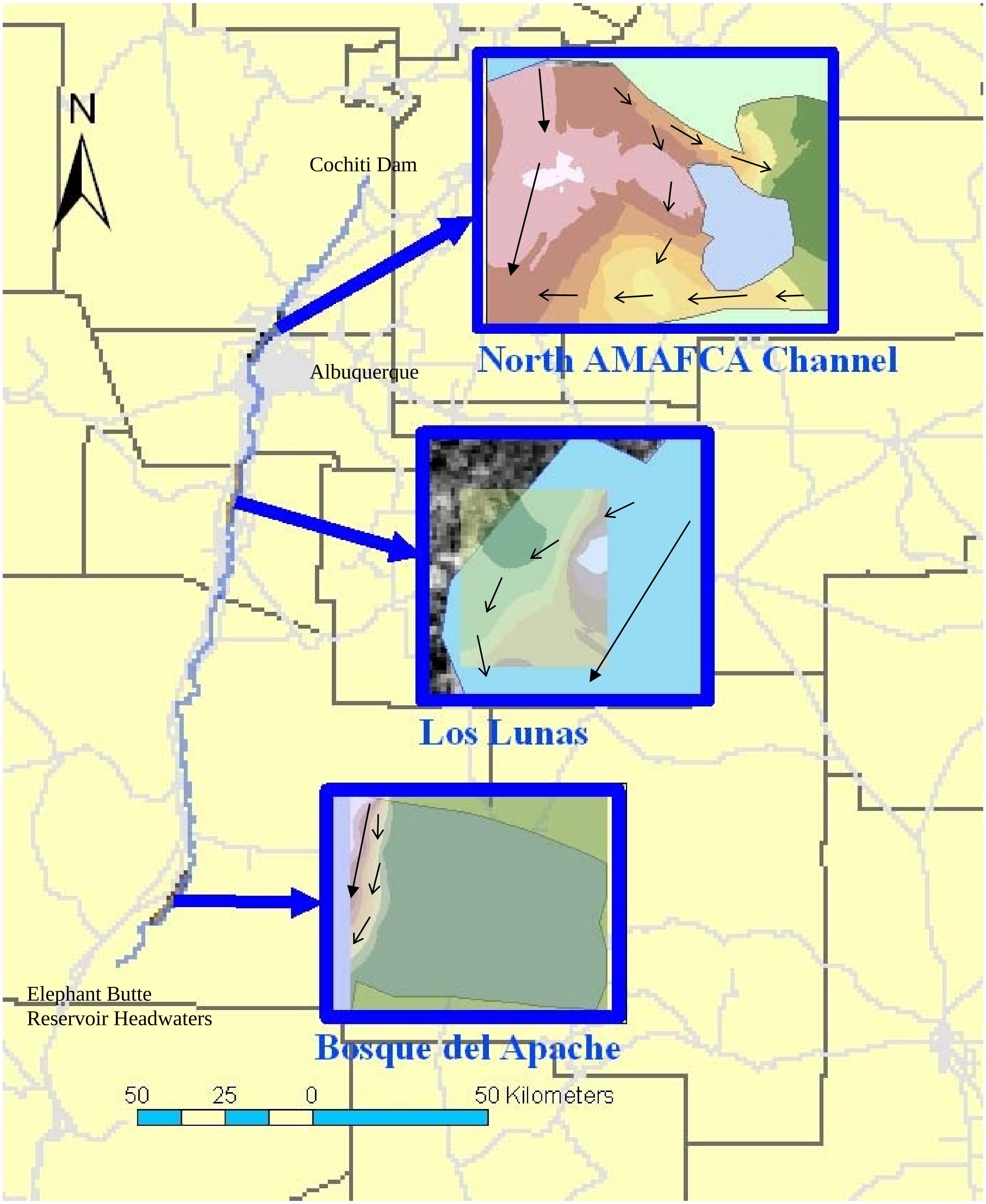

Figure 1. Middle Rio Grande valley, New Mexico with the three study sites noted. The inset pictures show each of the three inlets plus the generalized flow patterns within the inlet. Major roads are in gray, while the Rio Grande is blue.

Figure 2. A) setting fence posts to create the grid (matrix) of quadrats at the Los Lunas study site. B) the quadrats deployed on the nylon rope.

Topographic data collected at each of the three locations sampled was transformed into a Digital Elevation Model (DEM). The metal fence post locations are noted in each DEM. The topographic data is in NAD83 UTM coordinates. Velocity data, flow direction and water depth data was measured at each of the fence posts as well as at numerous other locations in each of the study sites. Velocity data was collected using a Marsh-McBirney pressure meter at the Los Lunas and BDA sites and a Global Water Flow Probe at the NDC site. Flow velocities are reported in meters per second (m/s). Flow direction was determined with a Brunton compass at each velocity measurement location. Water depth was measured to the nearest tenth of a foot with the velocity rod and converted to meters.

The coordinates of the individual quadrats and all the hydrologic measurement locations were interpolated from the fence post data which were imported into ArcGIS. Interpolated velocity and water depth maps were created using the ArcMAP Spatial Analysis kriging interpolation. The locations of the quadrats, artificial eggs and minnow egg data were added as map layers for data analysis and correlation with the physical data.

RESULTS

Los Lunas

The Los Lunas nursery habitat site is approximately 75 meters by 20 meters. Flow velocities ranged from 0.1-0.4 m/s within the sampling area, with a maximum flow rate of 1.0 m/s just outside the inlet. The shallowest water depths (0.06-0.09 meters) were located where the higher Rio Grande flows entered the inlet and deposited a sand bar. The deepest water (0.6 meters) measured in the inlet was located in the area where the water was exiting the inlet (an area that was actively scouring during the sampling period). Silt and sand sized bed material dominated the inlet; however a new bar actively depositing in the entrance to the inlet was composed of coarser sand sized material. A total of 17 eggs were collected in the MEC during the three hours of sampling, illustrating the low number of silvery minnow eggs present in the river channel at this location. The MEC collected 478 out of approximately 300,000 artificial eggs scattered into the river. The quadrats collected only one silvery minnow egg and 57 artificial eggs. The silvery minnow egg was collected in approximately the middle of the study area (Figure 3), a location where the flow direction shifts from a mostly parallel angle to the Rio Grande flow towards the exit (Figure 3). The artificial eggs were located throughout the low velocity flow areas.

Bosque del Apache

The Bosque del Apache inlet is approximately 40 meters by 45 meters. Unlike the Los Lunas site, measurable through-flow of water was limited to the first 12 meters (first three lines of quadrats) of the inlet, such that the water flow was un-measurable beyond the third line of quadrats (Figure 4). The depth of water was relatively shallow (0.3-0.4 meters) near the Rio Grande, becoming deeper further into the inlet (0.7-0.8 meters). Although the velocity of water flow in the Rio Grande was relatively fast (0.72-0.86 m/s), the inflow and outflow velocities were only 0.28 m/sec and 0.14 m/sec respectively. The bed material throughout the inlet was fine silt. Eighty-three silvery minnow eggs and 202 out of approximately 100,000 artificial eggs were collected with the MEC in one hour. The quadrats collected 29 silvery minnow eggs and 76 artificial eggs over three one hour periods (Figure 4). Most of the artificial eggs were collected within the first two lines of quadrats, while nearly all the silvery minnow eggs were collected beyond the second line of quadrats. The peak number of silvery minnow eggs at a site 32 km downstream of the study site occurred on May 20-21, 2003 (Platania and Dudley, 2003b), indicating that our sampling on May 19 was prior to the peak spawn.

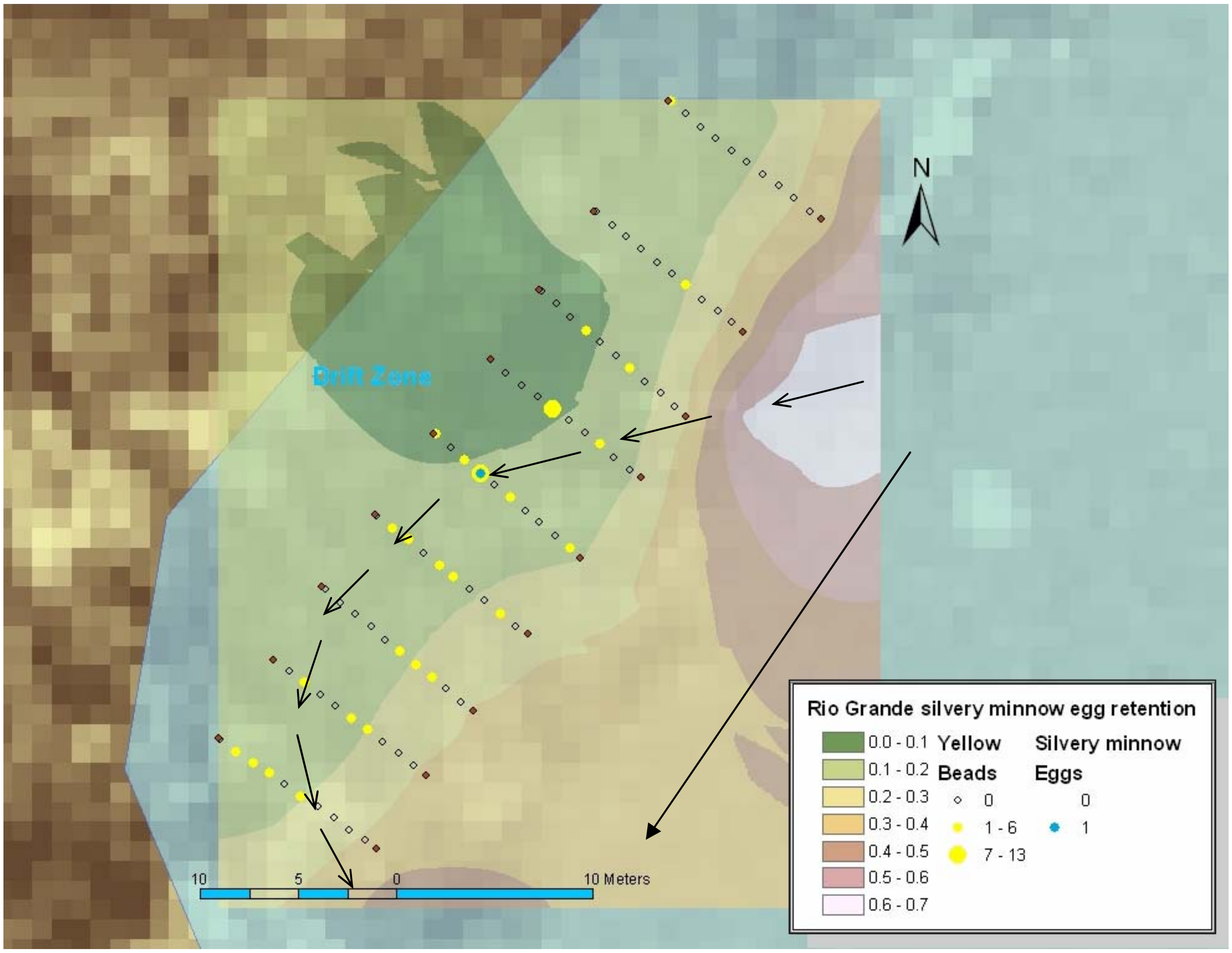

Figure 3. Distribution of silvery minnow eggs and artificial eggs (yellow beads) at the Los Lunas study site (5/17/2003). Flow direction is shown with arrows, while the water velocities are shown in color at 0.1 meters per second (m/s) intervals.

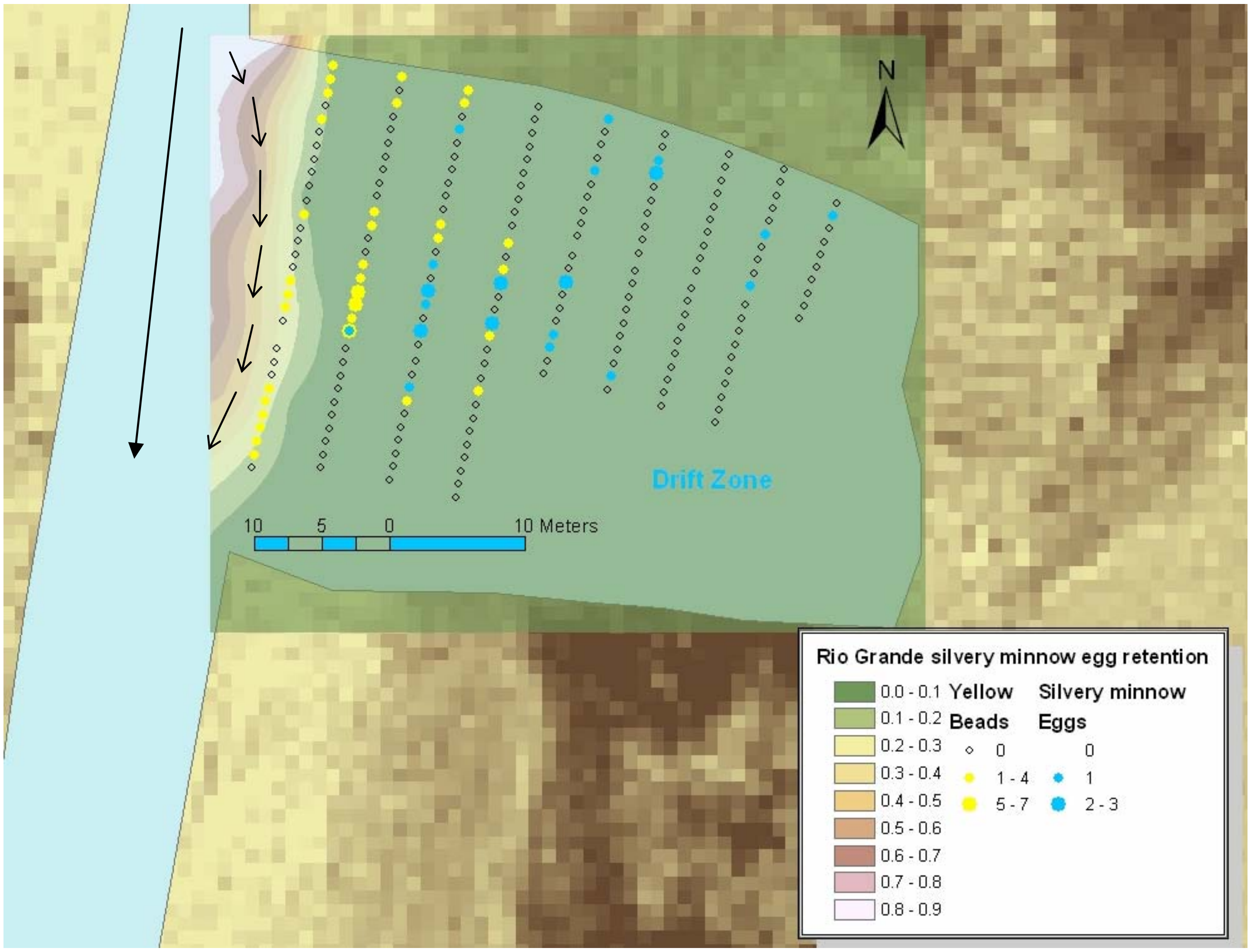

Figure 4. Distribution of silvery minnow eggs and artificial eggs (yellow beads) at the Bosque del Apache study site (5/19/2003). Water velocities are shown in 0.1 meters per second (m/s) intervals.

AMAFCA North Diversion Channel

The AMAFCA North Diversion Channel is approximately 50 meters by several hundred meters long. Unlike the other inlets where eggs were collected, this inlet is relatively complex, in that several bars existed within the inlet at the time of sampling. Due to the bars, the inflow splits into two channels: a channel that arcs back towards the Rio Grande (first channel) while the other channel (second channel) flows straight into the ponded water in the diversion channel (Figure 5). On the south side of the inlet, the outflow from the ponded water joins the out-flow of the first channel and both exit into the Rio Grande. Flow velocities in the first channel were ~0.45 m/s while the channel depths were ~0.11 meters. The second channel also is relatively shallow, ~0.1 meters and fast flowing, ~0.4 m/s. Both inflow channels have a silty-sandy substrate. The ponded area beyond the second channel (velocity was zero) ranged from 0.27-0.46 meters deep. The intersection of the first inflow channel and the outflow from the ponded area created a relatively shallow area (~0.15 meters), but with slow water (~0.03 m/s) and an extremely muddy bed material.

Lines of quadrats were concentrated in two locations, at the boundary between the second channel and the ponded water, and at the confluence between the first inflow channel and outflow from the ponded area. Quadrats at both locations collected artificial eggs (Figure 5). No eggs were collected because no silvery minnows were spawning at the time. Several species of fish were also collected on the quadrats (Table 1).

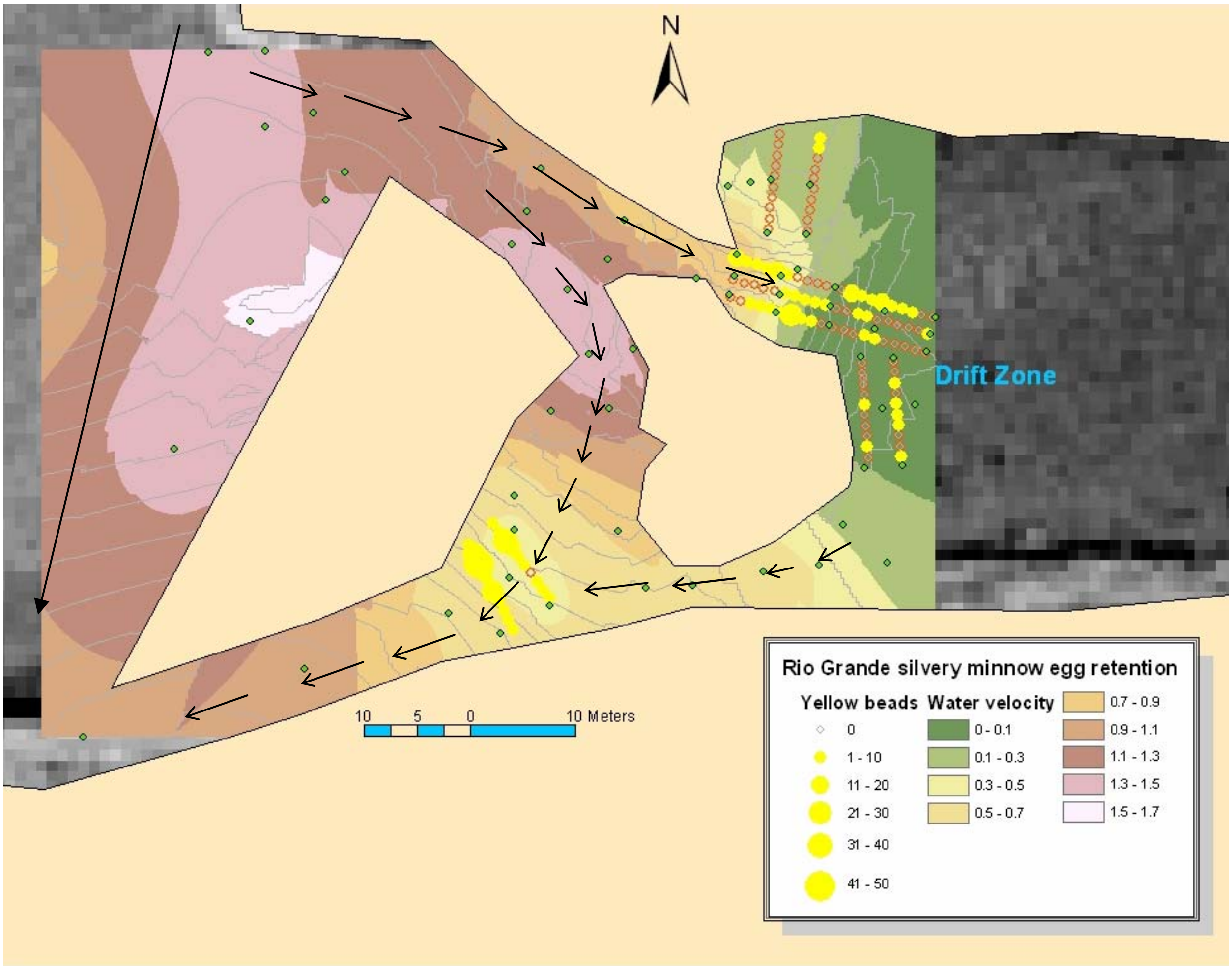

Figure 5. Distribution of artificial eggs (yellow beads) at the North AMAFCA Channel study site (7/29/2003). Water velocities are shown in 0.1 meters per second (m/s) intervals.

Table 1. Young of year fish collected on quadrats at the North AMAFCA Channel.

Red shiner	Cyprinella lutrensis	58
Fathead minnow	Pimephales promela	21
River carpsucker	Carpoides carpio	10
White sucker	Catostomus commersonni	3
Channel catfish	Ictalurus punctatus	65
Mosquitofish	Gambusia affinis	17
Yellow perch	Perca flavescens	1

DISCUSSION

The results show that artificial and silvery minnow eggs were retained in current off-channel inlets and in the two constructed nursery habitats. Key observations thus far are:

1) Although all three locations retained eggs, the two sites with large drift zones were more effective at egg retention.

2) The real eggs drifted further into the drift zone than the artificial eggs indicating length of the inlet is very important in egg retention.

3) Inlet shape and the location of the exit flow greatly influences egg retention.

4) Sampling in the deeper drift zone waters was problematic, and new or revised sampling methods are needed.

5) Since inlets naturally fill with sediments, more research is required to determine the longevity and quality of the created habitat at these restoration sites.

6) Field observations and some data at North AMAFCA Channel indicate that these inlets are also heavily used by juvenile and adult fish (including some predators), and catch significant organic debris.

The presence of a large drift zone (no measurable velocity or flow direction) appears to be vital for egg retention. At both the AMAFCA North Diversion Channel and BDA sites, the majority of eggs were collected within the drift zones. The artificial eggs mostly settled out of the water at the edges of the drift zones, while the silvery minnow eggs typically settled within the drift zone (Figure 4), indicating that artificial eggs have a higher specific gravity than the silvery minnow eggs.

The shape, size and exit flow locations influenced egg retention at the constructed sites. The constructed inlets at the Los Lunas Habitat Restoration project varied in size, shape and exit flow features, while the BDA inlets had greater water depths and hence more connectivity to the flow of water in the Rio Grande. The key observations were: 1) through-flow (an exit flow at the back of the inlet), greatly reduced egg retention, 2) width of the inlet mouth controlled water inflow/outflow patterns, and 3) angle of inlet to the Rio Grande also influenced flow patterns. For those inlets that had exit flow out the back of the inlet, egg retention was very low. The through-flow created a relatively fast flow pattern throughout the inlet, that kept the water in the entire inlet flowing. The inlet mouth width greatly influenced flow patterns, such that a width of 30-50 m wide appeared optimal to create an adequate tongue of water to inflow, but would then exit quickly. The optimal length of an inlet appeared to be 1.5-2 times the width of the mouth, however further information is needed on this subject.

Since the development of a sandbar at the mouth of these inlets is a natural feature, the longevity of these constructed habitats is not known. Also, the quality of habitat as the inlet fills is not known. However, the formation of a sand bar creates complexity within the inlet as seen at the AMAFCA North Diversion Channel, which assists in forming the low velocity habitat of the inlet. The accumulation of additional field data will aid in determining these unknowns.

These inlets also collected a noticeable amount of organic debris as well as providing good habitat to other fish. The collection of organic debris is particularly noteworthy since a potential limiting factor in silvery minnow larval growth appears to be an adequate food supply. The presence of other fish species young of year provides additional evidence of inlet suitability for fish.

Information gained from this project will help Reclamation and others design and construct effective habitat restoration projects for the endangered silvery minnow. It is believed that additional inlet construction in specific locations in the Albuquerque Reach can assist silvery minnow conservation without committing additional supplemental water supplies. Improvements should be made and new questions answered. In the future:

- increase sampling during the peak minnow spawn
- deploy more quadrats in more nursery habitats
- determine the optimal inlet length: mouth width
- document egg retention in the nursery habitats
- quantify water exchange between the river and the nursery habitats
- sample for larval silvery minnows after hatching
- sample to quantify the presence of post-larval silvery minnows
- sample to quantify the presence of larval cyprinids

ACKNOWLEDGMENTS

This project was funded by the U.S. Bureau of Reclamation Science and Technology Program, with the Middle Rio Grande Collaborative Program funding personnel time for monitoring at the Los Lunas Restoration Project. We appreciate the cooperation of the Middle Rio Grande Conservancy District, Bosque del Apache National Wildlife Refuge, and Sandia Pueblo in providing access to study sites. We thank R. Billings, S. Bulgrin, M. Carra, P.Castiglia, A. Coyenkendall, G. Dean, R. Dunai, C. Garcia, S. Gonzales, C. Gorbach, M. Hatch, M. Horner, H. Magaña, S. Mann, R. Moon, S. Susunkewa, L. Sam, D. Slaugh, and K. Smith for their assistance in collecting field data. We also recognize the work by V. Chaves, M. Gonzales, M. Nemeth, and D. Slaugh in constructing the nursery habitats at Los Lunas and Bosque del Apache.

Literature Cited

Altenbach, C., R.K. Dudley, and S.P. Platania 2000. A new device for collecting drifting semibuoyant fish eggs. Transactions of the American Fisheries Society 129:296-300.

Bestgen, K. R. and S. P. Platania. 1991. Status and conservation of the Rio Grande silvery minnow, *Hybognathus amarus*. Southwestern Naturalist 36(2): 225-232.

Davin, W.T., C. Ethridge, C. Babb, and S. Hileman 1999. Estimation of Striped Bass (*Morone saxatilis*) egg drift rate in the lower Savannah River. Final report to the U.S. Army Corps of Engineers, Savannah District. 69 pgs.

Gammon, J.R. 1965. Device for collecting eggs of muskellunge, northern pike, and other scatter-spawning species. Progressive Fish-Culturist 27:78.

Kelso, W.E. And D.A. Rutherford. 1996. Collection, Preservation, and Identification of Fish Eggs and Larvae. Pages 255-302 *in* B.R. Murphy and D.W. Willis, editors. Fisheries Techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Platania, S.P. and R.K. Dudley. 2003a. Spawning Periodicity of Rio Grande Silvery Minnow, *Hybognathus amarus*, during 2002. Report to the U.S. Bureau of Reclamation. 47 pgs.

Platania, S.P. and R.K. Dudley. 2003b. Rio Grande Silvery Minnow Spawning Periodicity Study 2003. http://msb-fish.unm.edu/rgsm2003/Spawning/index.html.

Porter, M.D., T. Massong, and D. Slaugh. 2003. Assessing microhabitat requirements for Rio Grande silvery minnow life history. American Fisheries Society Annual meeting, Quebec, Canada, August 10-14, 2003.

U.S. Department of the Interior. 1994. Endangered and Threatened Wildlife and Plants; Final rule to list the Rio Grande silvery minnow as an Endangered Species. Federal Register 59: 36988-36995.

U.S. Fish and Wildlife Service. 2003. Biological and Conference Opinions of the Effects of Actions Associated with the Programmatic Biological Assessment of Bureau of Reclamation's Water and River Maintenance Operations, Army Corps of Engineers; Flood Control Operation, and Related Non-Federal Actions on the Middle Rio Grande, New Mexico. 128 pgs.