Final Report

*Phase II: Demography of Western River Cooter (*Pseudemys gorzugi*) populations within the Black River Drainage*

Submitted to:

Share with Wildlife Program

New Mexico Department of Game and Fish

1 Wildlife Way

Santa Fe, NM 8750

By

Ivana Mali, Andrew W. Letter, Thanchira Suriyamongkol; Department of Biology, Eastern New Mexico University, Portales, NM 88130, USA

9 March 2018

INTRODUCTION

Population monitoring is essential to wildlife management and evaluating a species' conservation status. Natural resource agencies rely on these monitoring programs to facilitate state-dependent decision making regarding the management of wild populations. This requires managers to develop survey designs and conduct long term monitoring that allow for the estimation of abundances, survivorship, and somatic growth rates (Gibbons 1990; Duarte et al. 2014). The current conservation status of the Western River Cooter (*Pseudemys gorzugi*) makes this species a candidate for a long term monitoring program. *P. gorzugi* is designated a near threatened species under the International Union for Conservation of Nature (IUCN) mainly due to habitat degradation and pet trade collection (VanDijk 2011). Moreover, the species is listed as threatened in Mexico and New Mexico (NMDGF 2006; SEMARNAT 2010) and a species of greatest conservation need in Texas (TPWD 2012), while it is currently awaiting a federal listing decision from the United States Fish and Wildlife Service (USFWS; Adkins Giese et al. 2012).

P. gorzugi are found in the Rio Grande watershed from the lower Rio Grande valley of Texas northward to the Big Bend, north of Del Rio, and in the Pecos River drainage of northwestern Texas and southeastern New Mexico (Ernst and Lovich 2009). Current research suggests *P. gorzugi* generally prefer sections of river with deep clear pools (Degenhardt et al. 1996), but the species has also been found in nearby lentic water bodies (Pierce et al. 2016). Although *P. gorzugi* have been found to be locally abundant at a few locations (Dixon 2013), a low range-wide population density may be a natural characteristic for this species (Bailey et al. 2008).

P. gorzugi is one of the least studied freshwater turtle species in North America. Very few studies have assessed the population status and demographic trends of *P. gorzugi* across its range (Ernst and Lovich 2009). In the US, it is believed that this species' 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 carried out over a decade ago found that populations are patchy and concentrated in only a few stretches of the Rio Grande and several Pecos tributaries (Forstner et al. 2004). Christman and Kamees (2007) studied the distribution of *P. gorzugi* in New Mexico and found the species to occur at 11 of 24 surveyed sites. Genetic surveys suggest that *P. gorzugi* exhibits low genetic diversity (Bailey et al. 2008).

We began surveys of *P. gorzugi* along the Black River in New Mexico in 2016, with a goal of establishing a long-term monitoring program. As a part of a Share with Wildlife project, we conducted field surveys within a Bureau of Land Management (BLM) owned stretch of the Black River and additional sites located downstream. In 2017, we were able to return to these sites and conduct a second year of surveys. We expanded our survey area along the lower stretch of the river and trapped additional sites not surveyed in 2016. In this report, we focus on the results of these 2017 surveys, particularly capture success and food habits of *P. gorzugi*. However, we also compare 2017 surveys to 2016 survey data and include preliminary results on annual somatic growth rates and other natural history observations.

METHODS

Sites

All 2017 surveys occurred on the Black River in Eddy County, NM. The majority of sites represent the same stretches of the river surveyed in 2016. These include two stretches at the upper portion of the Black River, within BLM lands, and three stretches along the lower reaches of the Black River, within private properties (Private 1). Stretches within the upper and lower reaches of the river are directly adjacent to each other and therefore are combined in analyses to an upper and a lower site. BLM site was surveyed from June 2 to June 14. The Private 1 site, located downstream from the BLM sites, was surveyed from May 16 to May 22 and July 18 to July 22. In addition, we also surveyed two new sites. One site (Private 3) is downstream from Private 1 and we surveyed it from August 8 to August 14. The second site is also located within private property (Private 2), upstream from Private 1. This site was surveyed August 11 to August 15. Cottonwood day use area (CDU) within BLM managed lands and a pond (Pond) on private lands were opportunistically surveyed in 2017.

Surveys

Every stretch of the river was trapped with traditional turtle hoop net traps. 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 downing.

We continued to use fresh shrimp and canned sardines as bait. 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 live vegetation. We checked traps once a day and baits were replaced every two days. At five stretches (i.e., two stretches of BLM, two stretches of Private 1, and one stretch of Private 3), we placed 50 traps for six days, resulting in 300 trap days per stretch (Table 1). At two stretches of private land (third stretch of Private 1 and one stretch of Private 2), only 20 traps were placed for four days (80 trap days total) due to logistical constraints (i.e., trap availability and potential trap theft). We opportunistically surveyed turtles at other sections via snorkeling where the water was clear enough (i.e., Cottonwood day use area – CDU and Pond).

Table 1. Summary of Western River Cooter (*Pseudemys gorzugi*) survey sites, dates, and trap days on the Black River, Eddy County, New Mexico, from May to August 2017. We also include 2016 trap effort for comparison.

Site	No. of stretches/site	2017 Trap Dates	2017 Trap Days	2016 Trap Days
BLM	2	2 – 14 Jun	600	594
Private 1	3	15 – 28 May; 18 – 22 Jul	680	874
Private 2	1	11 – 15 Aug	80	14
Private 3	1	8 – 14 Aug	300	NA

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 using secondary sexual characteristics. Adult males have elongated foreclaws 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 they were clearly male. The smallest male captured with obvious secondary sexual characteristics was 118 mm in carapace length; every turtle smaller than that was considered a juvenile. Turtles were marked with at least one of the following methods depending 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; juveniles larger than 65 mm CL and adults), 2. Drilling marginal scutes using a portable rotary tool and the numbering system of Cagle (1939; adults; Figure 1), and 3. Toe clipping (juveniles smaller than 65 mm CL).

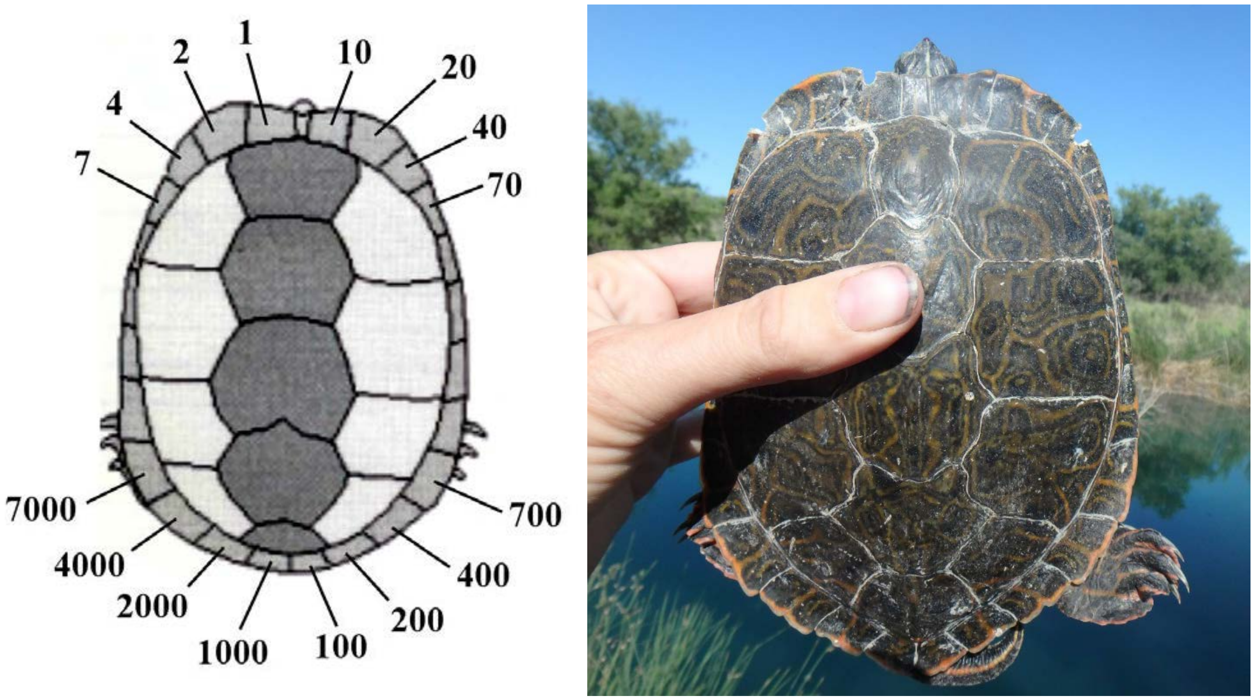

Figure 1. Diagram showing the numbering system used to mark the carapace of hard shelled turtles (left) and an example of an actual marked turtle (right). The Western River Cooter (**Pseudemys gorzugi*****) on the right is marked #45.***

Food Habits

To obtain fecal samples for a *P. gorzugi* food habits study, we kept all captures for ~8 hours in a shaded area outside or climate-controlled room in clear plastic containers with a small amount of water (Figure 2). Before placing the turtles in the labeled containers, each turtle was cleaned to remove all sediment or algae that could potentially skew fecal collection results. Lids were secured with a partial gap to allow airflow. Turtles were showered with water periodically to ensure hydration. Upon defecation, fecal material was strained and placed in sealed Falcon™ 50mL Conical Centrifuge Tubes containing 95% ethanol for preservation and further analyses. Turtles were released at the capture location and containers rinsed with water.

Figure 2. Western River Cooters (*Pseudemys gorzugi*) contained in clear plastic bins for fecal matter collection during summer 2017 field season.

Fecal samples were taken to a lab at Eastern New Mexico University and analyzed under an Amscope SM745 dissecting microscope to determine composition (Zyznar and Urness 1969; Piña 2012). Identifying features from fecal vegetative materials include leaf venation patterns, trichomes, epidermal cell morphology, and gross structures (Zyznar and Urness 1969; Johnson et al. 1983). We also identified invertebrates found within fecal samples to the lowest possible taxonomic grouping (BLM 1993). Invertebrates were identified via morphological features of indigestible chitinous portions. Fecal matter was prepared using techniques modified from those used by Platt et al. (2016). Briefly, fecal sample components were separated into four categories: animal, filamentous algae, vegetation, and unknown. We calculated percent occurrence of dietary items as the number of fecal samples containing a diet item divided by the total number of fecal samples and then multiplied by 100 (Demuth and Buhlmann 1997; Seminoff et al. 2002; Platt et al. 2016; Sung et al. 2016). For example, if out of 50 fecal samples, 25 contained filamentous algae, percent occurrence of filamentous algae is 50%. Percent occurrence was calculated for males, females, and juveniles, separately. We also investigated differences in percent occurrence between turtles caught in the upper and lower stretches of the river.

Annual Growth Rates

One of the most important life history traits is growth rate; growth rate can influence other life history aspects of an organism, particularly reproductive outputs like clutch and egg size (Rowe 1997). In turtles, growth rates vary individually, depending on turtle size, age at maturity, sex, and environment (Christiansen and Burken 1979; Rowe 1997). Due to differences in growth rates, males mature at a smaller size compared to females, which leads to sexual size dimorphism (Frazer et al. 1993; Rowe 1997). Given how understudied *P. gorzugi* is, growth rate is unknown. With our long-term monitoring program, we were able to compile two years of data to estimate the rate of growth in both juvenile and adult turtles from 2016 to 2017. We used straight-line carapace length (CL) as a measure of growth (Gibbons 1990). Additionally, we compared the growth rate between sexes, age classes, and locations (i.e., upper and lower sites). Since we assessed the growth rates of captured turtles between 2016 and 2017, we assumed that they were measured approximately a year apart. To identify growth rate differences between sexes and age classes, we conducted an analysis of variance (ANOVA). Due to small sample sizes when comparing growth rates of different age classes between the locations (i.e., upper and lower stretches of the river), we applied a slightly different approach for these comparisons. We used randomization tests with 10,000 iterations. The P values in these tests represent the proportion of trials resulting in growth rate differences as great as or greater than those obtained (Sokal and Rohlf 1995). Thus, a small P value means that it is unlikely our results were obtained by random chance given the inherent distribution of the data. For all tests, we inferred statistical significance at $\alpha = 0.05$. We conducted statistical analyses using program R 3.4.3 (The R Foundation for Statistical Computing, Vienna, Austria).

Photo Identification

Because each captured turtle was photographed (carapace and plastron), we tested the possibility of using plastron pattern for individual recognition of *P. gorzugi*. Specifically, we tested the efficiency of using photo-identification software, I3S Pattern+ and WILD-ID. However, since this was not originally part of this project, the photos were taken under field conditions and were not standardized. This allowed us to additionally test the effect of photo quality on the accuracy of the software. We processed all images (i.e., cropping and rotating) for consistency and grouped all images into two categories: high-quality and low-quality. Photos were considered high-quality if they were taken under good lighting, turtles were clean, and the plastron pattern was clear (Figure 3 top). Low-quality photos contained shadows or glare, turtles were muddy, or parts of the plastron pattern were covered (Figure 3 bottom). Software ranked results where the first rank was the best match. We only used the first five matches for further investigation. We were able to know the exact matches before running the program because all turtles larger than

65 mm CL were PIT tagged or notched. For juvenile turtles that were toe clipped in cohort, we manually inspected images by eye and were able to confirm recaptures.

Figure 3. Examples of Western River Cooter (**Pseudemys gorzugi*****) plastron photos that met criteria for the high-quality (top) and low-quality categories (bottom) used to assess efficacy of two different photo identification softwares.***

RESULTS

Surveys

The 2017 field season resulted in 1660 trap days, where 1280 trap days were conducted at sites surveyed in 2016 and 380 traps days were at new locations (Table 1). Capture per unit effort (CPUE) varied between sites from 0.14 to 0.35. We caught a total of 393 *P. gorzugi* via hoop-nets, including inter and intra year recaptures (Table 2). At BLM sites, we caught 18 recaptures from 2016 (27% recapture rate of turtles caught in 2016; Table 2) and marked an additional 147 turtles. At Private 1, we caught 13 recaptures from 2016 (11% recapture rate) and marked an additional 64 turtles. At Private 2 and 3, two new sites, we marked an additional 23 and 75 *P. gorzugi*, respectively. We opportunistically surveyed *P. gorzugi* via snorkeling where water clarity allowed (i.e., CDU and Pond) and caught a total of 23 *P. gorzugi* (Table 2). To date, we have marked a total of 519 *P. gorzugi* on the Black River and surrounding lentic water bodies (i.e., Pond).

Table 2. Summary of Western River Cooter (*Pseudemys gorzugi*) captures on the Black River, Eddy County, New Mexico from 2017 and 2016 field seasons.

Site	2017 Total No. Captured[1]	2017 Total No. Marked	2016 Total No. Marked	Total No. Marked to Date	Method of Capture
BLM	182	147	67	214	Hoop net/Hand[2]
Private 1	95	64	118	182	Hoop net
Private 2	28	23	1	24	Hoop net
Private 3	92	75	NA	75	Hoop net
Cottonwood	12	12	NA	12	Hand
Pond	11	9	3	12	Hand
Total	**420**	**330**	**189**	**519**	NA

[1]This number includes inter- and intra-year recaptures; [2]Hand captures were opportunistic and only 11 turtles were caught and marked via this method (4 in 2017 and 7 in 2016).

Food Habits

We obtained 78 fecal samples: 24 from males, 18 from females, and 36 from juveniles. Across all sites, vegetation occurred in 95.8% of male, 66.6 % of female, and 86.1 % of juvenile fecal samples (Table 3). On a finer scale, we identified netleaf hackberry, cottonwood, willow, and salt cedar. Filamentous algae comprised 37.5 % of male, 66.6 % of female, and 8.3 % of juvenile fecal samples (Table 3). Among arthropods, Class Insecta was most abundant. Class Insecta was found in 87.5 % of male, 50 % of female, and 66.6 % of juvenile fecal samples (Table 3). Within Class Insecta, 9 Orders were identified: Hymenoptera, Lepidoptera, Coleoptera, Diptera, Hemiptera, Orthoptera, Odonata, Isoptera, and Neuroptera. In addition to the main dietary groups, we also observed three Oligochaeta worms, one in a single male sample and two in different female samples; one bird feather in a single male sample; one fish vertebra in a single female sample; one crustacean part in a single male sample; and two separate samples with pink monofilament fishing line. Turtles at the downstream sites consumed notably more filamentous algae than turtles at upstream sites (Table 4). The opposite trend was observed for insects, with higher frequency of insects in fecal samples at the upstream sites in comparison to downstream sites (Table 4).

Table 3. Percent occurrence of dietary items in male, female, and juvenile Western River Cooter (*Pseudemys gorzugi*) fecal samples collected in summer of 2017 on the Black River, Eddy County, New Mexico. Number of turtles from which a particular dietary item was recovered is followed by percent occurrence (%) per age/gender combination in parentheses.

	Male (n=24)	Female (n=18)	Juvenile (n=36)
Vegetation	23 (95.8)	12 (66.6)	31 (86.1)
Filamentous Algae	9 (37.5)	12 (66.6)	3 (8.3)
Class Insecta	21 (87.5)	9 (50)	24 (66.6)

Table 4. Percent occurrence of dietary items in in male, female, and juvenile Western River Cooters (*Pseudemys gorzugi*) at the upstream (BLM) and downstream (Private 1) sites of the Black River, Eddy County, New Mexico. Number of turtles from which a particular dietary item was recovered is followed by percent occurrence (%)per age/gender/location combination in parentheses

	Male		Female		Juvenile	
	Up (n=19)	Down (n=5)	Up (n=13)	Down (n=23)	Up (n=13)	Down (n=23)
Vegetation	19 (100)	4 (80)	5 (38.4)	2 (40)	11 (84.6)	20 (86.9)
Filamentous Algae	4 (21)	5 (100)	8 (61.5)	4 (80)	1 (7.6)	2 (8.6)
Class Insecta	17 (89.4)	4 (60)	8 (61.5)	1 (20)	11 (84.6)	13 (56.5)

Annual Growth Rates

During summer 2017, we recaptured 32 individuals that were originally marked in 2016. Of those, 13 were juveniles, 7 were females, and 12 were males. Straight-line carapace length (CL) of the initial captures in 2016 ranged from 44.2 to 114 mm for juveniles, 124 to 173 mm for males, and 203 to 255 mm for females. The mean growth rate was 13.91±6.15 mm/year for juveniles and 3.05±3.96 mm/year for adults. Furthermore, mean growth rate was 4.08±4.40 mm/year for males and 1.29±2.43 mm/year for females (Figure 4). Growth rates were not significantly different between males and females ($P = 0.14$; Table 5); however, juvenile growth rates were significantly higher in comparison to adults ($P < 0.01$; Table 6). The growth rates of turtles were not significantly different between the two locations ($P = 0.32$; Table 7). However, the growth rate of adults caught in the upper stretch of the Black River was significantly higher than the lower stretch sites ($P < 0.05$), while the growth rate of juveniles was not significantly different between these two locations ($P = 0.051$; Table 8).

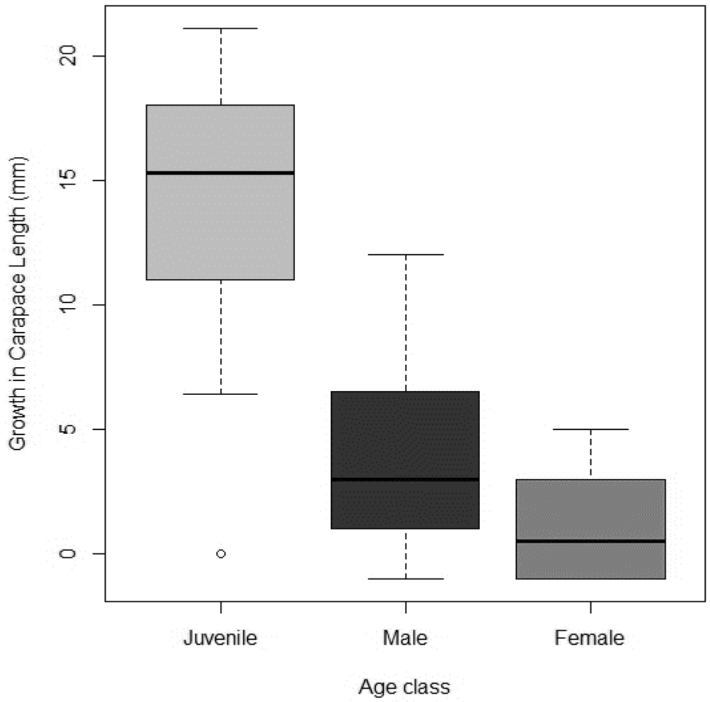

Figure 4. Box plots comparing growth rates of Western River Cooters (**Pseudemys gorzugi*****), measured in straight-line carapace length, between juveniles, males, and females from 2016 to 2017 along the Black River, Eddy County, New Mexico.***

Table 5. Growth rate comparisons of female and male Western River Cooters (**Pseudemys gorzugi*****) from 2016 to 2017 along the Black River, Eddy County, New Mexico.***

	Female	Male
N	7	12
2016 CL (mm)	203–255	124–173
Growth rate (mm y^{-1})	1.29±2.43	4.08±4.40
P-value	0.14	

Table 6. Growth rate comparisons of juvenile and adult Western River Cooters (**Pseudemys gorzugi*****) from 2016 to 2017 along the Black River, Eddy County, New Mexico.***

	Juvenile	Adult
N	13	19
2016 CL (mm)	44.2–114	124–255
Growth rate (mm y^{-1})	13.91±6.15	3.05±3.96
P-value	<0.01	

Table 7. Growth rate comparisons of Western River Cooters (*Pseudemys gorzugi*) between the upper and lower stretches of the Black River, Eddy County, New Mexico, from 2016 to 2017.

	Upper Stretch	Lower Stretch
N	18	14
2016 CL (mm)	46.4–253	44.2–255
Growth rate (mm y^{-1})	6.31±5.92	8.94±8.76
P-value	0.32	

Table 8. Growth rate comparisons of juvenile and adult Western River Cooters (*Pseudemys gorzugi*) between the upper and lower stretches of the Black River, Eddy County, New Mexico, from 2016 to 2017.

	Juvenile		Adult	
	Upper Stretch	Lower Stretch	Upper Stretch	Lower Stretch
N	4	9	14	5
2016 CL (mm)	46.4–112	44.2–114	124–253	129–255
Growth rate (mm y^{-1})	13.92±5.24	13.91±6.81	4.14±4.07	0±1
P-value	0.051		0.029	

Photo Identification

For high-quality photos, we had 306 initial photos and 62 photos of recaptures. WILD-ID resulted in 52 correct matches (83.9%), while I3S Pattern+ resulted in 31 correct matches (50%) (Figure 5). Among the low-quality photos, there were 223 initial photos and 44 recaptures. WILD-ID resulted in 34 correct matches (77.3%), while I3S Pattern+ resulted in 13 correct matches (29.5%) (Figure 5). Additionally, we noticed that the plastron pattern fades as turtles grow larger than >110 mm straight-line carapace length (Figure 6). However, fading of the pattern did not appear to influence software effectiveness.

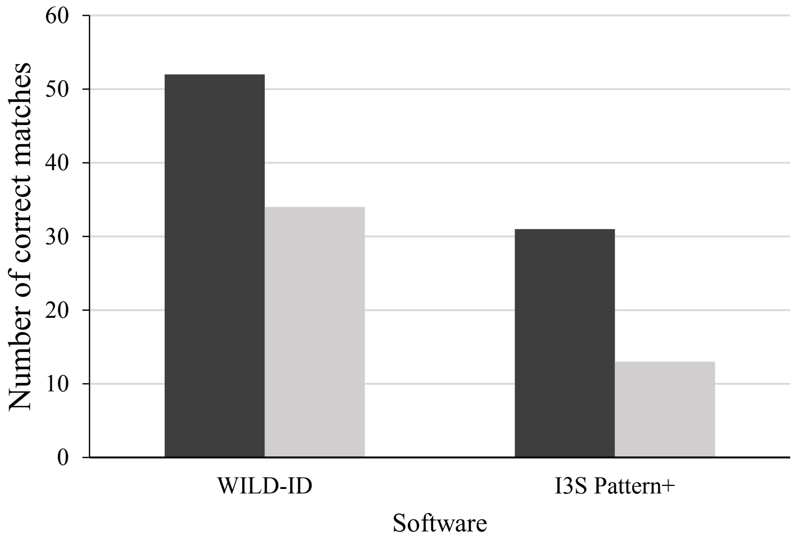

Figure 5. Comparison between the effectiveness of WILD-ID and I3S Pattern+ for correctly matching pairs of high-quality photos (Black) and low-quality photos (Gray).

Figure 6. Examples of the change in patterns as Western River Cooters (**Pseudemys gorzugi*****) grow larger. These images range from a recently hatched turtle (33.05 mm straight-line carapace length) to an adult turtle (~300 mm straight-line carapace length).***

Other Natural History Observations

In 2017, we captured a female *Pseudemys gorzugi* (carapace length = 151 mm) at the CDU site that had a fishing line protruding from its mouth and, upon further investigation, a hook could be seen in the back of the throat (Figure 7; Waldon et al. 2017). Our observation is the first evidence of fish hook ingestion by *Pseudemys gorzugi*. We also caught a female at the Pond site that appeared to have kyphosis, although the individual was not radiographed for confirmation. At the same site, on 13 June 2017, we caught a gravid female (carapace length = 265 mm) with the largest clutch size reported to date (N = 12; Letter et al. 2017; Figure 8). We observed reticulate melanism in 16 out of 128 males caught in 2017. The straight-line carapace length of the smallest melanistic male was 174 mm. However, turtles between 200 and 220 mm CL showed the highest proportion of melanistic males (89%).

Figure 7. Photo of a mouth (top) and radiograph (bottom) of Western River Cooter (**Pseudemys gorzugi*****) showing ingested fish hook. The turtle was caught at Cottonwood Day Use area on the Black River, Eddy County, New Mexico, in July 2017***

Figure 8. Radiograph of a gravid Western River Cooter (**Pseudemys gorzugi*****) with 12 eggs caught at the Pond site in close proximity to the Black River, Eddy County, New Mexico. This is the largest clutch size reported for the species to date.***

Other Freshwater Turtle Species

Besides *P. gorzugi*, we also caught five other species, though in much fewer numbers. Specifically, we caught *Apalone spinifera*, *Chelydra serpentina*, *Chrysemys picta*, *Kinosternon flavescens*, and *Trachemys scripta*. In 2016, we only caught *Apalone spinifera* and *Trachemys scripta*. Interestingly, one *Chelydra serpentina* captured at the BLM site had already been marked by C. Painter in the year 2000 (NMDGF, unpublished data).

DISCUSSION

In 2017, we continued to see an abundance of *P. gorzugi* at the same sites sampled in 2016 and new sites on the Black River, and it is clear the freshwater turtle community in the Black River is dominated by this species. We continued to capture turtles of all size/age classes. At BLM we had higher capture success than 2016 as we caught 182 turtles, 147 of which were new captures, compared to only 67 captures in 2016. At Private 1, we had a lower success rate in comparison to 2016: we caught 95 turtles, 64 of which were new captures, in 2017 in comparison to 118 turtles in 2016. This change in capture rate at the Private 1 site could be due to survey timing. Based on both years of surveys, it appears that mid-March to early-June surveys may result in fewer captures than July/August surveys. Importantly, we recaptured 18 turtles at BLM and 14 turtles at Private 1 that were marked in 2016. Recapturing turtles that were marked in previous survey seasons is promising. With the continuation of these survey efforts for another 3–4 years, and assuming continuing recapture success, we will be able to derive accurate survivorship and population size estimates for juveniles and adults at both stretches of the Black River.

We have not noticed any visible changes to the river at the lower private sites (i.e., Private 1), but the BLM portion of the Black River appeared drastically different in comparison to the 2016 field season. In 2017, the river at this site was at a markedly lower level, and there was an obvious “drought” line on the reeds that was due to a river drop (Figure 9). In addition, the water was noticeably more turbid. We currently do not know what effect this has on *P. gorzugi*, but it could have potential influence on food availability. Given that our trapping methodology remained the same as in 2016, it is possible that a lack of food resources drove the turtles to our traps in 2017.

At new survey locations (Private 2 and 3), we marked a total of 98 *P. gorzugi* representing all size and age classes and had some of the highest captures per unit effort: 0.35 and 0.31 for Private 2 and 3, respectively. Although we trapped the Private 2 site in 2016, we conducted only 14 trap days (and caught a single turtle) and therefore considered this a new site where we completed 80 trap days in 2017. Of further interest is surveying a larger segment of the Black River within Private 3. However, this segment is fairly remote, therefore we may have to consider alternate and less labor-intensive surveys, such as visual surveys (Mali et al. in review).

Diet analyses suggested that *P. gorzugi* have a more diverse diet than previously thought. *Pseudemys* turtles are generally considered omnivorous as juveniles and herbivorous as adults, with ontogenetic shift in diet (Lindeman 2007). *Pseudemys gorzugi* on the Black River were rather opportunistic, showing high frequency of plant, algae, and animal material in the diets of all size classes and sexes. This could potentially explain the high success rate in capturing turtles in hoop-net traps using fish-based baits (Mirabal et al. in review). Interestingly, we did catch several adult *P. gorzugi* that only had algae in their feces, so it is a little puzzling that even these individuals were attracted to our fish-based baits. However, this single sample does not mean these individuals were strictly herbivores. Our results could be affected by food availability, especially given the lower water levels at the BLM site, and it is of future interest to examine this variable in comparison to the diet at both sites. We did find that juvenile fecal samples had the highest percent volume of animal material (mean = 26.6%) whereas female fecal samples contained a high percentage of filamentous algae (mean = 33.4%). This metric should be considered with caution because we do not know the digestibility of animal and plant matter at the site and therefore what items may have been fully digested and not detected in our fecal samples.

Capturing and monitoring hatchling and juvenile age classes is challenging for many freshwater turtle populations. Although largely unknown, it is generally assumed that hatchling turtles have relatively high survivorship rates once they enter the water (Gibbons 1990). Interestingly, we continue to capture *P. gorzugi* of all age/size classes at both upper and lower sites on the Black River in stark contrast to Texas populations on the Devils River where juvenile turtles are seldom caught (Mali et al. in review). These differences between states have been historically observed by Bailey et al. (2008) and Degenhardt et al. (1996) and continue to hold true. It is currently unresolved what drives these drastic differences in the structure of *P. gorzugi* populations in New Mexico and Texas and, given turtle longevity, it may take decades to determine how these differences impact population demographics. The Black River system should remain of interest for future work, especially as survey continuation will yield new information on many ecological aspects of this sensitive species. Apart from estimating survivorship of juveniles and adults, we can use these populations to study somatic growth rates, age at sexual maturity, habitat partitioning between juveniles and adults, and overall population trends over time, especially in relation to river flow alterations. Our preliminary results on somatic growth rates show expected results in terms of energy allocation, with significantly higher growth rates in juveniles than adult turtles. More importantly, the results do not show differences in growth rates between the upper and lower stretches of the river for juvenile turtles, but larger sample sizes are needed to infer more meaningful conclusions.

In 2018, we will continue to monitor all previously surveyed sites, especially BLM and Private 1 given that we now have two years of data at these sites. Our efforts aim to expand our understanding of *P. gorzugi* natural history on the Black River. Besides continuing to work on a larger, multi-year dataset, in 2018 we will focus on two additional projects: assessment of reproductive status of captured females and prevalence of fish hook ingestion of all age/size classes. In 2017, we found a female with an ingested fish hook. Discussion with a recreational fisherman revealed that this may be a common phenomenon. Steen et al. (2014) found that 0–33% of turtles contained ingested fish hooks, depending on the species, sex, and age class. Moreover, fish hook ingestion can cause population declines and presents a serious threat that is often overlooked (Steen et al. 2017). Therefore, assessing this potential threat to *P. gorzugi* should be of interest to natural resources agencies.

Figure 9. A side by side comparison of Bureau of Land Management (BLM) portion of the Black River in June 2017 (top) and June 2016 (bottom), showing lower water levels in 2017 and its effects on riparian vegetation.

ACKNOWLEDGMENTS

We thank Cassandra Brooks and John Sherman with BLM for working with us and allowing us to trap turtles. We thank Judy Bock with Carlsbad Soil and Water Conservation District and ENMU for additional funding. We also thank private land owners for continuing to work with us and allowing us access to their properties. All work was conducted under NMDGF Scientific

Research Permit Authorization No. 3621 issued to Ivana Mali and Michael R.J. Forstner, as well as Eastern New Mexico University IACUC approval number 03-02/2016.

LITERATURE CITED

Adkins Giese CL, Greenwald DN, Curry T. 2012. Before the secretary of the interior: petition to list 53 amphibians and reptiles in the United States as threatened or endangered species under the Endangered Species Act. Circle Pines, MN: Unpublished report, Center for Biological Diversity.

Bailey LA, Dixon JR, Hudson R, Forstner MRJ. 2008. Minimal genetic structure in the Rio Grande cooter (*Pseudemys gorzugi*). Southwestern Naturalist 53:406–411.

Buhlmann KA, Tuberville TD. 1998. Use of passive integrated transponder (PIT) tags for marking small freshwater turtles. Chelonian Conservation and Biology 3:102–104.

BLM [Bureau of Land Management]. 1993. New Mexico Biological Inventory- Upper Black River Area of Critical Environmental Concern Carlsbad Resource Area. New Mexico Bureau of Land Management.

Cagle FR. 1939. A system of marking turtles for future identification. Copeia 1939:170–173.

Christiansen JL, and Burken RR.1979. Growth and maturity of the snapping turtle (*Chelydra serpentina*) in Iowa. Herpetologica 35:261–266.

Christman BL, Kamees LK. 2007. Current distribution of the Blotched Watersnake (*Nerodia erythrogaster transversa*) and the Rio Grande Cooter (*Pseudemys gorzugi*) in the Lower Pecos River System. Eddy County: New Mexico Department of Game and Fish. Interim Report.

Degenhardt WG, Painter CW, Price AH. 1996. Amphibians and reptiles of New Mexico. Albuquerque, New Mexico: University of New Mexico Press.

Demuth JP, Buhlmann KA. 1997. Diet of the Turtle *Deirochelys reticularia* on the Savannah River Site, South Carolina. Journal of Herpetology 31(3):450–453.

Dixon JR. 2013. Amphibians and Reptiles of Texas. 3rd edition. College Station, Texas: Texas A&M University Press.

Duarte A, Hines JE, Nichols JD, Weckerly FW. 2014. Age specific survival of male Golden-cheeked Warblers on the Forst Hood Military Reservation, Texas. Avian Conservation and Ecology 9(2):4.

Ernst CH, Lovich JE. 2009. Turtles of the United States and Canada. 2nd edition. Baltimore, Maryland: Johns Hopkins University Press.

Forstner MRJ, Bailey L, Ferrell S, Dixon JR, Hudson R. 2004. Population status, genetic structure, andecological aspects of the Rio Grande River Cooter (*Pseudemys gorzugi*) in Texas. Final Technical Report. Submitted to the Non-Game Division of TPWD.

Frazer NB, Greene JL, Gibbons JW. 1993. Temporal variation in growth rate and age at maturity of male painted turtles, *Chrysemys picta*. American Midland Naturalist 130:314–324.

Gibbons JW, Lovich JE. 1990. Sexual dimorphism in turtles with emphasis on the slider turtle (*Trachemys scripta*). Herpetological Monographs 4:1–29.

Gibbons JW. 1990. Life history and ecology of the slider turtle. Washington, District of Columbia: Smithsonian Institution Press.

Johnson MK, Wofford H, Pearson HA. 1983. Microhistological techniques for food habits analyses. New Orleans, Louisiana: United States Department of Agriculture, Forest Service, Southern Forest Experiment Station.

Letter AW, Waldon KJ, Mali I, Reams RD. 2017. *Pseudemys gorzugi* (Rio Grande Cooter). Maximum Clutch Size. Herpetological Review 48(4):836-837

Lindeman PV. 2007. Diet, Growth, Body Size, and Reproductive Potential of the Texas River Cooter (*Pseudemys texana*) in the South Llano River, Texas. The Southwestern Naturalist 52(4):586–594.

Mali I, Letter AW, Foley III D, Forstner MRJ. *In Review*. Differential Demographics of Rio Grande Cooter in Two Populations from New Mexico and Texas. Journal of Fish and Wildlife Management.

Mirabal J, Letter AW, Waldon KJ, Mali I. *In review*. Pseudemys gorzugi (Rio Grande Cooter). Successful hoop net baits in New Mexico. Herpetological Review.

NMDGF [New Mexico Department of Game and Fish]. 2006. The comprehensive wildlife conservation strategy for New Mexico. Santa Fe, New Mexico: New Mexico Department of Game and Fish.

Pierce LJS, Stuart JN, Ward JP, Painter CW. 2016. *Pseudemys gorzugi* Ward 1984 – Rio Grande Cooter, Western River Cooter, Tortuga de Oreja Amarilla, Jicotéa del Río Bravo. In: Rhodin, A.G.J., Iverson, J.B., van Dijk, P.P., Saumure, R.A., Buhlmann, K.A., Pritchard, P.C.H., and Mittermeier, R.A. (Eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs 5(9):100.1–12.

Piña V. 2012. Changes in habitat with subsequent changes in diet of the Texas River Cooter in Spring Lake, Hays County, Texas. (Master Thesis, Texas State University).

Platt SG, Berezin AR, Miller DJ, Rainwater TS. 2016. A dietary study of the rough-footed mud turtle (*Kinosternon hirtipes*) in Texas, USA. Herpetological Conservation and Biology 11(1):142–149.

Rowe JW. 1997. Growth rate, body size, sexual dimorphism and morphometric variation in four populations of painted turtles (*Chrysemys picta bellii*) from Nebraska. American Midland Naturalist 138:174–188.

SEMARNAT [Secretaríade Medio Ambiente y Recursos Naturales]. 2010. NORMA Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo. Diario Oficial de la Federación, 30 Diciembre 2010, No. 2, 77 pp.

Seminoff JA, Resendiz A, Nichols WJ. 2002. Diet of East Pacific Green Turtles (*Chelonia mydas*) in the Central Gulf of California, México. Journal of Herpetology 36(3):447–453.

Sokal RR, Rohlf FJ. 1995. Biometry: the Principle and Practice of Statistics in Biological Research. 3rd Edition. New York, New York: Freeman Press.

Steen DA, Hopkins BC, Van Dyke JU, Hopkins WA. 2014. Prevalence of ingested fish hooks in freshwater turtles from five rivers in the southeastern United States. PloS one 9(13):e91368.

Steen DA, Robinson OJ. 2017. Ingestion of fish hooks by freshwater turtles: estimating mortality rates and associated population declines. Conservation Biology. In press.

Sung Y, Hau BCH, Karraker NE. 2016. Diet of the endangered big-headed turtle *Platysternon megacephalum*. PeerJ doi: 10.7717/peerj.2784.

TPWD [Texas Parks and Wildlife Department]. 2012. Species account: the Rio Grande river cooter (*Pseudemys gorzugi*). Pages 1075–1076 in Bender S, Shelton S, Bender K, Kalmbach A, editors. Texas Comprehensive Wildlife Conservation Strategy 2005–2010. Austin, Texas: Texas Parks and Wildlife Department, Nongame Division.

Van Dijk PP. 2011. *Pseudemys gorzugi*. The IUCN Red List of Threatened Species 2011: e.T18459A97425928. http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T18459A8297596.en.

Waldon KJ, Letter AW, Mali I. 2017. *Pseudemys gorzugi* (Rio Grande Cooter). Ingested fish hook. Herpetological Review 48(4):837.

Zyznar E, Urness PJ. 1969. Qualitative identification of forage remnants in deer feces. Journal of Wildlife Management 33(3):506–510.

APPENDIX
SCHOLARLY OUTPUT SINCE SEPTEMBER 2017

Presentations

Mali, I., A. Duarte, and M.R.J. Forstner. 2017. Comparison of survey methods enabling estimates of population size and population demographics of Rio Grande River Cooter (*Pseudemys gorzugi*). The Wildlife Society, 24th annual conference, Albuquerque Convention Center, Albuquerque, NM, September 23-27. (Oral)

Suriyamongkol, T., A.W. Letter, K.J. Waldon, and I. Mali. 2017. Assessing somatic growth of Rio Grande river cooter (*Pseudemys gorzugi*) in the Black River drainage, New Mexico. 2017 New Mexico Academy of Science Research Symposium, Embassy Suites, Albuquerque, NM, November 4. (Poster)

Suriyamongkol, T., K. Waldon, and I. Mali. 2018. Validity of computer-assisted software for analyzing natural markings in *Pseudemys gorzugi* (Rio Grande cooter). Joint Annual Meeting of the AZ and NM Chapter of TWS&AFS. Little America Hotel, Flagstaff, AZ February 1-3. (Oral)

Waldon, K.J., T. Suriyamongkol, A. W. Letter, and Ivana Mali. Rio Grande cooter (*Pseudemys gorzugi*) natural and life history observations in New Mexico. Joint Annual Meeting of the AZ and NM Chapter of TWS&AFS. Little America Hotel, Flagstaff, AZ February 1-3. (Poster)

Suriyamongkol, T., K. Waldon, and I. Mali. 2018. Validity of computer-assisted software for analyzing natural markings in *Pseudemys gorzugi* (Rio Grande cooter). 44th Annual Student Research and Creativity Conference, Eastern New Mexico University, Portales, NM, April 4. (Oral)

Letter, A.W**.**, K.J. Waldon, and I. Mali. 2018. Dietary habits of Rio Grande cooter, *Pseudemys gorzugi*, within Black River Drainage, Eddy County, New Mexico. 44th Annual Student Research and Creativity Conference, Eastern New Mexico University, Portales, NM, April 4. (Oral)

Waldon, K.J., T. Suriyamongkol, A. W. Letter, and Ivana Mali. 2018. Rio Grande cooter (*Pseudemys gorzugi*) natural and life history observations in New Mexico. 44th Annual Student Research and Creativity Conference, Eastern New Mexico University, Portales, NM, April 4. (Poster)

Mali, I., A.W. Letter, A. Duarte, M.R.J. Forstner. 2018. Rio Grande cooter ecology on the Black River: results of high intensity surveys in 2016–2017. Southwestern Association of Naturalist – 65th Annual Conference, Texas State University, San Marcos, TX, April 12-15. (Oral)

Publications (peer reviewed)

Mali, I., A. Duarte, and M.R.J. Forstner. *Pending revisions*. Comparison of hoop-net trapping and visual surveys to monitor abundance of the Rio Grande cooter (Pseudemys gorzugi). *PeerJ*.

Mirabal, J., A.W. Letter, K.J. Waldon, and I. Mali. *In review*. Pseudemys gorzugi (Rio Grande Cooter). Successful hoop net baits in New Mexico. *Herpetological Review*.

Letter, A.W., K.J. Waldon, I. Mali**,** and R.D. Reams. 2017. *Pseudemys gorzugi* (Rio Grande cooter). Maximum clutch size. *Herpetological Review* 48(4):436-437.

Waldon, K.J., A.W. Letter, and I. Mali. 2017. *Pseudemys gorzugi* (Rio Grande cooter). Ingested fish hook. *Herpetological Review* 48(4):437.

Mali, I., A. Letter, D. Foley III, and M. R. J. Forstner. *In review*. Variation in population structure, body size, and body condition of Rio Grande cooter (*Pseudemys gorzugi*) populations from New Mexico and Texas. *Journal of Herpetology*.

Thesis

Letter, AW. *In progress*. Dietary habits of Rio Grande cooter, *Pseudemys gorzugi*, within Black River Drainage, Eddy County, New Mexico. (Master Thesis, Eastern New Mexico University).