

- I. Project Title: Guide to Cyprinid Larvae and Early Juveniles of the Upper Colorado River Basin with Computer-Interactive Key.
- II. Principal Investigator(s): Darrel E. Snyder and Kevin R. Bestgen (Project Manager)  
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- III. Project Summary: This project will improve the ability of Recovery-Program and other researchers to accurately identify cyprinid larvae and early juveniles collected from the Upper Colorado River Basin (UCRB). Objectives are to: (1) document the morphological development of each species, (2) verify existing and find new diagnostic criteria, (3) assemble a computer-interactive key, and (4) prepare a manuscript guide similar to our recently updated guide for UCRB catostomids. Co-sponsors are the National Park Service Glen Canyon National Recreation Area and indirectly the Bureau of Reclamation for species also included in a guide for the middle Rio Grande (the USBR-MRG project).
- IV. Study Schedule:  
Task 1: Acquisition of specimens needed for developmental study—FY 2006-2007.  
Task 2: Description and illustration of eggs, larvae, and early juveniles—FY 2006-2008.  
Task 3: Preparation of computer-interactive key—FY 2006-2009.  
Task 4: Synthesis, reporting, presentation, and publication of results—FY 2006-2009.
- V. Relationship to RIPRAP: This project is related to General Recovery Program Support Action Plan items V.B (conduct research to acquire needed life history information) and V.C (develop and enhance scientific techniques required to complete recovery actions).
- VI. Accomplishments of FY 2010 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings: Most of FY 2010 was spent continuing to try to locate and borrow preserved series of golden shiner *Notemigonus crysoleucas* larvae or arrange for their collection; illustrate the morphological development of selected fish; conduct morphometric, meristic, morphological, and pigment-pattern analyses; assemble or update species accounts; and present results for selected species at annual Recovery Program and professional society meetings. Despite the no-cost extension of the project for a fifth year, still more time is needed to complete specimen analyses (Table 1), descriptive species accounts (Table 2), the remainder of the manuscript (Table 3), and the key. Although we are requesting an additional no-cost extension through FY 2011, we anticipate completion of the project by late next spring.  
Task 1: Acquisition of specimens needed for developmental study—This task is now completed. Only the acquisition of formalin-preserved series of golden shiner

remained in FY 2010 to substantially supplement existing specimens in the LFL Collection, some of which were used for an earlier description of the larvae by Snyder et al. (1977). Unfortunately, those existing specimens are limited in size and number, and most are in relatively poor condition (old, alcohol-preserved, and faded) for current descriptive purposes. Our holdings also include a small locally collected, formalin-preserved series of larvae (6-10 mm TL), but some normally diagnostic pigment characters are lacking or incomplete and additional samples from the collection site would be needed to assure that this condition is not an anomaly. Although nearly all other rearing efforts conducted for this project were successful, our attempts to rear the golden shiner species beyond yolk absorption from 2007 through 2009 unexplainably failed. Similarly, our renewed efforts to locate and borrow formalin-preserved larvae and early juveniles from museum and research collections across the country failed to reveal holdings of sufficiently good-condition specimens in the size range needed for our purposes. New efforts to collect larvae and early juveniles locally also failed except for several 50-60 mm TL juveniles. Fortunately, Rene Reyes, an associate with the Bureau of Reclamation in Byron, California, was able to collect (spring 2010) and send us a series of specimens (5-15 mm TL) sufficient to cover most of the larval period. However, due to a paucity of larger specimens, the golden shiner species account will not include as much morphometric, meristic, and pigmentation data as we desired for later metalarvae and juveniles; still, the limited data we have should be adequate for identification purposes.

Task 2: Description and illustration of larvae and early juveniles—All illustrations and about 75% of the descriptive work for the guide are now complete. In FY 2010, our illustrator, C. Lynn Bjork, prepared the final two of 65 new three-view drawings for the guide: a recently transformed metalarva and later juvenile golden shiner. We had hoped to also do a new illustration of a recently transformed juvenile, but failed to secure specimens in good condition in that size range. In its place we will use a lateral-view-only drawing of a very late metalarvae (almost juvenile) from Snyder et al. (1977). Six optionally planned drawings will not be done. Because recently transformed and later juvenile common carp *Cyprinus carpio* are extremely similar in appearance, we decided to use an existing lateral-view-only drawing of a later juvenile rather than prepare a new three-view illustration. The remaining five optional drawings were intended to replace previously published but less detailed three-view drawings of creek chub and longnose dace. In FY 2010, considerable progress was made in conducting still needed morphometric and meristic, morphological, and pigment-pattern analyses and assembling or updating the 15 species accounts for the guide, but about 25% of that work remains to be done (Tables 1 and 2).

Task 3: Preparation of computer-interactive key to the larvae and early juveniles of UCRB cyprinids—This task is about 50% complete. A draft computer-interactive key to families of fish larvae had been prepared and work was initiated on the key in FY 2007 and 2008 for cyprinid larvae using existing data for some species. Little additional work was done on the cyprinid key during FY 2009 or 2010.

Task 4: Synthesis, publication, presentation, and reporting of results—This task is about 75% complete. In addition to FY-2010 work on the species accounts (Task 3), progress was also made in preparation of other portions of the guide manuscript, but again, much remains to be completed (Table 3). Inquiries regarding prospective outlets

and costs for publication of the guide (beyond those made 2009) have been deferred to FY 2011. Presentations in 2010 included a poster on “Larvae and early juveniles of endangered cyprinids in the Upper Colorado River Basin: *Ptychocheilus lucius*, *Gila cypha*, and *Gila elegans*” by Darrel Snyder, Robert Muth, and Lynn Bjork which was presented at the annual Recovery Program Researchers Meeting in Grand Junction, 26-27 January, the annual meeting of the Colorado-Wyoming Chapter of the American Fisheries Society (AFS) in Laramie, Wyoming, 1-3 March, and the annual AFS-Early Life History Section Larval Fish Conference in Santa Fe, New Mexico, 31 May-3 June. Also presented at the 2010 Larval Fish Conference were project-related oral presentations on a “New description of larval and early juvenile brassy minnow, *Hybognathus hankinsoni*” by Jennifer Charles, Sean Seal, Darrel Snyder, and Lynn Bjork, and “The ontogeny of a larval fish drawing—how we do it in the Larval Fish Laboratory” by Lynn Bjork, as well as an updated poster paper on “A family-level computer-interactive key to the larvae of freshwater fishes in the United States and Canada” (including a subset specifically for the Upper Colorado River Basin) by Darrel Snyder. Our fourth annual project report was submitted to the Recovery Program on 12 November 2009. The final project report (the manuscript for the guide and a proposal for publication thereof) has been deferred to FY 2011.

VII. Recommendations: As in our previous annual report, we recommend that a provision for guide publication be included in Program Guidance.

VIII. Project Status: Despite an extension through FY 2010 at no additional cost to the Recovery Program, and notable progress made during that year, this project remains behind schedule, but is on track for completion by the end of FY 2011, if not by late spring.

IX. FY 2010 Budget Status

A. Funds Provided: \$0 (+ ~\$35,000 remaining from FY 2009 as part of USBR-MRG project).

B. Funds Expended: \$0 (+ ~\$20,000 via USBR-MRG project).

C. Difference: \$0 (+ ~\$15,000 via USBR-MRG project).

Explanation: See Section VI regarding tasks to be completed in FY 2011.

D. Percent of the FY 2010 work completed, and projected costs to complete: 57%, ~\$15,000 to complete (as part of USBR-MRG project).

E. Recovery Program funds spent for publication charges: \$0

X. Status of Data Submission (Where applicable): Not applicable.

XI. Signed: Darrel E. Snyder 13 November 2010  
Principal Investigator Date

Signed: Kevin R. Bestgen 13 November 2010  
Principal Investigator Date

Table 1. Project status—estimated percentage completion of specimen analyses by species.

Species	% Completed			Overall
	Morphometrics	Morphology	Pigmentation	
<i>Cyprinella lutrensis</i>	75	90	90	85
<i>Cyprinus carpio</i>	75	50	50	58
<i>Gila atraria</i>	75	100	100	92
<i>Gila cypha</i>	75	0	0	25
<i>Gila elegans</i>	75	50	50	58
<i>Gila robusta</i>	75	50	50	58
<i>Hybognathus hankinsoni</i>	100	100	100	100
<i>Notemigonus crysoleucas</i>	90	95	95	93
<i>Notropis stramineus</i>	75	50	50	58
<i>Pimephales promelas</i>	50	50	50	50
<i>Ptychocheilus lucius</i>	75	90	90	85
<i>Rhinichthys cataractae</i>	100	100	100	100
<i>Rhinichthys osculus</i>	75	90	90	85
<i>Richardsonius balteatus</i>	100	100	100	100
<i>Semotilus atromaculatus</i>	100	100	100	100

Table 2. Project status—estimated percentage completion of species accounts.

Species Accounts	% Completed								Overall
	Figures			Text	Tables		Morph		
	Ad	Lar	Map	Desc	Meri	Size/de			
<i>Cyprinella lutrensis</i>	100	100	100	95	99	95	95	75	95
<i>Cyprinus carpio</i>	100	95	100	100	99	95	95	75	95
<i>Gila atraria</i>	95	99	0	50	95	95	95	75	76
<i>Gila cypha</i>	95	100	50	50	90	90	90	75	80
<i>Gila elegans</i>	100	99	100	100	100	99	99	90	98
<i>Gila robusta</i>	100	100	100	100	100	99	99	95	99
<i>Hybognathus hankinsoni</i>	100	99	95	95	99	99	99	99	98
<i>Notemigonus crysoleucas</i>	95	95	0	0	0	0	0	0	24
<i>Notropis stramineus</i>	95	99	0	0	50	50	50	50	49
<i>Pimephales promelas</i>	100	100	100	100	95	95	95	50	92
<i>Ptychocheilus lucius</i>	100	99	100	100	100	99	99	90	98
<i>Rhinichthys cataractae</i>	95	90	0	50	99	99	99	99	79
<i>Rhinichthys osculus</i>	100	99	100	100	100	99	99	95	99
<i>Richardsonius balteatus</i>	95	99	0	50	99	99	99	99	80
<i>Semotilus atromaculatus</i>	95	95	0	50	99	99	99	99	80

Table 3. Project status—estimated percentage completion of final draft of guide by section (guide contents).

Contents	% Completed
PREFACE	80
ACKNOWLEDGMENTS	80
ABSTRACT	25
INTRODUCTION	
Importance of Early Life History Investigations and Identification	95
This Guide and Prior Descriptions	10
Status and Distribution of the Fish	10
A Combined Developmental Interval Terminology	100
Characteristics Useful in Identification of Cypriniform Fish Larvae	
Myomeres	99
Fins and finfolds	99
Other countable structures	99
Morphology	99
Pigmentation	99
Osteology	99
METHODS	
Specimens Examined	0
Specimen Data, Observations, and Illustrations	95
Computer-Interactive Key	99
RESULTS AND DISCUSSION	
Species Accounts	
<i>Cyprinella lutrensis</i>	85
<i>Cyprinus carpio</i>	58
<i>Gila atraria</i>	92
<i>Gila cypha</i>	25
<i>Gila elegans</i>	58
<i>Gila robusta</i>	58
<i>Hybognathus hankinsoni</i>	100
<i>Notemigonus crysoleucas</i>	93
<i>Notropis stramineus</i>	58
<i>Pimephales promelas</i>	50
<i>Ptychocheilus lucius</i>	85
<i>Rhinichthys cataractae</i>	100
<i>Rhinichthys osculus</i>	85
<i>Richardsonius balteatus</i>	100
<i>Semotilus atromaculatus</i>	100

continued

Table 3. Continued.

Contents	% Completed
Comparative Summary	
Size relative to state of development	50
Meristics and morphometrics	50
Pigmentation	50
Mouth characters	50
Computer-Interactive Key	
Installation	99
Use	99
LITERATURE CITED	50
APPENDIX I–Pictorial Guide to Families of Fish Larvae in the Upper Colo. R. Basin	90
APPENDIX II–Glossary	100