FINAL PERFORMANCE REPORT

As Required by

THE ENDANGERED SPECIES PROGRAM

TEXAS

Grant No. TX E-169-R

(F14AP00868)

Endangered and Threatened Species Conservation

Biological Monitoring of the Reintroduction Efforts of the Rio Grande Silvery Minnow into the Big Bend Region of Texas and Mexico

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28 July 2017

INTERIM REPORT

STATE: Texas GRANT NUMBER: TX E-169-R-1

GRANT TITLE: Biological Monitoring of the Reintroduction Efforts of the Rio Grande Silvery Minnow into the Big Bend Region of Texas and Mexico.

REPORTING PERIOD: 1 September 2014 to 31 August 2017

OBJECTIVE(S). To assess present distribution and conservation genetic status of *N. jemezanus* in Texas over two years.

Segment Objectives:

Task 1. October – December 2014. Post-Release Monitoring of Rio Grande silvery minnow populations in Big Bend reach of Rio Grande.

Task 2. January 2015- Dec. 2015. Monitoring of Rio Grande silvery minnow populations.

Task 3. January 2016 – December 2016. Monitoring of Rio Grande silvery minnow populations.

Task 4. September – December 2016. Assessment of fish community structure and habitats where Rio Grande silvery minnows are found and a assessment of the habitat characteristics of areas where the species is not found for use in adaptive management of the restocking efforts.

Significant Deviations:

None.

Summary Of Progress:

Please see Attachment A.

Location: Rio Grande from Presidio, TX, to Amistad Reservoir, Texas, USA.

Cost: Costs were not available at time of this report, they will be available upon completion of the Final Report and conclusion of the project.

Prepared by: Craig Farquhar Date: 28 July 2017

Approved by: _____ Date: 28 July 2017
C. Craig Farquhar

ATTACHMENT A

Abstract

The Rio Grande Silvery Minnow (*Hybognathus amarus*) is one of the most endangered fishes in North America and was first federally listed in 1994. Originally inhabiting the Rio Grande from Española, New Mexico to the mouth of the river near Brownsville, the species is currently found in approximately 5% of its former range in central New Mexico. The Recovery Plan for the species recommended that it be reintroduced into portions of its former range. The first experimental reintroductions of the species were approved and undertaken in December 2008 and have continued at yearly intervals since that time. To date, more than 2,600.000 minnows have been released in the Big Bend region since reintroductions began. The reintroduced fish have shown at least some survival at each of the sites and have been found considerable distances away from the reintroduction sites. Rio Grande Silvery Minnow eggs have been collected from two of the monitoring sites in 2010 and in August 2010, a 37-mm standard length juvenile Rio Grande Silvery Minnow was taken at one site, indicating some successful reproduction; however, successful, sustaining populations have not yet been achieved. In the present monitoring efforts in the upper portion of the Big Bend region, no Rio Grande Silvery Minnows were obtained from the over 8,000 fishes captured. The habitats occupied by captured 20 species of fishes were recorded for use in future habitat assessments in the Big Bend region.

Introduction

The historical distribution of the federally Endangered Rio Grande Silvery Minnow, *Hybognathus amarus,* included the Rio Grande from Española, New Mexico, through the Big Bend reach to the Gulf of Mexico, and the Pecos River from near Santa Rosa, New Mexico, to the confluence with the Rio Grande. Seven collections made between 1938 and 1960 documented that Rio Grande Silvery Minnow was among the most common fishes of the Big Bend reach. Despite several sampling events from 1977 to the present, the species has not been found in the area and there are no records of the silvery minnow in the Río Conchos of Mexico in either historic or recent collections (U.S. Fish and Wildlife Service 1999, 2010).

The reasons for the species' extirpation in the Rio Grande in Texas are uncertain, but are believed to have been due to drought and diversions, in combination with water pollution. However, the continued presence of other native members of the pelagic spawning guild to which the species belongs (e.g., speckled chub and Rio Grande shiner) is evidence that the Big Bend reach may support the reestablishment of Rio Grande Silvery Minnow (U.S. Fish and Wildlife Service 1999, 2010). But, a natural repopulation of the Rio Grande Silvery Minnow to the Big Bend reach of the Rio Grande was not possible without human assistance (Federal Register 2008).

Based on the presence of suitable habitat, the presence of fish species that have similar habitat requirements, the recommendations of the Rio Grande Silvery Minnow Recovery Team's reach-by-reach analysis of the entire Rio Grande basin, and the results of a feasibility study (;

Edwards 2005, U.S. Fish and Wildlife Service 2010), the area in which silvery minnow are most likely to become reestablished after potential reintroduction in the Rio Grande is from Mulato Dam near Presidio, Texas to Foster's Weir (Dryden or Shaffer's Crossing) near the Terrell/Val Verde County line.

The U.S. Fish and Wildlife Service finalized its NEPA and rulemaking process and Federal Register rule for the reestablishment of the Rio Grande Silvery Minnow into its historic habitat in the Big Bend reach of the Rio Grande in Texas in December 2008. This monitoring study was a cooperative endeavor involving the U.S. Fish and Wildlife, the National Park Service, the Texas Parks and Wildlife Department and U.S. Geologic Survey. The reestablished fish have a 10(j) status, meaning that they are classified as a nonessential experimental population (NEP) under the federal Endangered Species Act provisions (Federal Register 2008).

Objective

It was the purpose of this study to continue to monitor the stocked Rio Grande Silvery Minnow populations in the Big Bend region that was begun in 2008, to determine whether the stocking was successful, to determine various life history parameters, such as habitat occupation, time of reproduction, movements and interactions with other species, and to be able to provide timely data on the species' status in its environment to adaptively manage the multiple year restocking efforts in order to maximize the potential for the successful reestablishment of the species. A further objective was to establish a baseline of data to be able to compare various of the species life history parameters with those found in the Rio Grande Silvery Minnow source populations in New Mexico (Edwards and Garrett 2013).

The aim of the reestablishment of the Rio Grande Silvery Minnow into the Big Bend region is to create a self-sustaining population of the species in part of its historic range and to partially fulfill one of the recovery goals of the Recovery Plan which, when other goals are also satisfied, would ultimately lead to the downlisting of the species. The draft revised Recovery Plan defines a self-sustaining population as one that can sustain a minimum of 500,000 unmarked fish, for five consecutive years without augmentation from captive-bred fish (U.S. Fish and Wildlife Service 2010).

Based on the presence of suitable habitat, the presence of fish species that have similar habitat requirements, the recommendations of the Rio Grande Silvery Minnow Recovery Team's reach-by-reach analysis of the entire Rio Grande basin, and the results of a feasibility study (U.S. Fish and Wildlife Service 1999, 2006; Edwards 2005), the area in which silvery minnow are most likely to become reestablished after potential reintroduction in the Rio Grande is from Mulato Dam near Presidio, Texas to Foster's Weir near the Terrell/Val Verde County line.

The first experimental reintroductions of the species were approved and undertaken in December 2008. More than 2,000,000 minnows have been released in the Big Bend region in the past 9 years. The reintroduced fish have shown at least some survival at each of the sites and have been found considerable distances away from the reintroduction sites. Rio Grande Silvery Minnow eggs have been collected from two of the monitoring sites in 2010 and in August 2010,

a 37-mm standard length juvenile Rio Grande Silvery Minnow was taken at one site, indicating some successful reproduction (Edwards and Garrett 2013).

The life history of the Rio Grande Silvery Minnow in New Mexico as well as from a previously examination of museum records indicate that the species reproduction is highly dependent upon rising water levels associated with winter runoff levels in New Mexico or summer tropical storm river rises in Texas (Edwards and Garrett 2013). This "boom or bust" reproductive pattern has proved problematical for the management of this species, but the U.S. Fish and Wildlife Service has been cognizant of this and continues to reintroduce the species in New Mexico and has determined that this reintroduction should continue in Texas as part of the management strategy for this species.

Monitoring of the reestablished populations will provide data on 1) how the species is adapting to the habitats found within the Big Bend region; 2) potential or realized species interactions with the existing fish communities or the repatriated area; 3) the effects of various stocking conditions and release sites on the survival and establishment of the species; 4) assessment of whether the goal of establishing two year-classes is being met; 5) a better assessment of the need for habitat remediation within the region to increase the potential for obtaining a self-sustaining population of Rio Grande Silvery Minnows in the area; and 6) to establish and implement a statistically valid baseline to be able to compare various of the species life history parameters with those found in the Rio Grande Silvery Minnow source populations in New Mexico.

Timeline

March 2014 – October 2014. Raise Rio Grande silvery minnow in captivity. Eggs collected from the wild are the preferred source for Rio Grande silvery minnow raised in captivity for this reestablishment effort. However, Rio Grande silvery minnow will be raised from eggs spawned in captivity, if needed. This will be the responsibility of the U.S. Fish and Wildlife Service.

October 2014. Stock fish in Big Bend reach of Rio Grande (including site selection and preparation such as installation of holding pens). Release sites include sites in the Big Bend Ranch State Park (Grassy Banks), in Big Bend National Park (Mouth of Terlingua Creek, Rio Grande Village boat ramp) and near Stillwell's Crossing at the Adams Ranch. This will be the responsibility of the U.S. Fish and Wildlife Service with cooperation and assistance by the National Park Service and the Texas Parks and Wildlife Department.

Task 1. October – December 2014. Post-Release Monitoring of Rio Grande silvery minnow populations in Big Bend reach of Rio Grande.

The Middle Rio Grande Long-Term Fish Population Monitoring Program methodology as the model in the development and implementation of the sampling protocol.

The four release sites and areas nearby localities that have harbored released Rio Grande silvery minnows during the previous five-year reintroduction period will be sampled biannually to add to our nearly five years of quarterly monitoring that was collected to form the baseline information at selected monitoring sites. Specimens collected will be identified to species and counted in our laboratories at the University of Texas-Pan American and at the HOH Fisheries Science Center. In addition, other ecological and life

history measurements will be taken at the collection sites in order to correlated these with species abundance and life history stage data.

Task 2. January 2015- Dec. 2015. Monitoring of Rio Grande silvery minnow populations.

The four release sites and areas nearby localities that have harbored released Rio Grande silvery minnows during the previous five-year reintroduction period will be sampled biannually to add to our nearly five years of quarterly monitoring that was collected to form the baseline information at selected monitoring sites. Specimens collected will be identified to species and counted in our laboratories at the University of Texas-Pan American and at the HOH Fisheries Science Center. In addition, other ecological and life history measurements will be taken at the collection sites to correlate these with species abundance and life history stage data.

Task 3. January 2016 – December 2016. Monitoring of Rio Grande silvery minnow populations.

The four release sites and areas nearby localities that have harbored released Rio Grande silvery minnows during the previous five-year reintroduction period will be sampled biannually to add to our nearly five years of quarterly monitoring that was collected to form the baseline information at selected monitoring sites. Specimens collected will be identified to species and counted in our laboratories at the University of Texas-Pan American and at the HOH Fisheries Science Center. In addition, other ecological and life history measurements will be taken at the collection sites to correlate these with species abundance and life history stage data.

Task 4. September – December 2016. Assessment of fish community structure and habitats where Rio Grande silvery minnows are found and an assessment of the habitat characteristics of areas where the species is not found for use in adaptive management of the restocking efforts.

Methods

The Middle Rio Grande Long-Term Fish Population Monitoring Program methodology was used as the model in the development and implementation of the sampling protocol. We followed the same methods used in previous monitoring efforts (Edwards and Garrett 2013) except that we sampled biannually instead of quarterly. We also limited our sampling to sites within Big Bend National Park and Terlingua Creek, since these sites consistently yielded greater numbers of Rio Grande Silvery Minnows than the Contrabando Canyon or Adams Ranch sites.

Rio Grande Silvery Minnows were stocked originally at four sites: Colorado Canyon River Access point; mouth of Terlingua Creek; Rio Grande Village Boat Ramp; and the Rio Grande at the Adams Ranch. In 2013, stockings were primarily made in the Rio Grande at Dryden (Shaffer's) Crossing. In 2015, a small number (2,000) Rio Grande Silvery Minnows were stocked at Terlingua Abajo in addition to a much larger number at the Dryden Crossing.

Fishes were monitored at the sampling sites by seining in all habitats in the relative proportion in which they occurred using sei8nes that were (usually) 10' and 15' long with 1/8" mesh. The following physical measurements were recorded: time of each collection, stream temperature, stream width, stream depth, stream flow, substrate characteristics, and vegetation density. Periodic measurements were taken of dissolved oxygen (DO), conductivity or salinity. For the most part, captured specimens were preserved in 10% formalin, separated, and counted by species in the laboratory at the University of Texas Rio Grande Valley (Appendix A).

Specimens were then transported for permanent curation at the Biodiversity Collections (formerly Texas Natural History Collections) at the University of Texas at Austin.

Results and Discussion

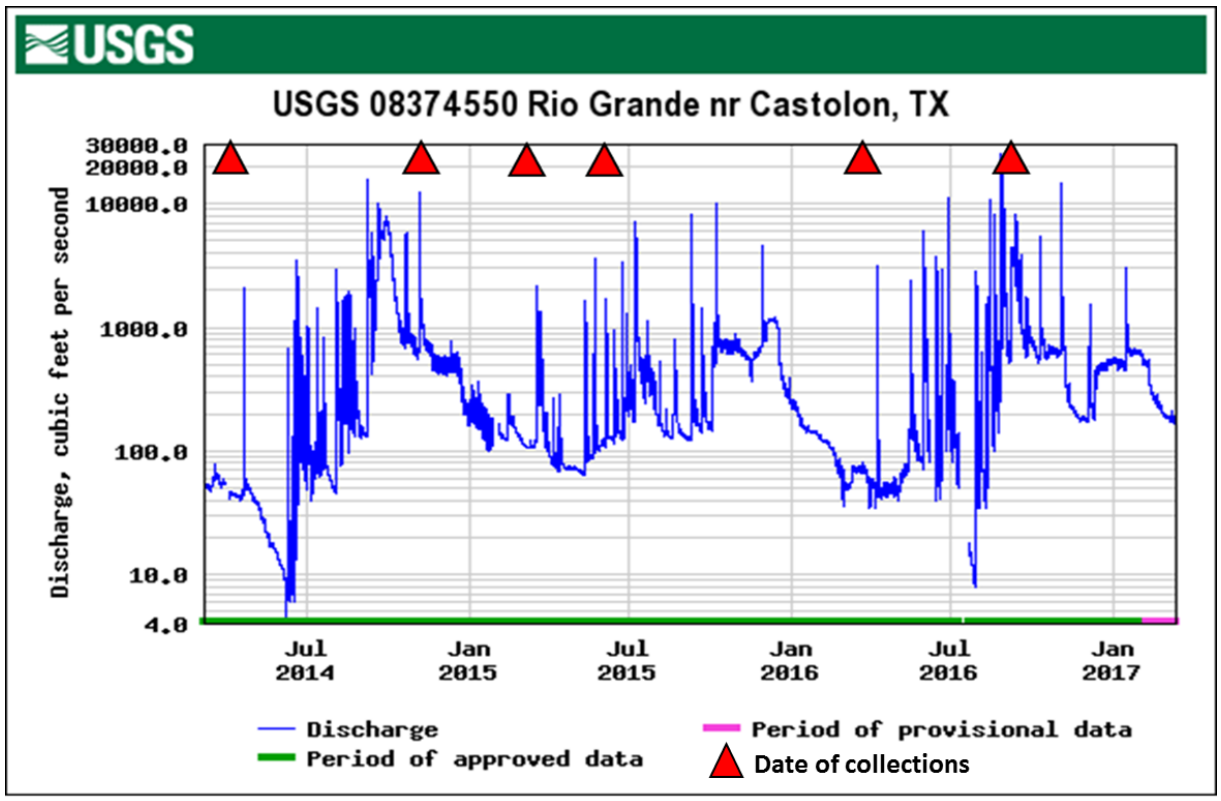
This project is a continuation of the reintroduction efforts for the Rio Grande Silvery Minnow into the Big Bend region. Table 1 shows the history of stockings through the present. From 2008 through 2012, approximately equal numbers were stocked at four localities distributed through the region (Edwards and Garrett 2013), and from 2013 through the present, most stockings occurred only in a Lower Canyon site (Dryden's Crossing). To date, more than 2.5 million Rio Grande Silvery Minnows have been stocked in the region.

Table 1. Rio Grande Silvery Minnow Stocking Information 2008-2016

Date	Number stocked (equal numbers at each of 4 sites unless otherwise indicated
December 2008	431,000
October 2009	509,988
October 2010	500,000
October 2011	304,648
October 2012	120,000
October 2013	72,000 (Dryden (Shaffer's) Crossing only)
December 2014	70,523 (Dryden Crossing only)
October 2015	216,118 (214,118 at Dryden Crossing; 2,000 at Terlingua Abajo)
October 2016	410,000 (Dryden Crossing only)
Total All Stockings	2,634,277

During the study period, water flows were extremely variable (Figure 1). The "flashy" hydrograph of the Rio Grande in the Big Bend region is indicative that rising water levels, important conditions for the successful reproduction of the Rio Grande Silvery Minnow, are present during the known spawning season of the species. While some rain events can cause significant flooding of the Rio Grande and the tributary creeks, others are more moderate in their impacts. Regardless, the reasons why successful recruitment is not taking place remains elusive. The new focus on releases in the Lower Canyon reaches of the Rio Grande, while largely inaccessible, does provide more spring inflow than areas upstream and future efforts may have a greater chance of succeeding in these areas. However, to date, recruitment in this area is low and inconsistent (K. Saunders, pers. comm.).

Figure 1. Daily Discharge Rio Grande near Castolon. Data from USGS for the 2014 to 2016 study period. Shown also are the dates that collections were taken during this study period.



A total of 8,199 fishes were captured in the present study, comprising 20 species, but no Rio Grande Silvery Minnows, *Hybognathus amarus* (Appendix A). Of the fishes captured, the most abundant species taken were Red Shiners (*Cyprinella lutrensis*) with 62% of all captures, followed by Tamaulipan Shiners (*Notropis braytoni*) with 25% of all captures. Table 2 lists the percentage of each species taken by family. Over 90% of the total fishes taken were minnows in the family Cyprinidae, about 4% in the topminnow family Fundulidae, 2% suckers in the family Catastomidae, and less than 1% of the remaining 7 families.

The large number and percentage of minnows captured is, in part, a reflection of the composition of the species present in the Big Bend region as well as an artifact of the specific habitats that we sampled to maximize our chances to document successful recruitment of *H. amarus*.

Table 2. Percent composition of the families of fishes taken during the study period.

	Percent Composition
Lepisosteidae	0.06%
Clupeidae	0.18%
Cyprinidae	91.78%
Catastomidae	2.13%
Characidae	0.77%
Ictaluridae	0.56%
Fundulidae	3.66%
Poeciliidae	0.80%
Centrarchidae	0.04%
Sciaenidae	0.01%

Species-Habitat Associations

Habitat associations were determined for the species captured with special emphasis on: stream temperature, stream width, stream depth, stream flow, substrate characteristics, and vegetation density. The largest influence on species distributions and diversity were stream temperature and flow. Diversity tended to be lower in winter than summer and lower during high flow conditions following rain and storm events than during periods of low flow. The latter is considered to be an artifact of the collection method, rather than real, as seining is quite inefficient during high flow conditions, in deep water, in substrates with boulders, and in dense vegetation. Regardless, certain species mesohabitat characteristics were observed and recorded (Table 3).

Species that were generally found in pools, runs and deeper water environments were: *Lepisosteus osseus, Dorosoma cepedianum,* some *Cyprinus carpio,* some *Carpiodes carpio, Astyanax mexicanus, Ictalurus punctatus, I. furcatus, Lepomis macrochirus, L. megalotis,* and *Aplodinotus grunniens*. Riffle species with smaller (cobbles to sand) substrates included *Macrohybopsis aestivalis* and *Rhinichthys cataractae*. *Pylodictis olivaris* was also found in riffles, but these tended to have larger substrates (cobbles to boulders). *Gambusia affinis* was the primary edge species, although both *Pimephales* species (*P. vigilax* and *P. promelas*) were also captured along the stream edge, although only minimal numbers of these were captured. *Campostoma ornatum, Notropis chihuahua* and *Fundulus kansae* were strongly associated with sandy substrates, especially in the Rio Grande tributaries, Terlingua and Tornillo creeks. Finally, the two most abundant species captured, *Cyprinella lutrensis* and *Notropis braytoni* were found ubiquitously in most habitats, but primarily in those with moderate to slow current flows, with or without vegetation or algae. Each of these species mesohabitat associations were similar to those found during earlier studies (Edwards and Garrett 2013, Miyazono and Taylor. 2015).

Conclusions

No Rio Grande Silvery Minnows were captured during this study. Several factors may be at play. First, the majority of the stockings were in the Lower Canyons stretch of the Rio Grande, a great distance downstream from the Big Bend National Park study area. While *H. amarus* is known to move considerable distances upstream, much of this information is from the Rio Grande in the Albuquerque, NM area, where much of the stream bed is in low gradient, sandy areas and where few canyon rapids are found. The fishes introduced in October 2015 in the Terlingua Abajo area was apparently washed downstream following a rainfall event and none were obtained at this site or downstream at the mouth of the creek in the Rio Grande at the Santa Elena station.

The concordance of the species-habitat associations in these studies suggest that management strategies to reestablish *Hybognathus amarus* to the Big Bend region should also use these species-habitat associations in order to conserve the ecosystem functions upon which the Rio Grande Silvery Minnow and the other aquatic organisms depend.

Table 3. Species associations with various mesohabitat types.

Species	Number Captured	Habitat	Depth	Velocity	Vegetation	Brush/Cover
Lepisosteus osseus	5	pools	deep	slow to moderate	none	none
Dorosoma cepedianum	15	pools	deep	slow to moderate	none	none
Campostoma ornatum	3	sandy riffles	shallow	moderate	algae	some brush
Macrhybopsis aestivalis	83	riffles	shallow to moderate	moderate to swift	none	none
Cyprinella lutrensis	5067	all except very swift	shallow to moderate	slow to moderate	none to vegetated/algae	none to brush
Rhinichthys cataractae	196	riffles	shallow to moderate	moderate to swift	none	none
Notropis chihuahua	57	sandy runs	shallow	moderate	none	none to brush
Notropis braytoni	2090	all except very swift	shallow to moderate	slow to moderate	none to vegetated/algae	none to brush
Pimephales vigilax	1	run/edge	shallow	backwater	none	none
Pimephales promelas	2	run/edge	shallow	backwater	none	none
Cyprinus carpio	26	pools/edge	shallow to deep	backwaters/slow	none to vegetated/algae	some brush
Carpiodes carpio	175	pools/edge	shallow to deep	backwaters/slow	none to vegetated/algae	some brush
Astyanax mexicanus	63	pools/runs	shallow to deep	moderate to swift	usually none	some brush
Ictalurus furcatus	12	pools/runs	moderate to deep	slow to swift	usually none	underhangs or none
Ictalurus punctatus	29	pools/runs	moderate to deep	slow to swift	usually none	underhangs or none

Table 4. Species associations with various mesohabitat types (continued).

Species	Number Captured	Habitat	Depth	Velocity	Vegetation	Brush/Cover
Pylodictis olivaris	5	boulder/cobble riffles	moderate to deep	moderate to swift	none	boulders/cobbles
Fundulus kansae	300	sandy runs	shallow	slow	algae or none	none
Gambusia affinis	66	edges and backwaters	shallow	slow	none to vegetated/algae	usually none or vegetation
Lepomis macrochirus	2	pool	deep	moderate	none	none
Lepomis megalotis	1	pool	deep	moderate	none	none
Aplodinotus grunniens	1	run	deep	swift	none	none

Acknowledgments

Funding for this project came from Section 6 Funds provided by the Texas Parks and Wildlife Department and I thank them for their funding. I also would like to thank the following departments, agencies and individuals: Big Bend National Park, Raymond Skiles and Jeff Bennett; U.S. Fish and Wildlife Service, Aimee Roberson, Texas Parks and Wildlife Department, Ken Saunders and the others who have helped with our sampling, especially Deborah C. Edwards who served as an unpaid volunteer field assistant.

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Appendix A. Fishes captured at the study sites, along with various environmental parameters.

		Rio Grande at Santa Elena	Terlingua Creek mouth Isolated Pool	Terlingua Cr. at Terlingua Abajo	Boquillas Overlook	Rio Grande at RGV Boat Ramp
	Latitude	29º 09’54.34” N	29º 09’54.35” N	29°12'5.70"N	29°11'57.58"N	29º 10’46.67” N
	Longitude	103º36’38.45” W	103º36’38.45” W	103º36’00.63”W	102°55'3.37"W	102º57’38.95” W
	Date	5/13/2014	5/13/2014	5/13/2014	5/14/2014	5/14/2014
Common name	Species					
Longnose Gar	*Lepisosteus osseus*					
Gizzard Shad	*Dorosoma cepedianum*					
Mexican Stoneroller	*Campostoma ornatum*					
Speckled Chub	*Macrhybopsis aestivalis*	18		5	1	
Red Shiner	*Cyprinella lutrensis*	109	85	51	74	268
Longnose Dace	*Rhinichthys cataractae*	21			4	1
Chihuahua Shiner	*Notropis chihuahua*			7		
Tamaulipas Shiner	*Notropis braytoni*	25		14	59	58
Fatnead Minnow	*Pimephales promelas*		2	1		
Common Carp	*Cyprinus carpio*	7	7		2	9
River Carpsucker	*Carpiodes carpio*	1			1	36
Mexican Tetra	*Astyanax mexicanus*				17	12
Blue Catfish	*Ictalurus furcatus*		3		2	
Channel Catfish	*Ictalurus punctatus*		1			
Flathead Catfish	*Pylodictis olivaris*					
Plains Killifish	*Fundulus kansae*	35	80	39		
Western Mosquitofish	*Gambusia affinis*				24	8
Bluegill	*Lepomis macrochirus*					
Longear Sunfish	*Lepomis megalotis*					
Freshwater Drum	*Aplodinotus grunniens*	1				
	Total Captured	217	178	117	184	392
	N Species	9	7	7	10	8
	Temperature (C)	19.8	19.1	21.5	21.2	20.9
	Dissolved Oxygen (mg/l)					
	Conductivity (µmhos/cm)	2974	1140	970	805	837
	Salinity (ppt)	1.6	0.6	0.5	0.4	0.4
	Shannon (H')	1.48	0.99	1.33	1.45	1.05
	Evenness	0.71	0.55	0.74	0.66	0.54

Appendix A (continued).

		Rio Grande at Santa Elena	Terlingua Cr. at Terlingua Abajo	Boquillas Overlook	Rio Grande at RGV Boat Ramp	Rio Grande at Santa Elena
	Latitude	29º 09’54.34” N	29°12'5.70"N	29°11'57.58"N	29º 10’46.67” N	29º 09’54.34” N
	Longitude	103º36’38.45”W	103º36’00.63”W	102°55'3.37"W	102º57’38.95”W	103º36’38.45”
	Date	12/15/2014	12/15/2014	12/16/2014	12/16/2014	4/11/2015
Common name	Species					
Longnose Gar	*Lepisosteus osseus*					1
Gizzard Shad	*Dorosoma cepedianum*					
Mexican Stoneroller	*Campostoma ornatum*					
Speckled Chub	*Macrhybopsis aestivalis*	1			4	1
Red Shiner	*Cyprinella lutrensis*	874	76	11		66
Longnose Dace	*Rhinichthys cataractae*					54
Chihuahua Shiner	*Notropis chihuahua*					1
Tamaulipas Shiner	*Notropis braytoni*	61	1	9		58
Fatnead Minnow	*Pimephales promelas*					
Common Carp	*Cyprinus carpio*					
River Carpsucker	*Carpiodes carpio*	2				
Mexican Tetra	*Astyanax mexicanus*	5		5		1
Blue Catfish	*Ictalurus furcatus*					
Channel Catfish	*Ictalurus punctatus*					
Flathead Catfish	*Pylodictis olivaris*					
Plains Killifish	*Fundulus kansae*		22			
Western Mosquitofish	*Gambusia affinis*	1				
Bluegill	*Lepomis macrochirus*					
Longear Sunfish	*Lepomis megalotis*					
Freshwater Drum	*Aplodinotus grunniens*					
	Total Captured	944	99	25	4	182
	N Species	7	4	4	2	8
	Temperature (C)	15.7	25.2	16	15.5	19.1
	Dissolved Oxygen (mg/l)					6.8
	Conductivity (µmhos/cm)	866				866
	Salinity (ppt)	0.6	0.6	0.6	0.6	0.4
	Shannon (H')	0.30	0.58	1.05	0.00	1.21
	Eveness	0.17	0.53	0.96	0.00	0.62
	Notes:	Water low but signs of recent rains				

Appendix A (continued).

		Terlingua Cr. at Terlingua Abajo	Rio Grande at Tornillo Cr. mouth	Rio Grande at RGV Boat Ramp	Boquillas Overlook	Boquillas Overlook
	Latitude	29°12'5.70"N	29º 10’ 39” N	29º 10’46.67” N	29°11'57.58"N	29°11'57.58"N
	Longitude	103º36’00.63”W	102º59’49” W	102º57’38.95” W	102°55'3.37"W	102°55'3.37"W
	Date	4/11/2015	4/12/2015	4/12/2015	4/12/2015	6/16/2015
Common name	Species					
Longnose Gar	*Lepisosteus osseus*					
Gizzard Shad	*Dorosoma cepedianum*					
Mexican Stoneroller	*Campostoma ornatum*					
Speckled Chub	*Macrhybopsis aestivalis*					15
Red Shiner	*Cyprinella lutrensis*	33	11	1	19	161
Longnose Dace	*Rhinichthys cataractae*	1	10		7	
Chihuahua Shiner	*Notropis chihuahua*	12				
Tamaulipas Shiner	*Notropis braytoni*	3	11		115	17
Fatnead Minnow	*Pimephales promelas*					
Common Carp	*Cyprinus carpio*		1			
River Carpsucker	*Carpiodes carpio*		5		6	1
Mexican Tetra	*Astyanax mexicanus*	1			1	1
Blue Catfish	*Ictalurus furcatus*				1	
Channel Catfish	*Ictalurus punctatus*					13
Flathead Catfish	*Pylodictis olivaris*					
Plains Killifish	*Fundulus kansae*	11			1	
Western Mosquitofish	*Gambusia affinis*		1	1	2	6
Bluegill	*Lepomis macrochirus*					
Longear Sunfish	*Lepomis megalotis*					
Freshwater Drum	*Aplodinotus grunniens*					
	Total Captured	61	39	2	152	214
	N Species	7	7	2	9	8
	Temperature (C)	24.6	24.8	25.7	25.2	28.1
	Dissolved Oxygen (mg/l)	7.23	5.6	6.52	6.7	5.74
	Conductivity (µmhos/cm)	799	1273	1818	1669	1619
	Salinity (ppt)	0.6	0.6	0.9	0.8	0.8
	Shannon (H')	1.24	1.51	0.69	0.90	0.92
	Eveness	0.69	0.85	1.00	0.43	0.47
	Notes	Intermittent	Tornillo-low flow. Many tadpoles	Recent rains		Water very high and muddy

Appendix A (continued).

		Rio Grande at RGV Boat Ramp	Rio Grande at Santa Elena	Terlingua Creek at mouth	Terlingua Cr. at Terlingua Abajo	Terlingua Cr. at Study Butte
	Latitude	29º 10’46.67” N	29º 09’54.34” N	29º 09’54.35” N	29°12'5.70"N	29°19'36.94"N
	Longitude	102º57’38.95” W	103º36’38.45” W	103º36’38.45” W	103º36’00.63”W	103°33'12.95"W
	Date	6/16/2015	6/17/2015	6/17/2015	6/17/2015	6/17/2015
Common name	Species					
Longnose Gar	*Lepisosteus osseus*			4		
Gizzard Shad	*Dorosoma cepedianum*		1	14		
Mexican Stoneroller	*Campostoma ornatum*				2	1
Speckled Chub	*Macrhybopsis aestivalis*	3	15	1		
Red Shiner	*Cyprinella lutrensis*	8	59	204	31	42
Longnose Dace	*Rhinichthys cataractae*		2			
Chihuahua Shiner	*Notropis chihuahua*				2	
Tamaulipas Shiner	*Notropis braytoni*		402	272	30	
Fatnead Minnow	*Pimephales promelas*					
Common Carp	*Cyprinus carpio*					
River Carpsucker	*Carpiodes carpio*	1	36	42		
Mexican Tetra	*Astyanax mexicanus*		1	6		1
Blue Catfish	*Ictalurus furcatus*				1	
Channel Catfish	*Ictalurus punctatus*	7				
Flathead Catfish	*Pylodictis olivaris*			1		
Plains Killifish	*Fundulus kansae*		2		13	5
Western Mosquitofish	*Gambusia affinis*					
Bluegill	*Lepomis macrochirus*			2		
Longear Sunfish	*Lepomis megalotis*					
Freshwater Drum	*Aplodinotus grunniens*					
	Total Captured	19	518	546	79	49
	N Species	5	9	10	7	5
	Temperature (C)	28.8	26.1	23.8	26.3	28.8
	Dissolved Oxygen (mg/l)	5.6	6	7.14	6.5	6.3
	Conductivity (µmhos/cm)	2178	1395	574	872	634
	Salinity (ppt)	1.1	0.7	0.3	0.4	0.3
	Shannon (H')	1.18	0.80	1.14	1.27	0.52
	Eveness	0.85	0.38	0.52	0.71	0.38
	Notes	Water very high and muddy; 2” rain on 6/13/15	Water murky; current 1.0 m/s)	Water high (> 1m deep)	Slightly murky; flow 0.2m/s	Slightly murky; flow 0.2m/s - 1.0m/s

Appendix A (continued).

		Rio Grande at Santa Elena	Terlingua Creek at mouth	Terlingua Cr. at Terlingua Abajo	Rio Grande at Tornillo Cr. mouth	Boquillas Overlook
	Latitude	29º 09’54.34”N	29º 09’54.35” N	29°12'5.70"N	29º 10’ 39” N	29°11'57.58"N
	Longitude	103º36’38.45”W	103º36’38.45”W	103º36’00.63”W	102º59’49”W	102°55'3.37"W
	Date	5/19/2016	5/19/2016	5/19/2016	5/20/2016	5/20/2016
Common name	Species					
Longnose Gar	*Lepisosteus osseus*					
Gizzard Shad	*Dorosoma cepedianum*					
Mexican Stoneroller	*Campostoma ornatum*					
Speckled Chub	*Macrhybopsis aestivalis*	3				3
Red Shiner	*Cyprinella lutrensis*	800	34	185	1666	157
Longnose Dace	*Rhinichthys cataractae*			95		
Chihuahua Shiner	*Notropis chihuahua*			31		
Tamaulipas Shiner	*Notropis braytoni*	32		14	515	218
Fatnead Minnow	*Pimephales promelas*					
Common Carp	*Cyprinus carpio*					
River Carpsucker	*Carpiodes carpio*	2	18	7		2
Mexican Tetra	*Astyanax mexicanus*			4		
Blue Catfish	*Ictalurus furcatus*					
Channel Catfish	*Ictalurus punctatus*					1
Flathead Catfish	*Pylodictis olivaris*					
Plains Killifish	*Fundulus kansae*	7	2	77		
Western Mosquitofish	*Gambusia affinis*				1	22
Bluegill	*Lepomis macrochirus*					
Longear Sunfish	*Lepomis megalotis*				1	
Freshwater Drum	*Aplodinotus grunniens*					
	Total Captured	844	54	413	2183	403
	N Species	6	4	8	5	7
	Temperature (C)	23	25.6	30.2	25	24.4
	Dissolved Oxygen (mg/l)					
	Conductivity (µmhos/cm)	1064	442.1	1106	1865	2006
	Salinity (ppt)	0.5	0.2	0.5	0.9	1
	Shannon (H')	0.25	0.78	1.43	0.55	0.94
	Eveness	0.15	0.71	0.74	0.40	0.52
	Notes	Muddy, medium flow	Water low	Water clear, new gravel bar midstream		River changed course since last year

Appendix A (continued).

		Rio Grande at Santa Elena	Terlingua Creek at mouth	Terlingua Cr. at Terlingua Abajo	Rio Grande at Tornillo Cr. mouth	Boquillas Overlook	
	Latitude	29º 09’54.34” N	29º 09’54.35” N	29°12'5.70"N	29º 10’ 39” N	29°11'57.58"N	
	Longitude	103º36’38.45” W	103º36’38.45” W	103º36’00.63”W	102º59’49” W	102°55'3.37"W	
	Date	8/9/2016	8/9/2016	8/9/2016	8/10/2016	8/10/2016	Totals
Common name	Species						Total
Longnose Gar	*Lepisosteus osseus*						5
Gizzard Shad	*Dorosoma cepedianum*						15
Mexican Stoneroller	*Campostoma ornatum*						3
Speckled Chub	*Macrhybopsis aestivalis*	12				1	83
Red Shiner	*Cyprinella lutrensis*	10	2	4	1	25	5067
Longnose Dace	*Rhinichthys cataractae*	1					196
Chihuahua Shiner	*Notropis chihuahua*			4			57
Tamaulipas Shiner	*Notropis braytoni*	132	2	36		6	2090
Fatnead Minnow	*Pimephales promelas*						3
Common Carp	*Cyprinus carpio*						26
River Carpsucker	*Carpiodes carpio*	3	2	3		7	175
Mexican Tetra	*Astyanax mexicanus*			8			63
Blue Catfish	*Ictalurus furcatus*		1	1		3	12
Channel Catfish	*Ictalurus punctatus*	4			1	2	29
Flathead Catfish	*Pylodictis olivaris*	1			2	1	5
Plains Killifish	*Fundulus kansae*			6			300
Western Mosquitofish	*Gambusia affinis*						66
Bluegill	*Lepomis macrochirus*						2
Longear Sunfish	*Lepomis megalotis*						1
Freshwater Drum	*Aplodinotus grunniens*						1
	Total Captured	163	7	62	4	45	8199
	N Species	8	5	8	4	8	21
	Temperature (C)	29	29	33.2	28.7	27.1	
	Dissolved Oxygen (mg/l)						
	Conductivity (µmhos/cm)	1366	no data	1238	1019	731	
	Salinity (ppt)	0.6	no data	0.5	0.5	0.3	
	Shannon (H')	0.76	1.35	1.37	1.04	1.37	1.17
	Eveness	0.39	0.98	0.71	0.95	0.71	0.39
	Notes	Water is very low	Only mudhole at mouth	Water flowing slowly	Very high water; Tornillo Cr. in flood	Signs of recent rains, water very muddy	