NM WRRI Student Water Research Grant Final Report

May 15, 2019

1. Student Researcher: Thanchira Suriyamongkol
   Faculty Advisor: Dr. Ivana Mali

2. Project title: Monitoring basking activity and assessing water conditions in relation to basking of Rio Grande cooters along the Black River

3. Description of research problem and research objectives.

   Rio Grande cooter is a threatened turtle species in New Mexico (New Mexico Department of Game and Fish [NMDGF] 2016). However, little is known about this species ecology. Although our knowledge about Rio Grande cooter biology has been increasing over the past three years, there is still insufficient data to fully understand the life history traits and its conservation status. The Black River, where the species occur, is surrounded by recreational use, cattle ranching, irrigation, and oil drilling operations (Martin 2011), which may cause disturbances for the turtles and potentially interfere with their basking behavior. Basking is an essential thermoregulation process for ectothermic organisms. Previous studies have shown that turtle basking activity is affected by time of day, human activities (i.e., disturbance), availability of basking substrates, age, sex, nutritional status, and locations (Hammond et al. 1988; Peterman 2009; Picard et al. 2011).

   My goal was to monitor basking behavior of Rio Grande cooter along the Black River. I measured the turtle basking periods in correlation with environmental conditions (i.e., temperature and light intensity), seasonality, and time of day. Studying basking behavior can inform natural resource managers about turtle seasonal activities and can help determine the optimal times to conduct visual distance sampling in order to derive accurate abundance estimates (Mali et al. 2018). Visual surveys have potential to become a major monitoring strategy for this elusive species if basking behavior becomes better understood (Mali et al. 2018).

4. Description of methodology employed.

   My study was conducted on the Black River in Eddy County, New Mexico. The project began in July 2018 with basking behavior of Rio Grande cooters being monitored at 4 different basking locations: one at a lentic water body (pond) in close proximity to the Black River and three along the edge of a lotic water body (the Black River; Fig.1). To observe turtles, I have deployed Reconyx HyperFire2 game cameras, which were positioned 2-5 meters away from the basking structure (i.e., felled logs). Cameras were set up to take an image every 15 minutes from 0700 to 2000. At each site, I also deployed two Temperature/Light HOBO data loggers: one on a tree branch to measure air temperature and the other in the water (~ 30 cm in depth) to measure water temperature. The data loggers were also set up to measure the temperature and light intensity every 15 minutes.

To evaluate a change in basking frequency with environmental factors, I fitted generalized linear mixed effect model for binomial data using package GlmmML in program R (version 3.4.2, R Core Team. 2017). For the basking frequency, I divided the photos into three time periods: morning (0700-1045), afternoon (1100-1445), and evening (1500-1900). Then, I calculated for the proportion of photos with turtles present within each time period. I ran models that included different combinations of fixed factors that could affect basking frequencies: time of day (H), Julian day (D; with August 1st 2018 as day 1), ambient temperature (Ta), water temperature (Tw), ambient light intensity (La), and water light intensity (Lw), with locations of game cameras as a random effect. The best fit model was selected based on the Akaike Information Criterion (AIC; Burnham and Anderson 1998).

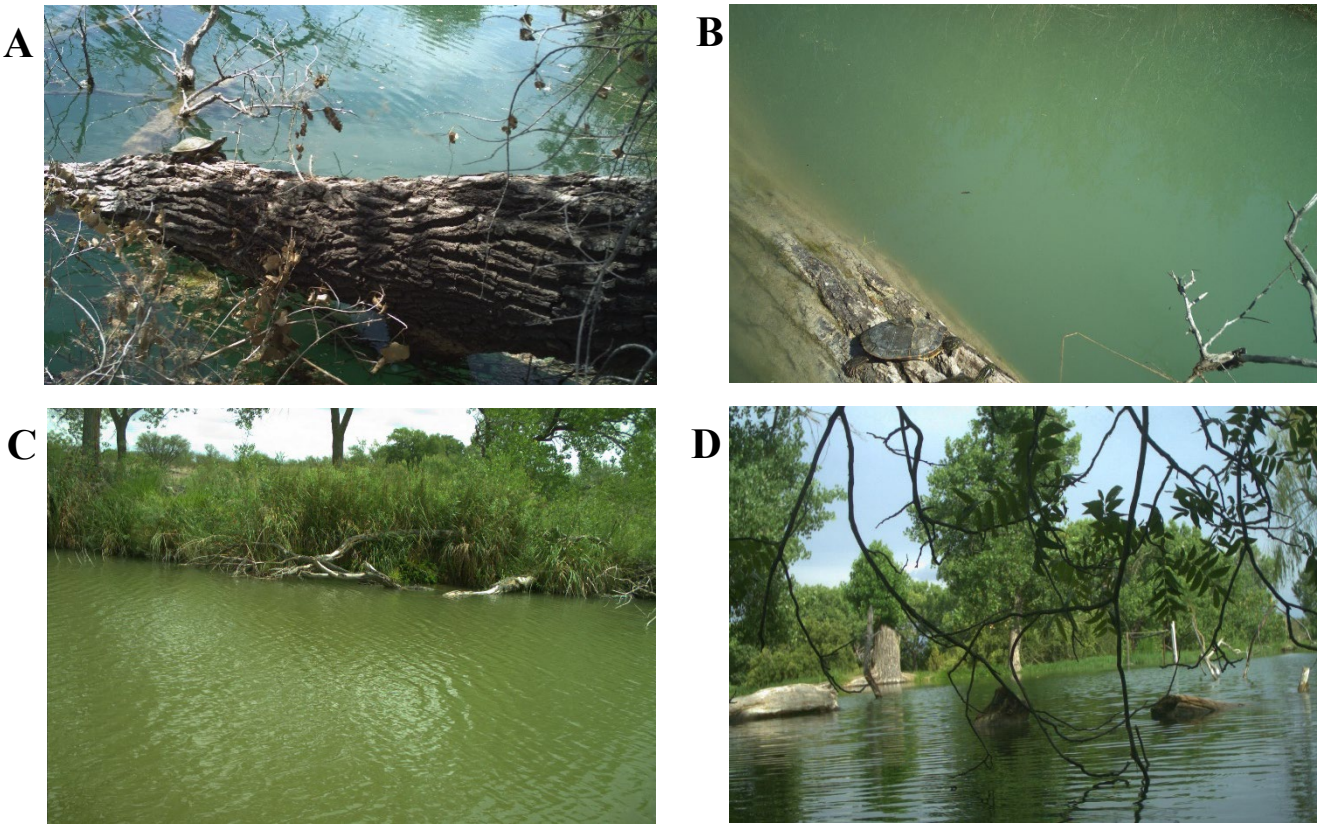

Figure 1. Four basking sites along the Black River. A and B are located on a portion of the Black River by the headwaters managed by the Bureau of Land Management (BLM), and are approximately 650m apart. Site C is located ~30km downstream from sites A and B. Site D is the lentic waterbody located near location A and B.

5. Description of results; include findings, conclusions, and recommendations for further research.

Thermoregulation is a crucial activity that is directly related to basking behavior of ectotherms including turtles (Dubois et al. 2009; Bulté and Blouin-Demers 2010; Clavijo-Baquet and Magnone 2017). Moreover, energy obtained through basking is allocated to other life history aspects of a species such as growth, foraging, and reproduction (Ernst 1986; Jain-Schlaepfer et al. 2017). Studying basking activity can help researchers and conservation managers better understand population status and health of a species, in particular a threatened species such as *P. gorzugi.*

To date, I have obtained and analyzed basking and environmental data from August 2018 to March 2019. Unfortunately, the game camera at location A was stolen in October; therefore, I omitted location A from the data set. Based on the best model, variables that significantly affected the basking activities of *P. gorzugi* included D^2 (quadratic term for Julian date), Ta (ambient temperature), Tw (water temperature), and H (time of day; Table 1). Overall, turtles tended to bask less in the evening and in the morning in comparison to the afternoon. Daily temperature both in the water and also on land also affected basking frequency by which the activities increased as the temperature increased.

For a seasonal pattern, I observed a difference in monthly basking frequency of *P. gorzugi* on the Black River in correlation to the change in temperature among months. According to HOBO data loggers, monthly temperature varied from August 2018 to March 2019 by which December was the coldest month for all sites during the data collection period (Fig. 1). As expected, the activity level of turtles was also the lowest in December. Thus far, I found *P. gorzugi* to be active in all surveyed months (August to March), which contradicted to previous observations on this species. Ernst and Lovich (2009) reported the active seasons of the species were from Spring to Fall and the hibernation period was during the coldest time of the winter. However, this species was also found active in December during a temperature of 12°C (Degenhardt et al. 1996). During my study, I observed *P. gorzugi* being active at -2°C in March and basking in 4°C in November and as low as 2°C in March. Based on the findings, I speculate that not all *P. gorzugi* on the Black River do not fall into hibernation. From a management perspective, a year-round protection of the riparian habitats and basking sites are recommended. Interestingly, basking behaviors of *P. gorzugi* also varied between two types of habitats: pond (Site D) vs. river (Site B and C), by which the pond turtles exhibited observably higher basking activities throughout the surveyed months (Fig. 2). In addition to seasonal pattern, daily basking frequency differed among sites. To compare the daily basking frequency between sites, I ran a paired t-test between the basking frequency of pond site and river sites. Turtles inhabiting Site D basked more frequently in the morning in comparison to Site B and C ($P < 0.05$), although most basking activities occur in the afternoon for all sites.

Basking activities can be altered by disturbances such as intraspecific- and interspecific competition over basking structures (e.g., turtles pushing each other off the structure or other animals occupying the structure) or the presence of humans (Selman and Qualls 2011). During this study, I have observed animals from different taxa such as wood duck (*Aix sponsa*), great blue heron (*Ardea herodis*), turkey (*Meleagris gallopavo*), and bobcat (*Lynx rufus*) utilizing the same basking structures as the turtles, although the turtles were not disturbed by their presence (Fig. 3). Because the game cameras were positioned directly at the basking structures, the presence of humans around the perimeter of basking area could not be

observed, except occasionally at Site D. Out of 29 photos that captured humans, only 5 photos (17%) contained basking turtles. Based on personal observations during monthly data collection, abandonment of basking structures due to disturbances, mainly by the presence of researchers, was not permanent as the turtles quickly re-occupied the structures when humans disappeared.

It is also important to point out that although I was not able to identify turtle species from Site C and D due to image resolution, I could safely assume that the majority of turtles observed was *P. gorzugi*. Mali and Suriyamongkol (2019) reported that over 90% of turtle species composition on the Black River was comprised of *P. gorzugi* and the only species of turtle that occurred at Site D (pond) was *P. gorzugi.* In addition, even though the study sites only represented small segments of the river and might not cover all possible basking spots, it is noteworthy that hatchlings were rarely observed basking in this study though they are readily caught in the hoop net traps in the summer. Therefore, there could be a difference in activity periods among age/size classes. Unfortunately, I was not able to distinguish size classes (i.e., juvenile and adult) and sex classes of turtles based on the game cameras images due to the distance of the cameras from the basking structures and also image quality. However, this research is still on-going; therefore, my future work is to focus on continuing with the year-round data collection and measuring the size of turtles from the photos.

Table 1. The best-fit generalized linear mixed effect model of basking in *P. gorzugi* chosen based on AIC values. H = time of day (morning and evening in comparison with afternoon), D

= Julian days (August 1st, 2018 = day 1), D^2 = quadratic term of Julian days, Tw = water temperature, Ta = ambient temperature.

Parameter	Coef	P-value
D^2	$-9.394*10^{-5}$	<0.05
D	$3.246*10^{-2}$	<0.05
H(evening)	$-7.585*10^{-1}$	<0.05
H(morning)	-1.371	<0.05
Ta	1.133	<0.05
Tw	$3.641*10^{-1}$	<0.05

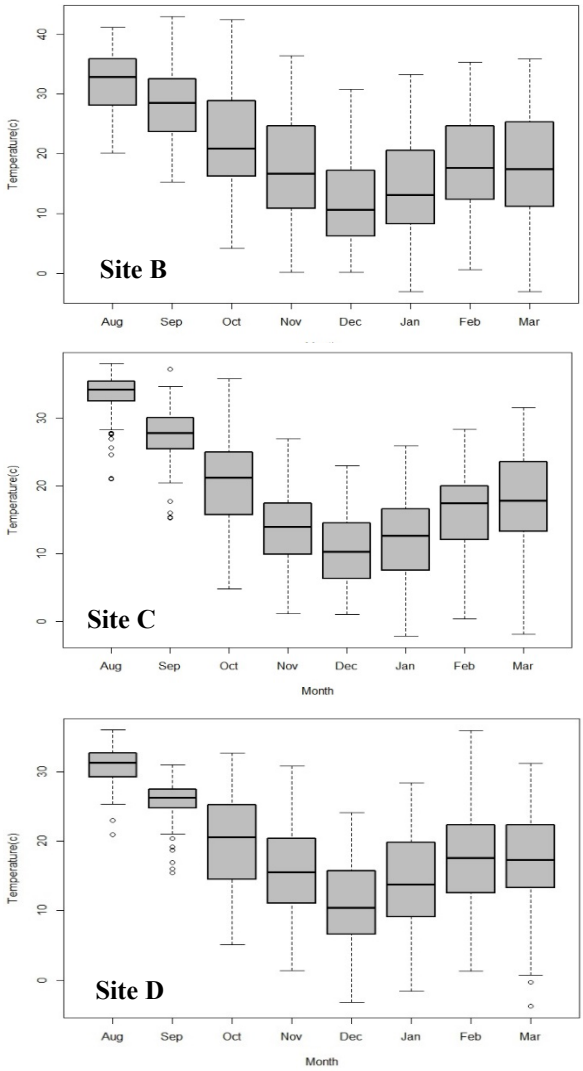

Figure 1. Average ambient temperature from August 2018 to March 2019 at each observation site.

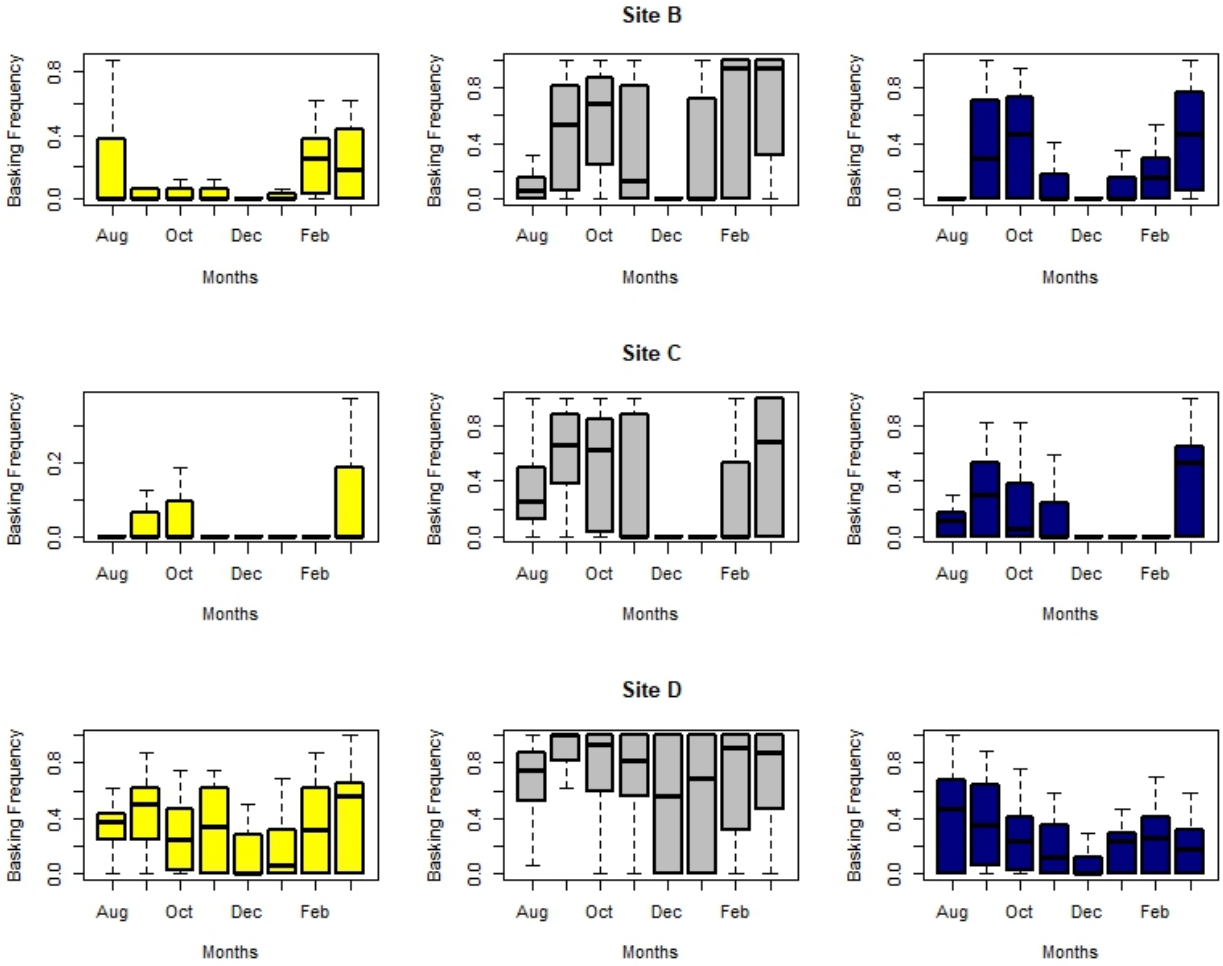

Figure 2. Monthly asking frequency at each basking site from August to December, 2018 and January to March 2019. Yellow plots represent morning period (0700-1045). Grey plots represent afternoon period (1100-1445). Blue plots represent evening period (1500-1900).

Figure 3. Examples of the presence of other animals utilizing the same basking structures during basking of turtles: (left) Rio Grande cooter and Wood duck and (right) Rio Grande cooter and Great blue heron.

6. Provide a paragraph on who will benefit from your research results. Include any water agency that could use your results.

   My research will provide a better understanding of the conditions that affect the active periods of Rio Grande cooters, which researchers can use to conduct a more efficient visual monitoring of the species. Ultimately, New Mexico Department of Game and Fish and U.S. Fish and Wildlife Service can potentially use this information when assessing the status and evaluating the best conservation practices for the Rio Grande cooter. Basking behavior in turtles is seldom studied and poorly understood. Freshwater turtle research groups interested in studying energetics physiology and basking behavior can use my study as a background information on basking behavior of riverine turtles.

7. Describe how you have spent your grant funds. Also provide your budget balance and how you will use any remaining funds. If you anticipate any funds remaining after May 15, 2019, please contact Carolina Mijares immediately. (575-646-7991; mijares@nmsu.edu)

   I have received the grant fund of $**5,731.92**. The funds were used to purchased five Reconyx HyperFire2 game cameras ($**2328.35**), 8 temperature/light HOBO data loggers ($**552**), and 5 chain locks to secure the game cameras ($**63.85**). Funds have also been used to cover the monthly traveling mileage from Portales, NM to the study sites ($**2156.09**). I also used the fund to cover the travel and registration fee for New Mexico and Arizona Wildlife Society Joint Annual Meeting in February, 2019, where I presented the research ($**355.63**). I also purchased 4 additional temperature/light HOBO data loggers ($**276**).

8. List presentations you have made related to the project.

   I presented my findings at 2019 Joint Annual Meeting of Arizona and New Mexico Chapters of the Wildlife Society in Albuquerque, NM on February 9th. I also gave a presentation at Texas Tech Biological Sciences Symposium in April 2019.

9. List publications or reports, if any, that you are preparing. Remember to acknowledge the NM WRRI funding in any presentation or report that you prepare.

   I am currently not preparing for any publications or reports as I aim to complete a full year of data collection first (From August 2018 to August 2019), but I will be submitting a manuscript once data collection is complete (i.e., September 2019).

10. List any other students or faculty members who have assisted you with your project.

    Several students have assisted me in checking the game cameras and exchanging SD cards including:
    - Vinicius Berno-Ortega, a Master's student in Biology from Eastern New Mexico University
    - Jeremiah Olivas, an undergraduate student from Eastern New Mexico University
    - Jazmin Mirabal and Matthew Creswell, former students from Eastern New Mexico University

11. Provide special recognition awards or notable achievements as a result of the research including any publicity such as newspaper articles, or similar.

    I have not received any special recognition or notable achievements as a result of the research.

12. Provide information on degree completion and future career plans. Funding for student grants comes from the New Mexico Legislature and legislators are interested in whether recipients of these grants go on to complete academic degrees and work in a water-related field in New Mexico or elsewhere.

    As a Master's student, I am working on the reproductive ecology of the Rio Grande cooter. I graduated from Eastern New Mexico University in May 2019. In the future, I plan to pursue a Ph.D. in a wildlife related field.

References

Bulté G, Blouin-Demers G. 2010. Implications of extreme sexual size dimorphism for thermoregulation in a freshwater turtle. Oecologia **162**(2):313–322.

Burnham, K. P., and D. R. Anderson. 1998. Model Selection and Inference: A Practical Information-Theoretic Approach. Springer Verlag, New York.

Clavijo-Baquet S, Magnone L. 2017. Daily and Seasonal Basking Behavior in Two South American Freshwater Turtles, *Trachemys dorbigni* and *Phrynops hilarii*. Chelonian conservation and biology **16**(1):62–69.

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

Dubois Y, Blouin-Demers G, Shipley B, Thomas D. 2009. Thermoregulation and habitat selection in wood turtles *Glyptemys insculpta*: chasing the sun slowly. Journal of Animal Ecology **78**(5):1023–1032.

Ernst CH, Lovich JE. 2009. Rio Grande Cooter. Turtles of the United States and Canada. Second edition. Johns Hopkins University Press, Baltimore.

Ernst CH. 1986. Environmental temperatures and activities in the wood turtle, *Clemmys insculpta*. Journal of herpetology **20**(2):222–229.

Hammond KA, Spotila JR, Standora EA. 1988. Basking behavior of the turtle *Pseudemys scripta*: effects of digestive state, acclimation temperature, sex, and season. Physiological Zoology **61**(1):69–77.

Jain-Schlaepfer SM, Blouin-Demers G, Cooke SJ, Bulté G. 2017. Do boating and basking mix? The effect of basking disturbances by motorboats on the body temperature and energy budget of the northern map turtle. Aquatic Conservation: Marine and Freshwater Ecosystem **27**(2):547–558.

Mali I, Duarte A, Forstner MRJ. 2011. Comparison of hoop-net trapping and visual surveys to monitor abundance of the Rio Grande cooter (*Pseudemys gorzugi*). PeerJ **6**:e4677

Mali I, Suriyamongkol T. 2019. Surveys for Western River Cooter (*Pseudemys gorzugi*) in the Pecos River drainage and its tributaries. New Mexico Department of Game and Fish.

Martin L. 2011. Summary of hydrogeologic investigations in the vicinity of Rattlesnake Springs, Carlsbad Caverns National Park, New Mexico. National Park Service.

New Mexico Department of Game and Fish [NMDGF]. 2006. The comprehensive wildlife conservation strategy for New Mexico. New Mexico Department of Game and Fish.
Peterman WE, Ryan TJ. 2009. Basking behavior of emydid turtles (*Chysemys picta*, *Graptemys geographica*, and *Trachemys scripta*) in an urban landscape. Northeastern Naturalist **16**(4):629–636.
Picard G, Carrière MA, Blouin-Demers G. 2011. Common musk turtles (*Sternotherus odoratus*) select habitats of high thermal quality at the northern extreme of their range. Amphibia-Reptilia **32**(1):83–92.
R Core Team. 2016. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.
Selman W, Qualls CP. 2011. Basking ecology of the Yellow-blotched sawback (*Graptemys flavimaculata*), an imperiled turtle species of the Pascagoula River system, Mississippi, United States. Chelonian Conservation and Biology **10**(2):188–197.