

AN ABSTRACT FOR THE THESIS OF

William Pence for the Master of Science Degree

in Biological Sciences presented on April 3, 2013

Title: Survey of rare herpetofauna at the Fort Riley Military Reservation

Abstract approved: _____

In 1993, the Kansas Biological Survey (KBS) conducted the first systematic herpetofaunal survey that was specific to the Fort Riley Military Reservation (Riley and Geary counties) and documented 39 reptile and amphibian species at the installation. Since 2002, the Directorate of Public Works at Fort Riley has conducted annual reptile and amphibian counts at the installation during April or May and has confirmed seven additional species not previously documented by the KBS. However, two species (Plains Spadefoot (*Spea bombifrons*) and Western Hognose Snake (*Heterodon nasicus*)) that were found by the KBS have not been seen at Fort Riley since 1993. During the summer of 2012, I conducted a herpetofaunal survey at Fort Riley with special focus on *S. bombifrons* and *H. nasicus*. A total of 666 individuals representing 28 reptile and amphibian species were found at the FRMR during the survey, which included three *S. bombifrons* individuals, but *H. nasicus* was not found. I attributed the rarity of *S. bombifrons* and *H. nasicus* at Fort Riley to the natural rarity of the soil type required for these species, which has been further reduced by increased urbanization. Because these two species are fossorial for most of their lives, the dry conditions of 2012 likely kept these species underground for most of the summer.

SURVEY OF RARE HERPETOFAUNA AT THE FORT RILEY MILITARY
RESERVATION

A Thesis

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Master of Science

By

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PREFACE

My thesis has only one chapter. My thesis follows the format guidelines of the American Midland Naturalist, to which I intend to submit this manuscript for publication. All of my protocols were approved by the ACUC (ESU-PROTOCOL-11-019) at Emporia State University.

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INTRODUCTION

The Fort Riley Military Reservation (FRMR) is located in Riley and Geary counties in northeastern Kansas between Manhattan and Junction City (Figure 1), and lies within the Flint Hills region of Kansas (Busby and Parmelee 1996). Since 1853, the FRMR has provided training facilities for Active Army, Army Reserve, and National Guard soldiers (Quist et al. 2003). Despite the intense training exercises that take place at the FRMR, it still retains large blocks of vegetation, which support a large diversity of wildlife (Busby, Collins and Suleiman 2005). A total of 223 bird species and 43 mammal species have been documented at the FRMR (Pitts, Levalley and Klinger 1987; Althoff et al. 2005). The Directorate of Public Works (Environmental Division) at the FRMR continually monitors species and habitats, which is necessary to provide data about the effects of management actions and military training on the land. Inventory is conducted to attain indicators of overall ecosystem integrity, capability of lands to sustain military missions, renewable product surpluses, and status of sensitive species and habitats. Each military installation explains this strategy through their Integrated Natural Resources Management Plan (INRMP) which is for the protection, development, and management of natural resources on the Fort Riley Military Reservation in accordance with Title 10, U.S. Code Section 2671: Title 16, U.S. Code, Section 670 (Fort Riley INRMP 2010).

Among the wildlife at the FRMR, the installation has a rich diversity of reptiles and amphibians (Busby, Collins and Suleiman 2005). The first systematic herpetofaunal survey conducted at the FRMR was by the Kansas Biological Survey (KBS) in 1993, which documented 39 reptile and amphibian species (Busby et al. 1994). Since 2002, the FRMR Environmental Division has conducted annual herpetofaunal counts and

documented 44 reptile and amphibian species at the installation as of 2012. Along with the annual herpetofaunal counts, the FRMR Environmental Division conducts amphibian call surveys during the late spring and early summer. The 1993 KBS survey and the annual FRMR Environmental Division herpetofaunal counts are the only reptile and amphibian surveys that have occurred at the FRMR (Tables 1 and 2).

The 1993 KBS survey documented nine amphibian species, six lizard species, 17 snake species, and seven turtle species at the FRMR (Busby et al. 1994). The FRMR Environmental Division herpetofaunal surveys documented one amphibian species, three lizard species, and three snake species at the FRMR that were not previously documented by the KBS: *Anaxyrus cognatus*, *Plestiodon fasciatus*, *P. septentrionalis*, *Sceloporus consobrinus*, *Carphophis vermis*, *Nerodia erythrogaster*, and *Thamnophis radix*. However, two species documented by the KBS have not been seen at the FRMR since 1993: *Spea bombifrons* and *Heterodon nasicus*.

Only three *S. bombifrons* and two *H. nasicus* were found at the FRMR by the 1993 KBS survey (Busby et al. 1994). While *S. bombifrons* has no federal status in Kansas, *H. nasicus* is currently listed as a Species in Need of Conservation (SINC) in Kansas (Collins, Collins and Taggart 2010). The preferred habitats of *S. bombifrons* and *H. nasicus* are those that contain loose and sandy soil (Hoyt 1960; Busby, Collins and Suleiman 2005).

S. bombifrons is fossorial, nocturnal, and only emerges from the ground after heavy rainfall (Hoyt 1960). *H. nasicus* is most active during the morning and late afternoon, but spends most of its time buried under loose soil to maintain its body temperature (Collins, Collins and Taggart 2010). Because these two species spend most

of their lives underground, locating them can be difficult. At the FRMR, the soil type required by these two species is limited to the Kansas and Republican Rivers, which are located in the southern tip of the installation (Busby and Parmelee 1996).

The annual FRMR Environmental Division herpetofaunal surveys occur during a single day in April or May, but the 1993 KBS survey was prolonged (April - October 1993). A prolonged herpetofaunal survey has not been conducted at the FRMR since 1993 and is needed to survey *S. bombifrons* and *H. nasicus* populations at the installation more thoroughly. From March – September 2012, I conducted a herpetofaunal survey at the FRMR in conjunction with the FRMR Environmental Division. The objective of my survey was to gather relative abundance data of the herpetofaunal assemblage at the FRMR, with special focus on *S. bombifrons* and *H. nasicus*.

Figure 1. Location of Fort Riley Military Reservation (FRMR) in Kansas
(www.dodpif.org).

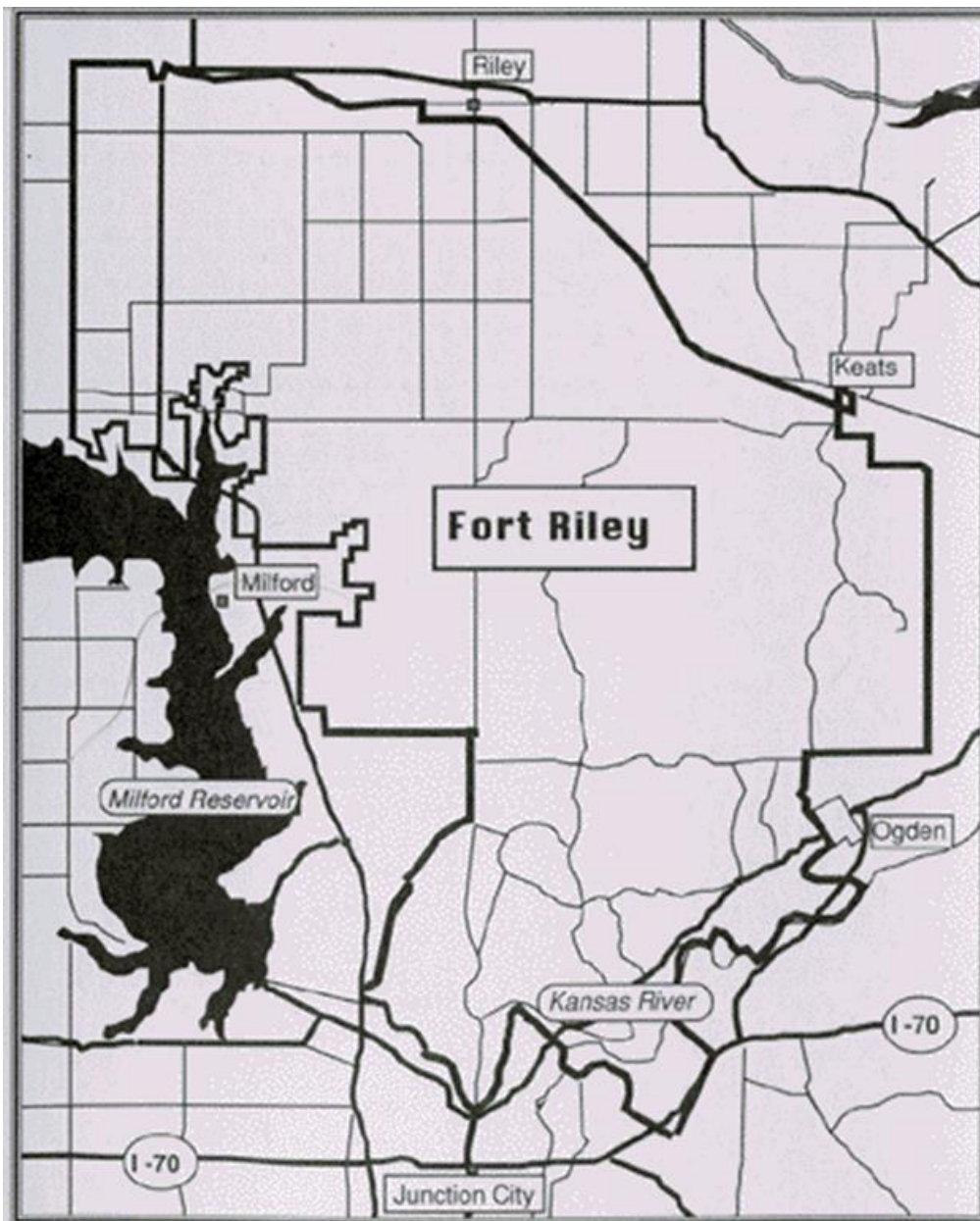


Table 1. Herpetofauna documented (x) at the FRMR by the KBS and the FRMR Environmental Division. (-) species was absent.

Species*	KBS survey (1993)	FRMR Environmental Division surveys (2002 – present) ¹
Amphibians		
Barred Tiger Salamander (<i>Ambystoma mavortium</i>)	x	x
Northern Cricket Frog (<i>Acris crepitans</i>)	x	x
Great Plains Toad (<i>Anaxyrus cognatus</i>)	-	x
Woodhouse's Toad (<i>Anaxyrus woodhousii</i>)	x	x
Great Plains Narrowmouth Toad (<i>Gastropryne olivacea</i>)	x	x
Cope's Gray Treefrog (<i>Hyla chrysoscelis</i>)	x	x
Plains Leopard Frog (<i>Lithobates blairi</i>)	x	x
American Bullfrog (<i>Lithobates catesbeiana</i>)	x	x
Boreal Chorus Frog (<i>Pseudacris maculata</i>)	x	x
Plains Spadefoot (<i>Spea bombifrons</i>)	x	-
Lizards		
Six-lined Racerunner (<i>Aspidoscelis sexlineata</i>)	x	x

Table 1 – continued

Species*	KBS survey (1993)	FRMR Environmental Division surveys (2002 - present) ¹
Eastern Collared Lizard (<i>Crotaphytus collaris</i>)	x	x
Western Slender Glass Lizard (<i>Ophisaurus attenuatus</i>)	x	x
Texas Horned Lizard (<i>Phrynosoma cornutum</i>)	x	x
Five-lined Skink (<i>Plestiodon fasciatus</i>)	-	x
Great Plains Skink (<i>Plestiodon obsoletus</i>)	x	x
Northern Prairie Skink (<i>Plestiodon septentrionalis</i>)	-	x
Prairie Lizard (<i>Sceloporus consobrinus</i>)	-	x
Ground Skink (<i>Scincella lateralis</i>)	x	x
Snakes		
Copperhead (<i>Agkistrodon contortrix</i>)	x	x
Western Worm Snake (<i>Carphophis vermis</i>)	-	x
Eastern Racer (<i>Coluber constrictor</i>)	x	x
Ringneck Snake (<i>Diadophis punctatus</i>)	x	x

Table 1 – continued

Species*	KBS survey (1993)	FRMR Environmental Division surveys (2002 – present) ¹
Western Hognose Snake (<i>Heterodon nasicus</i>)	x	-
Prairie Kingsnake (<i>Lampropeltis calligaster</i>)	x	x
Common Kingsnake (<i>Lampropeltis getula</i>)	x	x
Milk Snake (<i>Lampropeltis triangulum</i>)	x	x
Plainbelly Water Snake (<i>Nerodia erythrogaster</i>)	-	x
Northern Water Snake (<i>Nerodia sipedon</i>)	x	x
Great Plains Rat Snake (<i>Pantherophis emoryi</i>)	x	x
Western Rat Snake (<i>Pantherophis obsoletus</i>)	x	x
Gopher Snake (<i>Pituophis catenifer</i>)	x	x
Brown Snake (<i>Storeria dekayi</i>)	x	x
Flathead Snake (<i>Tantilla gracilis</i>)	x	x
Plains Blackhead Snake (<i>Tantilla nigriceps</i>)	x	x

Table 1 – continued

Species*	KBS survey (1993)	FRMR Environmental Division surveys (2002 – present) ¹
Western Ribbon Snake (<i>Thamnophis proximus</i>)	x	x
Plains Garter Snake (<i>Thamnophis radix</i>)	-	x
Common Garter Snake (<i>Thamnophis sirtalis</i>)	x	x
Lined Snake (<i>Tropidoclonion lineatum</i>)	x	x
Turtles		
Smooth Softshell (<i>Apalone mutica</i>)	x	x
Spiny Softshell (<i>Apalone spinifera</i>)	x	x
Common Snapping Turtle (<i>Chelydra serpentina</i>)	x	x
Northern Painted Turtle (<i>Chrysemys picta</i>)	x	x
Ouachita Map Turtle (<i>Graptemys ouachitensis</i>)	x	x
Ornate Box Turtle (<i>Terrapene ornata</i>)	x	x
Slider (<i>Trachemys scripta</i>)	x	x
Total	39	44

*Taxonomy by Crother (ed.) (2008)

¹Species data by Suleiman (2003), Suleiman (2005), Suleiman (2006), Houck (2009), Houck (2010), and Houck (2011).

Table 2. Herpetofauna documented at the FRMR by the FRMR Environmental Division surveys (2002 – present). (-) indicates species was absent in all surveys, (+) indicates species was found during all surveys.

Species*	Year (s) found at the FRMR ¹
Amphibians	
<i>Ambystoma mavortium</i>	2003
<i>Acris crepitans</i>	+
<i>Anaxyrus cognatus</i>	2012
<i>Anaxyrus woodhousii</i>	2002, 2003, 2004, 2006, 2007, 2009, 2010, 2012
<i>Gastropryne olivacea</i>	+
<i>Hyla chrysoscelis</i>	2002, 2007, 2008, 2009, 2011, 2012
<i>Lithobates blairi</i>	+
<i>Lithobates catesbeiana</i>	+
<i>Pseudacris maculata</i>	+
<i>Spea bombifrons</i>	-
Lizards	
<i>Aspidoscelis sexlineata</i>	2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2012
<i>Crotaphytus collaris</i>	+
<i>Ophisaurus attenuatus</i>	2004, 2005, 2007, 2009, 2010, 2011, 2012
<i>Phrynosoma cornutum</i>	2002, 2004, 2007, 2009, 2010, 2011, 2012
<i>Plestiodon fasciatus</i>	2003, 2007
<i>Plestiodon obsoletus</i>	+
<i>Plestiodon septentrionalis</i>	2003, 2004
<i>Sceloporus consobrinus</i>	2002, 2004
<i>Scincella lateralis</i>	2002, 2003, 2005, 2006, 2009, 2010
Snakes	
<i>Agkistrodon contortrix</i>	+
<i>Carphophis vermis</i>	2005, 2006, 2008, 2010, 2012
<i>Coluber constrictor</i>	+
<i>Diadophis punctatus</i>	+
<i>Heterodon nasicus</i>	-

<i>Lampropeltis calligaster</i>	2006, 2008, 2009, 2011
<i>Lampropeltis getula</i>	2007, 2008, 2009, 2010, 2012
<i>Lampropeltis triangulum</i>	+
<i>Nerodia erythrogaster</i>	2002
<i>Nerodia sipedon</i>	2002, 2003, 2004, 2005, 2007, 2008, 2009, 2010, 2011, 2012
<i>Pantherophis emoryi</i>	+
<i>Pituophis catenifer</i>	2002, 2005, 2007, 2008, 2009, 2010, 2011, 2012
<i>Scotophis obsoletus</i>	2002, 2003, 2004, 2007, 2008, 2009, 2010, 2011, 2012
<i>Storeria dekayi</i>	2004, 2009, 2012
<i>Tantilla gracilis</i>	2002, 2006, 2008
<i>Tantilla nigriceps</i>	2003, 2004
<i>Thamnophis proximus</i>	2004
<i>Thamnophis radix</i>	2008, 2011
<i>Thamnophis sirtalis</i>	2002, 2003, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012
<i>Tropidoclonion lineatum</i>	2002, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012
Turtles	
<i>Apalone</i> spp. ²	2002, 2003, 2004, 2007, 2008, 2009, 2012
<i>Chelydra serpentina</i>	2002, 2003, 2005, 2009, 2011, 2012
<i>Chrysemys picta</i>	2002, 2003, 2004, 2007, 2009, 2010, 2011, 2012
<i>Graptemys ouachitensis</i>	2002, 2003, 2008, 2011, 2012
<i>Terrapene ornata</i>	2004, 2007, 2010, 2012
<i>Trachemys scripta</i>	2002, 2003, 2004, 2005, 2007, 2008, 2009, 2011, 2012

*Taxonomy by Crother (ed.) (2008)

¹Species data provided by Suleiman (2003), Suleiman (2005), (Suleiman 2006), Houck (2009), Houck (2010), and Houck (2011). For 2002, 2004, 2005, 2007, 2008, and other incidental sightings, species data was provided by Mike Houck (FRMR Environmental Division).

²*Apalone mutica* and *A. spinifera* could not be positively identified during surveys.

METHODS

Survey Area

The FRMR covers an area of approximately 101,000 acres (Busby et al. 1994). The FRMR is composed of 16 Maneuver Areas represented by capital letters and 103 Training Areas represented by numbers (Figure 2). The southern area of the FRMR contains most of the urban areas of the installation, which include Camp Funston and Camp Forsyth. The Impact Area and the Multi-Purpose Range Complex (MPRC) are civilian-restricted areas where live firing and explosive ordinance exercises take place. The following habitat types were surveyed at the FRMR: upland prairie, sand prairie, deciduous forest, and riparian forest.

Upland Prairie

Upland prairie covers approximately 40% of the FRMR and is composed mainly of native tall grass (Suleiman 2005). The majority of upland prairie at the FRMR is located north of Vinton School Road. The upland prairie in the following Maneuver Areas at the FRMR were surveyed: Alpha (A), Bravo (B), Charlie (C), Delta (D), Echo (E), Foxtrot (F), Gulf (G), India (I), Juliet (J), Mike (M), and November (N). Training Areas surveyed: 14, 17, 20, 22, 25, 27, 28, 29, 31, 33, 34, 35, 37, 38, 39, 41, 43, 45, 46, 49, 50, 51, 52, 64, 65, 75, 79, 81, 82, 89, 91, 92

Sand Prairie

Sand prairie covers approximately 3% of the FRMR and is composed mainly of non-native grasses growing in sandy soil (Busby and Parmelee 1996). Sand prairie at the FRMR is limited to the Kansas and Republican River valleys located in the southern area of the installation (Busby and Parmelee 1996). The sand prairie located in the southern

portions of Camp Funston (Training Area 7A) and Camp Forsyth (Training Areas 18 and 19) was surveyed. This habitat was a special focus during the survey because the sandy soil is preferred by *Spea bombifrons* and *Heterodon nasicus*.

Training Areas surveyed: 7A, 18, 19, Camp Forsyth

Deciduous Forest

Deciduous forest covers approximately 15% of the FRMR and is composed mainly of Oak (*Quercus* spp.) and late successional vegetation (Busby and Parmelee 1996). The majority of deciduous forest at the FRMR is located east of the Impact Area and the areas between Custer Hill and Camp Funston (Training Areas 5 and 10). The deciduous forest in Maneuver Areas I, M, Rifle Range Road, and Williston Point Road was surveyed.

Training Areas surveyed: 5, 10, 20, 33, 92

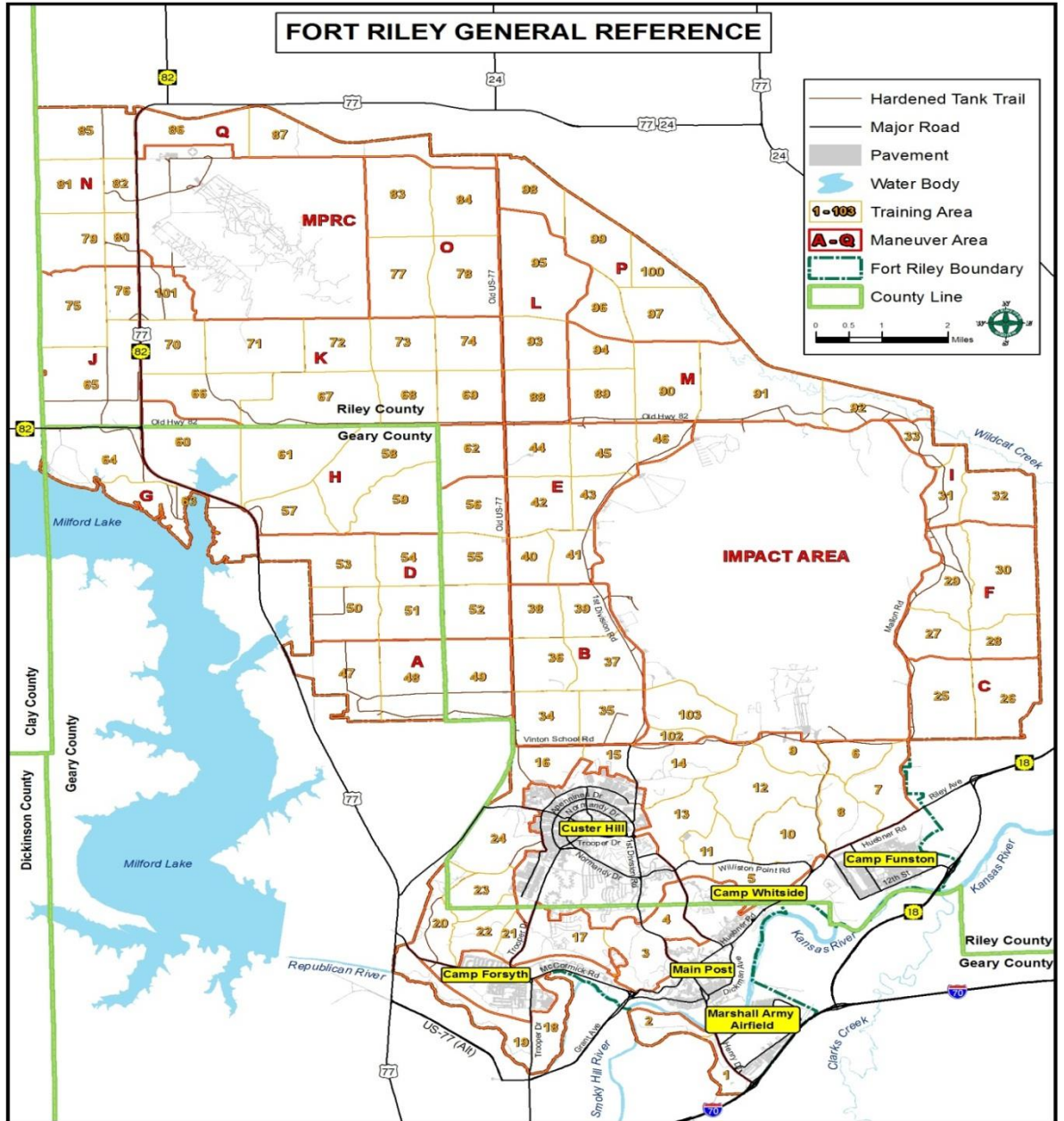
Riparian Forest

Riparian forest covers approximately 2% of the FRMR and is composed mainly of cottonwood-willow trees growing in sandy soil (Busby and Parmelee 1996). Riparian forest is limited to the Kansas and Republican River valleys located in the southern area of the installation (Busby and Parmelee 1996). The riparian forest located south of Camp Funston (Training Area 7A), west of Marshall Army Airfield (Training Areas 2 and 2A), and south of Camp Forsyth (Training Areas 18 and 19) were surveyed. This habitat was a special focus during the survey because the cover and sandy soil are preferred by

Heterodon nasicus.

Training Areas surveyed: 2, 2A, 7A, 18, 19

Figure 2. General layout of the FRMR (Map by Shawn White)



Survey Techniques

During the survey period, six techniques were employed to capture reptiles and amphibians at the FRMR: active off-road searches, cover boards, drift fences with funnel traps, natural cover, road cruising, and pond seining. A total of 515.5 person hours were spent surveying the herpetofauna at the FRMR.

Active off-road searches

Throughout the survey, if a reptile or amphibian was seen moving on the surface, not under any form of cover, not on a road, or heard, it was regarded as “active off-road.” For reptiles, examples of “active off-road” specimens include lizards seen basking on the top of a rock in a quarry site or turtles basking on logs. For amphibians, examples of “active off-road” specimens would be frogs and toads seen on the edge of ponds, swimming, or heard chorusing.

Maneuver Area(s) searched: A, C, D, F, G, I, J, M, N

Training Area(s) searched: 2, 5, 10, 14, 17, 18, 19, 20, 22, 25, 27, 28, 29, 31, 33, 34, 35, 37, 38, 39, 41, 43, 45, 46, 49, 50, 51, 52, 64, 65, 75, 79, 81, 82, 89, 91, 92

Cover boards

Cover boards composed of 1.2 m x 1.2 m plywood squares were used as artificial shelters to attract reptiles and amphibians at the FRMR. A total of 19 arrays of ten boards (190 boards) were placed in the four habitat types (Table 3; Figure 3). Cover board arrays were set out from 19 – 23 March 2012. In each array, boards were placed 20.0 m apart in a line. Each cover board array was checked once per week from 21 May – 3 August 2012 and 3 – 21 September 2012. Cover boards were not checked for most of August 2012 because of dry conditions.

Maneuver Area(s) placed: D, I, M, N

Training Area(s) placed: 2, 5, 7A, 10, 18, 19, 20, 22, 31, 50, 51, 79, 92

Table 3. Locations of cover board arrays at the FRMR

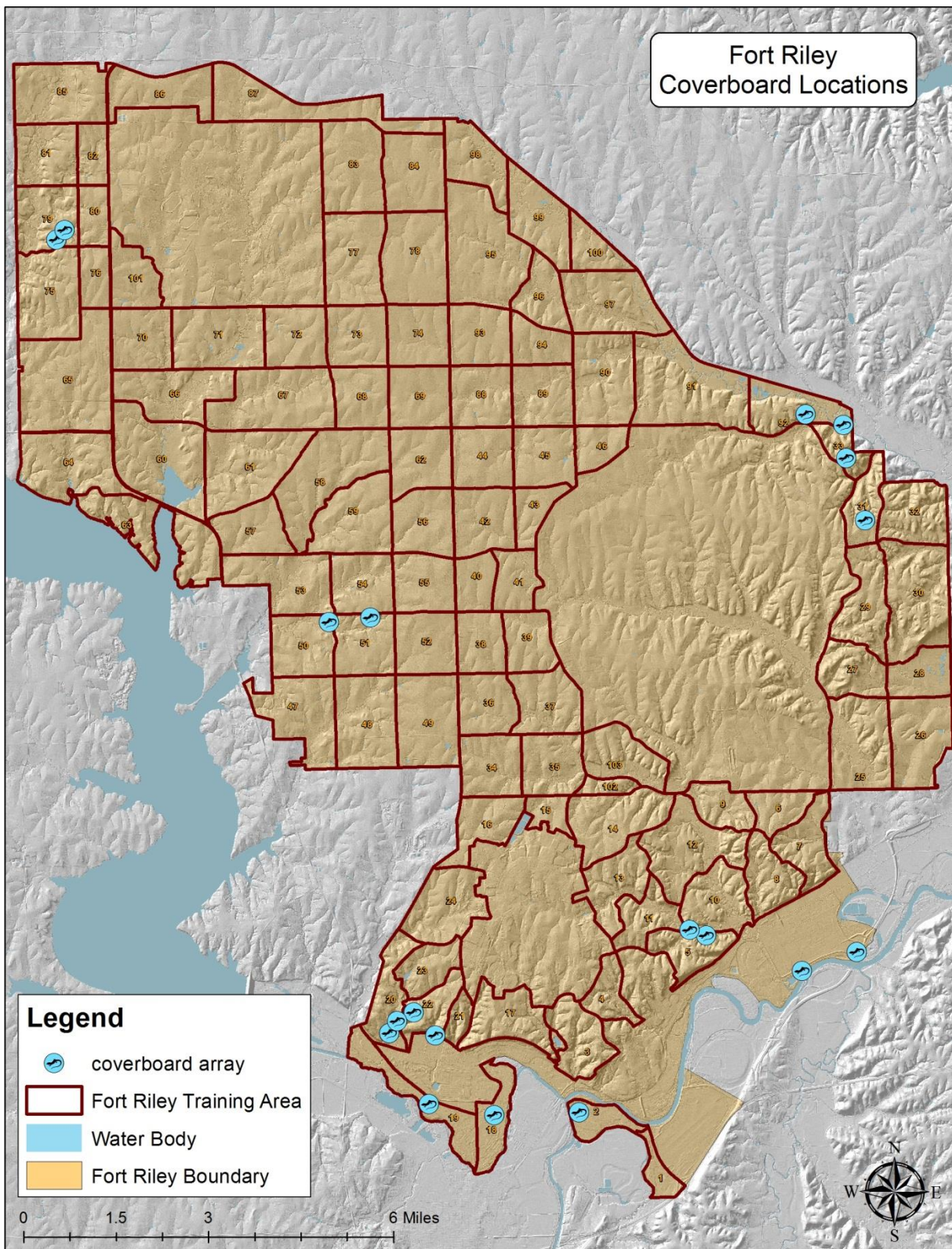
Code	Training Area	Latitude ¹	Longitude ¹	Comments
Upland Prairie				
BR-A1	22	390454	965048	Backstop Ridge
BR-A2	22	390435	965052	Rifle Range Rd.
IA-A1	31	391144	964223	E of Impact A
KE-A2	92	391312	964328	SW of Wildcat Creek and Keats
TA-A1	50	391024	965224	W of Old US Highway 77
TA-A2	51	391027	965126	W of Old US Highway 77
TC-A1	79	391556	965657	Timber Creek area
TC-A2	79	391604	965648	Timber Creek area
Sand Prairie				
CF-A1	7A	390536	964245	SE of Camp Funston, NW of Highway 18 and Kansas River
RF-A1	19	390336	965034	S of horse pasture at Camp Forsyth, N of Republican River trail

Table 3 – continued

Deciduous Forest				
BC-A1	20	390439	965106	N of Rifle Range Rd., obstacle course
BC-A2	20	390438	965114	N of Rifle Range Rd., S of Breakneck Lake
IA-A2	31	391260	964246	E of Impact A, W of food plot
KE-A1	92	391231	964240	SW of Wildcat Creek and Keats
WP-A1	5	390553	964528	Williston Point Rd.
WP-A2	10	390556	964542	Williston Point Rd.
Riparian Forest				
CF-A2	7A	390519	964348	Threemile Wetland
MP-A1	2	390323	964752	W of Marshall Army Airfield, E of Smoky Hill River
RF-A2	18	390325	964923	S of Commissary at Camp Forsyth

¹Format is 'DDMMSS' with degrees (D), minutes (M), seconds (S)

Figure 3. Locations of cover board arrays at the FRMR (Map by Shawn White)



Drift Fences

A total of two drift fences composed of silt fence were used in this survey (Table 4; Figure 4). A total of 12 funnel traps composed of 1/8" mesh hardware cloth and aluminum window screening were placed along the fences. The main purpose of these fences were to capture *H. nasicus* because drift fences with funnel traps are shown to be effective in capturing secretive species (Fitch 1992). Fences were set up from 14 – 15 May 2012 and funnel traps were placed along the fences on 21 May 2012. Funnel traps were checked once daily, but were stored on Saturdays and Sundays. Fences were operated for a total of 680 trap-days.

Maneuver Area(s) placed: N/A

Training Area(s) placed: 7A, 19

Natural Cover

Wherever available at the FRMR, natural cover objects such as logs, rocks, and leaf litter were searched for reptiles and amphibians. Natural cover located near cover board arrays and drift fences was searched whenever arrays and fences were checked. The upland prairie located north of Vinton School Road contained multiple rock quarries that were searched during the survey. A total of 430 person-hours were spent searching natural cover at the FRMR.

Maneuver Area(s) searched: A, C, D, F, G, I, J, M, N

Training Area(s) searched: 2, 5, 10, 14, 17, 18, 19, 20, 22, 25, 27, 28, 29, 31, 33, 34, 35, 37, 38, 39, 41, 43, 45, 46, 49, 50, 51, 52, 64, 65, 75, 79, 81, 82, 89, 91, 92

Table 4. Locations of drift fences with funnel traps at the FRMR

Code	Training Area	Latitude ¹	Longitude ¹	Comments
CF-DF ²	7A	390519	964348	Threemile Wetland
CO-DF ^{3,4}	19	390405	965109	Perimeter fence S of horse pasture in Camp Forsyth

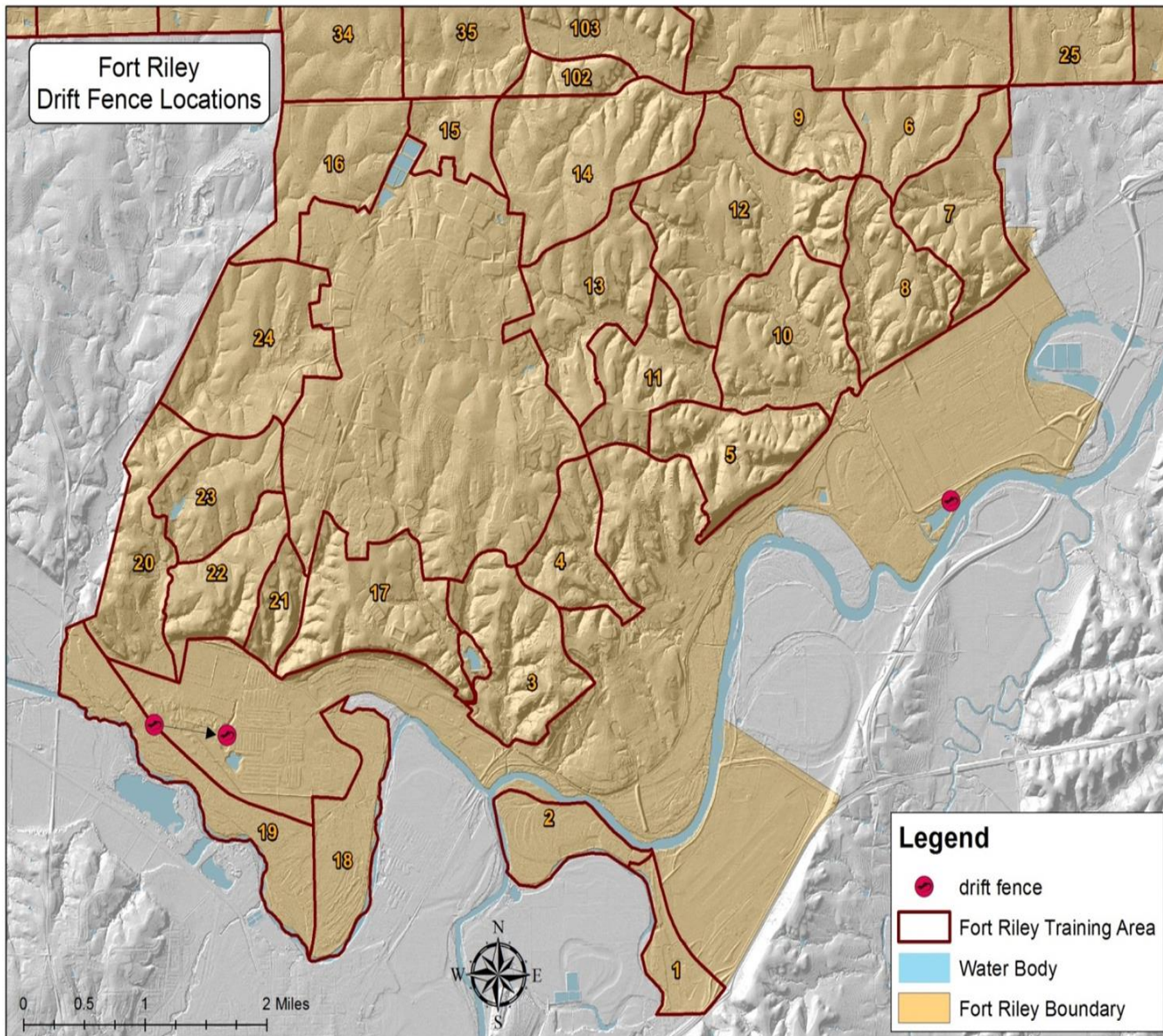
¹Format is 'DDMMSS' with degrees (D), minutes (M), seconds (S)

²Fence was 0.6 m x 12.0 m with 4 traps

³Fence was 0.6 m x 23.0 m with 8 traps

⁴Fence was moved to bike trail south of a wetland (390400.3, 965028.9) on 16 July 2012

Figure 4. Locations of drift fences at the FRMR (Map by Shawn White)



Road Cruising

Road cruising was conducted at the FRMR during the survey to capture reptiles and amphibians crossing roads at night. While moving between cover board arrays and drift fences, reptiles and amphibians that were found crossing roads would be noted and captured for measurement (if specimen could be captured). Nocturnal road cruise surveys were conducted mainly on moonless nights between 20:00 – 24:00. Driving speed during nocturnal road cruising surveys was between 10 – 15 mph. The dirt road that separates Camp Forsyth and Training Area 19 was a special focus because it is located within sand prairie, which is preferred habitat of the Plains Spadefoot and Western Hognose Snake. The paved road located on the west side of Training Area 20 was also surveyed at night. Mallon Road, which encircles the Impact Area, was able to be surveyed during early evenings, but civilians are not allowed north of Vinton School Road after sunset due to training exercises. A total of 78.0 person-hours were spent conducting nocturnal road cruise surveys.

Maneuver Area(s) surveyed: B, C, E, I, M

Training Area(s) surveyed: 17, 19, 20, 25, 27, 29, 31, 33, 34, 35, 37, 39, 41, 43, 46, 92,
Camp Forsyth

Pond Seining

On 7 June 2012, an unnamed pond in Maneuver Area A was haul-seined specifically for capturing larval *Ambystoma mavortium*. A 15' x 6' seine net with 3/16" mesh was used. The pond was seined from 10:30 – 11:40.

Maneuver Area(s) seined: A

Training Area(s) seined: 49

Animal Capture

Amphibians

Upon capture, amphibians were identified (sight or sound) to species and their capture times (military time – 00:00) were recorded. Capture points were recorded using a Garmin eTrex™ handheld GPS unit. Amphibians were measured for snout-to-vent length (SVL) using a pair of calipers. To prevent pseudoreplication, amphibians were marked by clipping the distal third portion of 1 – 2 toes with a pair of small scissors (McCarthy and Parris 2004) and released at capture points.

Lizards

Upon capture, lizards were identified to species and their capture times were recorded. Capture points were recorded using a Garmin eTrex™ handheld GPS unit. Lizards were measured for SVL and tail length (TL) using a pair of calipers. To prevent pseudoreplication, lizards were marked by clipping the distal third portion of 1 – 2 toes with a pair of small scissors (Borges-Landáez and Shine 2003) and released at capture points.

Snakes

Upon capture, snakes were identified to species and their capture times were recorded. Capture points were recorded using a Garmin eTrex™ handheld GPS unit. Snakes were measured for SVL and TL using a tape measure. To prevent pseudoreplication, snakes were marked by ventral scale clipping using a pair of small scissors (Brown and Parker 1976) and released at capture points.

Turtles

Upon capture, turtles were identified to species and their capture times were recorded. Capture points were recorded using a Garmin eTrex™ handheld GPS unit. Turtles were measured for carapace length (CL) and plastron length (PL) using a pair of calipers. To prevent pseudoreplication, turtles were marked by marginal scute notching using a small nail file (House, Nall and Thomas 2011). The only turtle species marked during the survey was *Terrapene ornata*. Although semi-aquatic turtles were not a focus of this survey, these turtle species were noted when observed during the survey.

Ethical Note

All marking equipment was sterilized before each animal marking to minimize infection. For reptiles, equipment was sterilized using 70% isopropyl rubbing alcohol. Because amphibians can absorb rubbing alcohol and other toxic chemicals through their skin, a small lighter was used to sterilize marking equipment for amphibians. Recently metamorphosed amphibians and juvenile reptiles were not marked because of their small size. Also, because of their small size, the following species were not marked: *Acris crepitans*, *Pseudacris maculata*, *Scincella lateralis*, and *Diadophis punctatus*. Because *Ophisaurus attenuatus* is known to auto reject its tail when handled, this species was not handled or marked (Collins, Collins and Taggart 2010). For personal safety, venomous snakes were not handled during the survey. All survey and marking techniques were approved by the Kansas Department of Wildlife, Parks, and Tourism (KDWPT), and the Animal Care and Use Committee (ACUC) at Emporia State University.

RESULTS

A total of 666 individuals representing 28 reptile and amphibian species were observed during the survey (Table 5). The most common species observed was *Anaxyrus woodhouseii*. The most effective survey technique overall was active off-road searching, which accounted for approximately 50% of the total individuals observed.

A total of 389 individuals representing nine amphibian species (one salamander species and eight anuran species) were observed, which accounted for approximately 58% of the total individuals observed during the survey. The most common amphibian species observed was *A. woodhouseii*. A total of three *S. bombifrons* were observed during the survey. The first *S. bombifrons* individual was observed on 21 June 2012 at 23:15. The second and third *S. bombifrons* individuals were observed on 22 June 2012 between 23:20 – 23:40. All *S. bombifrons* sightings occurred in a sandy wetland located on the southern side of Sietz Elementary School in Camp Forsyth. During each *S. bombifrons* sighting, the breeding chorus of this species was heard. The most effective survey technique for amphibians in this study was active off-road searching, which accounted for approximately 75% of the total amphibians observed.

For lizards, a total of 113 individuals representing six species were observed, which accounted for approximately 17% of the total individuals observed during the survey. The most common lizard species observed was *Aspidoscelis sexlineatus*. The most effective survey technique for lizards in this study was natural cover searching, which accounted for approximately 40% of the total lizards observed.

For snakes, a total of 159 individuals representing 11 species were observed, which accounted for approximately 24% of the total individuals observed during the

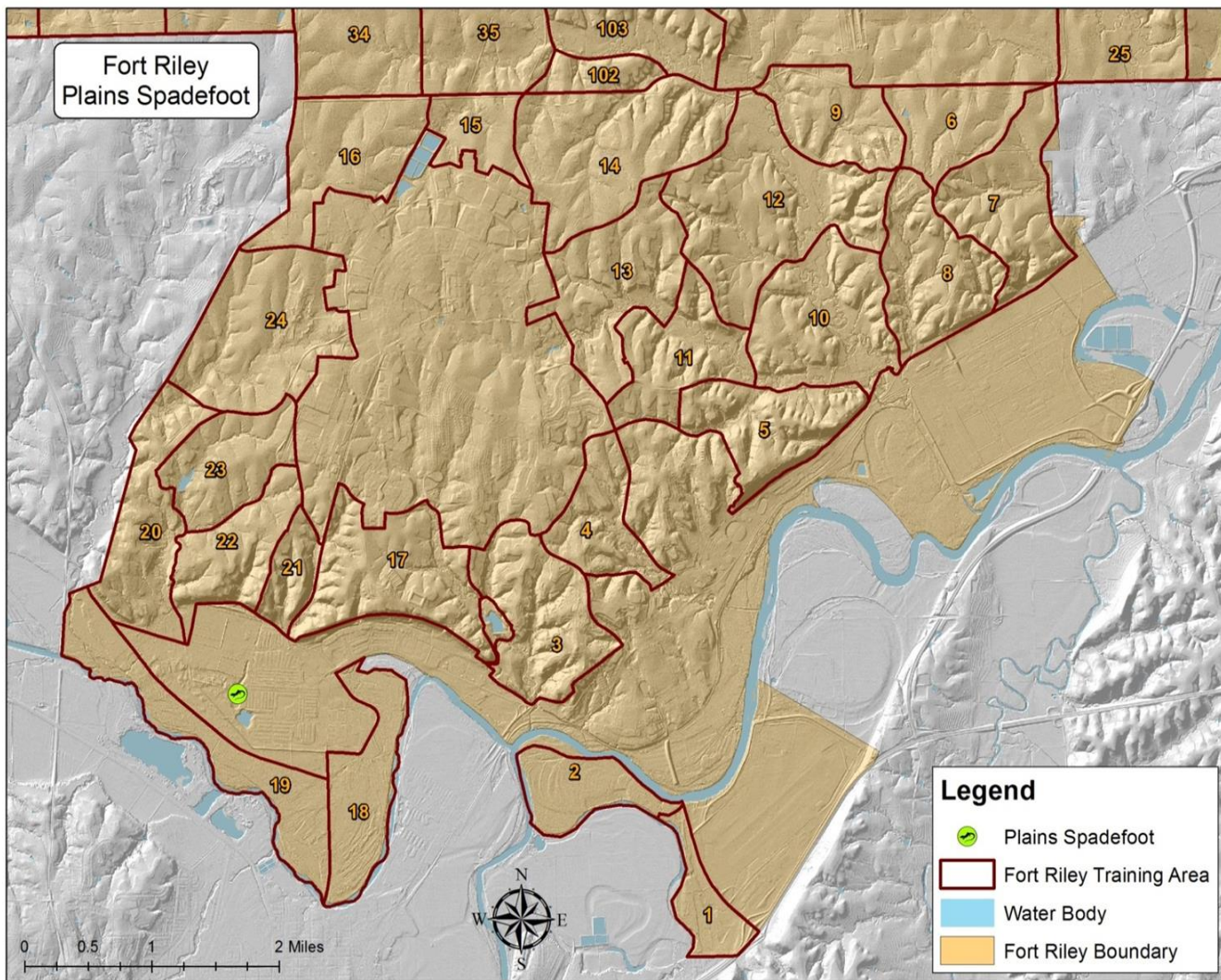
survey. The most common snake species observed was *D. punctatus*. The most effective survey technique for snakes in this study was using cover board arrays, which accounted for approximately 54% of the total snakes observed. However, *H. nasicus* was not observed during this survey.

For turtles, a total of five individuals representing two species were observed, which accounted for approximately 1% of the total individuals observed during the survey. The only terrestrial turtle species observed during the survey was *T. ornata*. The only semi-aquatic turtle species observed was *Trachemys scripta*, but semi-aquatic turtles were not focused on during the survey. Only three *T. ornata* individuals were observed: two during an active off-road search and one crossing a paved road. Only two *T. scripta* individuals were observed: one captured in a funnel trap and one observed basking on a pond log.

Table 5. Total number of reptiles and amphibians found at the FRMR during 2012 survey.

Species	# of individuals found
Amphibians	
<i>Ambystoma mavortium</i>	3
<i>Acris crepitans</i>	76
<i>Anaxyrus woodhouseii</i>	115
<i>Gastrophryne olivacea</i>	43
<i>Hyla chrysoscelis</i>	1
<i>Lithobates blairi</i>	77
<i>L. catesbienus</i>	68
<i>Pseudacris maculata</i>	3
<i>Spea bombifrons</i>	3
Lizards	
<i>Aspidoscelis sexlineatus</i>	35
<i>Crotaphytis collaris</i>	30
<i>Ophisaurus attenuatus</i>	2
<i>Phrynosoma cornutum</i>	2
<i>Plestiodon obsoletus</i>	29
<i>Scincella lateralis</i>	7
Snakes	
<i>Agkistrodon contortrix</i>	8
<i>Coluber constrictor</i>	21
<i>Diadophis punctatus</i>	83
<i>Lampropeltis triangulum</i>	5
<i>Nerodia sipedon</i>	3
<i>Pantherophis emoryi</i>	5
<i>Pituophis catenifer</i>	1
<i>Scotophis obsoletus</i>	11
<i>Storeria dekayi</i>	2
<i>Thamnophis radix</i>	2
<i>T. sirtalis</i>	18
Turtles	
<i>Terrapene ornata</i>	3
<i>Trachemys scripta</i>	2
Total	666

Figure 5. Location of Plains Spadefoot sightings at the FRMR (Map by Shawn White)



DISCUSSION

All amphibian species recorded at the FRMR by the 1993 KBS survey were also recorded during the 2012 survey (Table 6). During the 2012 survey, active off-road searching was the most effective survey technique for amphibians at the FRMR because large numbers of breeding amphibians and recently metamorphosed amphibians could be seen and/or heard around ponds. Searching natural cover was not very effective at surveying amphibians at the FRMR, with the exception of *Gastrophryne olivacea*, which was commonly found under moist rocks in upland prairie. Nocturnal road cruising was effective at surveying amphibians at the FRMR and yielded large numbers of *A. woodhouseii* and *Lithobates blairi*, especially after rainfall. The only amphibian species at the FRMR that was captured in funnel traps was *L. blairi*, and was only seen in traps after rainfall occurred. The only amphibian species at the FRMR that was seen under cover board arrays was *G. olivacea* and only eight individuals were seen under cover boards. Pond seining yielded three larval *Ambystoma mavortium*, but no adults of this species were seen during the 2012 survey.

All lizard species recorded at the FRMR by the 1993 KBS survey were also recorded during the 2012 survey. During the 2012 survey, searching natural cover was the most effective survey technique for lizards at the FRMR, especially for *Crotaphytis collaris* and *Plestiodon obsoletus*, which were commonly found under rocks in upland prairie. The only lizard species that was seen during active off-road searching was *A. sexlineatus*, which was commonly seen moving among rock quarries and sand dunes. *A. sexlineatus* was also the only lizard species captured in funnel traps, but only three individuals were captured in the traps. The only lizard species seen under cover boards

were *P. obsoletus* and *Scincella lateralis*. No lizards were seen during nocturnal road cruise surveys at the FRMR, but one *O. attenuatus* and two *Phrynosoma cornutum* were seen crossing Mallon Rd. during the afternoon.

A total of 17 snake species were recorded at the FRMR during the 1993 KBS survey, but only 10 of those species were observed during the 2012 survey, along with an additional species, *T. radix* (Table 6). During the 2012 survey, the most effective survey technique for snakes at the FRMR was cover board arrays, with *D. punctatus* being the most common species seen under the boards. Searching natural cover was also very effective at surveying snakes at the FRMR, with *Thamnophis sirtalis* and juvenile *Coluber constrictor* being the most common species seen under rocks. Nocturnal road cruising yielded only 13 individual snakes total, with *Agkistrodon contortrix* being the most common species. Funnel traps did not capture any snakes during the 2012 survey.

Only two turtle species were recorded at the FRMR during the 2012 survey, but five additional turtle species were recorded at the FRMR during the 1993 KBS survey (Table 6). The five additional species recorded by the 1993 KBS survey were all semi-aquatic species that were surveyed for using hoops (Busby et al. 1994), but semi-aquatic turtle trapping was not a focus of this survey. The two species that were recorded during the 2012 survey were *T. ornata* and *T. scripta*, which are a terrestrial and semi-aquatic species respectively, but only five individuals were recorded.

The relative abundance of reptiles and amphibians recorded at the FRMR during the 2012 survey was much lower than what was recorded by the 1993 KBS survey. The high number of individual reptiles and amphibians recorded at the FRMR in 1993 was attributed to the unusually wet conditions of that year, which likely extended the breeding

season of many amphibian species (Busby et al. 1994). The lower number of individual reptiles and amphibians recorded at the FRMR during the 2012 survey could be attributed to the dry conditions of that year, which probably kept many species underground for most of the summer.

Plains Spadefoot

During the 2012 survey, *S. bombifrons* was reconfirmed at the FRMR. All sightings occurred in the wetland located behind Sietz Elementary School in Camp Forsyth. The open sand prairie located south of the wetland contains sandy soil that is preferred by *S. bombifrons* and is likely where this species burrowed during dry conditions. On 20 June 2012, the FRMR received an estimated two inches of precipitation (pers. comm: FRMR Environmental Division) which likely stimulated *S. bombifrons* to come to the surface to breed. At the FRMR, the natural rarity of the soil type preferred by *S. bombifrons* makes this species naturally rare at the installation. The increased urbanization in the Camp Funston and Camp Forsyth areas is likely contributing to the decline in suitable habitat for *S. bombifrons*. Also, because of the 2012 drought, there was likely not enough precipitation to bring more *S. bombifrons* to the surface during the summer.

Future *S. bombifrons* surveys at the FRMR should be focused in the Camp Funston and Camp Forsyth areas. These are the only open areas at the FRMR where the soil type preferred by *S. bombifrons* is present (Busby, Collins and Suleiman 2005). *S. bombifrons* is a fossorial and nocturnal species and only emerges from the ground after heavy rainfall (Hoyt 1960), which means surveys should be conducted after heavy precipitation occurs. Because most *S. bombifrons* breeding choruses in Kansas have been

recorded between 22:00 – 03:00 (Collins, Collins and Taggart 2010), an extension in the amount of time spent in amphibian call surveys should be considered. Dip-netting for *S. bombifrons* tadpoles should also be considered, but could be difficult because the tadpole stage of this species is known to be as short as nine days (Busby, Collins and Suleiman 2005). Since Camp Funston and Camp Forsyth are two of the main urban areas at the FRMR, public education on how to identify *S. bombifrons* (sight and sound) and the ideal conditions for this species could help yield more sightings in the future.

Western Hognose Snake

During the 2012 survey, *H. nasicus* was not found at the FRMR. Like *S. bombifrons*, the increased urbanization in the Camp Funston and Camp Forsyth areas has likely contributed to the decline in the naturally rare sandy habitat for *H. nasicus* at the FRMR. Also, like *S. bombifrons*, the dry conditions at the FRMR in 2012 could keep burrowing *H. nasicus* underground for most of the summer.

Like *S. bombifrons*, future *H. nasicus* surveys at the FRMR should be focused in the Camp Funston and Camp Forsyth areas. These are the only open areas at the FRMR where the soil type preferred by *H. nasicus* is present. Since *H. nasicus* is a very secretive species, drift fences with funnel traps should continue to be used in the Camp Funston and Camp Forsyth areas to capture this species, but the fence length and number of traps should be increased. Educating the residents of Camp Funston and Camp Forsyth on how to identify *H. nasicus* and the importance of photographing a snake for proper identification could yield sightings in the future. From August – September 2012, *C. constrictor* and *Scotophis obsoletus* hatchlings were observed under natural cover and crossing roads in the Camp Forsyth area during the survey. The hatching period for *H.*

nasicus usually occurs from September – October (Collins, Collins and Taggart 2010), which means searching natural cover and road cruising in the Camp Funston and Camp Forsyth areas should be considered during this time period. Also, because of the increased hatchling activity from August – September, the FRMR Environmental Division should consider conducting herpetofaunal counts in the fall as well as in the spring.

Table 6. Total number of reptiles and amphibians found at the FRMR during 1993 KBS survey and 2012 survey.

Species	1993 KBS survey ¹	2012 survey
Amphibians		
<i>Ambystoma mavortium</i>	17	3
<i>Acris crepitans</i>	236	76
<i>Anaxyrus woodhouseii</i>	437	115
<i>Gastrophryne olivacea</i>	206	43
<i>Hyla chrysoscelis</i>	37	1
<i>Lithobates blairi</i>	353	77
<i>L. catesbienus</i>	142	68
<i>Pseudacris maculata</i>	753	3
<i>Spea bombifrons</i>	3	3
Lizards		
<i>Aspidoscelis sexlineatus</i>	105	43
<i>Crotaphytis collaris</i>	97	30
<i>Ophisaurus attenuatus</i>	10	2
<i>Phrynosoma cornutum</i>	3	2
<i>Plestiodon obsoletus</i>	197	29
<i>Scincella lateralis</i>	7	7
Snakes		
<i>Agkistrodon contortrix</i>	12	8
<i>Coluber constrictor</i>	29	21
<i>Diadophis punctatus</i>	617	83
<i>Heterodon nasicus</i>	2	-
<i>Lampropeltis calligaster</i>	1	-
<i>L. getula</i>	4	-
<i>L. triangulum</i>	35	5
<i>Nerodia sipedon</i>	4	3
<i>Pantherophis emoryi</i>	28	5
<i>Pituophis catenifer</i>	3	1
<i>Scotophis obsoletus</i>	16	1
<i>Storeria dekayi</i>	3	2
<i>Tantilla gracillis</i>	39	-
<i>T. nigriceps</i>	1	-
<i>Thamnophis proximus</i>	1	-
<i>T. radix</i>	-	2

Table 6 – continued

<i>T. sirtalis</i>	11	18
<i>Tropidoclonion lineatum</i>	18	-
Turtles		
<i>Apalone mutica</i>	9	-
<i>A. spinifera</i>	10	-
<i>Chelydra serpentina</i>	7	-
<i>Chrysemys picta</i>	19	-
<i>Graptemys ouachitensis</i>	14	-
<i>Terrapene ornata</i>	25	3
<i>Trachemys scripta</i>	52	2
Total	3563	666

¹Busby et al. (1994)

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