Final Report

*Survey of Western River Cooter (*Pseudemys gorzugi*) in New Mexico within the Black River Drainage*

Submitted to:

New Mexico Department of Game and Fish

1 Wildlife Way

Santa Fe, NM 8750

By

Ivana Mali, Department of Biology, Eastern New Mexico University, Portales, NM 88130, USA

Michael RJ Forstner, Department of Biology, Texas State University, San Marcos, TX 78666, USA

10 March 2017

INTRODUCTION

Western River Cooter (*Pseudemys gorzugi*) is one of ten species of freshwater turtles that inhabit the state of New Mexico. Nearly half of all turtle species in New Mexico are listed as species of greatest conservation need (http://www.wildlife.state.nm.us/download/conservation/swap/SWAP-November_2016-USFWS-approval-pending.pdf), including *P. gorzugi*. *P. gorzugi* is additionally listed as state threatened in New Mexico, while in Texas it can be harvested with an appropriate hunting license. The species is also designated as near threatened by the International Union for Conservation of Nature (IUCN) and it is currently awaiting a decision from the United States Fish and Wildlife Service (USFWS) regarding federal listing. The main threats identified for *P. gorzugi* are habitat degradation and pet trade collection.

P. gorzugi occurrence is restricted to the Rio Grande watershed, from the lower Rio Grande valley of Texas northward to the Big Bend, north of Del Rio, and the Pecos River drainage of northwestern Texas and southeastern New Mexico (Ernst and Lovich 2009). In New Mexico, the species occurs south of Avalon Dam, in the lower Pecos River drainage, and it is believed that it occurs across the entire length of the Black and Delaware Rivers (Degenhardt et al. 1996). Although it has a relatively large area of potential occurrence, *P. gorzugi's* area of occupancy seems to be small (<2,000 km^2; van Dijk 2013) and it is predominantly found in high flow areas with deep pools (Degenhardt et al. 1996).

This large riverine species is one of the least studied freshwater turtles in North America. Very few studies have assessed population status and trends across *P. gorzugi* range, and systematic studies of the ecology and behavior of this species are needed (Ernst and Lovich 2009). In the US, it is believed that its habitat is declining due to pollution and human alterations of river flow, such as dam and canal development (Bailey et al. 2008). A single, range-wide study was carried out a decade ago, and this study found that populations are patchy and concentrated in only a few stretches of US tributaries (Forstner et al. 2004). In contradiction to the common assumptions of limited dispersal or migration, *P. gorzugi* across New Mexico and Texas exhibit low genetic diversity and there is no genetic differentiation between New Mexico and Texas localities (Bailey et al. 2008).

The previous study by Bailey et al. (2008), and more recent surveys in Texas (Mali et al. in review), show that juvenile turtles are particularly rare in Texas. On the other hand, juveniles

were present in New Mexico river drainages historically (Bailey et al. 2008) and their presence is confirmed in this report. Unfortunately, consecutive multi-year survey data and monitoring is lacking for this species, and survivorship and population growth estimates are not known. As a part of a project supported by the Share with Wildlife program at New Mexico Department of Game and Fish, we surveyed previously known localities on, and previously unsurveyed stretches of, the Black River. Our goals were: 1. To assess whether the species is still present at historic locations; 2. To collect more information on new positive detections; 3. To assess current population demographics along the Black River; 4. To establish the best survey techniques for the species; and 5. To start gathering baseline mark-recapture data and initiate a long-term monitoring program that would yield much needed data on survivorship and population growth rates for this species.

METHODS

Sites

All surveys occurred on the Black River in Eddy County, NM. Two upper stretches of the Black River, sites 1 and 2, within Bureau of Land Management (BLM) land, were surveyed from May 23 to June 19, 2016. These two stretches are directly adjacent to each other and therefore the results are combined. This section of the river was also previously assessed by Painter (1993) and Christman (2006). We surveyed three lower stretches of the Black river: site 3 was surveyed from June 13 to June 19, 2016, site 4 was surveyed July 11 to July 17, 2016, and site 5 was surveyed July 17 to July 23, 2016. These three stretches are directly adjacent to each other, belong to private land owners, and have never been surveyed for *P. gorzugi* before. Site 6 was located ~3km upstream from site 5 and was added toward the end of the trapping season. Detailed information on the localities, dates, and survey methods are located in Table 1.

Table 1. Summary of survey sites, dates, and trap days during May, June, and July 2016.

Site #	Ownership	Start Date	End Date	Stretch (m)	Trap Days
1	BLM	5/23/2016	5/29/2016	700	300
2	BLM	5/29/2016	6/4/2016	800	294
3	Private	6/13/2016	6/19/2016	450	300
4	Private	7/11/2016	7/17/2016	490	300
5	Private	7/17/2016	7/23/2016	330	274
6	Private	7/22/2016	7/23/2016	130	14

Survey Methods

All six sites were trapped with traditional turtle hoop nets. Traps are 76.2 cm diameter, fiberglass, single-throated, wide-mouth hoop nets with a 2.54-cm mesh size and four hoops per net (Memphis Net and Twine Co., Memphis, TN). The nets were stretched by homemade wooden poles and a floating device was placed inside the trap to prevent drowning of captured turtles. We used three different baits: canned sardines, fresh mango, and frozen shrimp. The bait was placed in non-consumable containers with drilled holes for scent dispersal. The traps were placed in the river, with the mouth facing downstream, and tied to nearby, available vegetation for safety. We checked the traps once a day and baits were replaced every two days. At the first five sites, 50 traps were set for six days, resulting in ~300 trap days per site. At site 6, only 14 traps were set for one day. Additionally, we attempted to capture turtles via snorkeling but this generally yielded poor results due to lower than expected visibility.

For all captures, we took standard measurements: carapace length (CL), carapace width (CW), plastron length (PL), plastron width (PW), body depth (BD), and weight. Length measurements were taken using Haglof® tree calipers and weight measurements were taken using Presola® precision scales. Sex was determined based on evaluation of secondary sexual characteristics. Adult males have elongated fore claws and the pre-cloacal portion of the tail lies beyond the edge of the carapace (Gibbons and Lovich 1990). Small, juvenile turtles were not sexed unless it was clear that they were male. Turtles were marked using at least one of the following methods; methods used depended on the size of the turtle: 1. Injecting passive integrated transponder (PIT) tags into the body cavity in the anterior inguinal region parallel to the spine (Buhlmann and Tuberville 1998), 2. Drilling marginal scutes using a portable rotary tool and the numbering system of Cagle (1939; Figure 1), and 3. Toe clipping (hatchlings only).

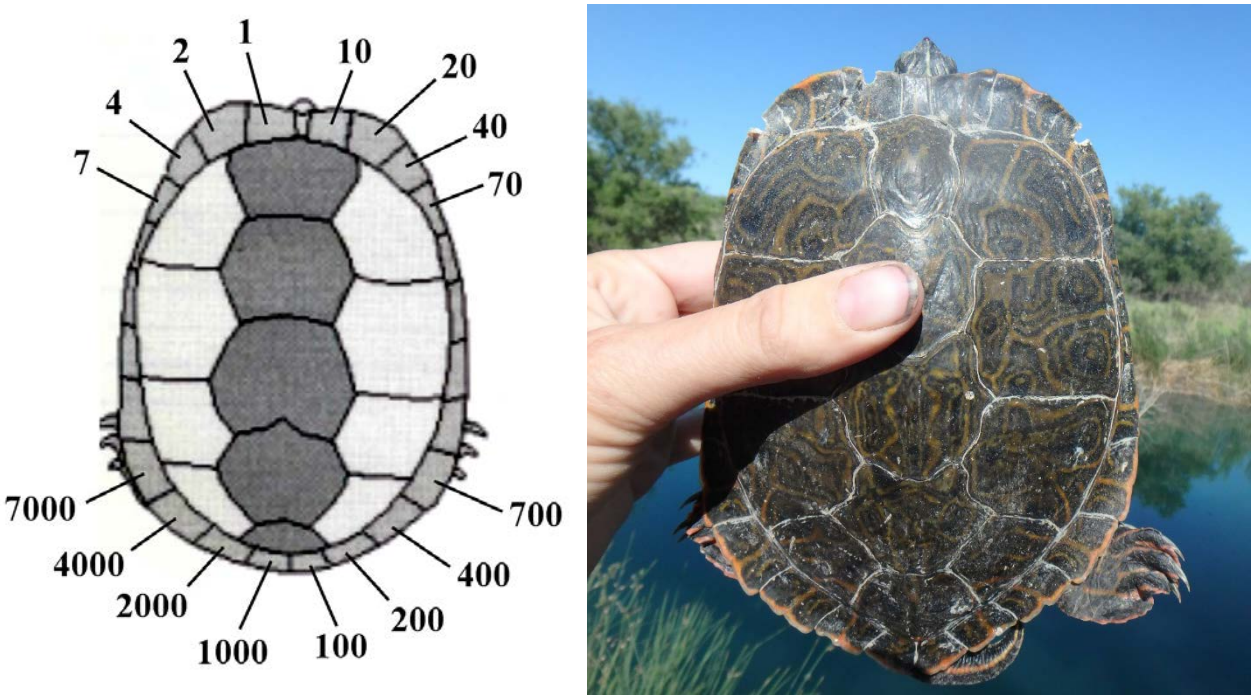

Figure 1. Diagram showing the numbering system used to mark the carapace of hard shelled turtles (left) and an example of an actual marked turtle (right). The Western River Cooter (*Pseudemys gorzugi*) on the right is marked #45.

In addition to traditional mark recapture methods, we conducted distance sampling surveys within the two sites on BLM land. Both sites were sampled on each of 9 distance survey occasions (1500m of river total). Each survey consisted of 2 workers: one person kayaking and recording the data (student) and one person surveying for turtles through binoculars (Dr. Mali). A survey consisted of observing basking turtles, recording the location along the transect line via GPS, and estimating the distance and direction from the observed turtle. Because distance sampling usually requires an excellent familiarity with, and precision in, identifying local freshwater turtle species in the water/basking, the primary surveyor was Dr. Mali, who has over 7 years of experience working with and surveying for turtles. The BLM stretch of the river provided ideal conditions for distance surveys; there was an abundance of basking sites (i.e., floating, fallen trees), and the river along the 1500m transect was wide and deep enough to allow uninterrupted movement of the survey kayak. We conducted five surveys in June and one survey per month from August to November 2016. Unfortunately, distance surveys were not possible on our other survey sites because these areas lacked basking sites that would make turtles easily

visible and because the river has shallow portions that do not allow for uninterrupted surveys. From August 2016 to February 2017, we documented abiotic parameters of the river at multiple locations within our 6 survey sites once a month (i.e., temperature, depth, visibility, and turbidity).

RESULTS

Population Demographics

In total, 1482 trap days yielded 221 *P. gorzugi*, 31 red-eared sliders (*Trachemys scripta*), and two spiny softshells (*Apalone spinifera*) (Table 2). The overall capture per unit effort (CPUE) for *P. gorzugi* was 0.17. Interestingly, we caught one female on BLM land that was a long-term recapture, most likely from Christman (2006) or Painter (1993). Table 2 depicts the capture success at each site.

Table 2. Summary of turtle captures using hoop net traps during surveys in May, June, and July 2016.

Site	*Pseudemys gorzugi*			*Trachemys scripta*			*Apalone spinifera*		
	total	recaptures	%recap	total	recaptures	%recap	total	recaptures	%recap
1	36	2	6	3	1	33	0	-	-
2	27	2	7	0	-	-	0	-	-
3	52	12	23	12	5	42	1	0	0
4	47	10	21	13	9	69	1	0	0
5	58	16	28	3	2	67	0	-	-
6	1	0	-	0	-	-	0	-	-
Sum	221	42	19	31	17	54	2	0	0

Additionally, we caught two *P. gorzugi* by hand on land near the river (BLM site) and four turtles via snorkeling (BLM site). With the permission of the owners of our camping site, we snorkeled a pond at the property and caught three turtles. We also found one female on land returning to the pond, but we could not subsequently determine whether she had been out of the water to nest.

In the lower stretch of the river, we caught 31 unique hatchlings (26%), 13 juveniles (11%), 40 males (34%), and 35 females (29%). In the upper stretch, we caught 15 unique hatchlings (23%), 7 juveniles (11%), 25 males (38%), and 19 females (29%; Figure 2). The proportions of adult vs non-adult turtles was similar in both stretches.

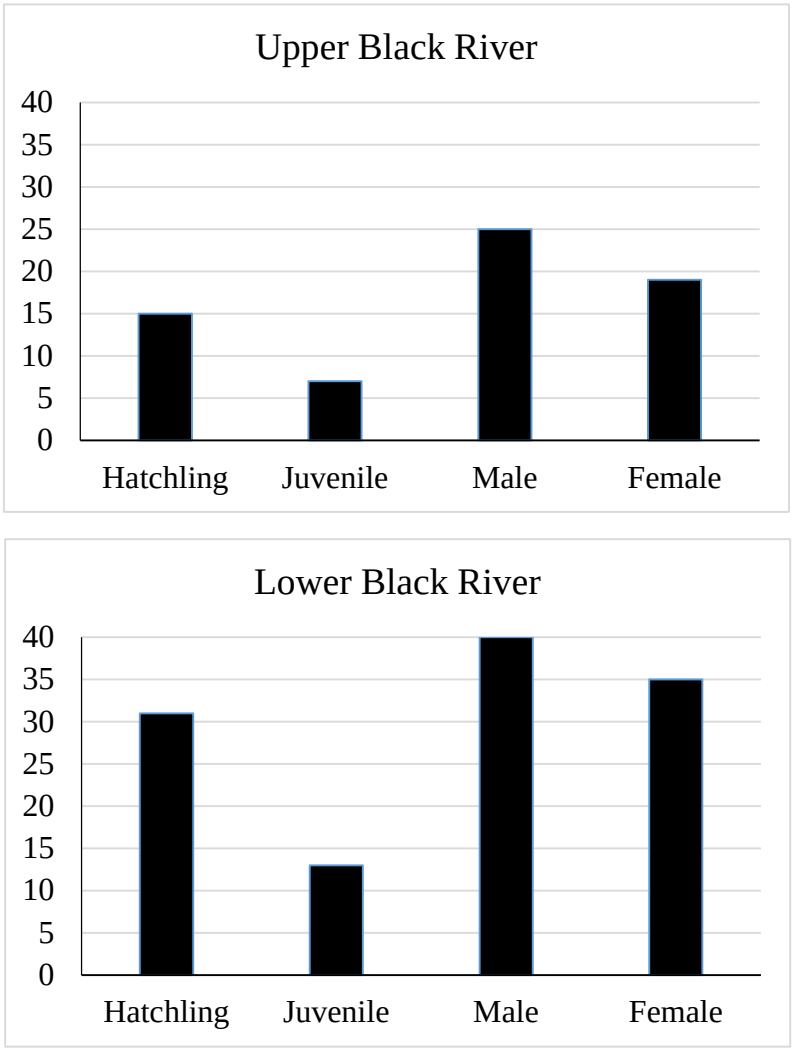

Figure 2. Sex distribution of Western River Cooter (*Pseudemys gorzugi*) captured during 2016 at the upper Black River – BLM sites and lower Black River – private sites.

We also summarized weight and carapace length of turtles in each class (Table 3). For turtles that showed secondary sexual characteristics (males and females in Table 3), we ran generalized linear model with log transformed carapace length as a response variable and site (upper vs lower stretch) and sex (male vs female) as explanatory variables. Males were significantly smaller than females ($P < 0.01$) and turtles from the upper stretch were marginally larger than turtles from the lower stretch ($P = 0.05$).

Table 3. Mean and standard error (in parentheses) of weight (g) and carapace length (mm) per age/sex class of *Pseudemys gorzugi* in the upper Black River (BLM sites) and lower Black River (private sites). Sex was determined only for turtles with secondary sexual characteristics.

	Upper Stretch		Lower Stretch	
	Weight	Carapace Length	Weight	Carapace Length
Female	1308.1 (101.3)	211 (5.9)	979.9 (106.4)	195.3 (8.0)
Male	469.6 (30.7)	156.2 (3.7)	452.9 (33.8)	152.5 (3.8)
Juvenile	104.5 (23.4)	88.7 (6.7)	140.3 (7.2)	98.8 (2.0)
Hatchling	23.6 (2.1)	50.8 (1.8)	23.3 (0.8)	51.1 (23.3)

Once we started trapping the lower stretch of the Black River (sites 3, 4, and 5), we recorded the exact trap in which each turtle was captured. With that data, we used ArcGIS to create a map of the sites of activity for *P. gorzugi*. This map reveals that, although some traps never caught a turtle, turtles were generally present along the entire stretch trapped. There was also no particular concentration of hatchling turtles. At sites 4 and 5, we processed the turtles in the boat at the exact capture site, which allowed us to calculate the short term movements of turtles that were recaptured. Based on this data, adults traveled an average of 61m +/-14 (18-114m) and hatchlings traveled 27m +/-6.5 (0-51m; Curtis et al. in review) between captures. Interestingly, we have never caught a recapture at site 5 that originated from site 4.

Bait Preferences

Throughout this study, we attempted to fine tune the hoopnet trapping methodology. Little is known about the food habits of *P. gorzugi*, but other *Pseudemys* species are known to be herbivorous, at least in their adult stages. In Texas, fish-based bait and hoop nets, in general, very rarely yielded captures. However, Degenhardt et al. (1996) noted that in New Mexico *P. gorzugi* has been captured with fish-based bait. With this in mind, we began our trapping by using fresh mangoes (suggested by colleagues in Texas) in half of the traps and canned sardines in the other half of the traps. Due to surprisingly low capture rates within the first 200 trap days (4 days of trapping): four turtles in mango-baited traps and 13 turtles in sardine-baited traps (including no captures during first 100 trap days), we decided to replace mangoes with fresh shrimp. This replacement improved our capture success. At sites 2, 3, 4, and 5, we alternated baits between shrimp and sardines, which allowed us to test bait preferences of the turtles. Overall, 57.5% *P. gorzugi* were caught with shrimp bait and 42.5 % were caught with sardine bait (Mirabal et al., *in prep*). When the data were separated by age/sex classes, the differences

between the bait types disappeared, with the exception of hatchlings, which are thought to be more omnivorous (Figure 3).

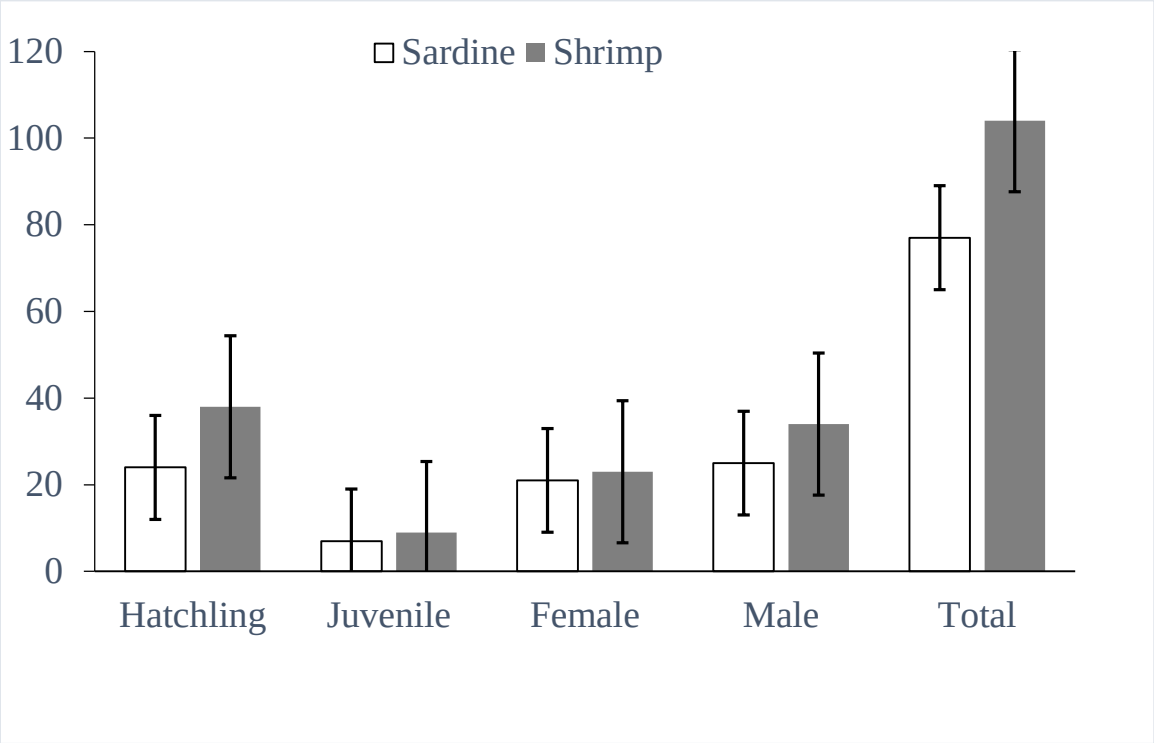

Figure 3. The number of *Pseudemys gorzugi* (y-axis) caught in hoop nets baited with shrimp and sardines per sex/age class.

Visual Surveys

A total of 9 visual distance sampling surveys were conducted between June and November 2016, with survey times varying from 8:45 to 15:30h. We observed between 17 and 44 turtles during a single survey (Table 4). Both adults and hatchlings were observed basking. The high abundance of basking logs were attractive to basking turtles, but turtles were also observed laying or floating on top of dense, mossy vegetation adjacent to the shore line. Given that these turtles were not seen actively swimming through this type of vegetation, or were not easily frightened, we are confident to say that *P. gorzugi* use this type of habitat as alternate basking locations. In December and January, while obtaining water quality measurements, we did not observe any turtles basking. Interestingly, in February we picked up one recapture hatchling out on the water's surface on a morning when the temperature was ~39°F.

Table 4. Summary of distance survey dates and number of *Pseudemys gorzugi* observed at the BLM survey site along the Black River (Sites 1 and 2 combined).

Date	Beginning Time	End Time	Total # of *P. gorzugi* observed
6/13/2016	15:30	16:30	18
6/14/2016	10:35	11:50	41
6/16/2016	10:30	11:35	38
6/17/2016	8:45	9:40	19
6/18/2016	9:30	10:45	44
8/6/2016	11:00	12:20	22
9/11/2016	12:50	13:30	36
10/22/2016	11:44	12:34	38
11/14/2016	13:00	13:50	17

Water Parameters

We chose 7 points on the upper, and 7 points on the lower, survey sites along the Black River that were 200m apart to obtain water parameters. From August to November 2016, water temperature decreased from 26 to 13.9 ^{0}C at the upper sites and from 28.8 to 11.7 ^{0}C on the lower sites. From October to December 2016, mean water turbidity was 7.1 NTU at the upper sites and 17.2 NTU at the lower sites. On average, the upper sites are deeper (~2.8m) than the lower sites (~1.5m). Water visibility was, on average, 1.5m at the upper sites and 0.5m at the lower sites.

Other Natural History Observations

We observed *P. gorzugi* at Rattlesnake Springs (Carlsbad Caverns National Park). Up to four turtles were observed at a time and we also observed one courtship event on 12 July 2016 at approximately 1400h. In August 2016, we snorkeled one juvenile *P. gorzugi* that appeared to have an infection on all four feet and its neck (Figure 4). We took swabs of the feet and neck for future analyses.

Figure 4. A juvenile Western River Cooter (*Pseudemys gorzugi*) caught at the BLM site with obvious infection on feet and neck area.

At the BLM site (site 2), one turtle was captured with an unusual injury on its plastron (Figure 5). Based on the shape and depth of the injury, it is likely that this was a gunshot wound. The turtle was most likely basking with part of its plastron exposed when it was shot at. Although only a x-ray could confirm our speculations, several spent rounds were also found on the shore along the surveyed site.

Figure 5. An injured female Western River Cooter (*Pseudemys gorzugi*). Based on the shape and depth of the wound, we speculate this was caused by a bullet.

CONCLUSIONS

During the first year of intensive turtle survey efforts described here, we obtained significant new information about *P. gorzugi* population demographics, distribution, and various survey techniques at our study sites on the Black River. After a decade, historically positive locations (i.e., BLM sites) continued to yield significant number of captures. In addition, previously unsurveyed locations now represent new positive detections for the species, which

supports Degenhardt et al.'s (1996) prediction that *P. gorzugi* likely occurs at sites along the entire stretch of the Black River. We have also shown that various sampling techniques can be successfully implemented if habitat conditions allow. Prior to this study, *P. gorzugi* had been surveyed with hoop net traps and snorkeling. Here, we introduced distance sampling as a useful technique for surveying basking turtles and its potential for estimating population size (manuscript in prep).

Hatchlings represented a significant proportion of the population at all surveyed sites. This is important for two reasons. First, capturing hatchling turtles is particularly difficult and rare in any freshwater turtle population. Our survey sites could serve as an important testbed for several research topics regarding the biology of this poorly studied species, including of juvenile emydid turtles. Survivorship of hatching turtles once they reach the water is unknown because so very few turtles are captured post emergence. Therefore, further consecutive year surveys could answer questions about hatchling survivorship and growth rates. Second, a significant number of hatchling and juvenile turtles could be an indication of a growing population. Our surveys indicate that this species is still potentially thriving at local sites in New Mexico. However, there are fundamental differences in population demographics between New Mexico and Texas sites (Mali et al., in review), with Texas populations consisting primarily of significantly larger adult turtles and lacking hatchling turtles.

Given that *P. gorzugi* prefers deep, fast-moving waters, river flow alterations can have a great influence on the future of this species. The extreme flood event that occurred along the Black River in September 2014 raised questions about the population status of many organisms that inhabit this system. In addition, the Pecos River and its drainages have both historically and recently experienced anthropogenically-induced modifications (i.e., construction of dams, water pumping, contamination, etc.). These modifications can have negative impacts on the distribution and local abundances of *P. gorzugi*, as well as other aquatic organisms. Oftentimes, especially in river systems, alterations along one stretch of the river have even greater consequences downstream. Given the comparatively short 20km distance between our two surveyed river stretches, the upper stretch differed significantly from the lower stretch in water visibility and turbidity. Although all of our survey sites yielded significant capture rates, we want to stress the importance of managing the Black River in its entirety and not just locally, especially given *P. gorzugi* status and narrow range of occurrence.

ACKNOWLEDGMENTS

We thank Johnny Chopp with BLM for giving us permission to conduct this research on BLM land. We also thank K. Waldon, G. Scheidner, T. Suriyamongkol, J. Mirabal, A. Villamizar, S. Sirsi, and M. Vandewege for their help with trapping and distance sampling. We also thank J. Curtis and A. Letter for their help with organizing the data. The work was approved by NMDGF Authorization #3621 and ENMU IACUC 03-02/2016 and supported in part by the Share with Wildlife Program at New Mexico Department of Game and Fish and State Wildlife Grant T-32-4, #11.

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PROFESSIONAL PRODUCTS

Manuscripts

Mali, I., A.W. Letter, D.H. Foley III, and M.R.J. Forstner. *In review*. Differential demographics of Rio Grande cooter in two populations from New Mexico and Texas. Journal of Fish and Wildlife Management.

Curtis, J., I. Mali, and M.R.J. Forstner. *In press.* Natural History Note. Rio Grande cooter hatchling movement. Herpetological Review.

Mali, I., A. Duarte, and M.R.J. Forstner. *In prep*. Evaluation of two survey techniques for estimating population size of threatened freshwater turtle, *Pseudemys gorzugi*.

Mirabal, J., K. Waldon, G. Scheigler, and I. Mali. *In prep*. Shrimp vs sardine: bait preference of western river cooters (*Pseudemys gorzugi*).

Presentations

Letter, A., I. Mali, D.H. Foley III, and M.R.J. Forstner. 2016. A comparison of population demographics and body condition of Western River Cooter, *Pseudemys gorzugi*, between two distinct regions of their distribution. New Mexico Academy of Science, 2016 Research Symposium, Embassy Suites, Albuquerque, NM, November 5. (Poster)

I. Mali, A. Letter, D.H. Foley III, and M.R.J. Forstner. 2016. Differential population structure and body condition of *Pseudemys gorzugi* between New Mexico and Texas Populations. Texas Herpetological Society Fall Symposium, Tarleton State University, Stephenville, TX, November 19. (Poster)

Letter, A., I. Mali, D.H. Foley III, and M.R.J. Forstner. 2017. Variation in Body Size, Body Condition, and Population Structure of Western River Cooter from New Mexico and Texas. American Fisheries Society and the Wildlife Society, 50th Joint Annual Meeting, Marriot, Farmington, NM, February 9-11. (Poster)

Mirabal, J., K. Waldon, G. Scheigler, and I. Mali. 2017. Shrimp vs sardine: bait preference of western river cooters (*Pseudemys gorzugi*). American Fisheries Society and the Wildlife Society, 50th Joint Annual Meeting, Marriot, Farmington, NM, February 9-11. (Poster)

SUPPLEMENTAL MATERIAL

PHOTOGRAPHS OF SURVEYED SITES