Section 6 (Texas Traditional) Report Review

Form emailed to FWS S6 coordinator (mm/dd/yyyy): 12/6/2012

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Project Title: Conservation status of Comanche Springs pupfish (*Cyprinidon elegans*) and Pecos gambusia (*Gambusia nobilis*) in the ciénegas of Balmorhea State Park, Texas

Final or Interim Report? Interim

Grant #: E-118-R

Reviewer Station: Austin ESFO

Lead station concurs with the following comments: NA (reviewer from lead station)

Interim Report (check one):

- ☒ Acceptable (no comments)
- ☐ Needs revision prior to final report (see comments below)
- ☐ Incomplete (see comments below)

Final Report (check one):

- ☐ Acceptable (no comments)
- ☐ Needs revision (see comments below)
- ☐ Incomplete (see comments below)

Comments:

INTERIM REPORT

As Required by

THE ENDANGERED SPECIES PROGRAM

TEXAS

Grant No. TX E-118-R

Endangered and Threatened Species Conservation

Conservation Status of Comanche Springs pupfish (*Cyprinodon elegans*) and Pecos gambusia (*Gambusia nobilis*) in the ciénegas of Balmorhea State Park, Texas

Prepared by:

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Executive Director

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2 November 2012

INTERIM REPORT

STATE: Texas **GRANT NUMBER:** E – 118-R

GRANT TITLE: Conservation Status of Comanche Springs pupfish (*Cyprinodon elegans*) and Pecos gambusia (*Gambusia nobilis*) in the ciénegas of Balmorhea State Park, Texas

REPORTING PERIOD: 1 Oct 11 to 30 Sep 12

OBJECTIVE(S):

To (1) assess the current conservation status of the endangered Comanche Springs pupfish and Pecos gambusia in the ciénegas at Balmorhea State Park, Texas, (2) assess the value of restored critical habitats for the conservation of these taxa, and (3) establish ecosystem-based management and conservation strategies for endemic taxa of desert ciénegas; over three seasons.

Segment Objectives:

1. Population estimates
2. Stable isotopes analysis
3. Gut contents.

Significant Deviation: None.

Summary Of Progress: Please see Attachment A (pdf file).

Location: Reeves County, TX

Cost: Costs were not available at time of this report.

Prepared by: Craig Farquhar **Date:** 2 November 2012

Approved by: _____ **Date:** 2 November 2012
C. Craig Farquhar

ATTACHMENT A

Interim Performance Report

USFWS Federal Assistance Grant E-118-1

Conservation Status of Comanche Springs Pupfish (Cyprinidon elegans) and Pecos Gambusia (Gambusia nobilis) in the ciénegas of Balmorhea State Park, Texas

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Date: November 2, 2012

Reporting Period: October 1, 2011 to September 30, 2012

SUMMARY OF PROGRESS

1. Population Estimates: We continued seasonal population estimates for January 2012, April 2012, and August 2012. Currently population estimates have been calculated for all sample events . The results for these estimates are detailed below in the REPORT section.

2. Population Size Structure: During each seasonal population estimate, pictures of all fish are taken and individuals are measured in the laboratory using a computer program. I have students currently processing these pictures. These results will be presented in the final report due February 2013.

3. Gut contents and Diet Overlap: We preserve ~10 *G. nobilis* and *C. elegans* for gut content analysis so we can document diet overlap (and potential competition between species). We also preserve ~20 to 30 individuals of all other non-endangered taxa. All stomach contents for January, April and August 2012 are currently being processed. These results will be presented in the final report due February 2013.

4. Stable isotopes: In addition to the preserved individuals, we freeze ~10 additional individuals for stable isotope analysis of food web structure. Samples are currently being processed and will be sent to the University of Arkansas Stable Isotope laboratory in mid-November. These data will be presented in the final report February 2013.

SIGNIFICANT DEVIATIONS

No deviations were made from our original plans. We are well on track to completing this project by February 2013.

REPORT

BACKGROUND

Historically, Comanche Springs pupfish (*Cyprinidon elegans*) and Pecos gambusia (*Gambusia nobilis*) inhabited two large desert wetland (ciénega) systems separated by approximately 100 km (Hubbs et al. 1981, Hubbs et al. 1983). One system was fed by the Balmorhea springs complex (Phantom Lake, San Solomon, Giffin, and East Sandia springs), and one by Comanche Springs. These ciénegas and their associated springs provided valuable habitat for these two endemic fishes as well as an entire community of interacting organisms (Hendrickson and Minckley 1984). However, human alteration of the Balmorhea and Comanche spring systems for agricultural irrigation destroyed the associated wetland habitats, and none of these natural systems remain today. This endangered the persistence of Comanche Springs pupfish and Pecos gambusia (Hubbs et al. 1981, Hubbs et al. 1983).

When the original San Solomon ciénega was modified, and for the most part destroyed, the only "aquatic habitat" remaining was in concrete irrigation canals. Although better than no habitat at all, the irrigation canals, at best, provided a tenuous existence for much of the aquatic biota. The Comanche Springs pupfish and Pecos gambusia managed to survive in the irrigation canals, but their numbers were greatly reduced. As a result, these species were elevated to endangered status and conservation efforts were aimed at preventing their extinction (Hubbs et al. 1981, Hubbs et al. 1983).

In an attempt to conserve these endangered species, the Texas Parks and Wildlife Department (TPWD) restored a critical desert wetland habitat by creating the San Solomon Ciénega at Balmorhea State Park in 1996 through a cooperative effort among private, state, and federal entities. This re-creation of a desert wetland habitat within the boundaries of the original, natural ciénega provided critical habitat necessary for survival of desert wetland biota. As a result, the native fish fauna, including Comanche Springs pupfish and Pecos gambusia, have flourished, and this location now provides a natural habitat with the largest known concentration of Comanche Springs pupfish and a viable population of Pecos gambusia. It is believed that the primary benefit of the San Solomon Ciénega to the survival of these endangered fishes is the creation of a "natural" habitat with viable ecosystem-level processes that promote population stability. However, there have been no concerted monitoring efforts since 2001 and there is no information on the ecosystem dynamics of this system.

Based on the success of the San Solomon Ciénega, TPWD is now in the process of creating a second ciénega at Balmorhea State Park by replacing the small, refuge canal with a new 'natural' wetland habitat. This small refuge canal (120 m) was constructed in 1974 at Balmorhea State Park in an effort to improve habitat for the endangered species (Echelle and Hubbs 1978). During a two-year sampling study (Garrett and Price 1993), Comanche Springs pupfish population size in the park refuge canal was estimated to be as low as 968 (May 1990) and as high as 6,480 (September 1990). It is expected that the creation of a second ciénega in this spring system will further promote the successful conservation of Comanche Springs pupfish and Pecos gambusia by doubling the amount of critical habitat and restoring critical ecosystem-level processes that promote population viability.

With the completion of this second ciénega by autumn of 2009 there now exists a great opportunity to document the ecological mechanisms driving the population dynamics of fishes in these desert wetlands. Because successful species conservation not only relies on a thorough understanding of population-dynamics of the species being conserved but also of the ecosystem-level process driving populations, we have begun to implement a 'whole ecosystem' conservation

approach in these ciénega ecosystems. Our goal is to more fully understanding both ecosystem and taxa, so an efficient and effective conservation plan can be established to promote long-term viability of these endangered fishes. With the information gained from this study, we can better manage the existing ciénegas in the San Solomon spring system and have useful insights into the development and functions of the new ciénegas across desert ecosystems.

OVERALL GOALS

Our goal of this mulit-year project is to (1) to assess the current conservation status of the endangered Comanche Springs pupfish and Pecos gambusia in the ciénegas at Balmorhea State Park, Texas, (2) to assess the value of restored critical habitats for the conservation of these taxa, and (3) establish ecosystem-based management and conservation strategies for endemic taxa of desert ciénegas.

METHODS

Density & Population Estimates and Size Structure

We estimated population sizes ($\hat{N}$) and associated variance $V(\hat{N})$ for all fish species in the old ciénega and refuge canal using the *counts on sample plots method*

$$\hat{N} = \frac{A}{a}\bar{n},$$

where A = total population area (the old ciénega or new ciénega), a = size of the plot, $\bar{n}$ = the average number of animals counted per sample plot, and

$$V(\hat{N}) = \frac{A^2}{a}\frac{V(\hat{N})}{s}\frac{A-s\cdot a}{A},$$

where $V(\hat{N}) = \sum_{i=1}^{s}\frac{(n_i-\bar{n})^2}{(s-1)}$, n_i = number of animals counted in the i^{th} plot, and s = number of plots used.

To capture fishes for the population estimates, we first blocked off five large sections of each habitat using five 16.7m × 2m (4.2mm mesh) seines. We repeatedly seined each section using a 7 pass depletion method. We carefully collect all fishes from the net and, immediately following capture, we transferred fishes to insulated coolers containing fresh stream water. We replaced water repeatedly to reduce stress and promote survival of all fishes. We removed individual fishes from the coolers with a dip net and transfer them to a small Plexiglas viewing tank marked with a 1cm grid. While the fishes are in the viewing tank, we identified and counted each species, and we took a digital photograph of the viewing tank.

Using this digital image and the 1cm grid for reference, we measured each individual using the Image J computer program. From these measurements, we created length frequency histograms to analyze size structure of each population.

We collected a random subsample (N = 20) of fishes from each of the sample plots described above. This random sample included fish from each size class in proportion to their natural abundance. For example, if 60% of fishes fell in the medium size class, we randomly selected 12 individuals from that group. From this subsample, we froze 10 individuals for stable isotope analysis (to be completed not reported herein) and preserved 10 individuals in 10% formalin for gut content analysis.

Gut content analysis

To evaluate the instantaneous food web structure at the time of sampling, we analyzed gut contents for 10 preserved individuals for each species from both habitats. These data, along with food availability data (collected for stable isotope analysis), will help indicate diet preference by each species in both habitats. To evaluate gut contents, we removed the upper portion of the alimentary tract and spread stomach contents on a 0.8mm gridded Petri dish (Hargrave 2006). We recorded percent area for each food item, which we assumed is proportional to the volume of food in the gut. We then calculated trophic overlap among species using a percent similarity index.

RESULTS

PHYSICAL CHARACTERISTICS OF THE HABITATS

The length of the open habitat (i.e., not inundated by cattail) in the Old Ciénega was 62 m, the average width of this habitat was 7.4m and the average depth was 0.35m. Mud was the dominate substrate type in the Old Ciénega at 77%, followed by *Chara* sp. and *Chlodophora* sp. (13% & 10%, respectively). The length of the New Ciénega is 52m, the average width is 16.7m and the average depth is 0.79m. The substrate is composed of mud (36.6%) and *Chara* sp. (63.3%). The *Chara* sp. is covered with epithitic algae. The surface area of the new ciénega was 80% smaller than the old ciénega and the total volume of the new ciénega was about 60% smaller than the total volume of the old ciénega. The refuge canal was the smallest of the habitats. The length of the Refuge Canal was 171m, the average width was 3.5m, and the average depth was 0.35m.

DENSITY & POPULATION ESTIMATES

The Old Ciénega

We estimated density (no./m^2) and population size (N) of all fishes in the Old ciénega at 11 time periods (March 2009, July 2009, December 2009, April 2010, July 2010, December 2010, March 2011, August 2011, January 2012, April 2012 and August 2012). *Cyprinidon elegans* density ranged from 0.3 to 1.6 individuals / m^2. *C. elegans* density also was stable across sample periods and averaged 0.9 ± 0.2 individuals / m^2 across time periods in the Old ciénega (Table 1). After extrapolating densities to the entire open habitat in the Old Ciénega, population estimates ranged from 209 - 825 individuals and averaged 560.8 individuals (Table 1). There appeared to be a temporal trend in *C. elegans* population density and size over time. For example, populations were smallest during spring samples periods (March) and largest during summer and fall.

Gambusia nobilis density ranged from 0.4 to 2.3 individuals / m^2. *G. nobilis* density averaged 1.9 ± 0.7 individuals / m^2 (Table 1). The population size of *G. nobilis* in the Old ciénega ranged from 325 to 2023 individuals (Table 1) after extrapolation to the entire open area in this habitat (see above). Again, total population size reflected density, averaging ~901 individuals in this habitat.

Table 1. Seasonal density (no./m^2) and population (N) estimates (± 95% CI) for the four most abundant species in three aquatic habitats at Balmorhea State Park - Old Ciénega, Refuge Canal, and New Ciénega per description in the text.

		Cyprinidon elegans	*Gambusia nobilis*	*Gambusia geiseri*	*Astyanax mexicanus*
OLD CIÉNEGA					
March 2009	*no./m²:*	0.3 ± 0.3	0.5 ± 0.1	14.1 ± 14.8	0.2 ± 0.3
	N:	208.9 ± 186.0	332.9 ± 311.0	9126.2 ± 9545.2	147.0 ± 192.5
July 2009	*no./m²:*	0.9 ± 0.9	2.3 ± 2.7	5.5 ± 7.1	0.03 ± 0.04
	N:	569.5 ± 569.6	1456.2 ± 1751.3	3569.7 ± 4593.7	17.0 ± 23.5
December 2009	*no./m²:*	1.0 ± 0.9	1.2 ± 2.0	1.9 ± 2.3	1.1 ± 1.7
	N:	667.2 ± 553.8	762.1 ± 1263.1	1218.2 ± 1465.4	718.2 ± 1098.2
April 2010	*no./m²:*	1.1 ± 0.7	1.5 ± 1.0	15.2 ± 7.9	0.5 ± 0.3
	N:	691.3 ± 451.4	939.2 ± 637.1	9806.8 ± 5104.5	308.8 ± 216.9
July 2010	*no./m²:*	1.1 ± 0.2	0.9 ± 0.6	11.3 ± 7.1	0.2 ± 0.2
	N:	679.9 ± 160.0	570.9 ± 417.1	7309.4 ± 4580.4	116.2 ± 111.7
December 2010	*no./m²:*	1.2 ± 0.8	0.6 ± 0.4	17.7 ± 6.5	0.1 ± 2
	N:	781.9 ± 494.8	401.1 ± 278.6	11422.6 ± 4196.9	89.9 ± 138.0
March 2011	*no./m²:*	0.6 ± 0.4	0.5 ± 0.4	4.5 ± 3.8	0.0 ± 0
	N:	369.6 ± 261.2	333.6 ± 228.5	3194.9 ± 2513.2	0 ± 0.0
August 2011	*no./m²:*	1.6 ± 0.4	2.2 ± 0.9	5.5 ± 4.8	0.9 ± 0.9
	N:	825.1 ± 261.2	2023.5 ± 500.2	4239.1 ± 2513.2	564.2 ± 564.2
January 2012	*no./m²:*	0.9 ± 0.2	1.2 ± 0.5	4.5 ± 3.8	0.1 ± 0.1
	N:	289.2 ± 254.2	823.5 ± 250.2	3002.5 ± 2987.5	95.5 ± 95.5
April 2012	*no./m²:*	0.8 ± 0.3	0.4 ± 0.2	12.5 ± 9.2	2.5 ± 1.1
	N:	422.6 ± 223.2	325.5 ± 222.2	7953.3 ± 4326.2	1500.0 ± 789.2
August 2012	*no./m²:*	1.1 ± 0.5	1.8 ± 0.6	19.2 ± 11.3	1.1 ± 1.1
	N:	669.5 ± 361.2	1955.5 ± 1800.1	12567 ± 7689.2	812.6 ± 812.6
REFUGE CANAL					
March 2009	*no./m²:*	1.9 ± 0.5	2.1 ± 1.0	19.1 ± 17.2	0.6 ± 0.6
	N:	1139.5 ± 277.3	1232.9 ± 584.4	11272.8 ± 10148.0	357.3 ± 340.9
July 2009	*no./m²:*	1.0 ± 0.7	6.2 ± 2.8	2.3 ± 1.5	1.0 ± 0.9

	N:	583.7 ± 433.3	3680.3 ± 1666.0	1369.1 ± 857.2	618.0 ± 531.6
NEW CIÉNEGA					
December 2009	*no./m²:*	0.9 ± 0.6	0.2 ± 0.1	0.2 ± 0.2	0.0 ± 0.0
	N:	800.1 ± 537.4	211.9 ± 91.6	133.7 ± 131.3	0.0 ± 0.0
April 2010	*no./m²:*	0.2 ± 0.1	<0.1 ± 0.1	<0.1 ± 0.1	0.1 ± 0.1
	N:	189.0 ± 119.3	28.6 ± 24.4	7.6 ± 7.0	47.7 ± 30.7
July 2010	*no./m²:*	5.0 ± 2.2	0.5 ± 0.3	0.9 ± 1.0	4.2 ± 3.3
	N:	4370.7 ± 1958.9	408.6 ± 280.6	819.1 ± 888.8	3654.6 ± 2838.9
December 2010	*no./m²:*	15.2 ± 13.7	2.7 ± 0.6	12.6 ± 4.1	1.22 ± 0.94
	N:	13248.5 ± 11925.1	2357.8 ± 561.7	10959.8 ± 3593.7	1065.6 ± 819.1
March 2011	*no./m²:*	4.4 ± 2.8	2.9 ± 1.8	6.9 ± 5.1	0.6 ± 0.3
	N:	3791.0 ± 2458.6	2556.8 ± 1606.0	5985.7 ± 4434.9	544.5 ± 324.9
August 2011	*no./m²:*	17.8 ± 12.0	4.2 ± 1.1	15.2 ± 8.2	2.5 ± 2.7
	N:	18789 ± 15621.1	4568.2 ± 2134.5	15234.6 ± 7568.8	2024.4 ± 2987.6
January 2012	*no./m²:*	10.2 ± 7.7	2.3 ± 1.0	10.6 ± 3.3	0.9 ± 0.9
	N:	9568.1 ± 736.5	2111.0 ± 1235.6	10222.2 ± 2935.7	946.2 ± 94.6.2
April 2012	*no./m²:*	6.5 ± 4.5	1.5 ± 0.8	5.5 ± 3.8	0.0 ± 0
	N:	5655.2 ± 4689.2	1865.4 ± 1346.2	5231.8 ± 3335.3	0 ± 0.0
August 2012	*no./m²:*	19.2 ± 15.1	4.1 ± 3.4	17.8 ± 10.0	4.5 ± 3.7
	N:	20235.2 ± 17986.3	4454.8 ± 3956.1	17789.5 ± 11234.2	3879.3 ± 2879.2

The invasive *G. geiseri* was the most dense species in the Old Ciénega. Densities in this habitat ranged from 1.9 to 19.2 individuals / m^2 (Table 1). There appeared to be a slight pattern in the density of *G. geiseri* in this habitat. In general, *G. geiseri* densities increase from winter to spring. They remain high in summer and then appear to decrease again in winter. Although variable through time, average *G. geiseri* density in the Old ciénega was ~10 individuals / m^2. Population size of *G. geiseri* reflected patterns of density and ranged from 1218 to 12,567 individuals / m^2. Average population size of *G. geiseri* in the Old ciénega was 6673 individuals.

Astyanax mexicanus was the least dense species in the Old ciénega, with densities that ranged between <0 to 2.5 individuals / m^2. There was no pattern in the temporal variation in *A. mexicanus* density. On average, *A. mexicanus* density was estimated at ~0.6 individuals / m^2. The population estimates for *A. mexicanus* in the Old ciénega reflected densities and ranged from 0 to 1500 individuals with an average of 396 individuals in this habitat.

The New Ciénega

The New ciénega was filled and stocked with fish from the Refuge Canal around October 2009. Therefore, we estimated fish densities and population size for 5 sample periods from this habitat (December 2009, April 2010, July 2010, December 2010, March 2011, August 2011, January 2012, April 2012 and August 2012). In general, density and population estimates for all species declined from the December 2009 to April 2010 sample periods, but then increased from the April 2010 to August 2012 samples (Table 1).

Cyprinidon elegans density and population estimates were about 10 times larger on average to those estimated from the Old ciénega (Table 1). For example, average density was 9 individuals / m^2 and average population size was 8516 individuals in this habitat. *G. nobilis* density and population estimates in the New Ciénega were similar to the Old ciénega (Table 1).

On average, *G. nobilis* density and population estimates were 2 individuals / m^2 and 2062 individuals, respectively. *Gambusia geiseri* density and population estimates in the New ciénega were similar to those in the Old ciénega (Table 1). For example, density ranged from 0.1 to 17.8 individuals / m^2 and averaged 7.8 individuals / m^2. Total population size of *G. geiseri* reflected density with an average of 7375 individuals in this habitat. *Astyanax mexicanus* density and population estimates ranged from 0 to 4.5 individuals / m^2 (average 1.5 ± 1.1 individuals / m2) and 0 to 3654 individuals (average 924 individuals), respectively.

Conclusions

In general, fish populations were stable in the Old ciénega across sample periods. The populations of the endangered *G. nobilis* and *C. elegans* were small compared to the invasive *G. geiseri* in this habitat. Populations in the New Ciénega changed dramatically across sample periods. Populations were extremely small by April 2010, probably because of high winter mortality. Flow through was not complete in the New ciénega by April 2010. Therefore, populations in this habitat were isolated from the system of irrigation canals in Balmorhea State Park. This could have limited immigration and emigration, and also affected variation in water temperature of this habitat. These processes could have enhanced death rates throughout winter. However, by August 2012 after the New Ciénega was open to the system of irrigation canals, the populations of all species increased dramatically.

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