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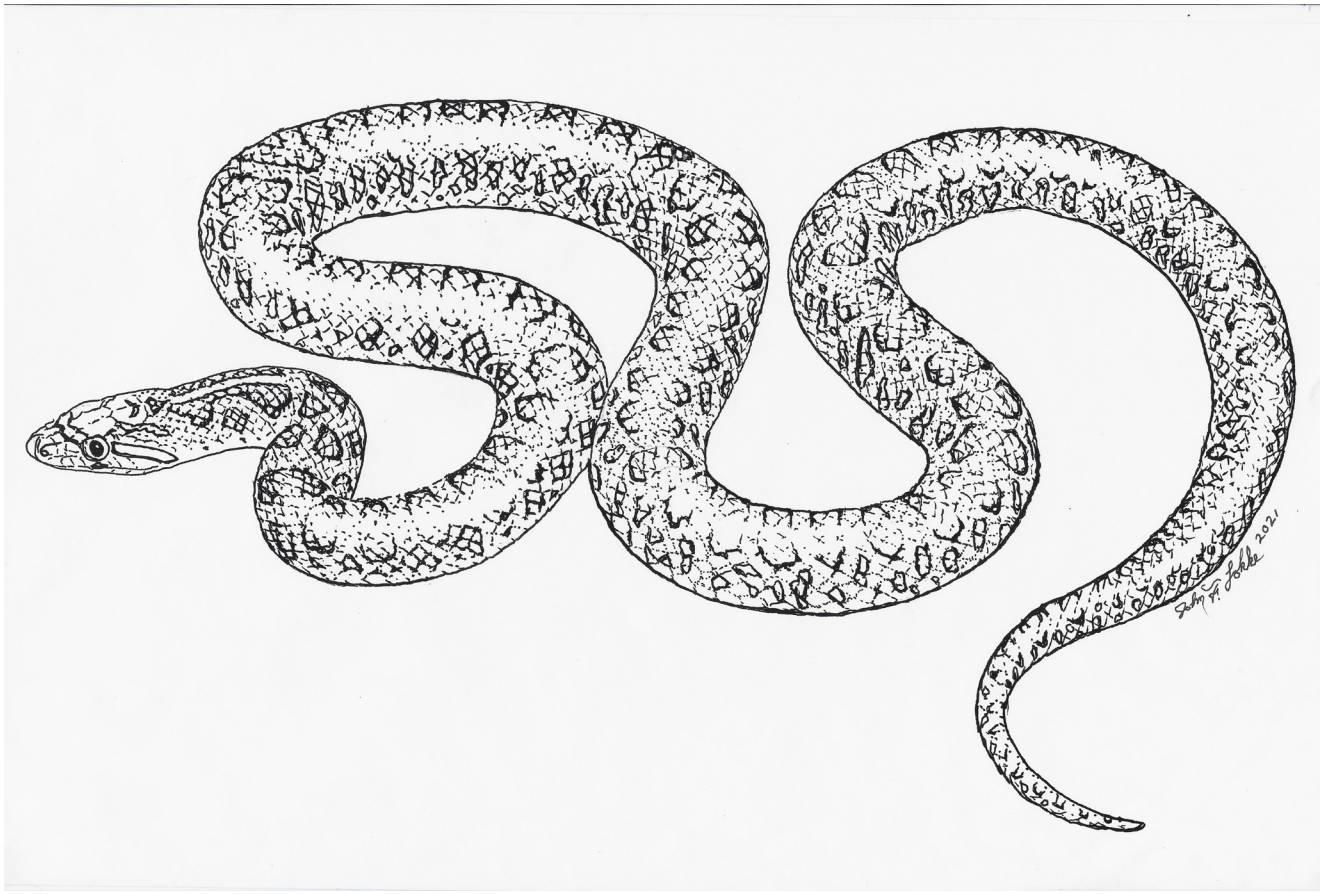

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Front Cover: Glossy Snake, *Arizona elegans*, pen and ink by John Lokke, 2020. This is one of over 65 illustrations for the forthcoming informative coloring book for all ages on the Amphibians and Reptiles of Nebraska by Dennis Ferraro, Jacki Loomis, and John Lokke.

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KHS BUSINESS

Letter From The Editor

What the year 2021 has been, and no, it is not because of COVID. It has been an eventful year for nongame species conservation, of amphibians and reptiles in particular. Somethings I cannot go into much detail about yet, but other things I can. A group of us from the KDWP Ecological Services Section have been working closely with Mammoth Creative, a marketing firm located here in Kansas, to revamp marketing efforts for the Chickadee Checkoff Program. As many of you may know, the Chickadee Checkoff Program is a donation and tax-checkoff program established in 1980 to provide funds for nongame research, outreach, and education in Kansas. Over the years the donations have decreased, while the advertising for the program has remained stuck in the 1980s. The kicker was a public opinion poll on threatened and endangered species recently conducted by Responsive Management. This poll has now been conducted in 1991, 2011, and 2021. One question related to public knowledge of the Chickadee Checkoff exhibiting a downward trend in the public awareness of the program. Catching up with the 21st century, Chickadee Checkoff now has its own on Facebook at https://www.facebook.com/WildlifeDiversityKDWP and has its own landing page at www.chickadeecheckoff.com. Look for video ads on social media soon as well.

As mentioned, we completed the 2021 public opinion poll on threatened and endangered species in Kansas. The survey itself could be summarized over a couple of questions, with 94% of those surveyed showing support for protecting habitat critical to the existence of threatened and endangered animals, which nearly half of the people polled owning 10 acres or more land. Finally, we at KDWP are near completing a complimentary pair of federal agreements known as Safe Harbor Agreements (SHA)/Candidate Conservation Agreements with Assurances (CCAA) for eleven species of aquatic species in Kansas, including Alligator Snapping Turtles. The purpose of these agreements is to provide regulatory assurances for private landowners when sensitive, threatened, or endangered species are released onto their properties. These agreements should provide a paradigm shift for how we do business regarding how we do conservation on private lands in Kansas.

For these reasons and several others, only two volumes of Collinsorum with only be published in 2021. I do hope to get the first 2022 volume out as quickly as possible to try and keep us on track. Regardless, thank you all for your support and I hope it continues through 2022. Big things happening again next year, inside and outside of KHS.

J. Daren Riedle
KHS Editor

2022 KHS Field Trips

SPRING	SUMMER	FALL
Pottawatomie State Fishing Lake #1	**Historic Lake Scott State Park**	**Elk City State Park**
15-17 April	24-26 June	16-18 September

Check out the KHS website and Facebook page for updates

Shorter Communications

On the type locality of *Pantherophis obsoletus*

Travis W. Taggart

Sternberg Museum of Natural History, 3000 Sternberg Drive, Hays, Kansas 67601

A type specimen is a single voucher, designated upon the original description of a new species, as the standard name-bearer for that species. The type locality is where the type specimen was collected. Type specimens have tremendous value in systematics and taxonomy, and are therefore afforded special care within the collection they reside.

Kansas has been considered the type locality owner of three currently recognized species of amphibians and reptiles. All three were described prior to Kansas becoming a state in 1861.

The Plains Narrow-mouthed Toad (*Engystoma olivaceum* [=*Gastrophryne olivacea*]) was described by Edward Hallowell in 1856 from specimens collected in "Kansas and Nebraska".

The Spring Peeper (*Hyla crucifer* [=*Pseudacris crucifer*]) was introduced to science by Prince Maximilian Alexander Philipp of Wied in 1838 from a specimen collected at "Cantonment Leavenworth".

The first species of amphibian or reptile collected from what would eventually become Kansas was the Western Ratsnake *Coluber obsoletus* (=*Pantherophis obsoletus*). Naturalist Thomas Say described the type specimen in 1823 from Isle au Vache (Cow Island), Kansas (a heavily forested island on the Missouri River) (Figure 1). Cantonment Martin was a military post established on Cow Island 1818.

Say's type locality stretches from NE Kansas to western Iowa. He wrote... "It is not an uncommon species on the Missouri from the vicinity of Isle au Vache to Council Bluff."

The Kansas herpetological histories compiled by (Smith, 1950, 1956; Collins 1974, 1982; Collins and Collins, 1993; and Collins et al., 2010), and various other publications have always documented the type locality (or at least Cow Island) as being in Kansas.

And so, I was surprised when I came across the following statement in a discussion of the earliest valid name for the populations of this

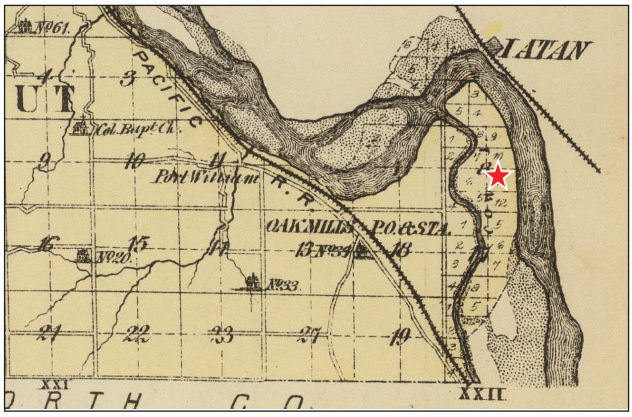

Figure 1. L. H. Evert's & Co. map of southeast Atchison County published in 1887 and showing Cow Island (star) and the associated hydrology prior to the flood of 1881.

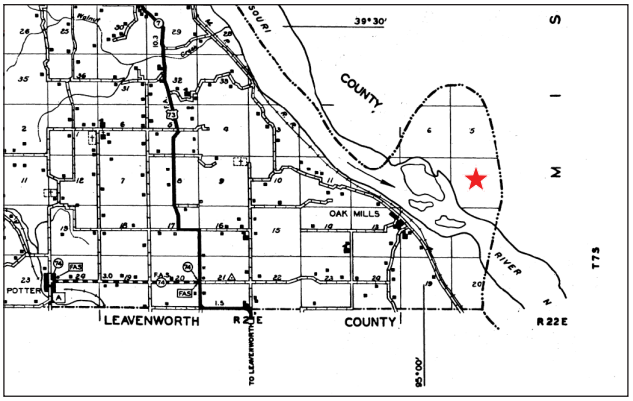

Figure 2. A Kansas Department of Transportation map of southeast Atchison County from 1936. Showing Cow Island (red star) in Kansas.

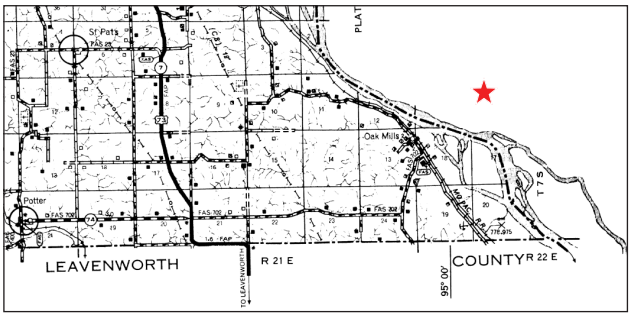

Figure 3. A Kansas Department of Transportation map of southeast Atchison County from 1956. Showing Cow Island (red star) outside of Kansas.

Ratsnake complex found west of the Mississippi River in Burbrink et al. (2021). "After course changes of the Missouri River, Cow Island (Fig. 1; 1) is now on the Missouri side and is no longer a distinct island; the historical locality is just south of Iatan, Missouri."

I contacted Frank Burbrink and he directed me to co-author Alex Pyron who had determined the correct locality by examining an online property boundary map of Platte County, Missouri (https://beacon.schneidercorp.com/Application.aspx?AppID=589).

At the time Say published his description of *Pantherophis obsoletus* the main channel of the Mississippi River was on the east side of Cow Is-land and the western side of the island was separated from present-day Atchison County, Kansas by a small slough (Figure 1).

That situation remained until a flood in 1881 shifted the main channel of the Missouri River west and Cow Island became connected to the Missouri side (Figure 2).

For several years, both Kansas and Missouri lay claim to Cow Island. The dispute was ultimately settled in 1890 when a court ruled that a boundary would change with the gradual movement of a natural boundary (accretion) but not due to a sudden change (avulsion). Cow Island was still in Kansas.

In 1949, the Kansas, Missouri, and US congresses ratified the Kansas-Missouri Boundary compact. This agreement set the boundary at the center of the current channel of the Missouri River (which by then dredged, leveed, and straightened to become effectively fixed) (Figure 3). Kansas lost Cow Island and the type locality of *Pantherophis obsoletus*.

Cow Island has been used regularly since the US military abandoned Cantonment Martin in 1826. It was utilized as a temporary military station during the Civil War.

Since the, it has been owned whole and in part by individuals and businesses. It was many of the businesses (most of them bars) that kept Cow Island in the papers between 1881 and 1920 during the respective state and national prohibition periods.

Currently, Cow Island is home to the Iatan 1 and 2 coal-fired power stations operated by Ev-ergy (Figure 4).

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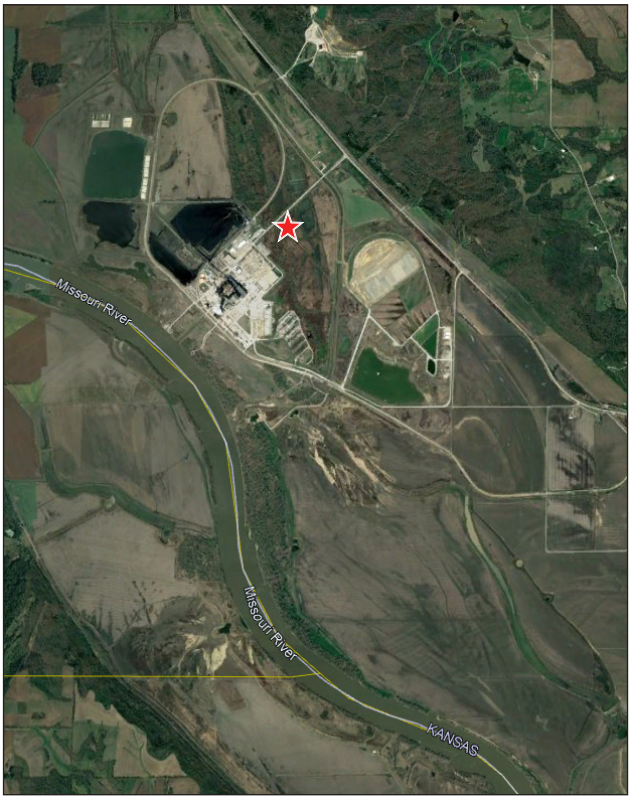

Figure 4. Contemporary view of Cow Island (red star) and the Iatan 1 and 2 coal-fired power station. Photo taken on 10 April 2021 and collected from the Google Earth service.

Articles

Colonization patterns of three artificial ponds by a Pennsylvania herpetofaunal community

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ABSTRACT - Three artificial ponds in a south-central Pennsylvania meadow were surveyed for amphibians and reptiles during March–November 2016. The ponds, created in 2014 and 2015 in a county park, were rapidly colonized by American Bullfrogs, *Lithobates catesbeianus*, and Northern Green Frogs, *L. clamitans melanotus*, in three ponds, Pickerel Frogs, *L. palustris*, and Painted Turtles, *Chrysemys picta*, in two ponds, and Eastern American Toads, *Anaxyrus americanus americanus*, in one pond. In addition, Eastern Garter Snakes, *Thamnophis sirtalis sirtalis*, were found foraging along the edges of two of the ponds, Northern Green Frogs comprised the highest number of sightings in each pond and comprised 82.2% of all individual sightings of aquatic species identified to species and 59.4% of all sightings of aquatic species including those of unidentifiable anurans. Distribution of body size among Green Frog tadpoles suggests reproduction within the year of most recently created ponds. The speed with which these species colonized the ponds and the high relative abundances of some of species indicate that at our site wetlands in open habitat remain a limited resource. These findings also underscore the potential for rapid colonization of suitable habitat by species for which geographic range expansion is an option in a changing climate.

Introduction

Published life history information remains wanting for much of the Pennsylvania herpetofauna, including that of frequently encountered species. Protected sites can provide an opportunity to investigate various life history phenomena, including those within urban areas. Wildwood Park, a county park since 1976, is situated within the city limits of Harrisburg, Dauphin County, Pennsylvania. The 85 ha park is comprised of disturbed wetland and upland habitats, including a 36.4 ha shallow artificial lake fed by Paxton Creek. Wildwood Park is subjected to habitat management plans and has been the focus of some herpetological interest. Seasonal activity and reproductive characteristics have been examined in American Bullfrogs, *Lithobates catesbeianus* (Meshaka et al., 2015), Northern Green Frogs, *L. clamitans melanota*, (Meshaka, 2013; Meshaka et al., 2015), Eastern Garter Snakes, *Thamnophis sirtalis sirtalis* (Meshaka, 2009; Meshaka and Morales, 2016), and Red-eared Sliders, *Trachemys scripta elegans* (Meshaka et al., 2015; Meshaka and Wingert, 2016) in this urban park. Management plans of Wildwood Park entail in part the creation of small shallow short hydroperiod pools in an old field as a means to enhance species diversity among aquatic species not associated with permanent wetlands. Two ponds were constructed in 2015, and a wet seep was enlarged in 2014. We took the opportunity to survey the newly created wetlands and answer the question, what are the colonization patterns following the creation of these adjacent wetlands.

Study Site and Methods

Wildwood Park (WP) is a 93.5 ha county park in Harrisburg, Dauphin County, Pennsylvania (40° 18′ 54″ N, 76° 53′ 6″ W). Approximately 60% of the park is comprised of a shallow artificial lake that is fed by Paxton Creek. A section of the Pennsylvania Canal runs along the west-

ern boundary of the park. The remainder of the park is comprised primarily of mixed deciduous forest. A 4948 sq m 0.50 ha. artificial meadow overlooks the lake on the eastern section of the park. This meadow was created in the 1970s as a site to hold fill associated with nearby road construction. Trees were cleared, and the soil was compressed. The park maintained the parcel as an open habitat with annual mowing. This meadow overlooks Wildwood Lake to the south and is surrounded on three sides by deciduous forest. An asphalt trail separates the meadow from the forest on its northern border. The meadow was mowed annually in November through 2004, after which time, the annual mowing schedule was switched to March.

Three ponds were created in the meadow in 2014 and 2015 (Figure 1). The meadow slopes downward from east to west, where a small seep was expanded in July 2014 to a 10.95 x 3.9 m pond and known as West Pond. Its depth ranges from 11–38 cm. It is referred to here as West Pond. Two other ponds were excavated in August 2015. North Pond, located adjacent to the asphalt trail, measures 6.68 x 2.43 m. Its depth slopes from 9–37 cm m. South Pond is located on the south border of the meadow and measures 7.6 x 2.04 m. Its depth slopes from 21–51 cm. Forty-nine diurnal visits were made to the ponds during March–November 2016. Ponds were visited from one to 10 times each month. Date, time, water temperature, and air temperature were recorded at the beginning of each survey. A survey consisted of one walk around the edge of the pond at which time, any amphibian or reptile was counted and identified to species when possible. The presence of eggs, amplecting pairs of anurans, and anuran calling were recorded. Adults, juveniles, and young-of-the-year were discerned when possible.

Once each month, ponds were sampled with the use of a dipnet for amphibian larvae. A representative sample was immediately fixed in formalin and later identified to species. The body length was measured to the nearest 0.1 mm using hand calipers, and any wounds were noted. Monthly body size distributions were used to indicate larval growth rate, time and body size at transformation, and age of the colony. As per Gosner (1960), tadpoles were categorized as those with poorly developed hind legs (less than Gosner stage 37) or fully developed hind legs (Gosner stage of at least 37). Statistics were performed on Excel 365.

Table 1. A list of amphibian and reptile species known from Wildwood Park, Harrisburg, Dauphin County, Pennsylvania. (*) denotes species associated with the ponds of our study during March–November 2016.

Amphibians
Ambystoma maculatum
Desmognathus fuscus
Eurycea bislineata
Plethodon cinereus
Notophthalmus viridescens viridescens
*Anaxyrus americanus americanus**
Hyla versicolor
Pseudacris crucifer crucifer
*Lithobates catesbeianus**
*Lithobates clamitans melanotus**
*Lithobates palustris**
Lithobates sylvaticus
Reptiles
Lampropeltis triangulum triangulum
Pantherophis alleghaniensis
Nerodia sipedon sipedon
Storeria dekayi
*Thamnophis sirtalis sirtalis**
Chelydra serpentina serptentina
Sternotherus odoratus
Chrysemys picta (*C. p. picta* X *C. p. marginata**)
Glyptemys insculpta
Graptemys geographica
Trachemys scripta elegans
Pseudemys rubriventris
Terrapene carolina carolina

Means are followed by one standard deviation.

Results

Pond colonization- Six of 25 species of amphibians and reptiles observed at WP were found to be associated with one or more of the three newly created ponds surveyed in our study (Table 1). Of 1,001 total sightings, 277 were assigned unknown ranid frogs (Table 2). Most species were amphibians, and the most individuals sighted were Northern Green Frogs (Table 2). North Pond was unique in having the highest number of species and being the only pond with Eastern American Toads. West Pond, the largest and oldest of the three ponds, also accounted for the majority of sightings (40.4%) of all three ponds (Table 2). However, per m2 of shoreline, West Pond was the least productive (Table 2).

Species accounts- Anaxyrus americanus americanus (Holbrook, 1836)- The Eastern American Toad was represented by eggs, tadpoles, and recently metamorphosed individuals at North Pond (Table 2). Freshly hatched eggs were detected on 29 April, five days af-

Table 2. Total number of observations of amphibians and reptiles in newly created aquatic habitat in a meadow at Wildwood Park, Harrisburg, Dauphin County, Pennsylvania during March-November 2016.

Species	North Pond	South Pond	West Pond	Total
Anaxyrus americanus americanus	22	0	0	22
Lithobates catesbeianus	2	9	44	55
Lithobates clamitans melanotus	147	260	186	593
Lithobates palustris	4	2	0	6
Unknown ranid frogs	89	60	128	277
Chrysemys picta	0	1	40	41
Thamnophis sirtalis sirtalis	1	0	3	4
Total	265	332	401	998
Total/ per m^2 of pond	16.33	15.50	42.71	-
No. *L. catesbeianus*/ m^2	0.12	0.58	1.03	-
No. *L. clamitans melanota*/ m^2	9.06	16.77	4.36	-

ter the last visit on 24 April. Tadpoles, some with hindlegs evident and some with both hind and fore-legs evident were seen on 8 June. A freshly hatched clutch was detected on 10 June, two days after the previous visit on 8 June. On the next visit of 15 June, 21 recently metamorphosed individuals were seen along the shoreline, and tadpoles and a single metamorphosed individual were seen on 24 June (Figure 2). Water temperatures of North Pond averaged 18.3–21.9 °C during this time (Figure 3).

Lithobates catesbianus (Shaw, 1802)- The American Bullfrog was represented by 55 observations of adults and sub-adults at all three ponds (Table 2). Most individuals were found at West Pond (80.0%), the preference for this pond being reflected in the number of individuals/ m2 (Table2). The Seasonal activity was unimodal during 25 March to 22 October and peaked in May (Figure 2). Few animals were seen after July (Figure 2). Calling was heard on 18 May when the water temperature was 13.5 °C and the mean water temperatures were warm (Figure 3).

L. clamitans melanotus (Rafinesque, 1820)- The Northern Green Frog was represented by 593 observations at all three ponds where they were abundant (Table 2). Northern Green Frog: American Bullfrog ratios among the three ponds increased with decreasing numbers of American Bullfrogs: North Pond (73.50:1.00), South Pond (28.89:1.00), West Pond (4.23:1.00). If unknown frogs were added to American Bullfrog counts, the pattern would hold for North (1.62:1.00), South (3.77:1.00), and West (1.08:1.00) ponds. However, we reject the latter analysis for two reasons. First, most unknowns were encountered early in the season when the Northern Green Frog emerges in spring earlier, it is unlikely that unknown frogs would be exclusively American Bullfrogs. Second, no tadpoles or juveniles of American Bullfrogs were encountered in any of the ponds, which decreases the likelihood that they were being missed in encounters. Numbers of Northern Green Frogs/ m2 were highest in the two smallest ponds, North and South ponds, and lowest in West Pond where numbers of American Bullfrogs/ m2 were highest (Table 2).

The seasonal activity was bimodal during 25 March–22 October and peaked in May and September (Figure 2). Calling was heard during 20 April–2 August and again on 21 September. Incidence of calling was most frequent at West Pond (n = 13), followed by North Pond (n = 6), and South Pond (n = 5). Diurnal calling was heard in air temperatures that averaged 23.7 °C (+ 5.7; range = 11–30; n = 24) and water temperatures that averaged 22.7 °C (+ 6.0; range = 11.5–33; n = 24) as monthly water temperatures were increasing (Figure 3). Egg masses were found on 8 June (n = 3), 10 June (n = 2), 24 June (n =1), 21 July (n = 2), and 22 July (n = 2). Most egg masses were found in West Pond (n = 5) and North Pond (n = 4). A single egg mass was found in South Pond.

Tadpoles were present in all three ponds (Figure 4). The monthly distribution of body size indicates overwintering, with tadpoles having been present in West Pond as early as 2015, the year following its creation Two metamorphoslings measured 27.8 and 28.6 mm, the latter missing its right foreleg. Body size distributions of tadpoles of the remaining younger ponds indicated the first successful reproduction in 2016, the year following their creation. Tail damage was evident in tadpoles from each of the ponds: 6.25% in North Pond, 3.06% in South Pond, and 4.46% in West Pond. In the

Figure 1. Three artificial ponds in a meadow at Wildwood Park, Harrisburg, Dauphin County, Pennsylvania. Photographs by Walter E. Meshaka, Jr.

former two ponds, all affected tadpoles were < 20.0 mm. Two of the 10 affected tadpoles in West Pond > 20 m (24.8 and 25.5 mm).

L. palustris (LeConte, 1825)-The Pickerel Frog was represented by six observations from two ponds (Table 2, Figure 2). Four individuals were seen in North Pond. An adult was seen on 2 April and 20 May. A young-of-year was seen on 19 August and 26 September. A young-of-year was seen in South Pond on 26 August. Two clutches of eggs were found in North Pond on 2 April. The visit previous from that date was 25 March. Reproductive activity was strongly associated with cooler months (Figure 3).

Chrysemys picta (Schneider, 1783)- The Painted Turtle at WW is an intergrade of the Midland Painted Turtle, *C. p. marginata* Agassiz, 1857, and the Eastern Painted Turtle, *C. p. picta* (Schneider, 1783). The Painted Turtle was represented by 41 sightings, 40 of which were at West Pond and a single adult at South Pond (Table 2, Figure 2). Seasonal activity was unimodal during 27 May to 16 August, with most turtles seen in June (Figure 2). Thirteen adult turtles and 28 individuals representing the previous year's hatchlings turtles were seen in the ponds during 27 May–16 August when water temperatures averaged at least 20.8 °C. In addition to the aforementioned individuals seen in the ponds, four nesting turtles were seen during 24 June–5 July.

Thamnophis sirtalis sirtalis (Linnaeus, 1758)-The Eastern Gartersnake was represented by four observations in two ponds (Table 2, Figure 2): A juvenile was observed hunting in the water along the shoreline of North Pond on 21 September. The air temperature was 29.4 °C and water temperature was 25.5 °C. On 15 July, two individuals were seen at rest on land close to the shore of West Pond. Air temperature was 19.0 °C. On 5 July, an adult was seen hunting in the water of West Pond. The air temperature was 25.0 °C, and the water temperature was 24.0 °C.

Miscellaneous species- On 28 July a male Woodland Box Turtle, *Terrapene carolina carolina*, was seen walking along the path near North Pond. On 12 August as fawn White-tailed Deer, *Odocoileus virginanus*, was seen sunning in high grass near West Pond. On 17 June, a Groundhog, *Marmota monax*, was startled while sunbathing near the shoreline of South pond. Once startled, it dove into the pond, surfaced and exited on other side, and headed into the forest.

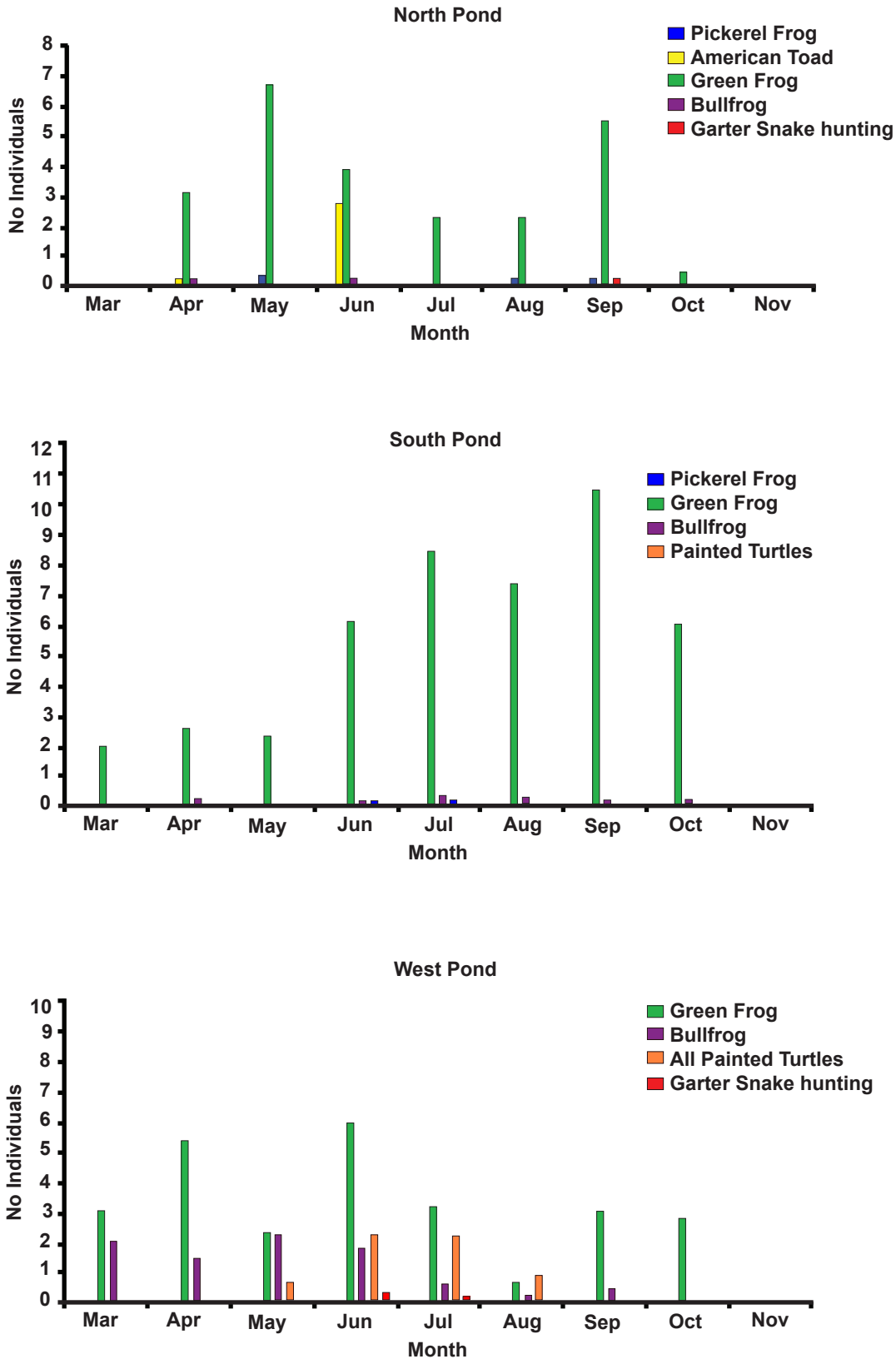

Figure 2. Monthly distribution of amphibians and reptiles from three artificial ponds at Wildwood Park, Harrisburg, Dauphin County, Pennsylvania during March–November 2016.

Discussion

Our study demonstrated a rapid colonization of new ponds by four anuran and one aquatic turtle species and its use by one snake species, all of which are known from the park. High relative abundance of the Northern Green Frog and American Bullfrog can be attributed to their close association with wetlands even outside of their breeding seasons. Even with addition of unknown ranids added to American Bullfrogs, the Northern Green Frog was still more frequently encountered especially in South Pond. A likely explanation for fewer American Bullfrogs could be the greater space required, as males are highly territorial (Emlen, 1977). This being the case, it is not surprising that the highest numbers of American Bullfrogs were recorded from the largest pond, West Pond, where they were still outnumbered 4:1 by the Northern Green Frog, scarcely present at the two smaller ponds. The least attractive pond to the American Bullfrog was North pond. Although a bit larger than South Pond and vegetated similarly around the edges, North Pond was much shallower which further contributed to its poor suitability.

Conversely, the Northern Green Frog excelled in these ponds. One reason for its success was because of the suitability of the ponds as habitat (see reviews by Pauley and Lannoo, 2005; Dodd, 2013). The second reason for its success because of the uncommonness of American Bullfrogs whose abundance negatively impacts that of the Northern Green Frog (Cortois et al., 1995; Hecnar and M'Closkey, 1997). To that end, ratios of Northern Green Frog: American Bullfrog among the three ponds increased with decreasing numbers of American Bullfrogs.

Monthly distribution of tadpole body sizes and developmental stages corroborated other findings of overwintering by tadpoles of this species elsewhere in Pennsylvania (Meshaka, 2011). Those of North and South ponds were indicative of breeding in 2016 only, whereas that of West Pond indicated a cohort from the previous year. The high relative abundance of this species at these ponds in so short a time can be attributed to close proximity of other wetlands from which to emigrate as well its

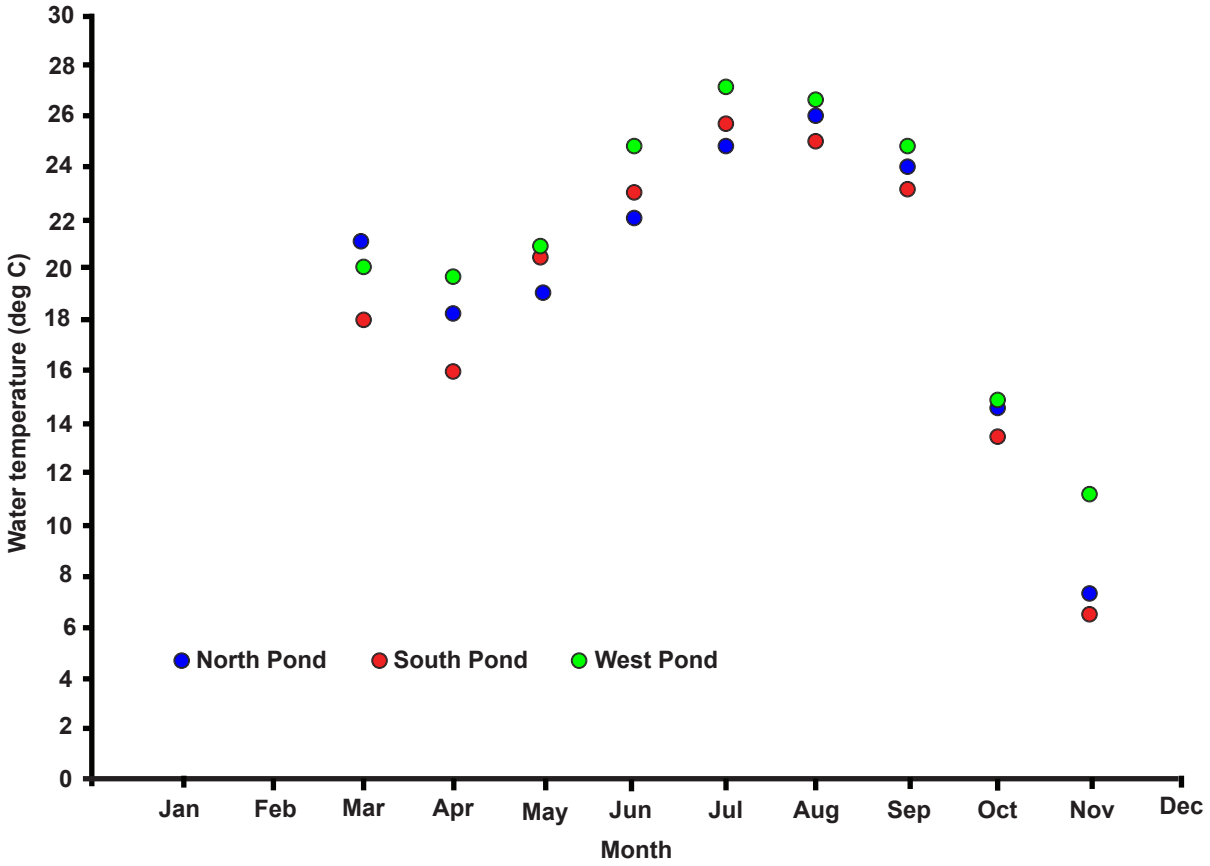

Figure 3. Mean monthly water temperature for each of three artificial ponds in 2016 at Wildwood Park, Harrisburg, Dauphin County, Pennsylvania, during March–November 2016.

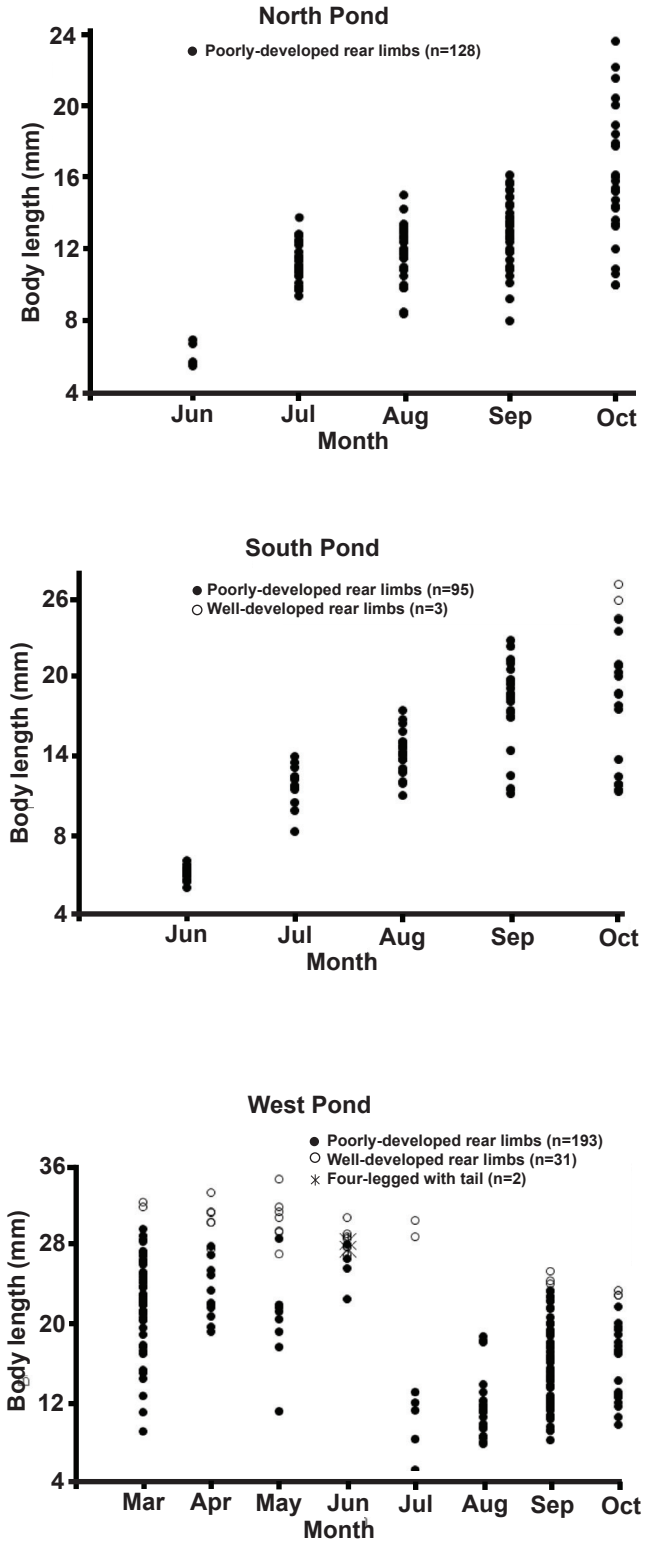

Figure 4. Monthly distribution of body size among Northern Green Frog, *Lithobates clamitans melanotus*, tadpoles in newly created aquatic habitat in a meadow at Wildwood Park, Harrisburg, Dauphin County, Pennsylvania, during March–November 2016.

high fecundity and early age at sexual maturity at Wildwood Park (Meshaka, 2013).

Collections at the State Museum of Pennsylvania and long-term observations by EW and WEM do not support the notion that either the Eastern American Toad or the Pickerel Frog or are common at Wildwood Park. The Eastern American Toad can be abundant in open habitats in Pennsylvania (Meshaka et al., 2017, 2020); however, this habitat is not at all common at Wildwood Park which might contribute to the scarcity of this species at the park. The pickerel Frog can inhabit meadows (Dodd, 2013) but requires nearby forest (Findlay et al., 2001). We do not know if low encounter rates of the Pickerel Frog were related to poor habitat quality of the meadow, its ponds, or perhaps even the quality of the forest in which it also resides. The Eastern Gartersnake is present at Wildwood Park and abundant in the meadow (Meshaka, 2009; Meshaka and Morales, 2016). These ponds are likely a boon for this species for water and an abundance of anuran prey. These ponds have also proven consequential for Painted Turtles. Females nest on the trails of the meadow, and the ponds provided initial habitat to emerging spring hatchlings from the previous year's clutch production. It remains to be seen if use of the ponds provides an advantage or differentially places them at risk of predation by American Bullfrogs, especially at West Pond.

The compacted fill interfered with the plans that they would be seasonal temporary ponds, and through 2019 ponds dried down only in 2018. Projected changes in climate in the mid-Atlantic region of the United States are expected to result in a warmer and wetter region (Polsky et al., 2000), and this trend could increase the likelihood of permanence in the hydroperiod of these ponds. These ponds revealed a range in colonization responses to small and permanent artificial bodies of water by local herpetofauna. Ponds such as these could provide of sorts of archipelagos that could maintain connectivity among populations and provide sources from which to disperse into novel habitat and northward in potentially expanding geographic ranges.

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Measuring Herpetofaunal Biodiversity in Southwest Missouri

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ABSTRACT - With amphibian and reptile population declines and extinctions increasing, continued ecological surveying is needed to detect any potential changes in populations, especially near geopolitical boundaries. From May 20th to August 8th, 2020, a survey of Kellogg Lake (Carthage, MO) was conducted to catalogue species richness and abundance. Individuals caught had morphological measurements taken and reptiles were marked for potential recapture. Individuals observed but not captured were also noted. In total, species found included *Anaxyrus americanus*, *Lithobates catesbeianus*, *L. sphenocephalus*, *Apalone spinifera*, *Chelydra serpentina*, *Nerodia erythrogaster*, *N. rhombifer*, *N. sipedon*, *Regina grahamii*, *Sternotherus odoratus*, *Storeria dekayi*, and *Trachemys scripta*. Several of these species had not been reported in Jasper County for decades. In three species (*S. odoratus*, *T. scripta*, and *R. grahamii*), enough information was available to describe the sex ratios and test for sexual dimorphism. For both *S. odoratus* and *T. scripta*, we detected no sexual dimorphism. For *S. odoratus* and *R. grahamii*, the populations were significantly female skewed in their sex ratios and female *R. grahamii* were significantly larger than males. Lastly, using historical records, neighboring Cherokee County, KS and Jasper County, MO were compared to detect potential differences in record abundance across state lines. The oldest documented records for herpetofaunal species between the two counties did not differ. However, Cherokee County has significantly more recent species detections and in significantly greater numbers than Jasper County. Future work should continue to consider the implications of geopolitical boundaries when monitoring populations.

Introduction

In less than a century, reptiles and amphibians have shown increasingly rapid rates of population declines and extinctions (Daszak et al., 1999; Falaschi et al., 2020; McCallum 2007). As reptile and amphibian populations continue to decline, regular reporting of species abundances and diversity can aid in monitoring and conservation efforts. An important factor in species monitoring involves the use of field surveys that regularly sample an area of interest (Elton and Miller, 1954; Hawlitschek, 2011). These surveys are integral pieces of baseline information that allow for immediate and long-term conservation efforts (Stroud and Thompson, 2019). Given the rate of global species decline (Sodhi et al., 2008), it is becoming increasingly important to establish long-term population monitoring programs (Andrei, et. al., 2012; Jiménez-Franco et al., 2020).

Detecting population declines can be quite difficult without the use of regular inventory surveys and up-to-date reporting (Gibbons et al., 2000). Further, documenting long-term patterns can allow for the observation of naturally occurring variation both within and across seasons and years (Fedy and Aldridge, 2011). Increased rates of population monitoring are needed, especially considering the rates of animal distribution changes caused by anthropogenic climate change (Hickling et al., 2006).

Coupled with the challenges involved in monitoring any given species are the geopolitical boundaries that arbitrarily divide the geographic distributions. Accompanying these geopolitical divides are changing regulations and laws that often govern how organisms are studied and used (Roger et al., 2011; Manfredo et al., 2017). Therefore, differences in the reported abundance and distribution

of any given organism may partially be determined more by local regulations than biological reality. For example, many commonly occurring reptile and amphibian species that span across Missouri and Kansas show large differences in abundance between neighboring counties (Daniel and Edmonds, 2020; Taggart, 2021). The area of SW Missouri, SE Kansas, NW Arkansas, and NE Oklahoma is of special importance because it is the area often reported as the NW most edge of many reptile and amphibian ranges in the United States (Powell et al., 2016).

Given the need for increased survey efforts at range edges and near state boundaries, we conducted a survey of reptiles and amphibians at Kellogg Lake in Carthage, MO (Figure 1). This man-made lake is approximately 29 kilometers east of the KS state line. The 10.1-hectare lake is co-managed by the Missouri Department of Conservation and the City of Carthage and has no regulations on wildlife apart from game fish. Our goal was to take preliminary data in the area in hopes of starting long-term population monitoring efforts in SW Missouri. Further, we hope to better quantify and describe reptiles and amphibians in a considerably understudied region of Missouri. Lastly, we make comparisons of species detected in the region between neighboring Kansas and Missouri counties.

Methods and Materials

We sampled Kellogg Lake from May 20th to August 8th, 2020. Our trap placement and searching methods remained systematic across our sampling days but our trap efforts increased throughout the season as we gained access to grant funding (and therefore more traps). In total, 328 person-hours were logged in exploring the region for visual confirmation of any reptiles and amphibians. When possible, species were caught and had morphological measurements recorded.

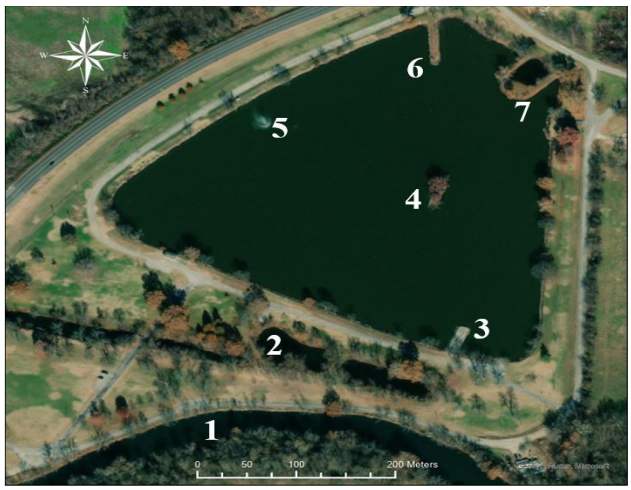

Figure 1. Overhead view of Kellogg Lake in Carthage, Missouri. Numbers denote specific features of the area including Spring River (1), permanent wetland (2), fishing peninsulas (3,6,7), a small island (4), and an aeration system (5).

Hoop nets (0.91 × 1.82 m, n = 7), crab traps (0.4 × 1 m, n = 34), and minnow traps (n = 13) were baited with sardines (oil, hot sauce, and mustard) or smoked oysters. Each trap type received each bait type and each bait × trap combination was spread evenly throughout the sampling area. The large hoop nets were modified to be held open using two pvc pipes. These were placed on the bank so that a portion of the trap was always above the water so that any caught animals could breathe. All crab and minnow traps had flotation devices within them (pieces of pool noodles) so that a portion of their netting would remain above water at all times. Each trap was placed at approximately 6pm and pulled the following morning by approximately 11am. Overall, data derives from 133 trap-nights, manual captures, and sightings.

For each animal caught, morphological measurements (length, mass, sex) were taken. We also kept voucher specimens of most species captured; all other individuals were released. For species in which we captured considerable samples, we tested sex ratios against an expected 1:1 using Chi-square tests. We also tested for sexual dimorphism using standard major-axis regressions with body mass and length as continuous measures and sex as a categorical predictor. Lastly, we compare our data to prior literature from the region using the Kansas Herpetological Atlas (Taggart, 2021) and the Missouri Herpetological Atlas (Daniel and Edmonds, 2020). Specifically, we compared data from Cherokee County, KS to Jasper County, MO. The age of the oldest record, newest record, and total specimens reported between these two counties were compared using paired t-tests or Wilcoxon sign-rank tests (paired by species) based on model assumptions. We only used species that were reported in both counties and modified data where appropriate (ex; we combined *Hyla chrysocelis* and *H. versicolor* data for KS into data for the *H. chrysocelis* × *H. versicolor* complex). We assume significance when $p < 0.05$.

Results

Eleven species were captured and a twelfth was visually identified. Listed below is the abundance (captured, spotted) for each species from highest to lowest. In total, we were able to find *Sternotherus odoratus* (captured = 93, spotted = 10), *Trachemys scripta* (n = 48, n = 11), *Regina grahamii* (n = 15, n = 18), *Lithobates catesbeianus* (n = 8, n = 4), *Apalone spinifera* (n = 3, n = 1), *Anaxyrus americanus* (n = 3, n = 1), *Lithobates sphenocephalus* (n = 3, n = 0), *Nerodia sipedon* (n = 1, n = 0), *Nerodia erythrogaster* (n = 1, n = 0), *Storeria dekayi* (n = 1, n = 0), *Nerodia rhombifer* (n = 0, n = 3), and *Chelydra serpentina* (n = 0, n = 1).

Large enough samples from three species were caught to make inferences about their population demographics. Of the *S. odoratus* captured (n = 93), three individuals were juveniles (body mass = 8–20 g), 27 were male (35–175 g), and 63 were female (35–145 g). The *S. odoratus* population was heavily female skewed and was significantly different from an expected 1:1 ratio ($X21 = 20.57$, $p < 0.0001$). While there was a significant difference in the sex ratio of *S. odoratus*, there was no significant difference between their sizes ($F1,88 = 0.098$, $p > 0.75$; Figure 2A).

For *T. scripta*, a similar number of juveniles (n = 17; 9.5–130 g), males (n = 14; 80–810 g), and females (n = 17; 75–700 g) were found. For several smaller *T. scripta*, we categorized them as juvenile if there were no obvious external characters to distinguish them between either a small female or large juvenile. No significant difference was found between the ratio of females and males and that of a 1:1 sex ratio ($X21 = 0.52$, $p > 0.46$). There was also no significant difference in the sizes of *T. scripta* caught ($F1,29 = 0.025$, $p > 0.87$; Figure 2B). We also caught fifteen adult *R. grahamii* that were heavily female (n =11) skewed compared to an expected 1:1 sex ratio ($X21 = 12.25$, $p < 0.001$). Female *R. grahamii* (150–610 g) were also significantly heavier than males (85–110 g; $t13 = 3.0$, $p < 0.02$).

When looking at historical records of herpetofaunal populations that span both Missouri and Kansas, there is a high number of overlapping species occurrences. There are a total of 53 species of reptiles and amphibians currently documented in Jasper County, MO (n=50; Daniel and Edmonds, 2020) and Cherokee County, KS (n=48; Taggart, 2021). Jasper county had reports of two Ophisaurus attenuatus (1899), and recent reports of the invasive *Podarcis siculus* (n = 5, 2013-2019). There was a total of 46 species reported in both counties. Two species (*Eurycea lucifuga* and *Kinosternon flavescens*) were removed from the comparison because there was incomplete data from Jasper County. All individual datasets are not normally distributed, so we report median values and visualize data using probability density functions. The oldest records date to 1899 (Jasper County) and 1911 (Cherokee County). There is no significant difference between the oldest reported records between counties (Jasper County = 1931.5, Cherokee County = 1932; $t45 = 0.03$, $p > 0.95$; Fig 3A). However, the most recent records for each species were significantly newer from Cherokee County (median = 2018) compared to Jasper County (median = 2008; $z = 4.88$, $p < 0.0001$; Fig 3B). Further, there have been significantly more specimens reported in Cherokee County (median = 34) compared to Jasper County (median = 3; $z = 5.79$, $p < 0.0001$; Fig 4).

Discussion

In general, we found many of the species expected to be found in the region (*A. americanus*, *L. catesbianus*, *T. scripta*, etc.). However, multiple species were found in high abundance that had few or no natural history records for Jasper County. For example, we found 93 *S. odoratus*, and to our knowledge, the last and only report of this species in Jasper County, Missouri comes from Julius Hurter's original thesis on the reptiles and amphibians of Missouri where he mentions having seen one in Carthage (Hurter, 1911). Reports from the surrounding counties are generally old or rare, including counties to the north (Barton County, MO; 2010) and south (Newton County, MO; 1976) of our study location. There are no reports of *S. odoratus* in the counties directly to the east of Jasper County in Missouri. However, there are 13 reports of *S. odoratus* to the west in Cherokee County, KS (multiple reports from 1934–2004).

During our survey, 33 *R. grahamii* were caught or spotted. Over the past century only seven individuals have been reported in the area: one in Newton County, MO in 1906 (juvenile), two in Barton County, MO (1982 and 2016), and four in Cherokee County, KS (1964 – 1978). Based on our gathered data, *R. grahamii* are sexually dimorphic in size with fe-

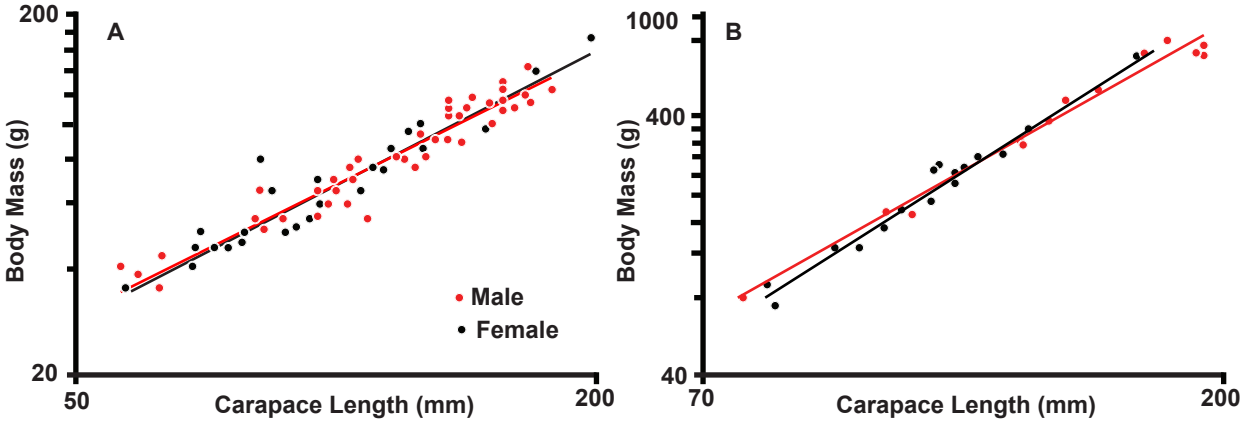

Figure 2. Scatterplot of body mass (g) regressed against carapace length (mm) for *Sternotherus odoratus* (A) and *Trachemys scripta* (B).

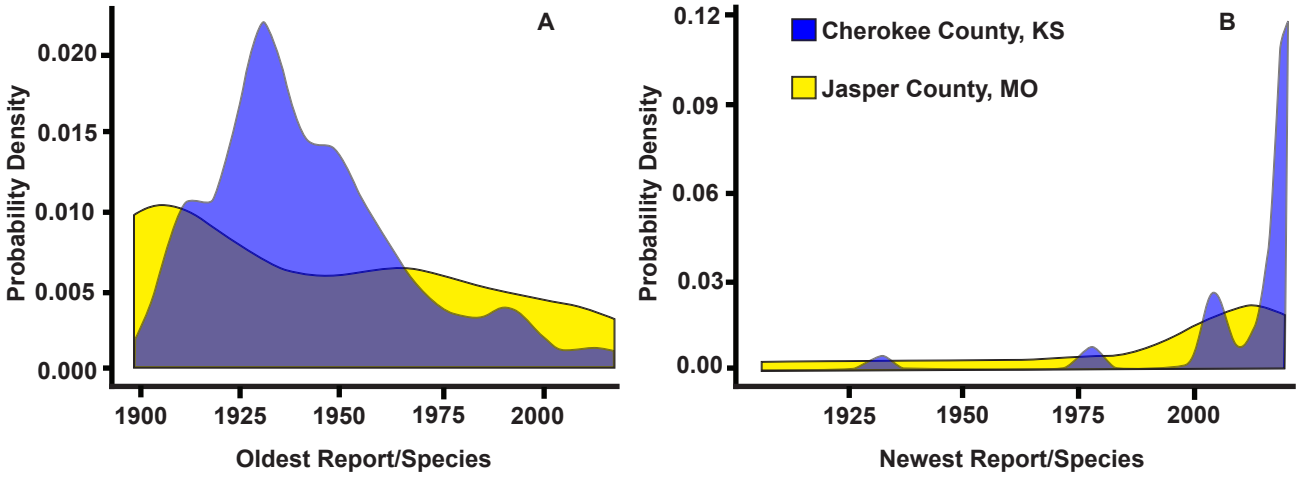

Figure 3. Probability density plots for the oldest (A) and newest (B) reports for 46 species of reptiles and amphibians from Jasper County, MO and Cherokee County, KS.

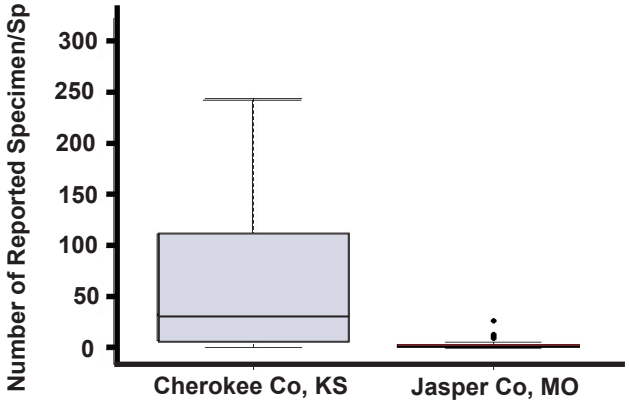

Figure 4. Box and Whisker plot of the total specimen count for 46 species of reptiles and amphibians found in both Cherokee and Jasper counties. The belt is the median, the box is the middle 50% of the data, the whiskers are the 95% confidence intervals, and the individual dots are values outside the 95% confidence intervals.

males being much larger. While we report a highly skewed female population, this is likely an artifact of our data collection methods and does not reflect the true male:female ratio. The captured males were considerably smaller than the females and all but one of our captures came from hand-capture (non-trap). It is likely that the smaller size of the males made them harder to detect than females but other behavioral or physiological factors may be causing the difference in detection. Further work using traps with similar detection probabilities of both sexes should help reveal the true biological ratio of this species. The size of our largest female *R. grahamii* is also worth noting. We captured a gravid female weighing 610 grams (SVL = 77.5 cm; tail length = 15.5 cm) containing 50 developing embryos (weighing 116.1 grams). Based on Johnson (2000),

this individual is the largest to be captured in Missouri.

While we did not physically catch any *N. rhombifer*, we had three confirmed sightings (by D. Penning) based on dorsal pattern. There are two reported locations of this species being found in Jasper County, Missouri (1899–1935), no reports to the east or south, and 69 reports from the north (Barton County; 1935–2018), the large majority of which come from a single report from 1935. There are six records to the east in Cherokee County, KS (1965–2004).

While there appears to be little difference in the species composition between Jasper County, MO and Cherokee County, KS, there are significant differences in the overall numbers and dates of the reported specimen. In both counties, collection efforts have varied considerably. Cherokee County, KS had a large collection effort in the 1930s. In Jasper County, MO there appears to be no focused collection effort when evaluating the first reports of species; the earliest collection dates are evenly dispersed across the early 1900s. In Jasper County, the median age of the most recent reports for amphibians and reptiles is 2008; a thirteen-year gap between then and this study. Meanwhile, the most recent reports from Cherokee County are far more up to date with a median age of 2018. Moreover, the overall abundance of the species within museums is very different between counties with Cherokee County having 10× the representation in museum collections (Fig 4). The causes for the differences between the reported modern collections between states is likely multifactorial. First, there are likely to be different reporting parameters between the two state-level resources used. Beyond the available natural history data, there are certainly differences between state-level rules, wildlife codes, and legislation. Further, the state of Kansas has had a long and robust history of reporting and collecting reptiles and amphibians whereas, based on historical data, Missouri has not seen the same overall efforts applied to its amphibians and reptiles. Regardless of the cause, we would encourage all natural history biologists to continue their collection and reporting efforts, and if possible, to publish their findings.

Local species' populations are in flux for a number of reasons, but this often goes undetected due to a lack of continuous monitoring. Data collection is commonly regulated and/or sponsored by state and educational organizations, and therefore varies widely, especially in areas in proximity of geopolitical borders. This is largely due to specific state or federal permits, licenses, and a range of variables governing the monitoring and collection of species. Natural history data is important because it shows species history and current productivity, which allows researchers to predict possible future population changes. This kind of information has helped researchers track species' migration north due to warming climates (Hickling et al., 2006), impacts from habitat loss and human disturbance (Lehtinen et al., 1999), and local/complete species extinctions. Given all of this, the need to keep natural history data consistently updated is more important than ever before.

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Autumn diet and ovary condition of adult *Lithobates catesbeianus* (Shaw, 1802) in northwestern Louisiana

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ABSTRACT - This study fills a gap in the life history of the American Bullfrog (*Lithobates catesbeianus*). These data suggest that bullfrogs from northwestern Louisiana have similar diets to those in other parts of the country. The most common stomach contents were crayfish (*Procambrus* sp.), with incidental plant material being the second most prominent component. It is not clear if crayfish are a dominant prey item or if they simply have much longer retention time in the digestive tract. Females in northwestern Louisiana may not reach maturity until they bridge SVL = 18 mm.

Introduction

The American Bullfrog (*Lithobates catesbeianus*) is native to the eastern two-thirds of North America. It is the largest of North American anurans and is of aquaculture interest world-wide. This species was introduced around the globe for human food, and when released frequently becomes an invasive species due to its catholic palate and explosive reproductive potential (Bury and Whelan 1984; Lowe et al. 2000). Its diet includes vertebrates and invertebrates (Bury and Whelan 1984; Crayon 1998; Cross and Gertenberger 2002; Carpenter 2002; King et al. 2002; Batista 2002) and has been investigated in both its native and exotic ranges. In its native range dietary studies exist for Arkansas (McAmie and Heidt 1974; Trauth et al. 2003), Kentucky (Bush 1959), Michigan (Werner et al. 1995), Missouri (Korschgen and Moyle 1955), New York (Kramek 1972; Stewart and Sandison 1972), Ohio (Bruggers 1973), Oklahoma (McCoy 1968; Tyler and Hoestenbach 1979), Oregon (Brown 1972), Pennsylvania (Frost 1932), Texas (Carpenter and Morris 1973), and Virginia (Brooks 1964). It has also been examined where it is an exotic invasive including Arizona (Clarkson and deVos 1986), California (Clarkson and deVos 1986; Morey 1999; Hothem et al. 2009), Nevada (Cross and Gertenberger 2002), New Mexico (Krupa 2002), Brazil (Boelter et al. 2012), Leivas et al. 2012), British Columbia (Jancowski and Orchard 2013), China (Wang et al. 2008; Wu et al. 2005), Jamaica (Mahon and Aiken 1977), Japan (Hirai 2004), Mexico (Ortiz-Serrato et al. 2014), New Brunswick (McAlpine and Dilworth 1989), Phillipines (Diesmos et al. 2008), Venezuela (de Pascual et al. 2008). Its reproductive biology has received some attention within its native (e.g. Arkansas [Trauth et al. 2003], Kentucky [Cecil and Just 1979], New Jersey [Ryan 1989], Pennsylvania [Rep et al. 2015]) and introduced range (e.g. Brazil [Kaefer et al. 2007], Europe [Stumbpel 1992]).

This study fills missing gaps in the life history of *L. catesbeianus* in northwestern Louisiana, USA.

Materials and Methods

Fourteen adult *L. catesbeianus* (4 males and 10 females) were collected by hand and dipnet from the Red River Research and Education Park located immediately adjacent to the Louisiana State University in Shreveport Campus, Shreveport, Louisiana (32.4447N, 93.6981 [Tremble XT]) on 28 August and 7 September 2004. They were euthanized with dilute chloretone and their snout-vent length (SVL) and body mass (BM) were measured. Their digestive tracts were removed and total mass of the filled stomach and rectum were recorded. Total contents of the stomach and rectum was removed, weighed and then examined with a dissecting microscope. Gastrointestinal contents were identified to the lowest taxomic level possible, and the numbers and mass of each item were recorded. Condition of the ovaries in female individuals was noted.

Table 1. Prey recovered from digestive tracts of 14 adult American Bullfrogs (*Lithobates catesbeianus*) from northwestern Louisiana.

Prey Item	% of frogs with N Prey	Total Mass when present
Crayfish (*Procambrus* sp.)	1-64.3%, 2=7.1%, 3=7.1%	14.59g (SE=4.83)
Bellastoma	1=14.3%	0.63g
Ephemeroptera	1-7.1%	*
Carabidae	1=7.1%, 2=7.1%	*
Aranea	1=7.1%	3.2g
Lepidoptera	1=7.1%	1.32 g
Reduviidae	1=7.1%	2.04g
Insects and Spiders	50%	1.7g (SE=0.43)
Plant Material	42.9%	1.9g (SE=0.50)
Hair	7.1%	

*the Epheneroptera and Carabid sample were difficult to separate. Combined mass = 1.97 g.

Results

Males (SVLmean = 16.6 cm, SE = 0.66; BMmean = 355.3 mg, SE = 15.52) and females (SVLmean = 18.39 cm, SE = 0.90; BMmean = 464.82 mg, SE = 40.82) were similar to those in other regions. Two females had eggs present, one contained a large clutch ready to lay and the other contained a small partial clutch which was accidentally disposed of (along with ovaries) by a helper before it could be examined in detail. Of the remaining eight females, four had yellow ovaries, three had yellow ovaries with black spots and one female had black pigmented ovaries. Females with yellow ovaries appeared smaller (SVL = 16.33 mm SE = 1.5; BM = 379 mg, SE = 75.82) than those with eggs, or otherwise pigmented ovaries (SVL = 20.04 mm, SE = 0.90; BM = 555.56 mg, SE = 41.76). The small sample size made statistical assessment of questionable value (F = 5.14, P = 0.058).

The diets of *L. catesbeianus* in northwestern Louisiana are similar to those reported in other areas (Table 1). Only 7.1% (1/14) of the specimens had an empty stomach, but 42.9% (6/14) had empty rectums. Stomach contents averaged 12.9 g (SE = 3.99) and rectal contents weighed 6.47 g (SE = 1.18). Frogs averaged 1.69 (SE = 0.26) prey items in their digestive tract.

Whole crayfish and crayfish parts were found in 71.4% (10/14) of the male and females that we collected. Other prey included Insects (Bellastoma, Ephemeroptera, Ground beetle, Lepidoptera, Rivudiidae [ambush bug]) and Arachnida (Aranea). Other contents included plant material (e.g. wood chips, seeds and nuts, leaves and twigs), a single hair, and unidentifiable animal matter (Table 1).

Discussion

The diets of American Bullfrogs in northwestern Louisiana are comparable to in other parts of its natural range such as California (Cohen and Howard 1958), Kentucky (Bush 1959), New York (Stewart and Sandison 1972), Oklahoma (McCoy 1967), and where it has been introduced like Brazil (Boelter and Cechin 2007). Crayfish may be an important component of bullfrog diets as suggested by observations on frog farms (Patera 1978), and predominance in the stomachs of wild caught frogs from Japan (Hirai 2004), Kentucky (Bush 1959), Missouri (Korschgen and Baskett 1963), Oklahoma (McCoy 1967), etc., although no crayfish were reported from St. Lawrence Co., NY (Stewart and Sandison 1972). The contribution of crayfish to bullfrog diets may be over-estimated from this observation because of the lengthy gastronomic retention time of chitonous structures, especially the chelicerae. This also begs-to-question if these components assist in digestion like do gastroliths in many organisms.

We did not find amphibians in any samples. This runs counter to observations of in Brazil (Boelter and Cechin 2007; Boelter et al. 2012), China (Wu et al. 2005), Arizona (Schwalbe and Rosen 1988), and California (Doubledee et al. 2003) where adult and larval anurans were signficant components. In Missouri, frogs and larvae occurred in only ~6% of the diet, with baby turtles (2.5%), snakes (0.7%), fish (3.3%), bats (0.7%), and mice (4.7%) together occurring in 18% of stomachs (Korschgen and Baskett 1963). Further, in New York Rana sp. occurred in 28% of diets and comprised 26.4% of the diet volume (Stewart and Sandison 1972). The number of

other studies demonstrating amphibians as dietary components is extensive. However, one must question if susceptibility to Bullfrog predation depends upon the amphibian community at hand. Clearly, Louisiana and Missouri amphibian communities evolved with Bullfrogs and should have adaptations to avoid them; whereas, those communities from outside or near the periphery of its range may be more susceptible when encounters occur.

The large proportion of frogs with plant material in their digestive tracts is most likely incidental. However, like with chitonous structures earlier discussed, they may play an unknown role in digestion. Plant matter included untallied leaves, sticks, and even a few acorns. One individual's stomach contained 2.06 g of plant material and no other prey. Bullfrogs from St. Lawrence Co., NY had 76.1% frequency and 19.7% by volume incidence of plant materials (Stewart and Sandison 1972). In hind sight, it might have been valuable to record the kinds of plant material as evidence of a gastrolithic or other function. Bullfrogs are known to eat rodents, but the strand of mammalian hair was from a larger mammal as it resembled dog (Canis sp.) hair. No serious attempt at hair identification was made. Personal experience with the readiness with which bullfrogs attack moving objects suggests these items were accidentally swallowed. Bullfrogs will attempt to eat non-living objects that show movement due to currents or wind, sometimes they do swallow them. Sometimes they will engulf vegetation or other matter in the process of catching prey as well.

I expected females to be done breeding. However, day-length of 12:12 prevents regression and atresia of bullfrog ovaries (Horseman et al. 1978) and day-length is still 14 hours by the last week of August in Shreveport. One must question whether females produce more than one brood during the summer. The three females with spotted ovaries probably bred earlier in the season because the black spots were reminiscent of Corpus bodies remaining after ovulation (McCallum et al. 2011). The individual with black ovaries may have oviposited more recently than the previous three, because their condition resembled closely that of females immediately after oviposition. The remaining females with uniformly yellow ovaries probably did not breed that year. Based on the lack of clutch development combined with their smaller average body size, either represented immaturity or evidence that females may not breed every year.

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