Herpetological Conservation and Biology 21(2):428–441.
Submitted: 11 December 2025; Accepted: 10 April 2026; Published: 31 August 2026.

Temperature and Size-selective Biases in Hoop Net Surveys of Aquatic Turtles: Insights from a 17-year Student-led Monitoring Program

***Thomas R. Laffoon*[1,2], *Dawson B. Hughes*[1,3], *Bryce S. Wade*[1,4,5,7], *Lindsey E. Hayter*[1,6], and *Evin T. Carter*[4,5]**

[1]*Clinch River Environmental Studies Organization, 191 Nature Lane, Oak Ridge, Tennessee 37716, USA*
[2]*Department of Biology, Tennessee Tech University, 1100 North Dixie Avenue, Cookeville, Tennessee 38505, USA*
[3]*Department of Ecology and Evolutionary Biology, University of Tennessee, 1416 Circle Dr, Knoxville, Tennessee 37996, USA*
[4]*Bredesen Center for Interdisciplinary Research and Graduate Education, University of Tennessee, 1508 Middle Drive, Knoxville, Tennessee 37996, USA*
[5]*Environmental Sciences Division, Oak Ridge National Laboratory, 505 White Oak Avenue, Oak Ridge, Tennessee 37830, USA*
[6]*National Ecological Observatory Network, 1685 38th Street, Boulder, Colorado 80301, USA*
[7]*Corresponding author, email: brycewade57@gmail.com*

***Abstract.*—Turtles are declining globally, and accurate estimates of demographic parameters are important for their conservation. Thus, understanding how environmental conditions may bias survey results is necessary for accurate assessments. We used data from a 17-y capture-mark-recapture dataset of Pond Sliders (*Trachemys scripta*) collected by the Clinch River Environmental Studies Organization (100 turtles captured 563 times), a youth science program that engages high school students, in eastern Tennessee, USA, to examine annual sex ratio and assess how water temperature was associated with capture rates and average body size of individuals captured. We added data by marking 50 male and 41 female turtles and we found that annual sex ratios were highly variable, but largely male-biased with a shift toward a more balanced ratio in the last decade with relatively even ratios in the last 3 y. We found that capture rates varied with temperature and were highest when water temperatures were near previously published estimates of the optimum activity temperature (about 25° C) of *T. scripta*. As temperatures increased, captures also became increasingly biased toward larger individuals. Our findings emphasize that sampling conditions can bias the results of surveys even when surveys are conducted during the same limited summer period. This student-led work also provides a case study that further supports current understanding of trap success and temperature and size-mediated activity levels in aquatic turtles. An understanding of the effects of environmental conditions on survey results can help guide targeted sampling or be used to reduce bias in future sampling efforts.**

Key Words.—aquatic turtles; hoop nets; sex ratio; sexual dimorphism; survey bias; Tennessee; thermal ecology

Introduction

Global wildlife populations are suffering large-scale declines owing to a variety of factors such as habitat loss, invasive species, and climate change (Brooks et al. 2002; Bellard et al. 2012; Mollot et al. 2017; Hald-Mortensen 2023). Turtle populations are particularly vulnerable to these declines (Garber and Burger 1995; Gibbons et al. 2000, Lovich et al. 2018; Stanford et al. 2020). Because of their long life-spans and delayed onset of reproductive maturity, turtles are especially susceptible to chronic disturbance (Congdon et al. 1994; Burger and Garber 1995). Turtle populations are currently threatened with local extirpation or extinction owing to overharvesting for the global pet trade/human consumption (Koch et al. 2006; Tomillo et al. 2008; Mandimbihasina et al. 2020), emerging diseases such as ranavirus (Dodd et al. 1988; Agha et al. 2017; Mullin et al. 2020), and the destruction and fragmentation of critical habitat (Gibbs and Shriver 2002; McClenachan et al. 2006; Quesnelle et al. 2013).

Population size, age structure, and survival rates are important metrics for managing turtle populations, and these metrics are difficult to ascertain without long-term data. Turtles benefit from sustained monitoring owing to their slow pace of life, which makes rapid assessment of population trends challenging. Long-term monitoring through regular surveys is thus essential for understanding how important parameters like population size, age structure, or disease prevalence change over time. Consistent sampling can help identify underlying causes of declines (Enneson et al. 2008; Magurran et al. 2010; Silva et al. 2017), and regular observations can be key to discerning true declines from background fluctuations (Gibbons et al. 1983, Keevil et al. 2018).

Given the significance of long-term monitoring for turtle conservation, it is important to understand biases that may influence the results of surveys. Turtle surveys may be biased by many factors, though prior research has been focused primarily on biases related to trap types and their characteristics (Ream and Ream 1966; Mali et al. 2014; Tesche and Hodges 2015; Grimes and Chatfield 2025). Environmental conditions at relatively fine temporal resolutions (i.e., within seasons), however, also have the potential to bias wildlife surveys (e.g., Pawlina and Proulx 1999; Read and Moseby 2001; Spence-Bailey et al. 2010). Temperature in particular has the potential to influence the capture rates of ectotherms like turtles, as the need for thermoregulation has a large effect on movement and behavior (Ernst 1982; Adolph 1990; Tetzlaff et al. 2017). This may be especially true in aquatic habitats where heat transfer is rapid (Fitzgerald and Nelson 2011). Understanding how temperature may influence survey results and downstream estimates (e.g., population size, age structure, sex ratio) is important as effective conservation management strategies rely on these estimates.

Here, we analyze a long-term dataset of aquatic turtle captures in eastern Tennessee collected by the Clinch River Environmental Studies Organization (CRESO). The Clinch River Environmental Studies Organization is a unique educational program connected to the Oak Ridge Reservation of the U.S. Department of Energy in which high school students are introduced to and engaged in scientific research programs like Eastern Box Turtle (*Terrapene carolina*) telemetry, snake surveys, and wetland monitoring/management (see Faust and Blomquist 2011; Allender et al. 2015; Biewer et al. 2024). Specifically, CRESO has collected and maintained data for a nearly 20-y aquatic turtle capture-mark-recapture study. Led by student researchers, we used this long-term dataset and our own field data to examine sexual dimorphism and long-term demographic trends in a population of Pond Sliders (*Trachemys scripta*). We then use this dataset to assess how water temperature influences *T. scripta* capture rates and the average body size of captured turtles during survey periods. We expected that because turtles have a preferred temperature for daily activities such as foraging (e.g., Ernst 1982; Crawford et al. 1983; Dubois et al. 2009), water temperatures that are higher or lower than some activity peak would lead to lower capture rates. We expected this peak would roughly correspond to an optimum temperature calculated for daily activity in *T. scripta* of about 25º C (Espindola et al. 2019). We also expected that we would catch larger turtles when water temperatures are high because smaller turtles have a lower thermal inertia and thus must seek refuges in deeper water to avoid overheating (Stevenson 1985).

Materials and Methods

***Site description and focal organism*.**—We conducted aquatic turtle sampling in two directly adjacent ponds (separated by a degrading berm < 1 m in width). These ponds were located along the Clinch River in the Three Bends Conservation Area (TBCA), a nearly 3,000-ac parcel of land located on the Oak Ridge Reservation (ORR) of the U.S. Department of Energy (Fig. 1) and managed by the Tennessee Wildlife Resources Agency (Baranski 2009). The ORR is located in Anderson and Roane counties in eastern Tennessee at the western edge of Ridge and Valley as it transitions to the Interior Plateau and contains large tracts of contiguous forest and unique aquatic features (palustrine wetland and riverine environments; Parr and Hughes 2006; Carter et al. 2019, 2025). During aquatic turtle sampling, we captured six species of turtle including Spiny Softshell Turtles (*Apalone spinifera*), Common Snapping Turtles (*Chelydra serpentina*), Painted Turtles (*Chrysemys picta*), River Cooters (*Pseudemys concinna*), Common Musk Turtles (*Sternotherus odoratus*), and Pond Sliders (*Trachemys scripta*), which is similar to other turtle assemblages recorded from ponds in the region (Stone et al. 1993; Price et al. 2013; Larkins et al. 2024). We focused on *T. scripta* as they represent the largest proportion of captures in our dataset (41%). *Trachemys scripta* is a generalist turtle species native to the Southeastern and Midwestern U.S. and is distinguished from other turtles by broad bands of yellow on the head, neck,

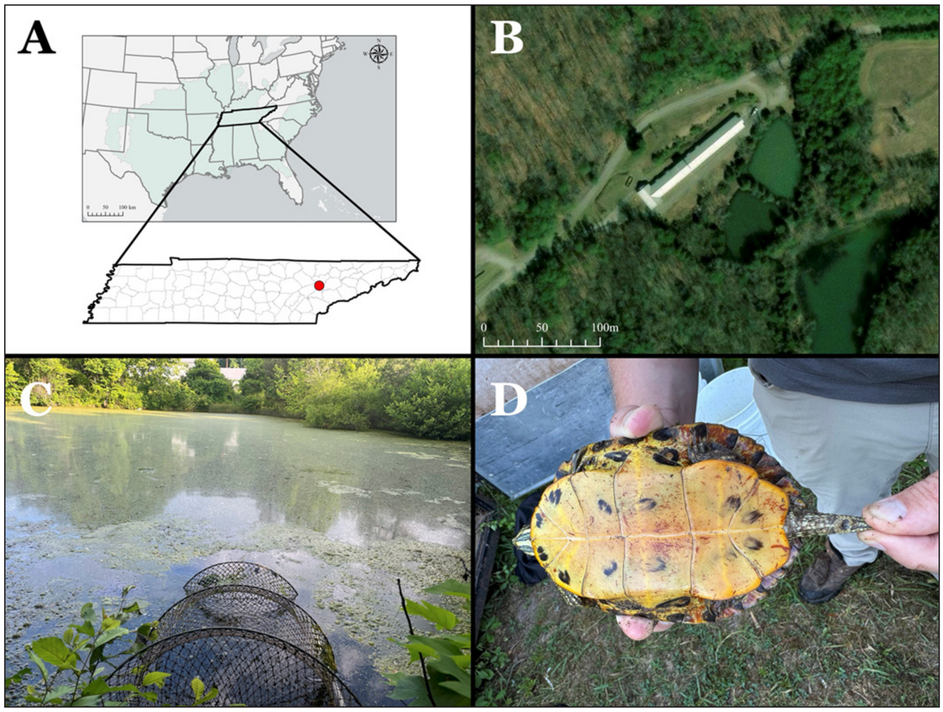

Figure 1. (A) The location of the Oak Ridge Reservation in eastern Tennessee denoted by a red dot and the native range of Pond Sliders (*Trachemys scripta*) in the U.S. in green (https://doi.org/10.5066/F7Q81B3R). (B) Aerial imagery of Clinch River Environmental Studies Organization (CRESO) survey ponds and the Clinch River to the southeast. (C) A hoop net trap set in one of our study ponds. (Photographed by Bryce Wade). (D) A CRESO student determining the sex of a male *T. scripta* by observing the position of the cloaca on the tail. (Photographed by Bryce Wade).

legs, and tail with the occasional red spot behind the eye (Vamberger et al. 2020). *Trachemys scripta* occupy a variety of habitat types such as lakes, rivers, and canals (Ryan et al. 2008; Peterman et al. 2009; Jaeger and Cobb 2012), and they are a common inhabitant of human-made ponds such as those in our study site (Stone et al. 2005; Price et al. 2013; Larkins et al. 2024). *Trachemys scripta* can live upwards of 20 y and maintain relatively small home ranges, making them excellent subjects for long-term capture-mark-recapture studies (Morreale et al. 1984).

Field methods.—We conducted aquatic turtle sampling primarily during the months of June and July (94% of sampling events) between 2007 and 2024, with the exception of 2020 because of the COVID-19 pandemic. We used hoop nets with three hoops and notched PVC pipes connected to the first and last hoops to stretch the nets out. Nets had a mesh size of 2.5 × 2.5 cm. We spread 10 hoop nets (eight nets with a diameter of 90 cm and two nets with a diameter of 75 cm) around both ponds to capture turtles. Surveys were conducted weekly during the summer and we set out nets on Thursday evenings and checked nets once on Friday mornings to avoid holding a turtle for more than 16 h in the trap. We set each net so that it was submerged 1 m under water with 0.3 m above water to allow captured turtles to breathe. We baited each net with a single can of commercially processed meat (Vienna sausages). We selected this bait because it is easily obtained in large quantities and has been used in associated turtle studies since the inception of CRESO. To prevent turtles from eating the bait, we removed the lid and squeezed the can shut.

After capture, we marked each turtle by filing notches into marginal scutes on the carapace, where each scute corresponds to a different letter (Cagle 1939; Gibbons 1968). Turtles were assessed and measured by students with supervision from CRESO instructors. Straight-line plastron and carapace length (CL) and width (CW) were measured using calipers (Haglöf, Langsle, Sweden). Next, the nail length (NL) of the longest front claw was measured in millimeters using a small ruler. We weighed turtles in strong plastic bags suspended from spring scales (Pesola Precision Scales, Schindellegi, Switzerland) in 1-g increments. All equipment was disinfected using alcohol wipes or 1% chlorhexidine after measuring each turtle. The sex of adult turtles was determined primarily by observing the placement of the cloaca beyond the shell in male turtles (Ernst and Barbour 1989). Turtles were handled briefly for measurements (generally < 10 min and were released at their point of capture within 3 h of being removed from a net.

Water temperature was measured on Friday mornings using a standard pool thermometer tied to the end of a golf ball retriever 1 m from the bank, and approximately 1 m underwater to mimic the depth of our hoop nets immediately before turtles were collected. Between 2007 and 2013, water temperature was taken at each trap; however, we found that temperature did not vary between these individual traps by visually inspecting the data and, thus, from 2014 to 2024, we measured water temperature at the midpoint of the two sections of the pond about 1 m away from the berm between the ponds (Fig. 1) and at a depth of 1 m. Because temperatures were taken from the berm between the two ponds, the two locations were within 3 m of one another. We the averaged these values together to get a single value for each survey for our analyses. Generally, water temperature was the same or nearly so between ponds (i.e., within 0.1° C).

Sexual dimorphism and sex ratio.—To assess sexual dimorphism within our population of *T. scripta*, we compared carapace length, carapace width, plastron length, plastron width, weight, and nail length between male and female turtles using Welch's Two-sample *t*-tests. If a turtle was captured on multiple occasions, we used measurements from its most recent capture. We also visually assessed differences between male and female Pond Sliders using a Principal Components Analysis (PCA) that included all morphological measurements using the rda function in the package vegan in R v4.4.0 (Oksanen et al. 2007; R Core Team 2024). We calculated the observed sex-ratio for each year and plotted it over time to visually assess how sex ratio varied in our study population over time.

Influence of water temperature on survey results.—To assess the influence of water temperature on the number of turtles captured during a survey, we fit Generalized Linear Models in a Bayesian framework using the brms package in R (Bürkner 2017) in which the number of *T. scripta* captured during each survey event was the dependent variable and water temperature measured during the survey was the independent variable. We included 126 surveys conducted by CRESO between 2007 and 2024 in our analyses (Fig. S1). *Trachemys scripta* are most active at around 25° C (Espindola et al. 2019). Thus, we would expect *T. scripta* movement (and subsequent encounter of hoop nets) to relate to temperature nonlinearly, with a peak near the optimum temperature for daily activities of *T. scripta* as has been documented in other turtle species (e.g., Crawford et al. 1983; Schwarzkopf and Brooks 1985; Chandler et al. 2020). To account for this, we also fit a model in which water temperature was a quadratic term. We then compared these models to each other and a null model using leave one out cross validation (LOO) and expected log pointwise predictive density (ELPD) using the loo_compare function in brms. This method of model comparison estimates out-of-sample predictive accuracy by summing the log-likelihood of each observation given the model fit to all other observations (Vehtari et al. 2017) and has gained popularity in Bayesian analysis of ecological data (e.g., Amirkhiz et al. 2021; Wanger et al. 2023; Wade et al. 2026). Because our *T. scripta* count data were over-dispersed, we modeled count as a negative binomial distribution (Ver Hoef and Boveng 2007). We assigned a weakly informative normal prior with a mean of 0 and standard deviation of 2 for the slope coefficient for average temperature. A gamma prior with shape 2 and rate 0.1 was placed on the negative binomial shape parameter.

We also assessed how water temperature during surveys affected the size of turtles captured by our hoop nets by fitting a Bayesian Regression Model in which the average carapace length of all *T. scripta* captured during a survey period (regardless of recapture status) was the dependent variable and water temperature was the independent variable using a gaussian distribution. We selected carapace length rather than weight because turtle weight can vary greatly between surveys while length is relatively invariable within a single season. Given sexual dimorphism in Pond Sliders in which females tend to be larger (Gibbons and Lovich 1990), however, an association between size and water temperature could be attributable to differential capture rates between sexes (i.e., females could be more active when water is warmer). To assess this possibility, we also fit a model in which the percentage of total captures that were female on any given survey was also included as an explanatory variable. We would expect any positive effect of water temperature on average size to vanish if this effect was primarily

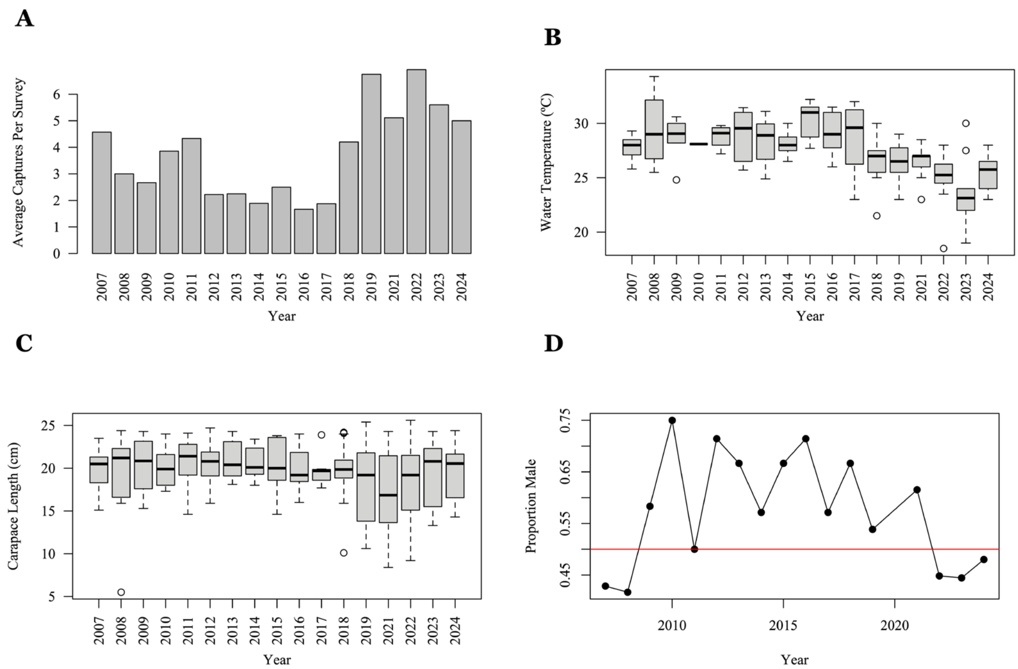

Figure 2. (A) A plot of the mean number Pond Sliders (*Trachemys scripta*) captured per survey in each year in eastern Tennessee, USA. (B) A boxplot of water temperatures (ºC) during surveys within each year where the black lines represent the median, the gray box represents the inner 50% of the data, whiskers represent the minimum and maximum (outliers excluded), and circles represent outliers. (C) A boxplot of captured *T. scripta* carapace lengths within each year. Only one measurement is shown for each uniquely identified turtle in a given year. (D) A plot of the yearly observed proportion of capture *T. scripta* that are male with a red line denoting a 1:1 sex ratio. Note there are no estimates for 2020.

explained by sex-biased capture rates. We assigned a weakly informative normal prior with a mean of 0 and standard deviation of 2 for the slope coefficient for average temperature. For all models we ran four chains with 10,000 iterations (2,000 warmup). We assessed model convergence by visually inspecting trace plots and Gelman-Rubin statistics (Rhat < 1.01).

Results

We captured and marked 100 individual *T. scripta* a total of 563 times. Each turtle was captured 5.63 times on average (standard deviation [SD] = 6.71; range of values, 1–36). During any given survey, we captured an average of 4.14 *T. scripta* (SD = 2.48; range of values, 1–12; Fig. 2). Of 100 marked turtles, 40 were female (248 total captures), 51 were male (285 total captures), and nine were listed as unknown sex due to juvenile status (30 total captures). The average water temperature in our ponds during surveys was 27.3° C and varied between 18.5° C and 34.3° C (Fig. 2).

Sexual dimorphism and sex ratio.—Our *T. scripta* population exhibited sexual dimorphism for all morphometric measurements and all comparisons were significant ($P < 0.05$ for all comparisons; Table 1). The first two axes of the PCA on male and female turtles accounted for 95.4% of the variation in morphometric measurements (Fig. 3). The first principal component (PC1) accounted for the majority of variance (83.4%) and was strongly loaded by all size-related variables, including carapace length, carapace width, plastron length (PL), plastron width (PW), shell thickness (TH), and weight (WTG). In contrast, the second principal component (PC2)

Table 1. Average (± standard deviation) carapace length (CL), carapace width (CW), plastron length (PL), plastron width (PW), shell thickness (TH), nail length (NL), and weight of Pond Sliders (*Trachemys scripta*) in our study measured at last capture. All *P*-values based on Welch's Two-sample *t*-tests comparing body measurements between males and females were < 0.001.

Sex	Carapace Length (cm)	Carapace Width (cm)	Plastron Length (cm)	Plastron Width (cm)	Shell Thickness (cm)	Nail Length (cm)	Weight (g)
Males (n = 50)	18.48 ± 2.28	13.90 ± 1.38	16.42 ± 1.94	10.70 ± 1.07	6.85 ± 0.91	1.72 ± 0.22	856.6 ± 298.37
Females (n = 41)	21.74 ± 2.13	16.11 ± 1.86	19.81 ± 1.88	12.89 ± 1.05	8.56 ± 1.05	1.08 ± 0.18	1,440.7 ± 412.47

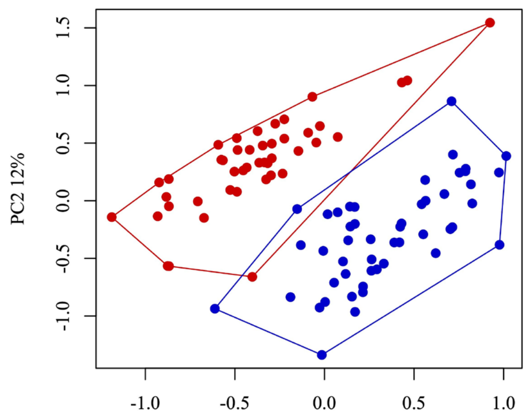

Figure 3. A Principal Component Analysis of Pond Slider (*Trachemys scripta*) morphometric data including carapace length, carapace width, plastron length, plastron width, shell thickness, nail length, and weight displaying PC1 and PC2. Blue points represent male turtles, and red points represent female turtles. Polygons denote minimum convex polygons for each sex.

explained less variance (12%) and was dominated by nail length (NL). The sex ratio of our sample was variable for most of our study, with a tendency towards male bias; however, in the final 3 y of this study, it has been relatively stable and slightly female biased (Fig. 2).

Influence of water temperature on capture rates and average size.—All Bayesian regression models converged well (visual inspection of trace plots and Rhat = 1). We found that the model describing capture rates that included a quadratic effect of water temperature was better supported, though there was uncertainty surrounding this estimate and both models outperformed a null model (Appendix Table 1). The posterior estimate for the coefficient of the effect of temperature on capture rates was positive (0.501; 95% confidence interval [CI] = -0.001–1.039), while the quadratic term was negative (-0.012; 95% CI = -0.021, -0.001]), suggesting a unimodal response in which captures increase with temperature up to a point and then decline (Fig. 4; Appendix Table 1). It is important to note that there is higher uncertainty surrounding predictions at low temperatures owing to a scarcity of data points in this temperature range (Fig. 4). We found that the average carapace length of turtles captured during a given survey period was positively associated with water temperature (0.194; 95% CI = 0.058–0.332; Fig. 4). Importantly, we found that the positive relationship between water temperature and size was not lost when the variation attributable to sex was accounted for in the model (0.265; 95% CI = 0.145–0.384). This indicates the observed relationship was not attributable to biased capture rates of female turtles when water temperatures were warm.

Discussion

Based on 17-y of capture data, we found clear sexual dimorphism and variation in sex ratio

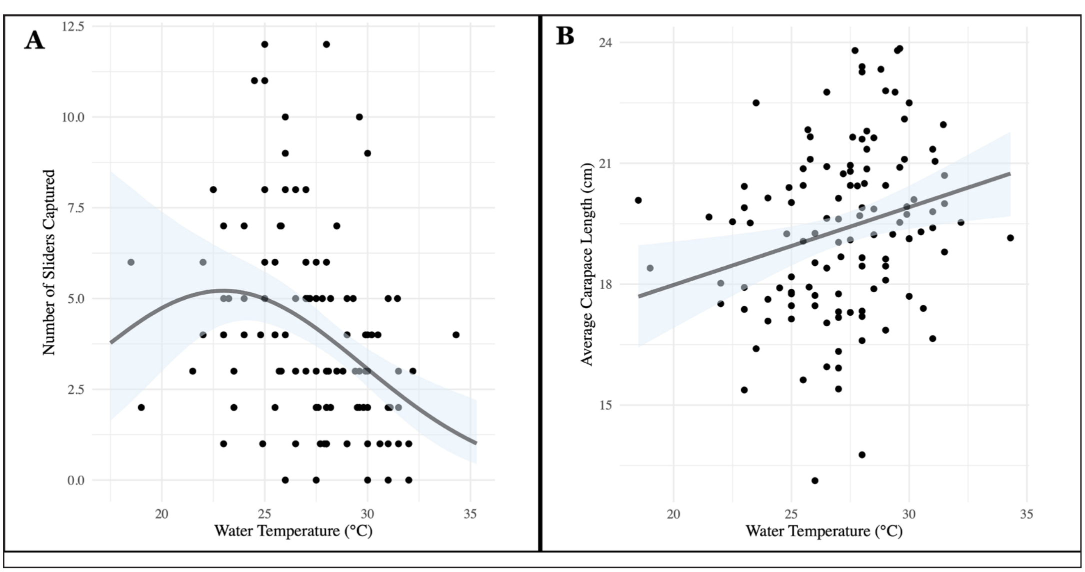

Figure 4. (A) The relationship between water temperature (°C) and the number of Pond Sliders (*Trachemys scripta*) captured during a survey in eastern Tennessee, USA. (B) The relationship between water temperature (°C) and the average carapace length (cm) of turtles captured in a survey. Lines represent lines of best fit with 95% credible intervals shown in light blue.

over time in a population of *T. scripta* in eastern Tennessee, USA. Sex ratio was largely male biased throughout our study but was relatively even over the last 3 y of the study. The number of turtles captured decreased when water temperatures deviated from a peak activity temperature. Additionally, we observed that the average size of turtles during a survey was positively associated with water temperature and this relationship was not attributable to sex biases. Altogether, these results suggest that environmental conditions, if they are not accounted for, may bias estimates of population size and demography in wildlife sampling.

Sexual dimorphism and sex ratio.—Our results indicate that male and female *T. scripta* display expected sexual dimorphism in size and shape and are similar to those reported by other studies assessing sexual dimorphism in *T. scripta* (Gibbons and Lovich 1990; Fritz and Wihelma 1998; Gradela et al. 2017, Larkins et al. 2024). These sexual dimorphic trends are well-established and likely due to the need for female *T. scripta* to be larger to increase egg-carrying capacity (Gibbons and Lovich 1990) and the courtship rituals of the species in which males use long nails to gain the attention of females (Gibbons and Lovich 1990; Fritz and Wihelma 1998). We also found that the observed sex ratio of captured *T. scripta* changed year to year and generally the trend has shifted from heavily male biased in the early 2010s to approximately equal today (with a slight female bias). *Trachemys scripta* is subject to temperature-dependent sex determination (TSD) in which higher temperatures lead to female-biased clutches (Crews and Bergeron 1994; Wibbels et al 1998). Prior studies have indicated that rising temperatures owing to anthropogenic climate change may cause female-biased shifts in sex ratio in organisms with TSD (Mitchell and Janzen 2010; Laloë et al. 2016; Roberts et al. 2023); however, we cannot directly address this mechanism with our data. Previous work has also found that female-biased road mortality may lead to male-dominated aquatic turtle populations (Aresco 2005). Because our study area lacks major roadways and heavy traffic, our study population is perhaps sheltered from this potential source of male bias. Nearby surveys of turtles in ponds on the ORR that border roads generally support this hypothesis (Mathews et al. 2024).

Influence of water temperature on capture rates and average size.—Generally, we captured fewer turtles when temperatures deviated from the optimal temperature for daily activity of *T. scripta* and the peak for predicted captures based on our data (about 23º C) roughly corresponded to this value (about 25° C) based on prior studies (for a thorough review see: Espindola et al. 2019). The difference between these values may be attributable to local adaptation of different populations of *T. scripta* to different climates as many of the studies analyzed by Espindola et al. (2019) took place in populations south of east Tennessee (e.g., Louisiana, Mississippi, South Carolina). The water temperatures during our sampling periods fell almost entirely within the range of feeding activity for *T. scripta* (17°–32º C; Espindola et al. 2019). As operative environmental temperatures move away from an optimal value, ectotherms generally become less active and suppress foraging activity until conditions become favorable (Parmenter 1980; Gunderson and Leal 2015). Turtles will balance thermal performance with specific activities such as foraging, digestion, and incubation and are thus less likely to encounter nets while basking during cooler conditions or seeking refuge in warmer conditions. At our study site during summer sampling conditions, when water temperatures are high, turtles are more likely to seek cool refuges in deep water. Because our hoop nets are set in shallow water, turtles likely encountered our traps at a lower rate during warmer water conditions.

Generally, when water temperature was higher the average size (carapace length) of turtles captured during a given survey was greater. This pattern is likely due to larger turtles having greater thermal inertia (McNab and Auffenberg 1976; Turner and Tracy 1985; Fitzgerald and Nelson 2011). A lower surface area to volume ratio allows larger turtles to remain active in warmer waters for longer without suffering a large change to their internal body temperature. Thus, larger turtles will be more active in shallow water when pond temperatures are high while small turtles will be restricted to deeper, cooler water (Lefevre and Brooks 1995; Fitzgerald and Nelson 2011). Altogether, our data suggests that sampling under overly hot or cold conditions can bias survey results, potentially influencing estimates of turtle abundance or other demographic parameters.

Sampling biases.—Water temperature appeared to affect both the number and size of individuals captured throughout our study. Therefore, restricting sampling to a relatively narrow temporal window (e.g., when temperatures are high) could easily bias populationlevel estimates. These biases are certainly present in our own data as most sampling occurred during June and July when CRESO student researchers are available; however, this allowed us to focus on finer-scale temporal trends during a generally active period for the turtles studied. Specifically, if sampling does not occur near the optimum activity temperature of a species, estimates of population size may underrepresent the true number of turtles present even during a period of the year when sampling conditions are conventionally considered optimal. For example, based on our models, we would expect turtle captures to be roughly twice as high when sampling at optimal conditions (approximately 24° C) compared to very warm water conditions (about 31° C). Differences of this magnitude could certainly bias downstream analyses of population size. Similarly, if surveys are conducted when temperatures are high, a bias towards capturing larger turtles may artificially inflate the estimated average size of turtles. Our models predict only a modest increase in average size (0.5 cm per 6.66° C increase in water temperature), though it is unclear how differences of this magnitude could potentially skew the predicted age class distribution in a population. Importantly, if biased estimates of population parameters are used to develop models used for conservation management this may lead to suboptimal management strategies (e.g., Samuel et al. 1992; Britnell et al. 2021; Dambly et al. 2021). In practice, researchers should aim to sample across a range of water temperatures to minimize bias, ideally including conditions near their optimum activity temperature. When this is not possible, it is important to recognize and report potential biases in the dataset, particularly those related to size or demographic structure. Alternatively, an understanding of these biases can assist in more targeted captures to develop models and more efficient management strategies specific to a given demographic (e.g., gravid females).

***Conclusions and future directions*.**—Sampling conditions should be considered during experimental design or, if not feasible, accounted for during data analysis. Understanding biases associated with environmental sampling conditions is important to making informed management decisions. It is also important to note that we would not have been able to answer these questions without the long-term data set of CRESO. This emphasizes the value of long-term ecological research for more robust population assessments over relevant time frames. Future studies should take advantage of long-term datasets to specifically evaluate how biased data can affect population estimates. For example, researchers could compare demographic estimates from captures obtained during periods that are above and below temperature thresholds to evaluate how sampling conditions influence conclusions, and this could be designed to evaluate effects at different temporal resolutions and extents. Altogether, our data highlights the importance of considering environmental conditions during sampling and we encourage other long-term monitoring programs to clearly account for temperature effects and to acknowledge potential biases wherever possible.

Acknowledgments.—We would like to thank everyone who has assisted in the culmination of this paper, including numerous Clinch River Environmental Studies Organization (CRESO) student researchers. We also thank Matthew Allender, Morgan Fleming, Whit Gibbons, and Nikki Jones for their helpful review of an early version of this paper. We especially thank John Byrd and Kathy Strunk, as their decades of hard work were vital for the development of this dataset and CRESO as a whole. We thank the U.S. Department of Energy Office of Environmental Management for providing program funding and support and DOE/TWRA for many years of access to the Three Bends Conservation Area. Additionally, we thank Oak Ridge Schools and Anderson County Schools for their support and oversight of the activities of CRESO. This research was permitted by the Tennessee Wildlife Resources Agency (#1660), and all activities were covered under University of Tennessee IACUC protocol (#1308-0222).

This manuscript has been authored by UT-Battelle, LLC under Contract No. DE-AC05-00OR22725 with the U.S. Department of Energy. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a non-exclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this manuscript, or allow others to do so, for U.S. Government purposes. The Department of Energy will provide public access to the results of federally sponsored research in accordance with the DOE Public Access Plan (http://energy.gov/downloads/doe-public-access-plan).

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Thomas R. Laffoon is a Wildlife Biologist who earned his B.S. in Wildlife and Fisheries Science from Tennessee Technological University, Cookeville, Tennessee, USA. His primary research interests center on the management of game birds, herpetofauna, and their habitats. Thomas was a participant in the Clinch River Environmental Studies Organization for 3 y. (Photographed by Alicia Laffoon).

Dawson B. Hughes has a B.S. in Ecology and Evolutionary Biology with a minor in Animal Science from the University of Tennessee, Knoxville, USA. His primary interests involve the study of wildlife biology, conservation of mammalian species, and broader ecological restoration. Dawson was a participant in the Clinch River Environmental Studies Organization for 3 y. (Unknown Photographer).

Bryce S. Wade graduated with his PhD from the University of Tennessee, Knoxville, USA, in 2026 and earned his B.S. in Ecology and Evolutionary Biology from the University of Tennessee in 2020. He is currently a Postdoctoral Associate in the Biological Sciences Department at Virginia Tech University, Blacksburg, USA. His research primarily focuses on conservation genetics, landscape ecology, and addressing spatial conservation challenges, especially with amphibians and reptiles. In addition, Bryce is a primary investigator for the Clinch River Environmental Studies Organization. (Photographed by Bryce Wade).

Lindsey E. Hayter is the Principal Investigator for the Clinch River Environmental Studies Organization and a Senior Field Ecologist at the National Ecological Observatory Network (NEON) in domain 07. She graduated with a B.S. in Wildlife Biology and Conservation from Ball State University, Muncie, Indiana, USA, in 2010 and her research interests center on the ecology and management of reptiles and amphibians. (Photographed by Evin Carter).

Evin T. Carter is an Ecologist in the Biodiversity and Ecosystem Health Group at Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA. He earned a B.S. in Biology from Indiana University Southeast, New Albany, USA, a M.S. in Biology from Purdue University, Fort Wayne, Indiana, USA, and a Ph.D. in Ecology and Evolutionary Biology from the University of Tennessee, Knoxville, USA. Evin merges field-based studies and quantitative methods to address problems in the conservation and evolutionary ecology of amphibians, reptiles, and sensitive ecosystems. (Photographed by Lindsey Hayter).

Appendix

Appendix Table 1. The support for each candidate model explaining captures based on difference in ELPD from the top model with standard error in the difference in parentheses and estimates for all coefficients with 95% credible intervals in parentheses.

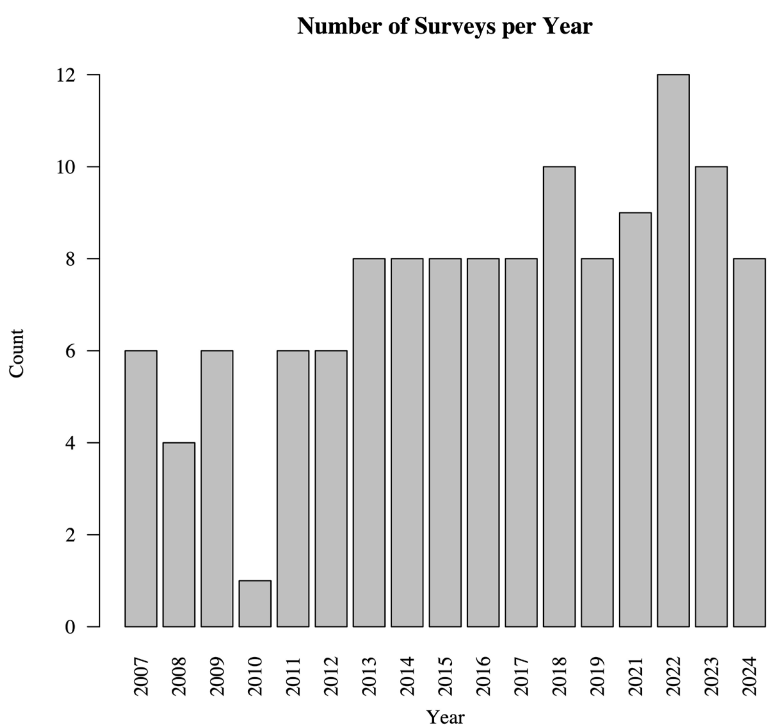
Model	ELPD Difference	Coefficient Estimate 1	Coefficient Estimate 2
Temp + $Temp^2$	0	0.501 (–0.001, 1.039)	–0.012 (–0.021, –0.001)
Temp	–1 (2.4)	–0.075 (–0.115, –0.035)	NA
Null	–6.1 (4.4)	NA	NA

Appendix Table 2. The support for each candidate model explaining average carapace length based on difference in ELPD from the top model with standard error in the difference in parentheses and estimates for all coefficients with 95% credible intervals in parentheses.

Model	ELPD Difference	Coefficient Estimate 1
Temp	0	0.193 (0.052, 0.332)
Null	–2.9 (2.1)	NA

Appendix Table 3. The number of total captures per trap over 17 survey seasons.

ID	L1	L2	L3	L4	L5	S1	S2	S3	S4	S5
Total Captures	57	47	91	54	69	24	64	62	52	43



Appendix Figure. The number of aquatic turtle surveys performed per year.