Updated Checklist of Amphibians and Reptiles at the University of Oklahoma Biological Station at Lake Texoma, Oklahoma

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Abstract: The University of Oklahoma Biological Station (UOBS) was established in 1950 in Marshall Co., Oklahoma along the newly created reservoir, Lake Texoma. Generations of biology students and independent researchers have documented the flora and fauna on the station grounds and surrounding areas. Herein we compare herpetological records for the area published in the 1950s to herpetology course survey events from 1978–1986 and 2008–2019. Overall, species richness has declined precipitously in the last 65+ years, likely due to several local anthropogenic factors such as habitat modification, environmental pollutants, and the spread of amphibian infectious diseases. We also highlight two species that are additions to the UOBS herpetofauna since its inception; one an introduced species and one a range expansion.

Introduction

The University of Oklahoma (OU) established a biological station on the shore of the newly created Lake Texoma (formed from the dammed Red and Washita Rivers) in the vicinity of Willis, OK (Marshall Co.) in 1950 (Riggs, 1955). The original purpose of the University of Oklahoma Biological Station (UOBS) was to provide infrastructure and protect several habitat types to be utilized by both biological researchers and OU students (Riggs, 1955). UOBS has continued that objective until the present day, with hundreds of research papers published from data collected on UOBS grounds and thousands of students taking courses on-site (UOBS, 2015). The station is currently comprised of 162 ha with a centralized dorm and dining hall building, additional student dorms and apartments, laboratory classrooms, a library, and several research laboratories and affiliated research spaces (greenhouse, mesocosm tanks, etc.), with the primary buildings surrounded by manicured lawns ~12 ha. The station also includes a small grassland, extensive sandy shoreline habitat, a small intermittent marsh (which changes in depth based on lake levels), and a strip of forested area between the shoreline and the access road (G. Wellborn, personal communication). The forest contains oaks of several species, cottonwood, elm, willow, cedar, pecan, and hackberry (G. Wellborn, personal communication).

Previous to dam construction, this region of Oklahoma was dominated by crop and pasture land, intermixed with natural grasslands and post oak/black hickory forests (Corbett et al., 2002, 2013). Little was known about local herpetofaunal species prior to impoundment, because research at that time prioritized fish and aquatic invertebrates only (White and White, 1977), so there are no historical data for comparison. Today, the primary forest vegetation within 15 m of the shoreline near UOBS is typical for riparian bottom-land forests, with minor invasions by Eastern Red Cedar (*Juniperus virginiana*) and Albizia (*Albezia julibrissin*) (Corbett et al., 2013). The watershed of Lake Texoma encompasses land used primarily for agriculture, ranching, and forest, with few human permanent residents (Eggleton et al., 2004). Due to its nature as a human-constructed reservoir, Lake Texoma water levels fluctuate rapidly within and between years, which has the potential to lead to decreased species richness as compared to a natural lake (Corbett et al., 2013; Roeder et al., 2018). However, these same changes in water levels and tributary flows also have the potential to increase species dispersal in the vicinity (Taylor and Laughlin, 1964). Additionally, unlike natural lakes, reservoirs tend to be highly dynamic in changes within the aquatic community structure, especially as they relate to abiotic (e.g. inshore wave turbulence) and biotic (e.g. dispersal between tributaries and the main reservoir) factors (Lienesch and Mathews, 2000; Matthews et al., 2004; Matthews and Marsh-Matthews, 2007).

The immediate area around Lake Texoma, and even adjacent to UOBS, is accessed heavily for tourism and aquatic recreation, such as boating, fishing, and swimming (An et al., 2002; An and Kampbell, 2003; Gonsoulin et al., 2003; Eggleton et al., 2004). The water in Lake Texoma exhibits higher than average conductivity and turbidity (Eggleton et al., 2004), and areas near marinas show evidence of high heavy metals and other environmental contaminants (An et al., 2002; An and Kampbell, 2003). A 1999–2000 study was conducted of Lake Texoma's littoral zone community responses to anthropogenic stressors, such as pollutants, nutrient enrichment from agricultural or septic run-off, and habitat modification (Eggleton et al., 2004). Researchers found that on a large scale, fish communities in the impacted sites were similar to non-impacted sites. Fish community differences between sites was linked more to habitat heterogeneity than point-source pollutants (Eggleton et al., 2004). In contrast, benthic invertebrate communities exhibited increased species richness at impacted sites, likely associated with degraded environmental conditions and increased eutrophication (Eggleton et al., 2004). A similar study of shoreline communities along the Oklahoma side of Lake Texoma quantified bird and plant community diversity in disturbed sites (i.e. in proximity to marinas, campgrounds, and boat launches) and undisturbed sites. Researchers found that both communities decreased in diversity in disturbed sites, with plants also showing reduced vegetation volume and percent canopy (Francl and Schnell, 2002). Forest communities along the Lake Texoma shoreline are dissimilar to others in Oklahoma, which has also been linked to human disturbance (Corbett et al., 2002).

Many of these anthropogenic factors could also impact local reptile and amphibian communities. The distributions of reptiles and amphibians have been well-studied at UOBS and in other nearby Lake Texoma habitats, with the earliest checklists dating back to the 1950s (Bonn and McCarley, 1953; Carpenter, 1955). Herein, we compare those earliest checklists to unpublished datasets obtained from intensive on-site Field Herpetology courses (1978–1986 and 2008–2019), and discuss potential changes in species composition due to anthropogenic factors in the area.

Methods

Presence/absence data for herpetological species expected to occur onsite at UOBS were collated from Marshall Co. (only) records from Carpenter (1955) and common/widespread Lake Texoma area species from Bonn and McCarley (1953) that one would expect to occur on-site (Table 1). Unfortunately, neither publication detailed the methods by which their species lists were obtained, so that information cannot be provided for direct comparison; however, both publications covered a larger land area than the UOBS grounds alone. Additional unpublished presence/absence data were collected from C. Carpenter's 8-week UOBS Herpetology course in June–July 1978, 1980, 1982, 1984, and 1986 (Table 1). A series of 1–2 drift fence arrays were placed on UOBS grounds and monitored daily by course participants. Drift fences were set up with 100 ft lengths, including six funnel traps (two on each side, at each end, and two in the middle) and eight pitfall traps (1 gal. metal cans). A renewed effort to survey the herpetofauna of UOBS as part of intensive undergraduate biology courses at OU began in 2008, with annual activities in the course Field Herpetology taking place from 2008–2019 (Table 1). Annual class survey efforts for the course lasted for 12 days and occurred in late May–early June (2009, 2011, 2012, 2015), mid-June (2013), mid-July (2018–2019), or late July–early August (2008, 2010, 2014, 2016–2017). Students spend up to eight hours per day sampling UOBS-controlled land for reptiles and amphibians through a combination of visual searches (including flipping rocks and logs), dipnetting, seining, various sizes/styles of aquatic traps, drift fence arrays with pitfalls and/or funnel traps, stand-alone funnel traps, cover boards, and frog call recognition (Willson and Gibbons, 2010; Graeter et al., 2013).

Details regarding the exact combination of sampling methods varied by year and were often determined by the students involved. By completing a wide variety of trapping and visual survey methods, which covered both active and passive sampling, we hoped to ensure that students caught or observed the maximum number of local herpetological species and reduced sampling bias (Crosswhite et al., 1999; Jenkins et al., 2003; Graeter et al., 2013). Results from the recent Field Herpetology courses are presented in two categories, based on differences in teaching/sampling styles: 2008–2015, as taught by C. Painter and G. Carpenter (or in the later years, by G. Carpenter alone) vs. 2016–2019, as taught by C. Siler and J. Watters (Figure 1). In addition to sampling during completed during Field Herpetology, we have also incorporated pooled citizen science data recently collected from within UOBS boundaries and exported from either iNaturalist (2014–present) or taxa lists from the 24-hr Oklahoma BioBlitz! in 2016 (Oklahoma Biological Survey, 2016; iNaturalist, 2020; Figure 1). Taxonomy follows

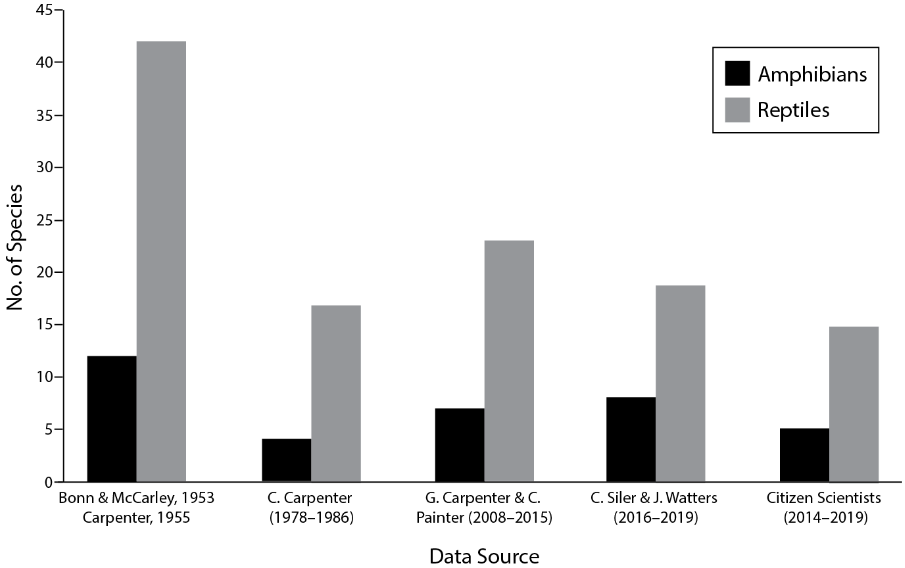

Figure 1. Summary of amphibian and reptile species numbers at the University of Oklahoma Biological Station as documented over time by publications (Bonn & McCarleyy, 1953; Carpenter, 1955), several on-site herpetology courses, and citizen science observations. Categories are representative of data source and in the case of herpetology courses, were divided by instructors and teaching style, in addition to dates.

Table 1. Checklist of University of Oklahoma Biological Station herpetological species comparing historical records from (A) the 1950s: pooled from the publications by Bonn and McCarley (1953) and Carpenter (1955), with unpublished course datasets from the following dates and professors (B) 1978–1986: C. Carpenter, (C) 2008–2015: C. Painter and G. Carpenter, (D) 2016–2019: C. Siler and J. Watters, in addition to (E) citizen science observations from 2014–2019 (Oklahoma Biological Survey, 2016; iNaturalist, 2020). The number in each column represents the total number of years the species was documented, or in the case of column A, the number of publications.

Classification	Common Name	A	B	C	D	E
AMPHIBIANS						
Anura (frogs)						
Bufonidae						
Anaxyrus americanus	American Toad	1		2	2	
Anaxyrus woodhousi	Woodhouse's Toad	2	3	5	3	1
Hylidae						
Acris blanchardi	Blanchard’s Cricket Frog	2		2	4	1
Hyla chrysoscelis/versicolor	Gray Treefrog Complex	2		1	4	1
Hyla cinerea	Green Treefrog			1	4	
Pseudacris clarkii	Spotted Chorus Frog	2				
Pseudacris streckeri	Strecker’s Chorus Frog	2	1			
Microhylidae						
Gastrophryne olivacea	Western Narrow-mouthed Toad	1	2	2		2
Ranidae						
Lithobates blairi	Plains Leopard Frog				1	
Lithobates catesbeianus	American Bullfrog	2			2	
Lithobates sphenocephalus	Southern Leopard Frog	2	4	3	4	2
Scaphiopodidae						
Scaphiopus hurterii	Hurter's Spadefoot	1				
Spea bombifrons	Plains Spadefoot	1				
Caudata (salamanders)						
Ambystomatidae						
Ambystoma texanum	Small-mouthed Salamander	1				
REPTILES						
Serpentes (snakes)						
Colubridae						
Coluber constrictor	North American Racer	2	4	3	2	2
Lampropeltis calligaster	Prairie Kingsnake	1	4	1		
Lampropeltis holbrooki	Coachwhip	1	2		1	
Masticophis flagellum	Speckled Kingsnake	1	2			
Opheodrys aestivus	Rough Greensnake	2	2	1	1	1
Pantherophis obsoletus	Western Ratsnake	2	4	5		2
Pituophis catenifer	Gophersnake	2				
Sonora semiannulata	Western Groundsnake	1				1
Tantilla gracilis	Flat-headed Snake	1				
Dipsadidae						
Diadophis punctatus	Ring-necked Snake	2				1
Heterodon platirhinos	Eastern Hog-nosed Snake	2				
Leptotyphlopidae						
Rena dulcis	Texas Threadsnake	1	1			
Natricidae						
Haldea striatula	Rough Earthsnake	2	1	2		1
Nerodia erythrogaster	Plain-bellied Watersnake	2	2	5	4	1
Nerodia rhombifer	Diamond-backed Watersnake	2		3	4	1
Storeria dekayi	Texas Brownsnake	1	4			
Thamnophis proximus	Western Ribbonsnake	2	4	1	1	1
Thamnophis sirtalis	Common Gartersnake	1				
Tropidoclonion lineatum	Lined Snake	1				

Table 1. Continued.

Viperidae						
Agkistrodon laticinctus	Broad-banded Copperhead	2	3	6	2	2
Agkistrodon piscivorus	Northern Cottonmouth	1			2	
Crotalus atrox	Western Diamondback Rattlesnake			1		
Crotalus horridus	Timber Rattlesnake	2		4	2	1
Sistrurus miliarius	Pigmy Rattlesnake	2			1	
Squamata (lizards)						
Anguidae						
Ophisaurus attenuatus	Slender Glass Lizard	1				
Gekkonidae						
Hemidactylus turcicus	Mediterranean Gecko			2	4	
Phrynosomatidae						
Phrynosoma cornutum	Texas Horned Lizard	2				
Sceloporus consobrinus	Prairie Lizard	2				
Scincidae						
Plestiodon fasciatus	Common Five-lined Skink	1	1	5	4	1
Plestiodon septentrionalis	Prairie Skink	1				
Scincella lateralis	Little Brown Skink	2	4	6	3	1
Teiidae						
Aspidoscelis sexlineata	Six-lined Racerunner	2	4	2		
Testudines (turtles)						
Chelydridae						
Chelydra serpentina	Snapping Turtle	1				1
Macrochelys temminckii	Alligator Snapping Turtle	1				
Emydidae						
Deirochelys reticularia	Chicken Turtle	1				
Graptemys ouachitensis	Ouachita Map Turtle	2		4	3	
Pseudemys concinna	River Cooter	1		2		
Terrapene carolina	Eastern Box Turtle	2	2	4	1	
Terrapene ornata	Ornate Box Turtle	2	2	3	1	1
Trachemys scripta	Pond Slider	2		7	4	1
Kinosternidae						
Kinosternon subrubrum	Eastern Mud Turtle	2	1	1		
Trionychidae						
Apalone mutica	Smooth Softshell	1		1	2	
Apalone spinifera	Spiny Softshell	2		1	1	

Frost (2020) for amphibians and Uetz (2020) for reptiles; common names follow SSAR (2017).

Results and Discussion

During the past nearly 70 years, many reptile and amphibian species have remained consistently present at UOBS (e.g. Woodhouse's Toad, Western Ratnsake, Plain-bellied Watersnake, Five-lined Skink, and Pond Slider), whereas several other species have not been seen since early collections (Table 1). Overall, four frog, one salamander, six snake, four lizard, and three turtle species have not been observed in the vicinity of UOBS since the 1950s, and an additional frog and snake species have not been observed during sampling in the 2000s (Table 1). While the earliest publications regarding Lake Texoma herpetofauna covered several counties, we have reduced our listing to those only expected to occur on UOBS grounds at that time, since in most cases, these details were not provided. However, all 1978–1986 and 2008–2019 data reflect the station grounds specifically, and it is possible to make direct comparisons between these latter groupings, within the larger context of the expected species from the 1950s.

Of particular note among the long-term observations is the loss of the following three reptile species, all of which are experiencing population declines throughout Oklahoma (and often throughout their range): Texas Horned Lizards, Alligator Snapping Turtles, and Chicken Turtles (Riedle et al., 2005, 2009; McKnight et al., 2012; Vesy et al., 2021). The habitat specialist Texas Horned Lizard has been declining in Oklahoma since at least the 1950s (Carpenter et al., 1993), with the primary causes linked to increased urbanization, habitat modification, exploitation for the pet trade, and most recently, the introduction of the red imported fire ant (Vesy et al., 2021), the last of which are known to be present on-site at UOBS (Helms and Tweedy, 2017). Alligator Snapping Turtles, were distributed historically throughout 15 Oklahoma counties, but recent research has located populations in five of these counties only, with populations found only in isolated or protected habitats (Riedle et al., 2005, 2009). Alligator Snapping Turtle declines are associated with overharvesting and habitat modification, particularly river damming, and as such, they would no longer be expected to occur in Lake Texoma (Riedle et al., 2005, 2009). Active conservation efforts to breed the species in captivity at the Tishomingo Fish Hatchery have continued from 2000–present, as well as reintroductions of individuals in appropriate river habitats in their original range and active monitoring post-release (Ligon and Voves, 2019). Chicken Turtles primarily inhabit vernal pools surrounded by pristine habitats during the spring, before going into estivation during dry summer months (McKnight et al., 2012). Although they were documented just west of UOBS in Mayfield Cove in the mid-1970s (G. Carpenter, personal observation), the species is known currently from only a handful of sites in Oklahoma (none in Marshall Co.) and, as such, requires conservation protection (McKnight et al., 2012). It is important to note that available habitat for all three species is lacking on the immediate UOBS grounds, so their loss was to be expected.

In addition to these highlighted declining reptile species, all UOBS amphibians are at risk from high levels of infectious disease on-site (Marhanka et al., 2017) and susceptibility to Lake Texoma environmental contaminants through their porous skin (An et al., 2002; An and Kampbell, 2003). Amphibian infectious disease sampling conducted on-site in 2015 resulted in a 96% prevalence rate for the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*), but a 0% prevalence rate for ranavirus (RV) (Marhanka et al., 2017; Davis et al., 2019); disease research is still ongoing at UOBS in order to understand changes of these two diseases over time. The observed environmental contaminants can also lead to numerous problems at various life stages, including sex reversal, difficulties in metamorphosis, changes in predator avoidance behavior, and an inability to fight off infectious disease (Polo-Cavia et al., 2016; McCoy and Peralta, 2018; Davis et al., 2020; Slaby et al., 2019).

According to the new Oklahoma field guide to reptiles and amphibians, there are an additional 13 species (2 amphibians and 11 reptiles) that are described as occurring in Marshall Co., but have yet to be documented at UOBS specifically (Sievert & Sievert, 2021). While some species of reptile and amphibian have declined in the last nearly 70 years, other species have moved into the Lake Texoma area. Two species of note have also been added to the more recent UOBS herpetofauna collections: Green Treefrog and Mediterranean Gecko (Table 1). The first recorded observation of Green Treefrogs at UOBS was in 2010 (Table 1), although no voucher specimen was collected. In 2011, an individual was captured nearby at Fobb Bottom Wildlife Management Area (WMA) and vouchered to obtain county record documentation for Marshall Co. (Butler and Juarez, 2011). The species has been seen consistently at UOBS ever since (Table 1). Mediterranean Geckos are unique case in that they are a non-native species that has been introduced throughout the southern United States through human-mediated dispersal events, both intentional and unintentional, and is found primarily in and around human habitation (White et al., 2019). The species was introduced to the Norman campus of the University of Oklahoma by Teague Self or C. Carpenter and/or their students in the 1950s–1960s, although there is some debate as to whether this was an intentional or accidental release (White et al., 2019; V. Hutchison, personal communication). Presumably the geckos were introduced to UOBS soon thereafter by C. Carpenter's student Dale Marcellini (G. Carpenter, personal observation), and have been seen fairly consistently to the present day (Table 1).

It is worth noting that the length of survey time (12 days maximum) and variation in the time of year (late Spring/early Summer vs. late Summer) for our most recent survey events may contribute to some biases in amphibian detection, especially for those species whose breeding cycles are linked to early Spring (e.g. many Hylidae) or only to intense rainfall events (e.g. all Scaphiopodidae) (Sievert and Sievert, 2021). Sampling events from 1978–1986 also occurred in mid-summer only, but lasted for 8 weeks. Similarly, the same combination of trapping and survey methods were not employed every year or in the same microhabitats, which may contribute to some annual variation in species-specific discovery. For example, turtle captures are highly dependent on bait type and trap style, and it is likely that large hoop traps and crab traps, baited with sardines, may have disproportionally caught turtle species that are more inclined to open water and basking, such as Pond Slider, River Cooter, and Ouachita Map Turtle (Riedle et al., 2009). However, despite each trapping and survey method having individual, associated biases (Willson and Gibbons, 2010; Graeter et al., 2013), by utilizing several methods simultaneously and repeatedly over this long-term monitoring program, including observations by citizen scientists, we feel confident in the inferred trends and patterns, for at least the collections from 2008–2019. Herpetological sampling from 1978–1986 involved land trapping only, further resulting in a potential loss of presence/absence data for turtles.

Long-term monitoring of species' natural history and habitats are necessary for understanding changes in species distribution through time as it relates to many human-mediated factors, such as urbanization and climate change (Bartholomew, 1986; Able, 2016). Additionally, accurate conservation assessments and mitigation cannot be completed without long-term monitoring (Able, 2016), yet these types of studies are in decline in herpetology (McCallum and McCallum, 2006) and many other biological disciplines (Tewksbury et al., 2014). At UOBS, we have a unique situation in that herpetological species presence/absence has been documented for nearly 70 years, albeit intermittently. Natural history-based courses like Field Herpetology, whether they occur in a classroom, field, or museum setting, provide students with an increased awareness of large-scale natural phenomena and allow them to make educated science-based decisions about the world they live in (King and Achiam, 2017). The data provided herein give both an important foundation for course-based research, but also a unique in-depth glimpse into one vertebrate group and locality, an area that is increasingly lacking in biology (McCallum and McCallum, 2006; Tewksbury et al., 2014).

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