ISSN 1540-773X

Collinsorum

THE NEWSLETTER/JOURNAL OF THE KANSAS HERPETOLOGICAL SOCIETY

Volume 9, Number 3 December 2020

1974-2020

Published by the Kansas Herpetological Society
ksherp.com

Front Cover: Photograph of juvenile *Heterodon platirhinos (L)* and *H. nasicus (R)*. Both specimens are from the Pratt/Kiowa County line. Photo by J. Daren Riedle, 2019.

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ISSN 1540-773X

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KHS BUSINESS

A Brief Word From Your Editor

This final 2020 issue of *Collinsorum* should be reaching you all in early 2021. At this point it is cliché to say so, but 2020 was quite the year. Despite the negatives, there were several positives that demonstrate the resilience and camaraderie of the Kansas Herpetological Society. First the society made a push to reinvigorate the annual herp counts. These herp counts are arguably one of the largest citizen science efforts in the state, only second to Audubon's Christmas Bird Counts, which have entered their 121st year. The 2020 counts are summarized in this issue and I can only hope the counts continue to grow in 2021. With the growing pandemic most societies either canceled their 2020 meetings or moved to a virtual setting. Initially the Kansas Herpetological Society Executive Council moved to cancel the 2020 meeting, but then a feeling of regret began to set in. We did not want to let our members and student speakers down, so we all rallied in late summer to provide a virtual venue for the meeting. The meeting itself was a success all things considered, and the meeting abstracts can be found in this issue. We should have a more detailed synopsis of the meeting an upcoming issue of *Collinsorum*. Speaking of Collinsorum it was my hope that after taking over as editor that we would have the normal three issues out in 2020. A bout of COVID suffered by your editor spoiled that plan, and I am a month late getting this issue out. Submissions for 2021 are lining up, so we should have a full slate of issues in 2021. As a reminder, if you have some interesting behavioral or natural history observations of amphibians and reptiles in Kansas you would like to share, please submit them to *Collinsorum.* The editorial staff is here to help!

J. Daren Riedle
Editor

Abstracts of papers presented at the Kansas Herpetological Society's 47th Annual Meeting. 6-7 November 2020, Fort Hays State University (Virtual)

Grip it and Flip it 4.0: Season Four of Herpetofaunal Composition and Monitoring at the Sternberg Natural Area

Jacob N. Alexander*, Curtis J. Schmidt, Morgan A. Noland, Mitchell J. Greer
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On 10 June 2017, twenty-one 2.4×1.2-meter plywood boards were placed throughout the Dr. Howard Reynolds Nature Trails property (Sternberg Natural Area) to begin monitoring of the area's herptofaunal richness and diversity. The objective of the project is to monitor changes in species richness and diversity in relation to changes in landscape composition, as we continue to restore the habitat to native prairie. In the 2020 season, the boards were checked twice weekly, varying the time of checks. Five temperature variables were recorded at each board each time they were flipped. The fourth season of monitoring began on 4 March 2020 with the first observation occurring on 31 March 2020. To date, 242 individuals of ten species have been encountered. In addition to temperature measurements, Passive Integrated Transponder (PIT) tags were implanted (beginning in the 2018 season) for individual recognition and to get accurate counts. To date, 94 individuals of six species have been implanted. Out of these implanted individuals, the Great Plains Skink (*Plestiodon obsoletus*), North American Racer (*Coluber constrictor*), Six-lined Racerunner (*Aspidoscelis sexlineata*), and the Gophersnake (*Pituophis catenifer*) have been recaptured at least once. In future seasons, we hope to implant more individuals with PIT tags and estimate population sizes for all species and continue collecting temperature data in attempts to correlate cover use and temperature. Herpetofaunal monitoring is an important part of any environmental or restoration assessment as these species act as indicator species of ecosystem health.

Oral Presentation

Preliminary Assessment of the Aquatic Turtle Community at the Sternberg Natural Area

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Starting in the spring of 2020, aquatic turtle surveys took place in the section of Chetolah Creek that runs through the Sternberg Museum Natural Area owned and maintained by Fort Hays State University's Sternberg Museum of Natural History (Sternberg Natural Area). Surveys consisted of five, three-foot diameter hoop nets baited with either sardine in Louisiana hot sauce, creamed corn, or both. Nets were deployed for three consecutive days every other week until 23 October. A total of 36 individuals were captured and implanted with Passive Integrated Transponder (PIT) tags for individual recognition with 22 total recaptures. Three of the four species known to occur here were captured: The Snapping Turtle (*Chelydra serpentina*), Painted Turtle (*Chrysemys picta*), and Pond Slider (*Trachemys scripta*). The Spiny Softshell (*Apalone spinifera*) has been observed at this site, but not captured. This project joined a number of established long-term projects aimed at monitoring responses of biotic communities to prairie restoration activities. Included in these projects are a small mammal, terrestrial herpetofauna, insect, soil microbe, fish, and vegetation research components.

Poster Presentation

Ranavirus Infections in Wild North American Herpetofauna

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Ranaviruses (family: Iridoviridae) are emerging infections in herpetofauna and fish. They are globally distributed, occurring on every continent where amphibians and reptiles exist. Ranaviruses are responsible for many diseases and die-off events in wild herpetofauna in the USA every year. However, infection with a ranavirus can be asymptomatic or result in disease or death in individuals of the same species. In some species, ranavirus outbreaks can have extremely high mortality (e.g. over 90% in wood frogs, *Lithobates sylvaticus/Rana sylvatica*). In wild amphibians, there are over 50 species of amphibians and at least 10 species of reptiles that are known to be affected by ranaviruses in North America. In amphibians, ranavirus infections can occur in multiple life-history stages. In amphibians, ranaviruses are considered to be a reportable disease by the OIE (World Health Organization for Animals) and if a disease/die-off event is suspected to be caused by a ranavirus, it should be reported to the appropriate state authorities and any suspected herp diseases reported to the Partners in Amphibian and Reptile Conservation (PARC) Herp Disease Alert System at herp_disease_alert@parcplace.org.

Poster Presentation

Assessing Behavioral Syndromes in the Ornate Box Turtle (*Terrapene ornata*)

Shelby Bloom*1, Aubrey Gauntt2, Samuel Wagner2, Amelia Weller2, Becca Tolbert2, Benjamin Reed2
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Behavioral syndromes are used to define suites of behaviors that are repeated by individuals over time and across contexts. It has been hypothesized that populations should benefit from having individuals fall along a continuum of behavior types for population persistence as certain behavior types such as shy or bold may either help or hinder the survival of individuals in different contexts. In this study, we determined whether we could identify and quantify behavior types and ultimately behavioral syndromes in two spatially distinct populations of Ornate Box Turtles (*Terrapene ornata*). A total of 59 turtles were assayed from two different populations, one in eastern Kansas and one in western Nebraska. Through three different controlled assays, it was concluded that individuals do demonstrate consistent and repeatable behaviors, indicating the presence of a behavioral syndrome. We developed assays to help us determine individual risk-taking behavior, activity level, and exploration; three of the five main axes of behavior and likely most relevant for ornate box turtles. Identifying the presence and relative strength of behavioral syndromes within and across populations can help us determine the health of the population and their susceptibil-

ity/buffer to environmental change.
Oral Presentation

Herpetofauna Communities on Mined Lands in Southeast Kansas

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Southeast Kansas has a rich history of coal mining, with decades of strip mining that severely altered ecosystems. The resulting habitat composition of forests, prairies, and wetlands makes this a unique area for the state, in addition to its location along the narrow swaths of the Cherokee Lowlands and the Ozark Plateau. Since 2018, herpetofauna surveys have been conducted on mined lands with the use of drift fence arrays that included funnel traps, pitfall traps, and cover boards. To expand herpetofauna surveys, we conducted call surveys and larvae sampling at 24 wetlands across the Mined Land Wildlife Areas in 2020. Surveys were conducted from May 15 to August 14, during which time we documented 12 reptile and 6 amphibian species at 5 drift fence arrays and 6 reptile and 5 amphibian species at wetland sites. Most notably we encountered adult and juvenile Broad-headed Skinks at a drift fence array location. Our project will be expanded for the 2021 and 2022 field seasons to encompass anuran distributions, wetland herpetofauna communities, and box turtle densities on mined lands.
Oral Presentation

Spatial Memory and Space-use of Ornate Box Turtles (*Terrapene ornata*) in Eastern Kansas

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Effective space-use is vital for the survival and fitness of individuals and the persistence of any given population. Quantifying an animal's use of space, such as home-range size and daily movement patterns, can enable a greater understanding of the ecological roles that an organism fills and the evolutionary mechanisms that led to traits related to space-use being selected for or against. One such trait is spatial memory, which should enable animals with better spatial memory to move more efficiently navigate between resource patches, avoid potential threats, and return safely to their refuge locations. Animals that are more physically limited in their ability to move may rely more on the use of spatial memory in order to offset their physical constraints. Ornate Box Turtles (*Terrapene ornata*) are one such species that cannot move quickly relative to other species in their habitat and thus may rely more on spatial memory to navigate their home-range. To determine an individual box turtle's spatial memory ability, we constructed a maze and repeatedly assayed turtle performance within the same maze over time (one week to four months apart). Individual maze performance was aggregated and compared to home-range size, body condition, external temperature, and sex to determine whether these variables could be related to an animal's spatial memory. We found a significant interaction between maze performance and sex, indicating a potential sexual dimorphism in how spatial memory is used differently between sexes as individuals move through their home-range. Our preliminary findings suggest that pursuing these interactions via maze assays could lead to a greater understanding of the link between spatial memory and space-use of wild animals.
Oral Presentation

A Survey for the Presence of *Batrachochytrium dendrobatidis* at Powdermill Nature Reserve, PA, USA

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Amphibian declines are a global phenomenon and are driven by multiple factors, including emerging infectious agents, such as *Batrachochytrium dendrobatidis* (Bd). Globally distributed, Bd is known to affect amphibians in Pennsylvania, USA. Here, using non-invasive

skin swabs, we screened 198 individuals of 14 amphibian species for Bd at Powdermill Nature Reserve (PNR) in southwestern Pennsylvania during the spring and early summer of 2020. All animals appeared to be healthy. Among the species screened using traditional polymerase chain reaction, none of the nine salamander species were positive and only one of the five frog species, the Northern Green Frog, *Lithobates clamitans melanota*, tested positive for Bd DNA, with 18% positive prevalence (5 of 28 individuals). The Bd-positive individuals originated from sites where conspecifics and other amphibian species were found to be Bd negative. The overall low prevalence for Bd (2.5%) is potentially good news for the PNR. Most, if not all, of the species we screened, are known to be infected by Bd in other areas. Perhaps, Bd is not infecting many species or individuals at PNR at this time, and those species that are infected are known to be relatively resistant to chytridiomycosis, the disease that can be caused by Bd infections. Future directions include targeted surveillance of *L. c. melanota* and the North American Bullfrog, *L. catesbeianus,* a known carrier of this pathogen elsewhere.
Poster Presentation

Behavior Types Relate to Measures of Space Use Differently Across Populations of Ornate Box Turtles (*Terrapene ornata*)

Aubrey Gauntt*[1], Samuel Wagner[1], Shelby Bloom[2], Amelia Weller[1], Kaylyn Hobelman[1], Benjamin Reed[1]
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Linking behavioral syndromes determined in the lab to space use in the field is an exceptionally challenging task that very few studies are able to do. This may be due to the inherent challenges of collecting wild animals, assaying them in the lab, as well as collecting field data on them. Ornate Box Turtles (*Terrapene ornata*) present a potential model system for investigating the interaction between behavior and space use because of their easily detectable variability in both behavior and movement. They can easily be transported between the field and the lab and their space use can be easily monitored via radio telemetry. The goal of this project was to determine whether we could link behavioral syndromes determined in the lab to field-based behaviors in two different populations of box turtles occupying ecologically different habitats. Our results indicate that some axes of behavior, but not all, could be linked to field behaviors including aspects of ranging and home range philopatry. We also found significant differences in how behavior types link to space use in different populations. These results are some of the first to show that behavior types determined through carefully controlled assays can be linked-to field behaviors. Our results indicate that behavior types covary with habitat variables to influence how animals use their habitat. These findings highlight the importance of how different selective pressures may influence how animals of the same behavior types respond differently across different habitats.
Oral Presentation

Seeing Red: Quantifying the Diversity of Constriction Pressures Generated by Snakes

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There are numerous mechanisms that predators use during predator-prey interactions. Snakes use their limbless body in predation and two of the most commonly used mechanisms during predation are constriction and striking. The mechanism of constriction, specifically, involves the wrapping or winding of the body around the prey while contracting muscles to produce high pressure. There are several hypotheses about how these high pressures impact the prey that are being constricted. Those hypotheses include suffocation, cardiac trauma and arrest, blunt force trauma, and neural damage. The Red-out effect is the most recently proposed hypothesis that aims to explain how constriction works. It suggests that when snakes constrict their prey, they are able to drive blood and bodily fluids towards the head of their prey, quickly incapacitating them. This eventually leads to the shutdown of the nervous system. However, to date, this has only been investigated in one species of kingsnake. Here, we aim to quantify constriction pressures within both the chest and cranium of prey to find evidence for or against the newly proposed Red-out hypothesis. We quantified these pressures in a more phylogenetically diverse group of snakes in order to better understand how constriction mechanisms work.

Poster Presentation

Demography of Two Aquatic Turtle Species in Southwestern Pennsylvania

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Multi-year studies of syntopic species provide a spatiotemporal framework for comparing their demographic responses to the same environmental conditions. We used data derived from 15 years of sampling at an artificial pond matrix in southwestern Pennsylvania to investigate the survival, growth, and ages of Midland Painted Turtles (*Chrysemys picta marginata*) and Common Snapping Turtles (*Chelydra serpentina serpentina*). We trapped turtles with baited hoop-nets at a primary wetland, which was the largest and deepest of five artificial ponds in a spatially aggregated matrix at the Powdermill Nature Reserve, a protected site in the Allegheny Mountains. We captured 81 Midland Painted Turtles 162 times, and 43 Common Snapping Turtles 136 times. For both species, apparent survival probabilities were higher for adults (range 79–95%) compared to juveniles (range 57–82%), and higher in females compared to males or juveniles. The average growth rate was highest in juvenile turtles of both species, indicating growth was maximal during periods of the lowest survival. Average growth rates, in general, were slower for Midland Painted Turtles compared to Common Snapping Turtles. Relating body size to age revealed estimates conforming to studies elsewhere and to longevity records based on known-age turtles. We interpret findings at this wetland matrix to represent the demographics of a deme within a fluid and dynamic regional network of demes for these two species and highlight the value of artificial pond networks to the conservation of freshwater turtle metapopulations in Pennsylvania.
Oral Presentation

Measuring Venom Delivery and Strike Performance Across Ontogeny in Cottonmouths

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Striking behavior represents one of the most important and adaptive traits to the biology of snakes. Although almost all snakes exhibit this behavior for both predation and defense, the physiological mechanisms used vary between the type of strike and species of snake. Defensive strikes offer insight into predator-prey interaction among snakes. Viperids and colubrids have acquired separate physiological responses to predators in their environment throughout evolutionary time. The viper clade has evolved highly effective venom that it uses for both prey capture and defense. This venom is produced by glands that are situated at either side of the maxilla. Changes in the size and shape of each individual are likely to have an effect on defensive responses, such as venom delivery. Here, we measured the striking performance and venom delivery of a widely-known viper (*Agkistrodon piscivorus*) across their ontogeny to better understand how size impacts defensive performance. All individuals were given the opportunity to strike three consecutive times while we recorded a high-speed camera. Here, we report the complete results from a sample of 42 snakes of varying size (body mass = 26.8–862 g; SVL = 270–845 mm).
Poster Presentation

Sirens Changed Their Relationship with Droughts to "It's Complicated."

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Aquatic organisms are experiencing in-

creasingly severe droughts with shorter periods between them. Simultaneously, the global footprint of drought effects carrying over to non-drought years is spreading. Animals that rely on inter drought years to prepare for seasonal or episodic droughts are thus experiencing less time to prepare for more severe droughts and given poorer conditions in which to do so. Many estivating animals rely on endogenous energy reserves to persist through droughts while they estivate. The goal of our study is to assess the impact of inter-drought year quality (as a function of the Palmer Drought Severity Index) on the growth (length) and accrual of resources (body mass) which determine the length of drought they can survive while estivating (estivation potential). In this study, we calculate growth rates (length) of *Siren lacertina* across 11 years of one of the most severe drought local minima in the SE US in the preceding 50 years. We use these growth rates to create age-class specifc estimates of length, mass, and estivation potential given site-specifc length-mass relationships and mass-dependent aestivation potential. We found that the average female in the population during the local minima grew slower, accrued less mass per unit length, and required approximately an extra year to reach the size class required to successfully persist through a typical local periodic drying event. Overall, drought-induced estivation by large long-lived animals is an effective strategy for persisting through predictable seasonal drying events and may provide a suitable strategy for periodic severe droughts under past climatic regimes. However, increasingly sub-optimal conditions associated with incomplete recovery of ecosystems from droughts alter the ability of organisms that rely on those intervening years to buffer against future perturbations. Thus, the quality of intervals among acute temporal events is essential to understand how well organisms respond to increasingly severe and frequent climatic events. Oral Presentation

Measuring Herpetofaunal Biodiversity of Southwestern Missouri

Lexis Mader*, Kelsea Tyson, Thomas Zapletal, Jeremiah Cline, Alyssa Farney, Loegan Hill, Jainee Cowen, Camron Matteson, and David Penning
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Kellogg Lake is a 22-acre man-made lake located in Carthage, Missouri. As a small group, we investigated the abundance and diversity of the reptiles and amphibians from May-August 2020. During our preliminary work, we spent a total of 328 person-hours and 133 trap nights to survey the area. We began this project as a way to conduct an animal inventory, as the records before were severely neglected. We also took measurements (mass, length, sex, temperature), and recorded the GPS location of each individual in order to build a more comprehensive map of SW Missouri. In total, we captured 173 individual animals including 1 *Lithobates sphenocephalus*, 3 *Anaxyrus americanus,* 8 *Lithobates catesbeianus*, 3 *Apalone spinifera*, 48 *Trachemys scripta*, 93 *Sternotherus odoratus*, 1 *Nerodia erythrogaster*, 1 *Nerodia sipedon*, 1 *Storeria dekayi*, and 15 *Regina grahamii*. From the data collected, female *Regina grahamii* (n=11, mean=311.82 ± 134.15 g) were significantly heavier than males (n=4, mean=96 ± 9.51 g). However, male (n=27 mean=72.4 ± 31.69 g) and female (n=60, mean=82.8 ± 27.3 g) *Sternotherus odoratus* were not significantly different in their mass, given their length. Further, male (n=17, mean=240.71 ± 138.11 g) and female (n=14, mean=456.36 ± 243.41 g) *Trachemys scripta* were not significantly different in their mass, given their length. Poster Presentation

Adult Body Size and Clutch Characteristics of the Wood Frog, *Lithobates sylvaticus* (LeConte, 1825), Along an Altitudinal Gradient

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We examined female body size and clutch characteristics of the Wood Frog, *Lithobates sylvaticus*, from four sites along an elevational gradient in south-central Pennsylvania. Body size varied among sites and increased with increasing elevation. Clutch size increased with female body size and also increased with elevation after standardizing female body size. However, ovum size was not related to female body size or to elevation. Our findings confirm in part to those of another such study in Virginia in which elevation played an important role in body size and clutch characteristics and indicate that elevational associations of body size and fecundity need not be coupled together strongly in this species. Oral Presentation

Effect of Controlled Prairie Burning on Ornate Box Turtle (*T. ornata ornata*) Space-use and Below-ground Temperatures

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Controlled burning of native land is an important tool at the disposal of landowners and land managers, particularly in areas where natural communities interface with landscapes altered for human use, and in areas where invasive species threaten the healthy function of naturally occurring communities. However, prescribed burning can have unintended consequences on native populations that co-occur along with the positive functions that are associated with controlled burns. Controlled burns work to reduce the fuel load in areas prone to high-intensity fires and to restore the overall health of an ecosystem, either through the reduction of invasive species or by influencing the life cycles of plant communities that can be dependent on fire to remain healthy. On the other hand, controlled burns can be devastating to individual populations within the overall ecosystem when used improperly. In this study, we investigate the impacts of the prescribed burning of prairie ecosystems on below-ground soil temperatures as well as its effect on the above-ground space use of ornate box turtles (*Terrapene ornata ornata*). We find that underground temperatures in both spring and summer burns at the depths tested were unaffected by localized fire conditions; however, space use in the post-summer burn environment of T. ornata was affected, suggesting that controlled burns during the active season for T. ornata are likely to have detrimental effects on populations, either through direct contact with fire or through altering space use. In instances where local animal populations are of major concern in the ecosystem, these types of effects must be considered when planning controlled burns, and communities may be best served by burning when targeted populations are at the lowest risk. Poster Presentation

Snake Entanglement in Erosion Control Blankets: Causes, Consequences, and Conservation.

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In road construction projects across the United States, erosion control methods (e.g., erosion control blankets [ECBs]), are mandated to stimulate seedbed regeneration and prevent soil loss. Previous reports have suggested that snakes are vulnerable to entanglement in ECBs. We conducted two entanglement experiments to examine what factors increase a snake's risk of ECB entanglement. From first our experiment, we found that ECBs that contain fixed-intersection, small diameter mesh consisting of polypropylene were significantly more likely to entangle snakes compared with ECBs with larger diameter polypropylene mesh or ECBs that have woven mesh made of natural fibers. Snake body size was also associated with entanglement; for every 1-mm increase in body circumference, the probability of entanglement increased 4%. Our second experiment tested if a modification to the installation methods of erosion control blankets affects the likelihood of snake entanglement. This experiment examined snake entanglement in two treatments: 1) exposed erosion control blanket edge (i.e., perimeter) and 2) buried erosion control blanket edge. Snakes were less likely to attempt to pass through the mesh on the buried edge treatment and all entanglements occurred on the exposed edge treatment. These results can help construct a predictive framework to determine those species and individuals that are most vulnerable to entanglement as well as inform natural resource agencies on additional steps that can be taken to

select products that pose low risks to wildlife. Oral Presentation

Demographics and Space-use of Ornate Box Turtles (*Terrapene ornata*) in Kansas and Nebraska: A Comparative Study

Samuel Wagner*[1], Aubrey Gauntt[1], Amelia Weller[1], Shelby Bloom[2], Kaylyn Hobelman[1], Colin Nelson[1], Megan Hanson[2], Natalie Radclife[2], Benjamin Reed[1]
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Species with large ranges are often composed of many populations that occupy areas that are ecologically different in terms of habitat, thermal conditions, resource availability, and stressors such as predation or parasite risk. Here, we investigated two geographically distinct populations of Ornate Box Turtles (*Terrapene ornata*), one in the southwestern panhandle of Nebraska and one in the northeastern region of Kansas. Our primary objective was to determine the space-use of individuals belonging to each population and the factors which may contribute to ranging variation within and between each population. We also compared basic demographic and morphometric characteristics of each population and found evidence for inverse-Bergmann's Rule but otherwise, population demographics were similar across populations. We found a significant interaction between location and body condition for predicting range size, with Kansas turtles having larger ranges when in better body condition and Nebraska turtles having smaller ranges when in better body condition. Similarly, we found females have larger ranges when in better body condition and males to have smaller ranges when in better body condition across both locations. We found flesh fly (*Sarcophaga cistudinis*) infection rates to be significantly higher in Kansas (n=10) than in Nebraska (n=0). Understanding variation within and across populations can be critical for our understanding of how organisms interact with their environment and how to best implement conservation and management practices for targeted species. Oral Presentation

Does Installation Method Affect Snake Entanglement in Erosion Control Blankets?

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At the conclusion of road construction projects, erosion control products (e.g., blankets, spray mulch) are installed to reduce soil loss and promote plant growth. Wildlife, such as snakes (suborder Serpentes), are prone to entanglement in erosion control blankets (ECBs) that contain polypropylene mesh with fused apertures. Previous reports have noted that the occurrences of entanglements are not uniform in their distribution across an ECB, but primarily occur where the edge of the mesh is exposed. We conducted an experiment to determine if a modification to the installation methods of ECBs affects the likelihood of snake entanglement. We conducted entanglement trials to compare the likelihood of snake entanglement between two treatments: 1) exposed ECB edge (i.e., perimeter) and 2) buried ECB edge. Snakes were less likely to attempt to pass through the mesh on the buried edge treatment and all entanglements occurred on the exposed edge treatment. These results support that modification to the installation methods reduces snake entanglement in ECBs in some settings. However, we conducted our study in an experimental setting, and it should be evaluated under natural field conditions. This research can be used to inform several parties including contractors, habitat managers, and agency decision-makers on additional steps that can be taken for products that fit their application needs to minimize risks to wildlife. Poster Presentation

Analyzing the Impact of Environmental Variables on Breeding Pond Occupancy of *Ambystoma* Salamanders

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One of the greatest threats to amphibian biodiversity is habitat loss. Many amphibians have biphasic life histories that require the use of both aquatic and terrestrial habitats. Aquatic habitat in Ontario has declined significantly in the past 150 years. To combat the loss of amphibian habitat, stewardship wetlands have

been created to replace natural wetlands. Because of the widespread wetland destruction in Southern Ontario, the Nature Conservancy of Canada has created over 20 constructed ponds on Pelee Island with the goal of increasing the number of breeding sites for *Ambystoma* salamanders; a pond breeding amphibian. Pelee Island, therefore, serves as an excellent study site, as both natural and stewardship ponds are available. The aim of this study is to answer three prominent questions. The first: what environmental variables influence occupancy of potential breeding sites by *Ambystoma* salamanders on Pelee Island? The second: what environmental variables predict the relative abundance of *Ambystoma* larvae? We used generalized linear models with up to two predictive variables to answer questions one and two. Canopy cover and crayfish presence had the most predictive power for occupancy. Temperature and substrate had the most predictive power for relative abundance. The third: do existing stewardship ponds adequately mimic the environmental requirements for *Ambystoma* breeding and larval habitat as observed in natural ponds? A Principle Component Analysis was run; the PC variables that explained > 10% variation were used in a MANOVA and followed by a univariate ANOVA to determine in what ways natural and stewardship ponds differ. Oral Presentation

Larval Amphibian Distribution Across Intermittent Stream Pools in the Flint Hills

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Climate change is expected to increase the frequency and severity of droughts and precipitation events. Intermittent stream pools in the Great Plains present an idealized replicated system to study the impacts of variable climatic conditions on the distribution of aquatic species including amphibians, invertebrates, and fishes. Here, we investigate the effects of hydroperiod, connectivity, and fish abundance on larval amphibian distribution in the Flint Hills of Kansas at Youngmeyer Ranch, a 4,700-acre Wichita State Field Station. We identified 82 stream systems on the property and selected 7 to sample for intermittent stream pool communities. We used a systematic random sampling regime to select 151 candidate pools and calculated preliminary hydroperiod scores (number of years wet out of total years observed) and stream connectivity using Google Earth Pro for each pool prior to sampling. We sampled 117 stream pools (the remaining 34 were dry) and recorded larval amphibian diversity and abundance with area-constrained searches (enclosure sampling). Fish presence, pool volume, and pool connectivity all influenced the distribution of amphibians on the landscape. Fish presence reduced the likelihood of detecting American Toad (*Anaxyrus americanus*) ($P < 0.0001$) or Plains Leopard Frogs (*Lithobates blairi*) ($P < 0.0001$). Overall, larval amphibians preferred larger pools that were not connected by inflow or outflow with the rest of the stream ($P < 0.05$). Surprisingly, hydroperiod was not a significant predictor of amphibian presence, potentially because our sampling occurred following a wet year when fish were widespread across pools that normally dry between years. Intermittent stream pools are by far the most abundant suitable amphibian spawning habitat and undoubtedly serve as key habitats at Youngmeyer Ranch for the maintenance of amphibian populations. However, the relative suitability of a given intermittent stream pool likely varies from year to year given its accessibility to fish which is enhanced by years with higher precipitation. Oral Presentation

Summary of the 2020 Kansas Herpetological Society Herp Counts and First Call for 2021 Counts

In a year of negatives, one major positive, at least as far as the Kansas Herpetology is concerned is the reinvigoration of the annual Kansas Herp Counts. The annual counts began in 1989 and were conducted frequently for the next decade or so before slowly fading away (see Riedle, 2020). The data from those early counts were invaluable for understanding trends and distribution of Kansas herpetofauna. In order to maintain biodiversity monitoring efforts in the state of Kansas, the Kansas Herpetological Society encouraged its members to conduct and submit counts throughout 2020. In 2020, thirty-four counts were submitted accounting for the observation of 1,280 individuals of 66 species of amphibians and reptiles in 20 counties. The surprising aspect of this was that only six individuals submitted counts, with each person submitting multiple counts. I hope moving forward in 2021 more folks will submit counts, and the counts will increase in geographic scope.

The basic rules for conducting and submitting herp counts are as follows:

-Counts can take place any time of the year.
-Pick sites that can be repeatedly surveyed at roughly the same time every year.
-The minimum level of data that should be provided includes:
  - -The county where the count occurs
  - -A GPS point where the count occurred
  - -Start and stop times of the count
  - -A complete list of names of participants
  - -A list of all species and the number of individuals observed
  - -Also note anuran choruses, egg masses or other observations of note

-Be sure to have a hunting license on your person whenever you are herping, and always have landowner permission before entering private property.

Submit all counts to daren.riedle@ks.gov

NEOSHO COUNTY: KHS-2020-01

17 April 2020: 18:00-18:30
Neosho State Fishing Lake
Active Searching along dam and fishing pier.
Verifier: Travis W. Taggart
Participants: Sarah Taggart
Species Observed

American Toad	20
Gray Treefrog complex	1
Boreal Chorus Frog	15
American Bullfrog	3
Southern Leopard Frog	1
Common Five-lined Skink	1
Six-lined Racerunner	2
North American Racer	1
Rough Greensnake	1
Ring-necked Snake	1
Common Watersnake	2
Western Ribbonsnake	1
Common Gartersnake	1
Snapping Turtle	1
Eastern Musk Turtle	1

Totals: 15 species and 52 individuals

CHEROKEE COUNTY: KHS-2020-02

18 April 2020, 10:00-12:00
Spring River Wildlife Area
Turning Rocks and Logs. Temps dropped to 30ºF the night before
Verifier: Travis W. Taggart
Participants: Sarah L. Taggart
Species Observed

Eastern Newt	1
American Toad	20
Blanchard's Cricket Frog	16
Gray Treefrog complex	1
Spring Peeper	3
Boreal Chorus Frog	1
Southern Leopard Frog	15
Prairie Lizard	1
Coal Skink	1
Five-lined Skink	7
Broad-headed Skink	2
Little Brown Skink	4
Six-lined Racerunner	1
North American Racer	1
Prairie Kingsnake	1
Rough Greensnake	1
Western Ratsnake	1
Eastern Copperhead	2
Western Wormsnake	1
Ring-necked Snake	32
Rough Earthsnake	2
DeKay's Brownsnake	2

Common Gartersnake	1
Eastern Box Turtle	2

Totals: 24 species and 119 individuals.

CHEROKEE COUNTY: KHS-2020-03

18 April 2020, 13:00-14:00
Verifier: Travis W. Taggart
Participants: Sarah Taggart
Active searching, Flipping Debris
Species Observed

Small-mouthed Salamander	1
Eastern Newt	2
American Toad	40
Blanchard's Cricket Frog	10
Gray Treefrog Complex	2
Spring Peeper	20
Green Frog	1
Southern Leopard Frog	6
Coal Skink	1
Common Five-lined Skink	1
Broad-headed Skink	1
Little Brown Skink	36
North American Racer	2
Milksnake	1
Coachwhip	1
Western Ratsnake	1
Eastern Copperhead	1
Western Wormsnake	2
Rough Earthsnake	3
Red-bellied Snake	1
Common Gartersnake	1
Eastern Box Turtle	1

Totals: 22 species and 135 individuals

ELLIS COUNTY: KHS-2020-04

25 April 2020, 13:30-14:45
Verifier: Curtis J. Schmidt
Participants: Avery Schmidt, Jacob Alexander, Nick Edge, Aaron Short, Killian Wheeler, Noah Fields.
Species Observed

Six-lined Racerunner	9
North American Racer	3
Speckled Kingsnake	3
Milksnake	5
Coachwhip	1
Great Plains Ratsnake	2
Ring-necked Snake	171

Totals: 7 species and 194 Individuals

PRATT COUNTY: KHS-2020-05

Texas Lake WMA
27 April 2020: 10:00-12:00
Road cruising, Checking Coverboards
Verifier: J. Daren Riedle
Participants: Tamera Dawn Riedle, Zachary Riedle, Greya Riedle
Species Observed

Boreal Chorus Frog	Calling
Plain Leopard Frog	3
Gophersnake	1
Plains Gartersnake	1
Common Gartersnake	1
Pond Slider	1

Totals: 5 species and 7 Individuals

COWLEY COUNTY: KHS-2020-06

Floyd and Edna Moore Ecological Field Station
29 April 2020: 10:00-11:30
Verifier and sole participant: Samuel Shane Abbott
Species Observed

Western Narrow-mouthed Toad	1
Slender Glass Lizard	1
Great Plains Skink	1
Ring-necked Snake	5

Totals: 4 species and 8 Individuals

PRATT COUNTY: KHS-2020-07

Pratt Sandhills WMA
30 April 2020: 0800-12:00
Checking coverboards
Verifier and sole participant: J. Daren Riedle
Species Observed

Boreal Chorus Frog	1
Six-lined Racerunner	3
Great Plains Skink	2
Ring-necked Snake	10
Plains Gartersnake	1

Totals: 5 species and 17 Individuals

SUMNER COUNTY: KHS-2020-08

Drury Park and Waterfall
30 April 2020, 11:00-17:00
Active searching along the Chikaskia River
Verifier: Dexter R. Mardis
Participants: Hannah A. Hoetmer, Jeff Hoetmer
Species Observed

Blanchards Cricket Frog	Many
Plains Leopard Frog	Many
American Bullfrog	13
Prairie Lizard	15
Six-lined Racerunner	6
Ring-necked Snake	2
Unknown Watersnake	30
Western Ribbonsnake	3
Snapping Turtle	1
Pond Slider	1

Spiny Softshell	3

Totals: 11 species, 74 Individuals

HODGEMAN COUNTY: KHS-2020-09

Jetmore City Lake
1 May 2020, 14:00-14:30
Rock Flipping
Verifier: Travis W. Taggart
Participants: Sarah Taggart
Species Observed

Great Plains Skink	1
Six-lined Racerunner	2
North American Racer	1
Speckled Kingsnake	1
Milksnake	3
Ring-necked Snake	1
Plains Black-headed Snake	1
Ring-necked Snake	1
Plains Gartersnake	1

Totals: 9 species and 12 Individuals

HAMILTON COUNTY: KHS-2020-10

1 May 2020, 17:00-17:30
Verifier: Travis W. Taggart
Participants: Sarah Taggart
Species Observed

Lesser Earless Lizard	1
Milksnake	1
Coachwhip	1
Gophersnake	1
Plains Black-headed Snake	1
Plains Gartersnake	1
Ornate Box Turtle	1

Totals: 7 species and 7 individuals

STANTON COUNTY: KHS-2020-11

Manter Dam
1 May 2020, 19:00-19:45
Verifier: Travis W. Taggart
Participants: Sarah Taggart
Species Observed

Six-lined Racerunner	1
North American Racer	1
Coachwhip	1
Gophersnake	2
Prairie Rattlesnake	1
Plains Hog-nosed Snake	1

Totals: 6 species and 7 individuals

MORTON COUNTY: KHS-2020-12

2 May 2020, 09:00-09:45
Verifier: Travis W. Taggart
Participants: Sarah Taggart
Species Observed

Lesser Earless Lizard	1
Prairie Lizard	2
Glossy Snake	1
Milksnake	1
Coachwhip	1
Gophersnake	1
Prairie Rattlesnake	2
Plains Hog-nosed Snake	1
New Mexico Threadsnake	4
Plains Gartersnake	1
Ornate Box Turtle	1

Totals: 11 species and 16 individuals

SEWARD COUNTY: KHS-2020-13

2 May 2020, 12:00-12:20
Verifier: Travis W. Taggart
Participants: Sarah Taggart
Species Observed

Western Narrow-mouthed Toad	1
Great Plains Skink	1
Six-lined Racerunner	1
Coachwhip	2
Gophersnake	1
Ring-necked Snake	21
Plains Hog-nosed Snake	1
Eastern Hog-nosed Snake	1

Totals: 8 species and 29 individuals

GREENWOOD COUNTY: KHS-2020-14

Beaumont Roadcut
2 May 2020, 13:10-13:30
Drove 6.3 km road with brief flipping.
Verifier: Dexter R. Mardis
Participants: Hannah A. Hoetmer
Species Observed

Eastern Collared Lizard	1
Great Plains Skink	1
North American Racer	1

Totals: 3 species and 3 individuals

COMANCHE COUNTY: KHS-2020-15

Flipped along outcrops of Cheyenne Sandstone and Kiowa Shale
2 May 2020, 16:00-16:45
Verifier: Travis W. Taggart
Participants: Sarah Taggart
Species Observed

Western Tiger Salamander	1
Plains Leopard Frog	1
Great Plains Toad	1
Texas Horned Lizard	2
Prairie Lizard	2
Great Plains Skink	1
Six-lined Racerunner	4

North American Racer	2
Speckled Kingsnake	1
Coachwhip	1
Western Massasauga	1
Eastern Hog-nosed Snake	2

Totals: 12 species and 19 individuals

RUSSELL COUNTY: KHS-2020-16

5 May 2020, 12:45-14:45
Active Searching
Verifier: Curtis J. Schmidt
Participants: Jacob Alexander, Travis Riley, Sandra Guzman, Kayla Wright
Species Observed

Western Narrow-mouthed Toad	1
Slender Glass Lizard	1
Eastern Collared Lizard	5
Great Plains Skink	11
Six-lined Racerunner	4
North American Racer	1
Milksnake	4
Great Plains Groundsnake	12
Plains Black-headed Snake	2

Totals: 9 Species and 42 individuals

McPHERSON COUNTY: KHS-2020-17

McPherson County Sate Fishing Lake
6 May 2020, 15:00-17:00
Active Searching around the lake
Verifier: Melanie Falcon
Participants: Treyton Falcon, Jaycie Falcon, Keaton Leiker
Species Observed

Prairie Lizard	3
Gophersnake	1

Totals: 2 species and 4 individuals.

McPHERSON COUNTY: KHS-2020-18

6 May 2020, 13:30-14:30
Active searching
Verifier: Melanie Falcon
Participants: Treyton Falcon
Species Observed

Blanchard's Cricket Frog	22
Plains Leopard Frog	6
Plain-bellied Watersnake	1
Pond Slider	1

Totals: 4 species and 30 individuals

RUSSELL COUNTY: KHS-2020-19

8 May 2020, 12:45-15:00
Active Searching
Verifier: Curtis J. Schmidt
Participants: Jacob N. Alexander, Kyle Goldwater
Species Observed

Woodhouse's Toad	1
Western Narrow-mouthed Toad	10
Eastern Collared Lizard	12
Prairie Lizard	2
Great Plains Skink	12
Prairie Skink	2
Six-lined Racerunner	8
Milksnake	5
Coachwhip	1
Great Plains Ratsnake	2
Great Plains Groundsnake	9
Plains Black-headed Snake	2
Ring-necked Snake	7
Ornate Box Turtle	1

Totals: 14 Species and 74 individuals

MONTGOMERY COUNTY: KHS 2020-20

Elk City Reservoir
8 May 2020: 15:00-15:30
Rock Flipping
Verifier: J. Daren Riedle
Participants: Tamera Riedle, Zachary Riedle, Greya Riedle
Species Observed

Five-lined Skink	1
Eastern Box Turtle	1
Ornate Box Turtles	1

Totals: 3 species and 3 individuals

ELLIS COUNTY: KHS 2020-21

9 May 2020: 12:00-12:15
Overcast and 72º, Rock flipping on a south and west facing hillside
Verifier: Travis W. Taggart
Participants: Meg Taggart, Amelia Jaeger, Jess Taggart, Karson Flaska
Species Observed

Slender Glass Lizard	1
Texas Horned Lizard	1
Prairie Lizard	2
Great Plains Skink	3
Milksnake	1
Great Plains Ratsnake	1
Plains Black-headed Snake	1

Totals: 7 species and 10 individuals

ELLIS COUNTY: KHS: 2020-22

Kayaking Big Creek from Frontier Park dam to Gross Coliseum and back.
9 May 2020: 13:00-15:00
Verifier: Meg Taggart
Participants: Travis W. Taggart, Jess Taggart, Amelia Jaeger, Karson Flaska
Species Observed

Plains Leopard Frog	4
American Bullfrog	12
Common Watersnake	3
Plains Gartersnake	1
Snapping Turtle	1
Pond Slider	3
Spiny Softshell	2

Totals: 7 species and 26 individuals

MONTGOMERY COUNTY: KHS 2020-23

Montgomery County State Lake
10 May 2020: 10:00-11:00
Rock Flipping
Verifier: J. Daren Riedle
Participants: Tamera Riedle, Zachary Riedle, Greya Riedle, Jim Riedle
Species Observed

Blanchard's Cricket Frog	2
American Toad	1
Ring-necked Snake	4
Western Wormsnake	1
River Cooter	2

Totals: 5 species and 10 Individuals

RUSSELL COUNTY: KHS 2020-24

13 May 2020: 18:00-19:00
Rock flipping both sides of a north-south oriented Canyon
Verifier and Sole Participant: Travis W. Taggart
Species Observed

Boreal Chorus Frog	1+Chorus
Slender Glass Lizard	1
Eastern Collared Lizard	16
Texas Horned Lizard	1
Great Plains Skink	6
Six-lined Racerunner	1
North American Racer	1
Milksnake	11
Great Plains Ratsnake	2
Gophersnake	1
Ring-necked Snake	2
Western Ribbonsnake	1
Snapping Turtle	1

Totals: 13 species and 45 individuals

RUSSELL COUNTY: KHS 2020-25

14 May 2020: 12:15-13:00
Rock flipping along a 0.2 mile stretch of east-southeast facing hillside. Partly cloudy, 72º
Verifier: Travis Taggart
Participants: Dan Fogell, Chris Visser
Species Observed

Slender Glass Lizard	1
Texas Horned Lizard	1
Prairie Lizard	1
Great Plains Skink	2
Prairie Skink	1
Six-lined Racerunner	2
Speckled Kingsnake	1
Milksnake	1
Great Plains Ratsnake	3
Ring-necked Snake	12
Ornate Box Turtle	1

Totals: 11 species and 24 individuals

HARPER COUNTY: KHS 2020-26

Road-cruised 1 pass K58 from K2 to Stateline. Half of road was blacktop.
Temp 64º, humidity 87%, dew pt. 60
16 May 2020: 10:00-10:30
Verifier and sole participant: Travis W. Taggart
Species Observed

Great Plains Toad	23
Woodhouse's Toad	36
Strecker's Chorus Frog	29
Plains Leopard Frog	2
Plains Spadefoot	45

Totals: 5 species and 135 individuals

SEWARD COUNTY: KHS 2020-27

Arkalon Park, starting temp 81ºF, ending temp 93ºF
5 June 2020: 8:00-10:00
Verifier: Meg Taggart
Participant: Travis W. Taggart
Species Observed

Great Plains Toad	4
Woodhouse's Toad	1
Plains Leopard Frog	5
American Bullfrog	11
Lesser Earless Lizard	2
Prairie Lizard	6
Great Plains Skink	3
Six-lined Racerunner	1
North American Racer	1
Coachwhip	1
Gophersnake	1
Prairie Rattlesnake	1
Ring-necked Snake	2
Plain-bellied Watersnake	2
Western Ribbonsnake	1
Plains Gartersnake	1
Snapping Turtle	1
Pond Slider	23
Yellow Mud Turtle	1
Spiny Softshell	3

Totals: 20 species and 71 individuals

BARTON COUNTY: KHS-2020-28
Cheyenne Bottoms
30 June 2020: 11:30-12:00
Road Cruising levee roads
Verifier and sole participant: J. Daren Riedle
Species Observed

Graham's Crayfish Snake	1
Western Ribbonsnake	1
Plains Gartersnake	1
Pond Slider	10

Totals: 4 species and 13 individuals

HARVEY COUNTY: KHS-2020-29
Red Coach Inn, Newton, KS
11 July 2020: 23:15-23:40
Verifier: Travis W. Taggart
Participants: Jesse Taggart
Species Observed

Woodhouse's Toad	1
Mediterranean Gecko	5

Totals: 2 species and 6 individuals

MONTGOMERY COUNTY: KHS-2020-30
Elk City Reservoir
4 September 2020: 15:00-15:45
Verifier: J. Daren Riedle
Participants: Tamera Riedle, Zachary Riedle, Greya Riedle
Species Observed

Five-lined Skink	1
Snapping Turtle	1
Coachwhip	1

Totals: 3 species and 3 individuals.

MONTGOMERY COUNTY: KHS-2020-31
Ralph Mitchell Zoo, Independence, KS
6 September 2020: 11:15-11:30
Verifier: J. Daren Riedle
Participant: Greya Riedle
Species Observed

Five-lined Skink	2

Totals: 1 species and 2 individuals.

ELLIS COUNTY: KHS-2020-32
Road Cruising northern Ellis County, 64 miles.
13 September 2020: 13:45-15:45
Verifier: Curtis J. Schmidt
Participant: Jacob Alexander
Species Observed

Slender Glass Lizard	2
Six-lined Racerunner	1
North American Racer	1
Coachwhip	2
Eastern Hog-nosed Snake	3
Plains Gartersnake	1
Lined Snake	1

Totals: 7 species and 11 individuals

PRATT COUNTY:KHS-2020-33
Hiking trails behind the Kansas Dept. of Wildlife, Parks, and Tourism Office
2 October 2020: 13:45-14:25
Verifier and sole participant: J. Daren Riedle
Species Observed

Plains Leopard Frog	7
American Bullfrog	5
Western Ribbonsnake	1
Painted Turtle	1
Pond Slider	2
Yellow Mud Turtle (Shell Only)	1

Totals: 6 Species and 17 individuals

STAFFORD COUNTY: KHS-2020-34
Quivira National Wildlife Refuge
Counted herps along the road while bird watching.
31 October 2020: 11:30-15:30
Verifier: J. Daren Riedle
Participants: Tamera Riedle, Greya Riedle, Zachary Riedle
Species Observed

Plains Leopard Frog	2
North American Racer	1
Gophersnake	1
Western Massasauga	1
Dekay's Brownsnake	1
Western Ribbonsnake	1
Plains Gartersnake	9
Common Gartersnake	36
Pond Slider	3

Totals: 9 Species and 55 individuals

Articles

Environmental Factors Associated with Breeding in Four Anuran Species in South-Central Pennsylvania

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Abstract- We made 144 visits to a permanent pond in south-central Pennsylvania during March 2015–November 2016 to determine environmental factors associated with timing of oviposition in four anuran species. Egglaying by the Bullfrog, *Lithobates catesbeianus*, was initiated in June at threshold average maximum and minimum air temperatures of 25.4 and 15.6 ºC, respectively. Egglaying by the American Toad, *Anaxyrus americanus,* and the Northern Green Frog, *L. clamitans melanota*, was initiated in May of both years at threshold average maximum and minimum air temperatures of 19.8 and 9.8 ºC, respectively. Egglaying by the Pickerel Frog, *L. palustris*, peaked in April of both years but began in March one year with threshold average maximum and minimum air temperatures of 13.1 and 0.7 ºC, respectively. Water temperature associated with calling, amplecting pairs, and freshly-laid eggs was at least 14 ºC in Pickerel Frogs, and 22–23 ºC in Northern Green Frogs. Beginning approximately one month since egglaying, toadlets of the American Toad were seen during 15–30 June. Northern Green Frog tadpoles born the previous year transformed during 20 May–24 July. Pickerel Frog metamoprhs of that year were seen during 27 June–28 July, approximately three months since oviposition. It remains to be seen if lower thresholds exist in these values for this population. As long as these populations adhere to these thresholds, predictability in breeding times is possible across space and over time, an issue no longer relatively static in light of global climate change in a region predicted to continue on its present trajectory of warmer and wetter climate.

Introduction

Basic ecological information is lacking for many of Pennsylvania's amphibians despite ubiquity of many of them. Four species, the American Toad (*Anaxyrus americanus*), the Bullfrog (*Lithobates catesbeianus*), the Northern Green Frog (*L. clamitans melanota*), and the Pickerel Frog (*L. palustris*), are widespread in geographic distribution in the mid-Atlantic region and in Pennsylvania (Powell e al., 2016). Aspects of reproductive ecology are known from specific locations in Pennsylvania in the former three species (Meshaka, 2011, 2013; Meshaka and Hughes, 2014; Meshaka et al., 2015, 2016, 2017) and statewide for the latter species (Meshaka et al., 2012). Reproductive characteristics of each of these species adheres to latitudinal trends with respect to timing of breeding and appearance of tadpoles or young of the year (YOY). Environmental thresholds have been demonstrated to be helpful in predicting likelihoods of breeding along a latitudinal gradient (e.g., Meshaka and Woolfenden, 1999; Meshaka and Layne, 2015). Our goal was to provide data for these four species in Pennsylvania from which to add predictive power of breeding likelihood and to relate to future seasons in light of a regional climate whose trajectory is to increase in warmth and precipitation (Ning et al., 2015; Polsky et al., 2000).

Study Site and Methods

Established in 1999 through a donation by Alexander Boyd, Boyd Big Tree Preserve Conservation Area encompasses 384.25 ha. in Lower Paxton and Middle Paxton townships, Dauphin County, Pennsylvania (40º 21'18'N -76º

51’29’W). The property is situated on Blue Mountain at 264 m in elevation. The habitat is mature mixed deciduous trees. A spring-fed pond (Figure 1), 225 m in circumference, served as the study site. The pond’s extensive littoral zone varied in the density of submergent aquatic vegetation. The pond was approximately 2–3 m in maximum depth. The pond froze during January through early March 2015 and during the latter one-half of January–February 2016 (Figure 1). Largemouth Bass (*Micropterus salmoides*) and *Lepomis* species were observed in the pond. Reproduction was confirmed in the Bullfrog (*Lithobates catesbeianus*), Northern Green Frog (*L. clamitans melanota*), Pickerel Frog (*L. palustris*), and American Toad (*Anaxyrus americanus*), and calling was heard by the Spring Peeper (*Pseudacris crucifer*). The Northern Water Snake (*Nerodia sipedon sipedon*) was observed at this pond.

The perimeter of the pond was walked during the day at an average of 7.2 times each month during 10 March–28 December 2015 and 2 January–11 November 2016. Water levels were especially high during 27 June 2015–7 August 2015 but did not impede surveys. The 144 walks averaged 24 minutes (±12; range = 5–60). At the beginning of each survey, water temperature was measured in the same portion of the littoral zone where each survey began. Frogs and toads within 1 m on either side of the shoreline were counted. Calling was noted, and egg masses of the ranid frogs were counted. American Toad eggs, laid in long strings, tadpoles, and metamorphic individuals were noted as present/absent. Weather data were accessed from climod2.nrcc.cornell.edu of NOAA Regional Climate Centers using weather station 363698 (Coop) USC00363698 (GHCN) HRBP1 (NWS LI) located at 40.2817, -76.8703 at an elevation of 128 m. All statistics were performed on Excel. Statistical significance was recognized at $P < 0.05$.

A

B

Figure 1. The study pond at Boyd Big Tree Preserve Conservation Area, Dauphin County, Harrisburg, Pennsylvania in 12 March 2015 (A) and 9 October 2015 (B). Photographs by M.A. Morales.

Results

Anaxyrus americanus- A single adult American Toad was seen on each of 7 and 26 May 2015. Egg masses were seen during 28 May–26 June 2015 and 16 May–7 July 2016. Freshly-laid eggs were found in shallow water of 17–31 ºC. First clutches of 2016 were localized in a 2.64 X 2.64 m shallow portion of the pond. The respective lowest monthly mean maximum and minimum air temperatures, monthly rainfall volumes (Fig. 2), and daylength associated with the presence of eggs were 19.8 ºC, 9.8 ºC, 4.3 cm, and 14.24 hrs. Tadpoles were seen during 24 May–6 June 2015, and recently metamorphic individuals were seen during 15–30 June 2016, the earliest of which were seen one month since the first eggs were laid. Adults and eggs were first detected in May of both years when daylength was 14.24 and 14.25 hours, respectively.

Lithobates catesbeianus-Bullfrogs were heard calling during 29 June–29 July 2015. Egg masses were seen during 1–15 June 2015 and 2 June 2016. Calling days were associated with water temperatures of 26 ºC (n = 2) and 27

ºC (n = 2). Three freshly laid clutches were laid in shallow water of 27 ºC each on a different day. A fourth fresh clutch was in water of 30 ºC. The respective lowest monthly mean maximum and minimum air temperatures, water temperatures (Fig. 2), and daylength associated with calling and oviposition were 25.4 ºC, 15.6 ºC, 25.4 ºC, 15.01 hrs. The minimum monthly volume of rainfall associated with calling (7.9 cm) was lower than that associated with oviposition (14.9 cm).

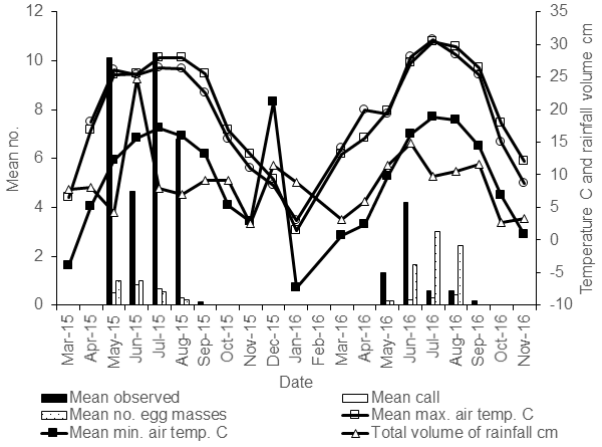

Figure. 2. Monthly distribution of Northern Green Frog (*Lithobates clamitans melanota*) reproductive activity and associated monthly totals of rainfall and means of air and water temperatures at Boyd Big Tree Preserve Conservation Area, Dauphin County, Harrisburg, Pennsylvania during March 2015–November 2016.

Individuals were active, and eggs were laid in water that ranged 22–32 ºC. Respective modes were 28 and 31 ºC (Fig. 3). Adults were found in and out of the water when water temperatures averaged (26.9 ± 2.4 ºC; range = 22–32; n = 349), and individuals were active in similar numbers (Chi-square = 0.645, P > 0.05) with (47.9%) and without cloud (52.2%) cover. One amplecting pair was found in water of 23 ºC, and three others were found in water of 28 ºC. Calling was heard in water temperatures ranging 22–32 ºC. A significant correlation was found between number of clutches and water temperature (multiple r = 0.66, P = 0.002). The respective lowest monthly mean maximum and minimum air temperatures, mean water temperature, monthly rainfall volumes (Fig. 2), and daylength associated with active Northern Green Frogs were 19.8 ºC, 9.8 ºC, 19.3 ºC, 4.3 cm, and 14.24 hrs.

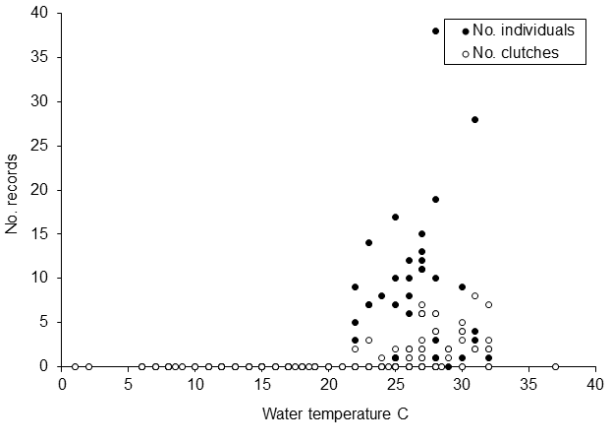

Figure 3. Water temperatures associated with numbers of individuals and egg masses of the Northern Green Frog (*Lithobates clamitans melanota)* from Boyd Big Tree Preserve Conservation Area, Dauphin County, Pennsylvania, during March 2015–November 2016.

Lithobates palustris- Pickerel Frogs were active during 6 April–8 September 2015 and 25 March–28 July 2016, and the mean monthly encounter rates were higher in 2016 (Figure 4). Calling was heard during 25 March–20 April 2016. Amplecting pairs were seen 6 (n = 1) and 26 (n = 1) April 2015 and 25 (n = 1) and 31 (n = 3) March 2016. Egg masses were seen during 13–20 March 2015 and 25 March–18 May 2016, and more egg masses were recorded in 2016 (Figure 4). The highest number of fresh clutches for each year was 100 clutches on 16 April 2015 and 61 clutches on 2 May 2016. A Red-spotted Newt, *Notophthalmus viridescens viridescens*, was observed eating eggs in one of the two clutches on 25 March 2016. Recently metamorphic individuals were seen during 13 July–7 September 2015 and 27 June–28 July 2016, the earliest of which were seen three months since the first eggs were laid.

Individuals were active in water temperatures ranging 14–31 ºC, and eggs were found in water temperatures ranging 14 - 24 ºC (Fig. 5). Respective modal water temperatures were 16 and 17 ºC. Water tempera-

tures associated with calling (n = 4) ranged 14–23 ºC. Four amplecting pairs were found in water that ranged 14–19 ºC. Adults were found in and out of the water during breeding when water temperatures averaged 19.0 ºC (± 3.7; range = 14–26; n = 458). Found later in the year, recently-transformed individuals were found in and out of the water at water temperatures averaging 29.8 ºC (± 3.8; range = 25–37; n = 29). The respective lowest monthly mean maximum and minimum air temperatures, mean water temperature, monthly rainfall volumes (Fig. 4), and daylength associated with activity and oviposition were 13.1 ºC, 0.7 ºC, 14.0 ºC, 3.1 cm, and 11.57 hrs.

A sample of adult males (mean = 55.1 ± 4.0 mm SVL; range = 49.5–63.6; n = 19) and females (mean = 69.1 + 9.2; range = 61.2–80.8; n = 4) were collected on 31 March and 12 April 2016. Female body SVL followed in parentheses by estimated clutch size, relative clutch mass (RCM), and mean ovum diameter for two of the gravid females are as follows: 61.2 mm SVL (1525.0, 23.12%, 1.8 ± 0.2; range = 1.5–2.1; n = 10) and 62.3 mm SVL (1079.1, 21.27%, 1.9 + 0.2; range = 1.7–2.2; n = 10).

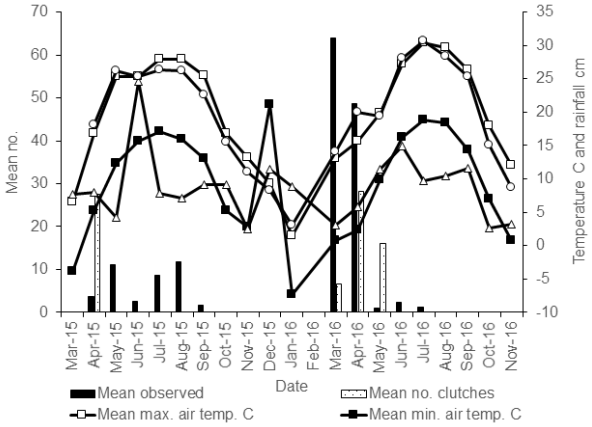

Figure. 4. Monthly distribution of Pickerel Frog (*Lithobates palustris*) reproductive activity and associated monthly totals of rainfall and means of air and water temperatures at Boyd Big Tree Preserve Conservation Area, Dauphin County, Harrisburg, Pennsylvania from March 2015–November 2016.

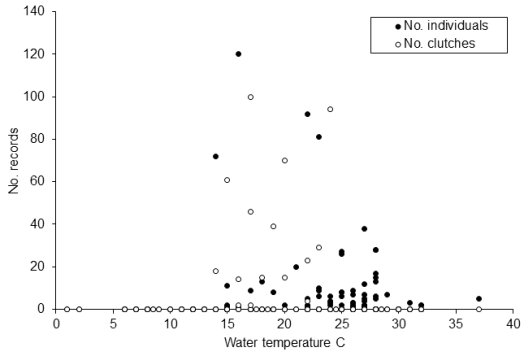

Figure 5. Water temperatures associated with numbers of individuals and egg masses of the Pickerel Frog (*Lithobates palustris*) from Boyd Big Tree Preserve Conservation Area, Dauphin County, Pennsylvania, during March 2015–November 2016.

Discussion

This study quantified the relationships between weather conditions and certain aspects of reproduction in four anuran species from a single site during two consecutive years. Temperature and rainfall can have predictable effects on calling and egglaying, including geographic trends (Meshaka and Woolfenden, 1999; Meshaka and Layne, 2005, 2015). For most species examined, calling seasons predictably decreased in seasonal length concomitant with ever-narrowing seasonal durations of climatic thresholds acceptable for reproductive activity (Meshaka and Layne, 2015). For example, the breeding season of the Eastern Narrowmouth Toad, *Gastrophryne carolinensis*, ranged longest in Southern Florida, with thresholds for temperature and rainfall associated with its breeding matching shorter northern seasons in the literature (Meshaka and Woolfenden, 1999; Meshaka and Layne, 2015). Its breeding season in Arkansas (Trauth et al., 1999) did not conflict with these patterns. This geographic pattern in reproductive phenophases is also evident in Green Frogs, Bullfrogs, and, American Toads, and among the two ranids peak reproductive activity centered on the warmer months (this study; Meshaka, 2011, 2013; Meshaka and Hughes, 2014; Meshaka et al., 2015, 2016, 2017).

A somewhat different pattern in latitudinal variation in reproductive phenophases in

Table 1. Monthly temperature and rainfall thresholds associated with reproduction-related activities in four anuran species at Boyd Big Tree Preserve Conservation Area, Dauphin County, Harrisburg, Pennsylvania during March 2015–November 2016.

Species	Daylength (hr)	Max. air temp. (ºC)	Min. air temp. (ºC)	Water temp. (ºC)	Rainfall vol. (cm)
			Anaxyrus americanus		
Oviposition	14.24	19.8	9.8	19.3	4.3
			Lithobates catesbeianus		
Call	15.01	25.4	15.6	25.4	7.9
Oviposition	15.01	25.4	15.6	25.4	14.9
			L. clamitans clamitans		
Adults	14.24	19.8	9.8	19.3	4.3
Call	14.24	19.8	9.8	19.3	4.3
Ovipostion	14.24	19.8	9.8	19.3	4.3
			L. palustris		
Adults	11.57	13.1	0.7	14.0	3.1
Ovipostion	11.57	13.1	0.7	14.0	3.1

eastern anurans is evident in northern species whose threshold temperatures associated with breeding are lower than aforementioned species, whereby breeding is extended in the South, beginning in late winter, while taking place in spring–early summer in the North (Dodd, 2013). For example, the Northern Leopard Frog breeds primarily during March or April–May (Redmer, 2005; Meshaka et al., 2011); however, in New Mexico, breeding extends longer during much of spring–fall, exclusive of August (Rorabaugh, 2005).

Southern Leopard Frog, *Lithobates sphenocephalus*, breeding season in northerly populations is associated with late-summer–fall, spring, or fall and spring (Butterfield et al., 2005), ceasing or declining in the winter (Dodd, 2013), in association with cooler temperatures than the aforementioned counterparts, thereby avoiding cold winter and hot summer temperatures (Meshaka and Layne, 2015). Extreme southeastern populations, on the other hand, undergo essentially year-round breeding; however, calling and oviposition are concentrated during fall–spring (Caldwell, 1986; Meshaka and Layne, 2015), and summer calling is sparse and heard primarily in the cool hours before dawn in the lowest latitudes (Meshaka and Layne, 2015).

The geographic pattern to the breeding season in the Pickerel Frog resembles that of leopard frogs, whereby breeding is restricted to spring in the North and commences earlier and continues longer by extending over winter–spring in southern latitudes (Redmer, 2005; Meshaka et al., 2012). Findings in our study corroborate this pattern. Our data corroborate the breeding temperatures associated northern species result in geographic trends whereby seasons hue towards the cooler parts of the year, with the opposite pattern evident in the southern species.

The utility of meteorological data in understanding triggers associated with breeding among anurans of a local assemblage has been recognized for a long time (e.g., Wright, 1931; Blair, 1961; Wiest, 1982) as well as the importance of water temperature on anuran egg viability (Moore, 1939, 1942). The environmental thresholds associated with various reproductive phenophases reported from our study revealed three thermal groupings associated with reproductive activities: warm (Bullfrog), intermediate (American Toad, Green Frog), and cool (Pickerel Frog). These groupings agree with comparative data from Pennsylvania and elsewhere. For example, Bullfrogs call when air temperature > 21 ºC and water temperature > 20 ºC (Fitch, 1956). In south-central Pennsylvania, Bullfrogs call at night during June–July in air temperatures averaging 20.1 ºC (Meshaka et al. 2015). Intermediate air temperatures averaging 19.3 ºC in southwestern Pennsylvania (Meshaka et al., 2016) and at least 12.8 ºC on an island in south-central Pennsylvania (Meshaka and Wingert, 2016) were associated with calling in the American Toad. Among

Northern Green Frogs, air temperatures associated with nocturnal calling averaged 20.1 ºC during May–August (Meshaka, 2013) and 20.6 ºC during May–July (Meshaka and Wingert, 2016) in south-central Pennsylvania. In Nova Scotia, calling takes place in water > 22 ºC (Oseen and Wassersug, 2002). Bronze Frogs, *L. c. clamitans*, call in air temperature minima of 20.0–23.9 C and maxima of 31.1–34.4 ºC in the Okefinokee (Wright, 1931) and in ambient air temperatures of 11–29 ºC, but mostly 22–24 ºC, in southern Louisiana (Meshaka et al., 2009). Cooler ambient temperatures are required for reproductive activity in the Pickerel Frog. In south-central Pennsylvania, air temperatures associated with May and July calling averaged 18.2 ºC (Meshaka and Wingert, 2016), and water temperatures of 7–10 ºC initiated migrations in Louisiana (Hardy and Raymond, 1991).

Importance of precipitation in calling and oviposition, as with temperatures, varies among species (Wright, 1931; Blair, 1961; Meshaka and Layne, 2015), and differences in thresholds of monthly rainfall totals associated with reproduction were evident among the species of this study as well (Table 1). Timing associated with these thresholds being met varies geographically, accounting for geographic differences in calling seasons, and temporally which is evident in cold or dry years.

It is logical then to expect shifting reproductive seasons as climate changes with species seemingly chasing a combined range of environmental conditions. The Mid-Atlantic region has become warmer and wetter over the past century, and this trend is expected to continue for the region (Polsky et al., 2000) with greater increase in precipitation in summer (Crane and Hewitson, 1998; Polsky et al., 2000). Rainfall data analyzed from 17 sites in Pennsylvania point to increased trends in annual precipitation for Pennsylvania in the middle of the 21st century (Ning et al., 2012). The Northeast, at the end of 21st century, will experience more warm temperature extremes, fewer cold temperature extremes, and more and intense precipitation extremes, resulting in an extended growing season with more days with rainfall exceeding 10 mm (Ning et al., 2015).

Akin to expectations that Southern Leopard Frogs of Virginia will adopt a more southerly pattern of reproductive season in the face of climate change (Hughes et al., 2017), the same we proffer is true of the species of this study in Pennsylvania as species match their reproductive activities with the changing climate. In the short-term, atypical fluctuations in temperature and rainfall might be tolerated by these species because of variation in their breeding strategies. However, seasonal changes in timing of environmental thresholds associated with reproduction and changes in thresholds by the species themselves will determine the extent to which climate change will be barriers or pathways to their continual survival.

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Failed colonization by the Mediterranean Gecko (*Hemidactylus turcicus*)

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Exotic species are increasingly becoming an important consideration for biodiversity scientists and professionals. Invasion by exotics follows four stages (Vankat and Roy 2002): 1) Introduction, when it becomes part of the regional species pool; 2) Dispersal, the movement of individuals into new areas of the region; 3) Colonization, the founding of a new population in the region; and 4) Establishment, a breeding thriving population is now present. A species must pass through filters as it moves from one stage of invasion to the next. One common filter is distance. Island biogeography predicts that successful immigration into a new habitat by potential colonists is inversely related to the distance that colonist must travel to arrive at the new habitat (MacArthur and Wilson 1967). This distance can be bridged as humans move species at high speeds and often under environmentally controlled situations around the world. General ecological theory predicts that any mechanism that reduces isolation between the source population and an uncolonized habitat should also stimulate movement of organisms from the source to the virgin habitat (Collinge 2000). Human transportation is one obvious factor that can reduce this isolation and promote colonization by exotic species, yet little is known about how easily some species travel as stowaways with humans.

Incidences of failed colonization opportunities typically go unnoticed and unreported (Lodge 1993, Stoker 1994, Gido and Brown 1999, Arii and Parrott 2006) so there are very few reports in the literature (Brown et al. 2008). Most examples of failed colonization by exotic species are known from anecdotal personal communications (e.g. A failed *Lithobates catesbeianus* colonization noted via personal communication in Giovanelli et al. 2007). However, Daphnia exilis successfully colonized Onondaga Lake, New York in the 1920s and subsequently failed to become permanently established when it disappeared in the 1980s due to environmental changes in the lake (Hairston et al. 1999). Wood Swallows were introduced into Otago (New Zealand) in the 1970s (Child 1974, 1975), but failed to establish, possibly due to the extreme cold at night (Wood 1998, Powlesland 2002, Neuhauser and Cuming 2007). The Myna Bird was introduced to the United States but failed to colonize, likely because of its unique incubation method (Krebs 2007). Isolated observations of Black Racers (*Coluber constrictor*) at Acadia National Park in the 1970s (McCrystal 1998) were probably a failed colonization (Brotherton et al. 2004). A failed introduction of *Anolis carolinensis* to Sand Island, Midway Atoll is known but unexplained (Muensch et al. 2006). Observations of failed colonizations provide us with the often ignored data that explains how effectively filters prevent dispersal from

an introduced population to an acceptable habitat where establishment may occur.

The Mediterranean Gecko (*Hemidactylus turcicus*) is a small lizard native to southern Europe and whose general biology as an exotic is well known (Meshaka 2011). It represents one of the most successful exotic species having populations established in every continent except Antarctica. In North America, it occurs in much of the Southeast United States (Meshaka 2006). Among the possible dispersal agents for *H. turcicus*, the most probable as a stowaway with humans (Conant and Collins 1998, Meshaka et al. 2004). In fact, their distribution in the United States often follows the primary highway systems (Davis 1974, Meshaka 1995, Meshaka 2006). However, much information about how this species disperses is either speculative or indirectly deduced and focuses on transport of the eggs rather than adults or juveniles (Selcer 1986). There appears to be only a single report of dispersal by this species that does not involve transport of the eggs, and this was delivery of a juvenile in the mail by the U.S. Postal Service (McCallum et al. 2008). This report also mentions locals in Shreveport, Louisiana that deliberately establish colonies on homes to control insects.

The contents of a garage in which a robust population of Mediterranean Geckos existed were placed into the unheated cargo area of a moving truck for shipping. Many of the 117 boxes were inadvertently loosely sealed due to age, which allowed geckos to easily enter. The boxes had been in the garage from July 2003 – January 2012. The truck carried the boxes from Texarkana (Liberty Eylau), Texas to Kansas City, Missouri in January 2012. The truck remained packed at the depot for two weeks and then all contents were carried to Holden, Missouri and unloaded into a new house. The weather conditions in Texas were sufficiently warm that geckos were actively foraging, however in Missouri it was cold with snow on the ground, although exact temperature data were not available.

Upon unpacking the boxes from February – April 2012, one loosely sealed box containing books contained a tailless dead and dehydrated adult Mediterranean Gecko (SVL = 53 mm). After searching the remaining 14 boxes, we discovered a young-of-the-year juvenile gecko (SVL = 14 mm) in a second box, and an adult (SVL = 61 mm) and an older non-mature juvenile (SVL = 38mm) in a third box. All were dead (Fig. 1). No geckos had been observed in the other boxes, and there was no evidence of living geckos surviving the trip 48 months later (June 2016). While living at the home in Texarkana, we often found live geckos in boxes of stored belongings.

The established population of Mediterranean Geckos in Texarkana was sufficiently large (McCallum and McCallum 2014) to expect stowaways in our belongings, so we were watching for them throughout the unpacking process. It is likely that these individuals entered the boxes alive and succumbed to the cold weather at the truck depot in Kansas City (January – February 2012). Upon arrival at our home, they were probably already dead because the animals were partially mummified, but some soft parts were still remaining. Had we moved the boxes during a warmer time, these animals would likely have survived the trip and have passed the second stage of invasion. Whether they could have survived the outdoor climate of northwestern Missouri is doubtful, but they certainly could have survived if they had been introduced into the partially-heated basement or crawlspace in the home. This would have provided sufficient warmth and insect prey to establish a small colony. However, the ability of this species to further expand in this region seems very questionable.

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Notes

Fall Mating in the Eastern Gartersnake, *Thamnophis sirtalis sirtalis*, in South-Central Pennsylvania

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Mating in the Eastern Gartersnake, *Thamnophis sirtalis sirtalis*, occurs most often during April–May in Pennsylvania, and mating aggregations can form comprising multiple males (Hulse et al., 2001). Less frequently, mating can also occur September– October (Hulse et al., 2001). Sperm production in summer is used for some Fall matings but most are stored overwinter for Spring mating (Seigel, 1996; Clesson et al., 2002). To that end, incidences of male-female groups in southwestern Pennsylvania were highest in June and continuous thereafter with an apparent second smaller peak during August–September (Meshaka, 2009). The scarcity of published reports of Fall mating in Pennsylvania prompted us to describe breeding activity by Eastern Gartersnakes on a Fall day at a site in south-central Pennsylvania.

In conjunction with archaeological research led by Dr. Kurt Carr at the Fort Hunter Mansion and Park, a county park in Harrisburg, Dauphin County, courtship activity was observed by three males and a female (Figure 1A) and copulation by a pair (Figure 1B) on the ground at 1400 hrs on 14 October 2020. The sky was nearly cloudless, and the air temperature was approximately 18.3–21.1 °C. The four snakes were alongside the stonewall of the milk house where it may have been warmer, and two additional males were resting on the stonewall close to the courting aggregation. Eastern Ratsnakes, *Pantherophis alleghaniensis*, are usually seen by the researchers in and on the milk house in October, where they are presumed to overwinter. Encounters with individual Eastern Gartersnakes near the milk house and in the immediate surrounding field site are common during October excavations by the Archaeology crew. Consequently, our observation represents a first record of Fall mating from this site during uninterrupted Fall research at the site over the past 14 years and corroborates the published pattern of less frequent Fall mating of the Eastern Gartersnake in northern climes.

A

B

Figure 1. A (A) mating aggregation of Eastern Gartersnakes, *Thamnophis sirtalis sirtalis*, and (B) a pair of that group in copula observed at Fort Hunter Park, Harrisburg, Dauphin County, Pennsylvania, on 14 October 2020. Photographs by (A) C. Holmes and (B) K. Sebestyen.

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The KHS is a non-profit organization established in 1974 and designed to encourage education and dissemination of scientific information through the facilities of the Society; to encourage conservation of wildlife in general and of the herpetofauna of Kansas in particular; and to achieve closer cooperation and understanding between herpetologists, so that they may work together in common cause. All interested persons are invited to become members of the Society. Membership dues per calendar year are $15.00 (U.S., Regular), $20.00 (outside North America, Regular), and $20.00
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KHS Meetings
The KHS holds an annual meeting in the fall of each year. The meeting is, minimally, a two day event with lectures and presentations by herpetologists. All interested individuals are invited to make presentations. The annual meeting is also the time of the Saturday night social and fund-raising auction.

Field Trips
The KHS hosts three field trips each year, one each in the spring, summer, and fall. Field trips are an enjoyable educational experience for everyone, and also serve to broaden our collective understanding of the distribution and abundance of the amphibians, reptiles, and turtles in Kansas. All interested persons are invited to attend.

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Collinsorum, currently issued as submissions warrant, publishes all society business.

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As space allows, *Collinsorum* publishes all manner of news, notes, and articles. Priority of publishing is given to submissions of Kansas herpetological subjects and by KHS members; however all submissions are welcome. The ultimate decision concerning the publication of a manuscript is at the discretion of the Editor. Manuscripts should be submitted to the Editor in an electronic format whenever possible. Those manuscripts submitted in hard copy may be delayed in date of publication. Manuscripts should be submitted to the Editor no later than the 1st of the month prior to the month of issuance. All manuscripts become the sole possession of the Society, and will not be returned unless arrangements are made with the Editor.

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Individuals selected as Distinguished Life Members are chosen by the KHS Executive Council based on their distinguished published research papers on Kansas herpetology.

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