Missouri Herpetological Association

Newsletter

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Contents

Cover: Basking turtles in Bear Creek near Hannibal, MO. Commercial harvesting has contributed to the decline in freshwater turtle populations worldwide. Recently, Missouri Department of Conservation has changed the regulations on commercial harvest in Missouri. See related article on page 14.

INTRODUCTION

The Thirty-first Annual Meeting of the **Missouri Herpetological Association** was held 29-30 September 2018 at the **Bull Shoals Field Station**, in Taney County, Missouri. This organization is designed to provide herpetologists in Missouri and surrounding states with an opportunity to meet and exchange ideas regarding current efforts in research and other professional activities. High on the list of priorities is to provide students, involved in research at either the graduate or undergraduate level, (1) the chance to interact with senior herpetologists, and (2) an outlet to present, in a semi-formal setting, the results of their labors.

This newsletter is the result of a decision made at the inaugural meeting to provide a means of publicly acknowledging papers presented at this and subsequent annual meetings. Further, the newsletter will inform the herpetological community of new distribution records of Missouri's herpetofauna, additions to the bibliography dealing with the state herpetofauna and provide an outlet for the publication of short notes dealing with the natural history of Missouri amphibians and reptiles.

ANNOUNCEMENTS

32nd Annual Meeting of the Missouri Herpetological Association

The Thirty-second Annual Meeting of the Missouri Herpetological Association will be held 28-29 September 2019. Next year we will return to the **Reis Biological Station** in Crawford County near Steelville, Missouri. The "call for papers" will be sent electronically in mid-July. For more information, please contact **Jeff Briggler** at:

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MHA on the Net

The Association has an official site on the Internet. Point your browser to https://mha.moherp.org/ for copies of current and past publications and to view photos and information from past field trips and meetings. Send ideas, suggestions, comments, and content to the Webmaster (webmaster@moherp.org).

Abstracts of Papers Presented at the 31st Annual Meeting of the Missouri Herpetological Association

Bull Shoals Field Station
29-30 September 2018

EFFECTS OF DRIFT ON PHENOTYPIC COVARIATION IN THE EASTERN COLLARED LIZARD (*Crotaphytus collaris*)

Andrew Feltmann, Emily Field, and Matthew Gifford
Biology Department, University of Central Arkansas, Conway, AR

Genetic drift is an important mechanism for evolutionary change between populations of the same species. The effects of drift can be profound and measurable in relatively short time scales, especially if there is no dispersal between patches. These effects result from the dispersal of a small number of organisms to a new patch causing a new genetic constitution based on the population that dispersed to the new patch, potentially causing a shift in phenotypic covariances. This project will test for phenotypic differentiation as a consequence of repeated founder events and drift in populations of Eastern Collared Lizards (*Crotaphytus collaris*) located on Stegall, Thorny and Mill Mountains in south-central Missouri. Qualitatively, male *C. collaris* on Thorny Mountain are different phenotypically than their Stegall Mountain. Jennifer Neuwald and Alan Templeton identified distinct genetic groups within a single mountain's glade complex. This suggests limits to gene flow among different glade clusters, potentially leading to an environment favoring phenotypic differentiation. I will examine the relative role of genetic drift in contributing to phenotypic variation. I will use the known colonization history of individual glades within and between mountains to test whether lizards inhabiting glades on the same mountain are more similar to one another than they are to lizards inhabiting glades on other mountains. Preliminary results suggest that there are differences in overall morphological and performance characteristics between sexes and mountains, supporting the idea that drift has had an impact on the phenotypic diversity between the two mountains. The data generated in this project will permit a better understanding of how genetic drift influences phenotypic differentiation within a metapopulation where dispersal is common between patches (glades) but rare between populations (among mountains).

THE FAST AND THE HUNGRY: FAST LIZARDS MISS OUT ON MEALS…SOMETIMES

David Adams[1] and Matt Gifford[2]
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Speeds chosen by an animal while performing tasks, like predator evasion and foraging, are dependent on a number of internal and external factors. Environmental conditions like habitat complexity, slope, visibility, and substrate should have influence over the movement speeds of animals. In addition, a functional tradeoff between speed and maneuverability should also constrain animal locomotion. Understanding the relationships between these factors and their impact on an animal's movement can help us better predict the speeds used by animals while performing tasks necessary for survival. Looking specifically at foraging, in more complex habitats both visibility and locomotion should be constrained; and foraging speed should be associated with prey capture success. Given these functional and environmental constraints, we first predicted that average velocities during successful foraging attempts would be slower than unsuccessful attempts. In addition, we predicted that increasing habitat complexity would eliminate the difference in speeds used in successful and unsuccessful foraging attempts. To test these predictions, we video recorded Prairie Lizards (*Sceloporus consobrinus*) in experimental enclosures and analyzed the speeds and distances they used while foraging. We exposed lizards to three habitat configurations. The open enclosure had no obstacles, while the other two had vertical dowels spaced at different intervals (one evenly-spaced and one clustered). Prey detectability and mean foraging velocity were significantly influenced by enclosure type. Consistent with our predictions, successful foraging attempts were significantly slower than unsuccessful ones. Finally, the difference in foraging speed between successful and unsuccessful attempts was dependent on the habitat configuration. This study emphasizes that functional constraints dominate in simple environments and that environmental constraints become more important with increasing habitat complexity.

RELOCATING TRAPS WITHIN A WETLAND INCREASES TRAPPING SUCCESS

Ethan C. Hollender[1], Donald T. McKnight[2], and Day B. Ligon[1]
[1]Department of Biology, Missouri State University, Springfield, Missouri
[2] College of Science and Engineering, James Cook University, Townsville, Queensland, Australia

To accurately assess the size and composition of a turtle community, it is necessary to maximize the proportion of individuals captured and marked. To determine whether regularly relocating traps in a wetland can improve capture rates, we simultaneously deployed two sets of eight traps in a small Kansas pond in the Mined Lands Wildlife Area. In one group, traps remained in their original locations for 35 days. In the other, traps were moved to new locations after 14 days, then returned to their original positions after a further 14 days. During the first period, there was no significant difference in capture rates between groups. During the second period, traps that had been moved captured 2.18 times more turtles than stationary traps, a difference that was statistically significant ($p = 0.005$). In the final period of 7 days, with all traps back in their original positions, traps that had been moved captured 2.10 times more turtles than traps that had been

stationary (p = 0.035). Our results demonstrate that trap relocation is an important component of maximizing trapping success.

ASSESSING SUITABILITY OF ALLIGATOR SNAPPING TURTLE (*Macrochelys temminckii*) REINTRODUCTION SITES IN EASTERN OKLAHOMA

Kameron Voves, Denise Thompson, and Day Ligon
Department of Biology, Missouri State University, Springfield, MO

Alligator snapping turtle populations have declined range-wide. Head-starting and reintroduction have been employed to reestablish extirpated populations and augment non-viable populations. Selection of suitable reintroduction sites is a critical first step in reintroductions, but past site selections have primarily relied on qualitative site descriptions. A broadly applicable, data-driven approach is needed to standardize future reintroduction site selection. To improve the methods involved in assessing habitat quality, we developed a preliminary standardized model to quantify key habitat features of both adult and nesting habitat based on known preferences of the species. The output from the model is an overall habitat suitability score. This model was then used in combination with turtle community surveys to identify locations with suitable habitat and healthy turtle communities for future reintroductions. Of the five sites we surveyed, two were classified as good habitat but were revealed to already harbor apparently reproducing populations of alligator snapping turtles. Therefore, we deemed reintroductions at these sites to be unnecessary. Two of the remaining three sites were classified as Good or Excellent habitat and supported healthy turtle communities but without alligator snapping turtles, making them good sites for future reintroductions. The final site was scored as Good despite lacking abundant submerged structures. Immersed structure has been identified as very important to the species in several habitat suitability studies; therefore, it may be necessary to refine our model to ensure critical environmental variables are given sufficient weight.

BEHAVIORAL ASPECTS OF CHEMORECEPTION IN JUVENILE COTTONMOUTHS (*Agkistrodon piscivorus*)

Chelsea E. Martin and Brain Greene
Department of Biology, Missouri State University, Springfield MO

For snakes, chemical recognition of predators, prey, and conspecifics has important ecological consequences. For example, detection of cues deposited by predators can reduce predation risk. Similarly, scent trailing of adult conspecifics to communal hibernacula can improve overwinter survival chances for neonatal snakes. We used y-maze choice trials to examine scent-trailing ability of 32 captive-born juvenile cottonmouths (*Agkistrodon piscivorus*) in two separate experiments. In conspecific trailing tests, subjects preferred to follow cues from their own mothers over a blank control cue (P=0.01, n=16), but also preferred to trail cues from unrelated adult females compared to cues from their own mothers (P=0.04, n=16). Our results are consistent with reports of conspecific scent trailing in neonate rattlesnakes and suggest that juvenile cottonmouths also trail conspecifics to hibernacula. However, the apparent preference for trailing non-maternal cues, given the occurrence of post-partum mother-offspring affiliations in cottonmouths, is not easily explained. In separate predator avoidance trials, test subjects showed no preference for the blank control and king snake cue arm (P=0.251, n=19), or non-predator

control (crayfish) and kingsnake arm (P=1.0, n=13). Indifference to kingsnake cues is inconsistent with results from similar tests in colubrids where kingsnake cues were clearly avoided. Although kingsnakes are known predators of venomous snakes, it is possible that cottonmouths may not exhibit an avoidance response to chemical cues without visual confirmation of a threat. Our results support a growing awareness that pit viper behaviors are more complex than currently appreciated.

BEHAVIORAL RESPONSE OF COTTONMOUTHS TO CONSPECIFIC MUSK GLAND SECRETIONS

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All snakes possess cloacal glands from which they secrete malodorous substances during predatory encounters. These secretions have been suggested to facilitate a variety of possible chemosensory communication functions. The two main hypotheses proposed for the function of snake musk gland secretions are predator deterrence and as a social alarm cue. However, experimental evidence addressing these hypotheses is limited. The recent discovery of cryptic sociality in pitvipers has sparked renewed interest in the alarm cue hypothesis. I tested the alarm cue hypothesis by examining behavioral responses of juvenile cottonmouths (*Agkistrodon piscivorus*) for evidence of threat sensitivity during both feeding trials and simulated predation events. Our results are consistent with snakes being wary when exposed to musk. This pattern was most clearly demonstrated by elevated defensive responses following musk exposure compared to control trials. A palatability test using dogs as test subjects did not indicate any inhibition of consumption of musk-treated food compared to controls, suggesting that cottonmouth musk does not act as a predator deterrent for mammalian carnivores.

THE ASSESSMENT OF BEHAVIORAL SYNDROMES WITHIN JUVENILE COTTONMOUTHS (*Agkistrodon piscivorus*)

Kenzie Medley and Brian Greene
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Behavioral ecologists have traditionally assumed that populations adapt to environmental conditions with one or more optimal strategies. However, recent evidence has shown that behavioral tendencies often vary consistently within individuals and are therefore analogous to personality traits. These pervasive behavioral tendencies, or behavioral syndromes, have been characterized in diverse taxa, including all vertebrate classes and many invertebrate animals. However, the taxonomic scope of behavioral syndromes and their various ecological consequences have been evaluated for few taxa. The objectives of this study are to assess cottonmouth snakes for evidence of behavioral syndromes by evaluating the consistency of individual responses across three ecologically relevant contexts: foraging, defense against a predator, and exploration of a novel area, as well as determining the correlation between these behavioral responses. Preliminary data suggests individual repeatability within foraging and defensive responses. Further study is planned to determine if the behavioral syndrome also has a thermal component.

SURVEY OF ARBOVIRUSES IN FREE-RANGING COTTONMOUTHS (*Agkistrodon piscivorus*) IN SOUTHERN MISSOURI

Ciera McCoy[1], Christopher Lupfer[1], and Brian Greene[1]
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Four arboviruses, Eastern equine encephalitis (EEEV), Western equine encephalitis (WEEV), Saint Louis equine encephalitis (SLEEV), and West Nile Virus (WNV), normally infect avian hosts but can be transmitted to various other organisms through mosquito vectors. Although infection risks are low, each virus is capable of causing significant central nervous system disease in humans, with mortality rates approaching 75%. Cottonmouths (*Agkistrodon piscivorus*) may serve as important EEEV reservoirs because of their high population densities and primary association with wetlands, where EEEV prevalence is highest. Because cottonmouths occur in a variety of aquatic systems, we hypothesized that the proportion of infected snakes may be population-specific and correlated with mosquito density. To determine if habitat type influences the likelihood of arbovirus infection, we examined arbovirus prevalence in free-ranging cottonmouths from contrasting habitats with different mosquito densities: an upland landscape and a lowland floodplain. We predicted that the individuals sampled from the swampy habitat would have the highest prevalence of arboviruses. Blood samples were taken from free-ranging cottonmouths in the spring and fall and analyzed for all four arboviruses using qualitative PCR. Preliminary results indicate that cottonmouths from a lowland floodplain habitat exhibit higher levels of arboviruses when compared to cottonmouths from an upland landscape habitat.

EFFECTS OF ELECTROFISHING ON BEHAVIOR OF TWO AGE-CLASSES OF ENDANGERED HELLBENDERS

Stephanie Morrison[1], Jeff Briggler[2], and Alicia Mathis[1]
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Electrofishing is a common prescribed method of freshwater fish sampling. Although electrofishing has been shown to negatively affect some fish species, the effects on non-target species have not been well studied. The hellbender, *Cryptobranchus alleganiensis* (state and federally endangered), is a non-target species that could be affected during fish censuses. We tested effects of electrofishing on behavior of captive-reared hellbender. Post-metamorphic juveniles (about 3 years old) were tested in the lab, with individuals in higher voltage treatments having a significantly greater incidence of skin secretions and had decreased ability to right themselves. Subadults (about 6 years old) were tested in both a lab and a natural river habitat. In lab trials, there was a significant difference among treatments, with individuals showing a higher incidence of skin secretions and longer latencies to right at higher voltage treatments. In the river trials, shocked subadults also had a higher incidence of skin secretions than control individuals. Electrofishing may cause short-term negative effects on hellbender behavior.

PHYSIOLOGICAL WATER LOSS AMONG JUVENILES OF FIVE *Ambystoma* SPECIES ACROSS LATITUDES

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Habitat suitability is determined by both the physiological tolerances of an organism, and the biotic and abiotic conditions acting on that organism. When conditions and an organism's physiology are misaligned, that individual may be unable to maintain minimum activity levels necessary for achieving energy balance (e.g., through sufficient foraging or movement to tolerable conditions). Energetic imbalances may affect growth, dispersal, reproduction, and increase the likelihood of mortality. Quantifying local conditions and identifying mechanisms by which organisms cope with stressors enable ecologists to better understand species distributions and population dynamics. Further, elucidating physiological responses to varying environmental conditions will improve predictions of habitat suitability and inform a growing body of conservation efforts in the face of global biodiversity losses. One diverse group of amphibians experiencing declines is the genus *Ambystoma*, which includes numerous pond-breeding salamanders. Terrestrial juvenile and adult ambystomatids require moist skin and are thermoconformers. Further, juveniles are both important for population viability and understudied. We examined whether juveniles of five *Ambystoma* species differed in physiological rates of water loss across a latitudinal thermal gradient in Missouri. We found that physiological water loss rates differed between individuals, species and populations. As there was not a strong latitude signature on physiological water loss, we are characterizing the abiotic microhabitat conditions across study sites. Insights into both the physiological tolerances of *Ambystoma* and the abiotic conditions experienced by juveniles of these species can inform efforts to protect a sensitive life stage among a diverse genus of amphibians.

DIEL EFFECTS ON THE ANTIPREDATOR BEHAVIOR OF TERRESTRIAL SALAMANDERS

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Most species have daily activity periods that are predictable, such as being primarily diurnal or primarily nocturnal. Do prey species respond differently to predators that are typically diurnal or nocturnal based on the time of day? We measured the antipredator responses of the primarily nocturnal Ozark zigzag salamander (*Plethodon angusticlavius*) exposed to the chemical cues of two different snake predators, nocturnal ring-necked snakes (*Diadophis punctatus*) and diurnal gartersnakes (*Thamnophis sirtalis*), and blank water during the day (1200 hours) and at night (1800 hours). . Salamanders distinguished between both snake cues and the blank during both time periods. At night, salamanders gave the strongest escape (increased activity) response to the nocturnal snake cue, but cues from the diurnal predator also elicited escape behavior. Salamanders also differentiated between the two snake cues during daytime trials, but the nature of the response was different—salamanders responded with avoidance to the nocturnal ring-necked snake cues, but with decreased activity to the garter snake cues. Decreased activity may be a better strategy for surviving in the presence of visual predators like garter snakes during the daytime when sprint

speeds are higher due to warmer temperatures. Responses of Ozark zigzag salamanders to snake cues are remarkably nuanced.

KEYSTONE EFFECTS AND FUNCTIONAL OVERLAP OF AN ENDEMIC POND-BREEDING SALAMANDER, *Ambystoma annulatum* AND THE CONGENERIC *Ambystoma opacum*

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Keystone species are known to have disproportionately large impacts on ecosystems relative to their abundance; thus identification and management of these species is of great conservation concern. A keystone species may function by selectively decreasing relative abundance of superior competitors, relieving competitive pressure and increasing relative abundance of inferior competitors - and consequently, increasing biodiversity. Functional redundancy explains how different species that share a specific niche can have either additive or redundant effects on a community's biological composition. In aquatic amphibian communities, a common species, the marbled salamander (*Ambystoma opacum*) is known to serve keystone functions. As a fall breeder, the aquatic larvae hold a competitive advantage over spring-breeding species and can increase tadpole diversity in a pond via selective predation. A congeneric endemic species, the ringed salamander (*Ambystoma annulatum*), is known to co-occur with *A. opacum* in Missouri, and has similar breeding phenology. To understand the conditions under which ambystomatid salamanders serve keystone roles, we conducted an artificial pond experiment, exposing a suite of tadpole prey items to four different experimental food webs. We found that *A. annulatum* acts as a keystone predator in local aquatic amphibian communities and promotes biodiversity on an ecosystem level. The keystone effects of *A. opacum* were reduced, showing no significant increase in diversity and dismissing the possibility for functional redundancy between these two intermediate-level predators. The similarities in phylogeny, life history, and phenology of *A. annulatum* to a well-documented keystone species as well as a lack of redundancy between the two species indicates the importance of protecting and promoting unique species. In the future, a better understanding of geographical variation, ecosystem-level function, and conditional keystone effects of *A. annulatum* can fuel conservation efforts and management decisions to protect a charismatic and endemic species.

EVALUATING THE CRITICAL THERMAL MAXIMA OF TWO SPECIES OF AMBYSTOMATID SALAMANDERS

Micah Turrell, Arianne Messerman and Manuel Leal
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Plasticity of physiological traits can contribute to the current and future distribution of species by facilitating their abilities to cope with a wide range of climatic conditions. Closely related species may have physiological variations that produce differences in thermal tolerance. These differences could be advantageous to one species over the other, and facilitate survival through climactic variation. We evaluated the thermal tolerance of terrestrial *Ambystoma maculatum* and *A. opacum*

by measuring the critical thermal maximum (CTMax) after acclimation to 19° C and 27°C. We found *A. maculatum* to have a higher CTMax than *A. opacum* under both treatments. Furthermore, we found both species to exhibit plasticity of CTMax by a mean increase in the upper thermal threshold of 1.5°C. Our findings provide evidence for plasticity in physiological traits, which may provide a mechanism by which organisms can tolerate changes in climactic conditions.

MORPHOMETRIC VARIATION IN POPULATIONS OF TWO SPECIES OF AMBYSTOMATID SALAMANDERS

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[1]Department of Biology, Missouri State University, Springfield, MO
[2]Department of Biology, College of the Ozarks, Point Lookout, MO

Morphometric measurements of two species of Ambystomatid salamanders from populations east and west of the Mississippi River were made. This preliminary study was conducted to determine if variation exists between populations of conspecifics separated by the river. Front limb (FLL), hind limb (HLL), and snout-vent lengths (SVL) were measured in populations of *Ambystoma texanum* and *A. opacum* specimens originating from Arkansas and Tennessee. The ratios of limb length to snout-vent length were then calculated and conspecifics were compared. The ratios of FLL:SVL and HLL:SVL in *A. opacum* were found to be significantly larger on the east side of the river than on the west side, while no significant differences in the ratios were found between the populations of *A. texanum* on either side of the river. The differences in the morphometrics of *A. opacum* may be influenced by a variety of factors including differences in habitat conditions and vicariance.

NEW HERPETOLOGICAL DISTRIBUTION RECORDS FOR MISSOURI IN 2018

Richard E. Daniel[1], Brian S. Edmond[2] and Jeffrey T. Briggler[3]
[1]Division of Biological Sciences, University of Missouri, Columbia, MO 65211
[2]Computer Services, Missouri State University, Springfield, MO 65897
[3]Missouri Department of Conservation, P.O. Box 180, Jefferson City, MO 65102

The following list represents new county records accumulated or brought to our attention since the publication of Daniel and Edmond (2017). Publication of these records extends our knowledge of the amphibians and reptiles found within the state of Missouri. In addition, recipients of this list have the opportunity to update checklists and distribution maps. Finally, the publication of this list allows us to acknowledge the contributions of the many individuals who have contributed information or specimens.

The records listed below represent the first report of the species within a given county and are based on catalogued voucher specimens or photographs deposited in a public institution. Distribution records are presented in the standardized format of Collins (1989): common and scientific name, county, specific locality (unless withheld for species of special concern), legal description of locality, date of collection, collector(s), catalogue number and institution where the specimen is deposited. Nomenclature and common names follow Crother (2017).

Specimens reported in this note have been deposited in the Dean E. Metter Memorial Collection, University of Missouri, Columbia, MO (UMC). Unless otherwise indicated, all distribution records are documented by post-metamorphic/hatchling fluid preserved specimens.

We would like to extend our appreciation to R. Caviness, C. Coffey, J. Dawson, E. East, D. Hoisington, A. Messerman, C. Montgomery, A. Nicholson, C. Poole, H. Quinn, and C. Runco for contributing photographs that were used in this note.

AMPHIBIA: ANURA (FROGS AND TOADS)

FOWLER'S TOAD
Anaxyrus fowleri
Macon Co.: nr. Long Branch Lake, ≃ 5.2 km NW Macon (T57N R14W Sec. 5); 3 July 2018; C. Coffey (digital image, UMC 3540P).

SPRING PEEPER
Pseudacris crucifer
Barton Co.: Prairie State Park (T32N R33W Sec. 20); 16 July 2015; D. Hoisington (digital image, UMC 3533P).

BOREAL CHORUS FROG
Pseudacris maculata
Barton Co.: Golden Prairie Restoration (T30N R29W Sec. 8); 23 April 2018; B. Edmond (digital images, UMC 3592-3593P). Prairie State Park (T32N R33W Sec. 16); 16 July 2015; D. Hoisington (digital image, UMC 3559P).

EASTERN NARROW-MOUTHED TOAD
Gastrophryne carolinensis

Reynolds Co.: 7.27 km WSW Ellington (T29N R1W Sec. 3); 20 May 2018; C. Runco (digital image, UMC 3536P).

AMPHIBIA: CAUDATA (SALAMANDERS)
MARBLED SALAMANDER
Ambystoma opacum
Randolph Co.: Rudolf Bennitt Conservation Area (T52N R14W Sec. 36); 9 March 2018; A. Messerman (larva (confirmed as metamorph), digital images, UMC 3556P).

REPTILIA: SQUAMATA (LIZARDS)
LITTLE BROWN SKINK
Scincella lateralis
Sullivan Co.: ≃ 4.0 km S Cora (T61N R20W Sec. 22); 21 July 2018; H. Quinn, H. Quinn (digital image, UMC 3542P).

REPTILIA: SQUAMATA (SNAKES)
EASTERN COPPERHEAD
Agkistrodon contortrix
Barton Co.: 9.5 km NW Lamar Heights (T33N R31W Sec. 28); 26 August 2018; M. Webb (digital image, UMC 3558P).
Jasper Co.: 8.0 km N Neck City (T30N R32W Sec. 22); 31 August 2018; D. Hoisington (digital image, UMC 3557P).

TIMBER RATTLESNAKE
Crotalus horridus
Mercer Co.: 1.78 km S Princeton (T65N R24W Sec. 34); 13 September 2018; J. Cridlebaugh, E. Oswalt (digital image, UMC 3537P).

EASTERN HOG-NOSED SNAKE
Heterodon platirhinos
Madison Co.: 1.85 km SW Oak Grove (T33N R6E Sec. 8); 7 June 2018; A. Nicholson (digital image, UMC 3474P).

SPECKLED KINGSNAKE
Lampropeltis holbrooki
Clinton Co.: Cameron, MO (T57N R30W Sec. 24); 17 October 2016; N. Woolery (digital image, UMC 3530P).
DeKalb Co.: Pony Express Lake Conservation Area (T58N R31W Sec. 34); 27 April 2018; C. Poole (digital image, UMC 3532P).

EASTERN MILKSNAKE
Lampropeltis triangulum
Adair Co.: Spring Lake (T61N R16W Sec. 11); 14 June 2018; C. Montgomery (digital image, UMC 3475P).

Monroe Co.: Mark Twain Lake, Indian Creek (T55N R7W Sec. 19); 23 April 2017; B. Edmond (digital image, UMC 3647P).

REPTILIA: TESTUDINES (TURTLES)

FALSE MAP TURTLE
Graptemys pseudogeographica
Shannon Co.: Jack's Fork River, nr. Alley Springs (T29N R5W Sec. 25); 12 July 2018; J. Dawson (digital image, UMC 3527P).

THREE-TOED BOX TURTLE
Terrapene carolina
Macon Co.: nr. Long Branch Lake, ~ 5.2 km NW Macon (T58N R14W Sec. 32); 21 June 2018; S. Coffey (digital image, UMC 3539P).
Ralls Co.: 6.7 km SE Center (T54N R5W Sec. 9); 22 September 2018; E. East (digital image, UMC 3547P).

Literature Cited

Collins, J.T. 1989. New records of amphibians and reptiles in Kansas for 1989. *Kansas Herpetological Society Newsletter* (78): 16-21.

Crother, B.I. (ed). 2017. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. Pp. 1-102. *SSAR Herpetological Circular* 43.

Daniel, R.E. and B.S. Edmond. 2017. Atlas of Missouri Amphibians and Reptiles for 2016. <https://atlas.moherp.org/pubs/atlas16.pdf>

CHANGES TO TURTLE HARVEST REGULATIONS IN MISSOURI

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Turtle populations worldwide are declining as a result of habitat loss and degradation, mortality from road traffic, diseases, increased predation, water pollution, and harvesting of wild populations for food, medicines, and the pet market. Commercial turtle harvest is considered one of the most important influences on population declines worldwide, and millions of turtles are exported to Asian markets annually. Turtles have relatively low reproduction, high egg and hatchling mortality, low recruitment (i.e., potential for juveniles to reach reproductive age), and delayed female maturation, which make them unsuitable for high levels of harvest, especially the harvest of large, reproducing adults. In addition, egg production is limited and cannot increase to compensate for removal of reproductive adults. Therefore, population rebound is extremely slow and can take decades.

With such demographic characteristics placing biological constraints on turtles, there has been an increase in studies to better understand if harvest of turtles is sustainable. Several publications modeling turtle populations suggest that small increases in annual mortality can be detrimental to population sustainability. In order to better understand potential impacts to turtle populations in Missouri, the Department's Regulations Committee in 2009 determined that additional information was needed to evaluate commercial harvest of the three commercially harvested turtle species (common snapping turtle, spiny softshell, and smooth softshell). A cooperative effort between the Department and University of Missouri-Columbia investigated the potential impacts of commercial harvest on populations of these three species of turtles from 2010-2013. Results showed that a large number of turtles can be harvested via commercial methods, and modeling of turtle demographic rates, including turtle harvest rates in Missouri, further support that commercial harvest is largely unsustainable.

Therefore, effective March 1, 2018 the commercial harvest of common snapping turtles, smooth softshell turtles and spiny softshell turtles was no longer permitted in Missouri. The Missouri Department of Conservation followed the rule-making process in the decision to eliminate commercial turtle harvest and the final decision was based on the following: stakeholder input received from commercial harvesters, citizens, and conservation organizations regarding changes to the existing commercial turtle harvest regulations; demographic characteristics (i.e., low reproductive output, high nest mortality, low hatchling/juvenile survivorship, delayed reproductive age, etc.) that make turtle species vulnerable to overharvest; increasing scientific evidence of the negative effect of commercial turtle harvest; and recent attention from various organizations and citizens to conserve turtle species and maintain viable populations. In addition, sportfish harvest of common snapping turtles and softshell turtles daily limit of 10 turtles in aggregate was reduced to 2 turtles in aggregate effective March 1, 2018. The elimination of commercial turtle harvest and reduction in sportfish turtle harvest was needed to ensure long-term protection to the turtle resource of the state.

Stephanie Zimmer of the University of Missouri-Columbia checking turtle traps as part of the collaborative project with Missouri Department of Conservation to investigate the impacts of commercial turtle harvest.

ADDITIONS TO THE BIBLIOGRAPHY OF HERPETOFAUNAL REFERENCES FOR MISSOURI

Compiled by
Richard E. Daniel
Division of Biological Sciences, University of Missouri, Columbia, MO 65211

The following is a list of publications dealing with the biology of amphibians and reptiles from Missouri that have been brought to the attention of the author since the publication of Daniel (2017). Readers are requested to notify the author of any additional references that should be included in future compilations.

Anderson, C. D., and M. S. Rosenberg. 2011. Variation in association with anthropogenic habitat edges exhibited by the timber rattlesnake (*Crotalus horridus*) in St. Louis County, Missouri. *Journal of Herpetology* 47(1):50-55.

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