A Herpetofaunal Survey of the Boehler Seeps Preserve, with Reports of New County Records and Recommendations for Conservation Efforts

Tim Patton
Department of Biological Sciences, Southeastern Oklahoma State University, 1405 Nth 4th Ave., PMB 4054, Durant, OK 74701

Jared Wood
Department of Biological Sciences, Southeastern Oklahoma State University, 1405 Nth 4th Ave., PMB 4054, Durant, OK 74701

A survey of the amphibians and reptiles of the The Nature Conservany's Boehler Seeps and Sandhills Preserve (BSSP) was conducted from March – October, 2008. The goal of the project was to provide baseline data, data to assist with designing future survey and monitoring efforts, and recommendations for herpetofaunal conservation. A variety of herpetofaunal survey protocols, including visual encounter surveys, anuran calling surveys, pitfall trapping, turtles trapping, and opportunistic detections, were used. The preserve was divided into three segments for our survey efforts, each stratified by two habitat types (upland forest and bottomland/wetland forest). We spent approximately 400 person-hours conducting surveys. A total of 2,673 individuals representing 41 species were captured or detected. All sampling protocols contributed to the overall species diversity detected. Seven new distribution records for Atoka County were documented, but we failed to detect several species that we expected to encounter. The BSSP provides unique habitat and refugia for a wide array of amphibian and reptile species native to southeastern Oklahoma, however, the area is not without impacts, both anthropogenic and natural, and we provide recommendations for conservation efforts that address some of the primary impacts.

INTRODUCTION

Declines in amphibian and reptile populations have recently been described in scientific and popular literature, and these declines have occurred regionally and worldwide (Blaustein et al. 1994; Stuart 2005; Gibbons et al. 2000; Browne and Hecnar 2007). Oklahoma is no exception. The Oklahoma Department of Wildlife Conservation currently lists 38 species of amphibians and reptiles as species of greatest conservation need (Oklahoma Comprehensive Wildlife Conservation Strategy 2005). Regardless of causation of species declines, the availability of refugia will likely play an important role in herpetofaunal conservation. Species inventories play an important role in identifying species occurrences and distributions, and potentially for prioritizing conservation efforts and as a basis for comparison for monitoring efforts.

The Nature Conservancy's (TNC) Boehler Seeps and Sandhills Preserve (BSSP) is an extension of the gulf coastal plain sandhill ecosystem, and is similar to the physiography of areas found further south and east in Oklahoma. Because it provides a unique and varied set of habitat characteristics, it likely has a rich and unique herpetofaunal community. However, there is a paucity of data on the amphibians and reptiles that occur on the preserve. An existing list of the taxa that have been reported on the preserve by TNC personnel include only a fraction of the species that likely occur there based on

distribution maps provided by Sievert and Sievert (2006) and available on-line distribution records (www.biosurvey.ou.edu). For example, the TNC list includes only 11 species, 10 of which are anurans (The Nature Conservancy 2009). This discrepancy is most likely due to lack of survey effort, and not to a depauperate community. Our overall goal was to provide data that resource managers could use for conservation of herpetofauna on this and similar habitats. Accordingly, the objectives of this survey effort were to (1) survey the amphibian and reptile community of BSSP, (2) compile a set of baseline data to which results of further monitoring efforts can be compared, and (3), based on species occurrences and observation of the available habitats, provide conservation recommendations for this and similar habitats.

METHODS

Study Site

The BSP is a 490 acre TNC preserve located in Atoka County in southeast Oklahoma (Figure 1). The preserve is a gulf coastal plain sandhill ecosystem and provides a unique set of soil, vegetation, and wetland characteristics. The preserve combines bluejack oak *Quercus incana* woodland and acid hillside seeps communities to form the only known habitat of this type in Oklahoma (Boehler Seeps and Sandhills Preserve 2009). As a result of sandy soils, acid hillside seeps, and dam-building activities by American beaver (*Castor canadensis*), two freshwater marshes, Hassell Lake and Boehler Lake, provide habitat for a variety of amphibians and reptiles. Additionally, an unnamed, ephemeral stream (flowing from northwest to southeast) and associated riparian forest bisects the preserve (Figure 1). Upland habitats are oak-hickory woodlands. Bottomlands and riparian areas associated with Hassell and Boehler lakes and the unnamed stream are predominantly river birch (*Betula nigra*) and green ash (*Fraxinus pennsylvanica*) woodlands. Two roads bisect the preserve: paved County Road N4010 between Hassell and Boehler Lakes, and an unnumbered gravel-surfaced county road south of Boehler Lake (Figure 1). For the purpose of this survey, the preserve was divided into three broad areas for sampling: the area surrounding Hassell Lake (approximately northern 1/3 of the preserve), the area surrounding Boehler Lake (approximately central 1/3 of the preserve), and the area surrounding the un-numbered county road (approximately southern 1/3 of the preserve) (Figure 1).

Survey Methodologies

Previous work has demonstrated that utilizing a variety of survey protocols maxi-

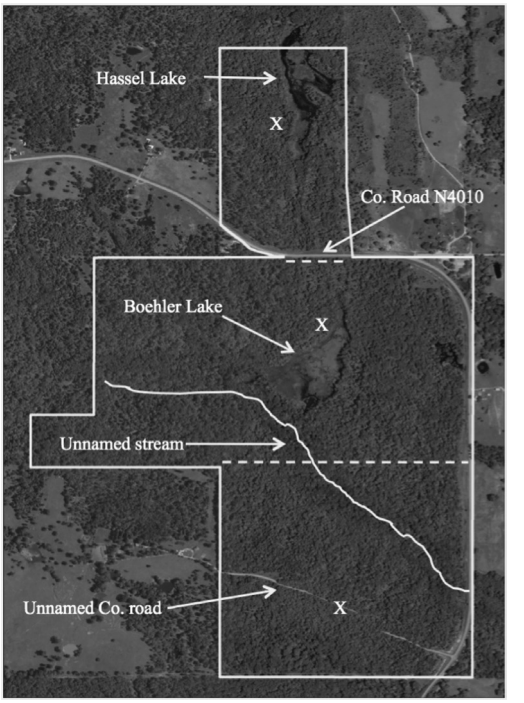

Figure 1. Boehler Seeps and Sandhills Preserve, Atoka County, Oklahoma. Featured are spatial elements relevant to the survey of amphibians and reptiles conducted March – October, 2008. Solid white lines indicate preserve boundaries. Dashed white lines indicate division of the preserve into three areas (north, middle, and south) for distributing survey efforts. The X's indicate the three stations at which anuran calling surveys were conducted.

mizes species detections (Crosswhite et al. 1999, Doan et al. 2003, Ribiero-Junior et al. 2008). Because we sought to survey a wide variety of tax across a wide spatiotemporal range, we employed five survey protocols: visual encounter surveys, anuran calling surveys, a pit fall trap array, hoop netting for aquatic and semi-aquatic turtles, and opportunistic detections. Most of these protocols require only visual or audible detections. Few of the survey methodologies we used required capture of animals. With the exception of a few individuals kept for verification, all captured animals were released. Animals kept were preserved in 10% formalin for positive identification in the laboratory. Descriptions of the methodologies used are described in the following sections.

Visual Encounter Surveys (VES). VES surveys have been shown to be effective and efficient for providing data across a wide range of taxa and habitats (e.g., Heyer et al. 1994, Doan 2003, Ribeiro-Junior 2008). Our VES surveys consisted of walking systematically through the study areas, overturning rocks, logs, and other cover types, and generally scanning for the presence of herpetofauna. VES were conducted by 2-6 people during each survey event, and were conducted once monthly from March - October (except that two surveys were conducted in April), for 12 person-hours/month. Effort was divided equally among the three sample areas (as described in "study site" above), and among upland and bottomland habitats (3 sample areas x 2 habitat types x 2 person-hours = 12 person-hours/survey).

Anuran Calling Surveys (ACS). Anuran calling surveys have been shown to be correlated with anuran abundance (Nelson and Graves 2004). We established one ACS station in each of the three sample areas. Stations were visited twice monthly during March and April, and once monthly during May – July. During each ACS event, one or more surveyors trained in recognizing anuran vocalizations would visit each station within 30 minutes of sundown and record all anuran species heard calling. Each species heard was assigned a calling intensity code of 1-3 as follows: 1 = one or few conspecific individuals calling with little or no overlap of calls; 2 = several conspecific individuals calling with some overlap of calls; 3 = many conspecific individuals calling with significant overlap of calls or constant calling. We followed the frogwatch protocol (Frog Call Survey Protocol, undated), with the exception of monitoring each station for 10 min/visit instead of three minutes/visit.

Pitfall Trapping. Pitfall trapping has been demonstrated to be a relatively cost-effective method for capturing herpetofauna in that the yield is high relative to the amount of time spent on this passive trapping method (Crosswhite et al. 1999, Ribeiro-Junior 2008). In this study, a single pitfall trap array was constructed approximately 50 m north of Boehler Lake, in an area of habitat transition between upland and bottomland forest. The array consisted of a single drift fence and four pitfall traps. The drift fence, made of galvanized sheet metal, was 15.2 m long x 0.6 m high. Pitfall traps (19 L buckets: 30 cm diameter x 37 cm deep) were buried flush with the soil surface, with the drift fence bisecting the center of each bucket. A small amount of organic matter, soil, and water was placed in each bucket to aid in retention and reduce mortality of captured individuals by holding moisture. Lids were placed on the buckets to prevent animal capture outside of trapping events, and removed one day prior to scheduled trap-checking dates. Pitfall traps were opened and checked as follows: a five-day event in June, a seven-day event in June, an eighteen-day event in July, and a nine-day event in September. During these events, traps were checked every one-three days (usually every two days).

Turtle Trapping. Turtle traps of various configurations, and hoop-style traps have shown to be effective for capturing turtles (Plummer 1979, Reidle et al. 2004). Hoop-style nets were used to trap turtles in Hassell and Boehler Lakes. The three

styles of hoop nets used were: (1) a 4-hoop net, 50 cm hoop diameter, 1.3 m long, 2.5 cm mesh; (2) a 3-hoop net, 75 cm hoop diameter, 1.3 m long, 2.5 cm mesh; and (3) a 7-hoop net, 90 cm diameter, 3.2 m long, 2.5 cm mesh. Between two and four nets of various dimensions were baited with fish and set in each of the two lakes as follows: a five-day event in June, a thirteen-day event in June, an eighteen-day event in July, and a nine-day event in September. During these events, traps were checked every one-three days (usually every two days). All turtles captured were marked via shell-notching to note frequency of recaptures, and to prevent counting individuals more than once.

Opportunistic Detections. Lastly, the presence and number of all herpetofauna that were detected outside of the search events described above were recorded. This included all individuals seen, or heard calling (restricted to anurans), while walking into the study area for the purpose of conducting VES, ACS, or trapping.

RESULTS

A total of 2,673 individuals (not counting anuran vocalizations, which cannot be enumerated) representing 41 species were detected (Table 1). The total effort included approximately 130 man-hours of active searching (not counting opportunistic encounters) and 494 trap nights. The search efforts spanned March – October, 2008.

Visual encounter survey efforts totaled 108 person-hours and resulted in detection of 1,643 individuals representing 31 species (Table 1). More individuals were detected in bottomland/riparian areas (1354) than in upland areas (289). Twenty-one and 22 species were detected in bottomlands and uplands, respectively, using VES. Southern leopard frogs made up the majority of the detections, comprising 51% and 53% of the individuals detected in upland and bottomland habitats, respectively (Table 1). Blanchard's cricket frogs were also very abundant in bottomlands, making up 38% of the individuals detected in those habitats. Anuran calling surveys were conducted for 7 nights in three locations (total = 21 location-nights) and detected 12 anuran species (Table 1). Among these, all but one species (Strecker's chorus frog) was confirmed present at BSSP with a physical specimen. Gray treefrogs and Blanchard's cricket frogs were the most frequently heard species, and were detected 14 (of 21 possible = 67%) and 10 (of 21 possible = 48%) times, respectively. Pitfall traps were opened for 156 trap-nights (4 traps x 39 nights), and resulted in the capture of 250 individuals representing seven species; only anurans were captured and Southern leopard frogs made up 82% of the catch in pitfall traps (Table 1). Turtle traps were out for 338 net-nights (144 in June, 144 in July, 50 in September), and resulted in the capture of 418 turtles representing six species (Table 1). Red-eared sliders and common musk turtles were the predominant species captured in turtle traps, but it should be noted that 11 Western chicken turtles, a state sensitive species (Oklahoma Comprehensive Wildlife Conservation Strategy 2005) and record for Atoka County, were also captured. Opportunistic detections provided for detection of 191 individuals representing 22 species (Table 1), but no attempt was made to quantify opportunistic survey effort.

Even though some of the survey methodologies employed resulted in detection of more species and individuals than others, all methods resulted in detection of unique species. Unique species among the various survey methods were VES = 6, ACS = 1, pitfall traps = 1, turtle traps = 4, and opportunistic encounters = 3 (Table 1).

DISCUSSION

Prior to this survey, the existing amphibian and reptile list for Boehler Seeps Preserve was 10 species, all of which were anurans. All previously recorded species were found during this survey except one (Woodhouse's

toad *Anaxyrus woodhousii*), plus an additional 31 species. As stated previously, this is probably due largely to lack of previous comprehensive survey efforts. Additionally, this survey resulted in the detection of seven species that represent new distributional records for Atoka County (Table 2) based on Oklahoma distribution maps (Sievert and Sievert 2006) and records (Oklahoma Biological Survey undated web site).

Despite a relatively comprehensive effort, and as with all survey efforts, there are likely several species at BSP that went undetected during the course of this survey. In an effort to identify species that may have been overlooked, we have included a list (Table 2) of the herpetofauna shown to be present in Atoka County based on the distribution maps provided by Sievert and Sievet (2006). Several reasons may exist for failure to detect a species within its geographic range. For example, failure to detect may be due to the cryptic nature of the species (e.g., many-ribbed salamanders *Eurycea multiplicata* and western lesser sirens *Siren intermedia*), low densities (e.g., alligator snapping turtles *Macrochelys temminckii* and Louisiana milk snakes *Lampropeltis triangulum*), lack of appropriate habitat (e.g., ornate box turtles *Terrapene ornata* and western slender glass lizards *Ophisaurus attenuatus*), search efforts that failed to target ideal species-specific spatiotemporal environmental conditions (e.g., smallmouth salamanders *Ambystoma texanum* may be active in a very small area and for a very short period of time), and chance. However, several of the species that are indicated as present in Atoka County (Sievert and Sievert 2006) are anecdotally considered to be abundant and not particularly hard to detect, and their absence from our survey results is puzzling. Notably missing are several species of snakes. Causes for their absence are unknown, but we speculate that they have been impacted by feral hogs and automobile strikes. The inclusion of amphibians and reptiles in the diet of feral hogs has been reported in general reviews of feral hogs (Gipson et al. 1998; Ditchkoff and West 2007) and in studies that have looked at specific feral hog diets (Taylor 1999; Jolley 2007), and we frequently observed indications of feral hog foraging throughout BSSP, especially in areas that are likely preferred amphibian and reptile habitat (under leaf litter and woody debris, especially in relatively moist areas). Roads and automobile strikes have been shown to contribute to the decline of many herpetofaunal species (Fahrig et al 1995; Gibbs and Schriver 2002; Steen et al 2006; Marsh et al 2008), and roadlessness has been shown to be correlated with herpetofaunal diversity (Chen and Roberts 2008). The BSSP is bordered on much of the east side and bisected by a paved road, and bisected in another area by a gravel county road (Figure 1). Further, an ephemeral stream and riparian corridor that connect the north and south portions of BSSP and likely serve as a travel corridor between Hassell and Boehler Lakes are bisected by the paved road.

While it was not among the objectives to quantify habitat conditions on BSSP, it is relevant to discuss the condition of Boehler and Hassell Lakes (Figure 1), as these seep lakes contribute substantially to the floral and faunal diversity of BSSP, and contribute to the unique nature of this TNC preserve. The beaver dams that are responsible for holding the majority of the water in both lakes have failed in recent years, resulting in reduced habitat area and volume for aquatic and semi-aquatic species. J. Tucker (The Nature Conservancy, personal communication) indicated that the dam on Boehler Lake was reported to be intact in 2003, and not intact in 2007, (i.e., it happened within that time frame), and speculated that the dam has likely been breached and repaired by beaver frequently over ecological time. The beaver dam on Hassel Lake failed during our June, 2008 trapping effort. While data was not collected on habitat conditions in these lakes, general observations were noted. As a result of dam failure, water levels have lowered and surface area of water has been substantially reduced in both lakes. We estimate

Proc. Okla. Acad. Sci. 89: pp 63-74 (2009)

Table 1. Amphibian and reptile species captured or detected during a herpetofaunal survey of the Boehler Seeps and Sandhills Preserve, March – October, 2008, using five detection methods: visual encounter surveys (VES), anuran calling surveys (ACS), pitfall traps (PFT), turtle traps (TT, and opportunistic detections (OD). Values in columns represent numbers detected for all survey methods, except that values under ACS are frequency of occurrence (three sites x seven survey events = 21 possible occurrences). Accordingly, total values do not include ACS data.

Common name	Scientific name	Detection Method VES	ACS	PFT	TT	OD	Total
Caudata							
Central Newt	*Notophthalmus viridescens*	4					4
Marbled Salamander	*Ambystoma opacum*	3					3
Anura							
Dwarf American Toad	*Anaxyrus americanus*	2	4	1			3
Hurter's Spadefoot	*Scaphiopus hurterii*			6		1	7
Eastern Narrowmouth Toad	*Gastrophryne carolinensis*	8	2	13		1	22
Blanchard's Cricket Frog	*Acris blanchardi*	528	10			2	530
Green Treefrog	*Hyla cinera*	61	7				61
Eastern Gray Treefrog	*Hyla versicolor*	8	14	17		7	32
Spring Peeper	*Pseudacris crucifer*	28	7				28
Strecker's Chorus Frog	*Pseudacris streckeri*		4				
Midland Chorus Frog	*Pseudacris triseriata*	3	7			1	4
Crawfish Frog	*Lithobates areolatus*	2	3				2
Bullfrog	*Lithobates catesbeianus*	13	2				13
Bronze Frog	*Lithobates clamitans clamitans*	14	5	3		1	18
Pickerel Frog	*Lithobates palustris*			4			4
Southern Leopard Frog	*Lithobates sphenocephalus*	842	7	206		121	1169
Testudines							
Common Snapping Turtle	Chelydra serpentina				7		7
Mississippi Mud Turtle	*Kinosternon subrubrum*	1			9		10
Common Musk Turtle	*Sternotherus odoratus*				179		179
Western Chicken Turtle	*Deirochelys reticularia miaria*				11		11

Eastern River Cooter	*Pseudemys concinna*				29		29
Three-toed Box Turtle	*Terrapene carolina triunguis*	2					2
Red-eared Slider	*Trachemys scripta elegans*	1			183		184
Squamata ("Lacertilia")							
Northern Green Anole	*Anolis carolinensis carolinensis*	5					5
Eastern Fence Lizard	*Sceloporus undalatus*	24				11	35
Six-lined Racerunner	*Cnemidophorus sexlineata*	2				5	7
Five-lined Skink	*Plestiodon fasciatus*	20				8	28
Ground Skink	*Scincella lateralis*	32				10	42
Squamata ("Serpentes")							
Racer	*Coluber constrictor*	5				5	10
Western Rat Snake	*Scotophis obsoletus*	2				1	3
Eastern Hognose Snake	*Heterodon platirhinos*					1	1
Eastern Coachwhip	*Masticophis flagellum*	1				2	3
Broad-banded Water Snake	*Nerodia fasciata confluens*					1	1
Diamondback Water Snake	*Nerodia rhombifer rhombifer*					2	2
Rough Green Snake	*Opheodrys aestivus*					3	3
Texas Brown Snake	*Storeria dekayi texana*	3					3
Western Ribbon Snake	*Thamnophis proximus proximus*	6				3	9
Southern Copperhead	*Agkistrodon contortrix*	6				1	7
Western Cottonmouth	*Agkistrodon piscivorus*	15				3	18
Timber Rattlesnake	*Crotalus horridus*	1				1	2
Western Pygmy Rattlesnake	*Sistrurus miliarius streckeri*	1					1
Totals		**1643**	**NA**	**250**	**418**	**191**	**2502**

Table 2. List of amphibian and reptile species shown to occur in Atoka County (based on Sievert and Sievert 2006) but not detected during a survey of the amphibians and reptiles on the Boehler Seeps and Sandhills Preserve (BSSP), March – October, 2008. Also listed are amphibian and reptile species that were detected during the survey of BSP, March – October, 2008, but that do not appear on the Atoka county distribution maps (Sievert and Sievert 2006).

Common name	Scientific name
Atoka County species not detected at BSSP during this survey	
Western lesser siren	*Siren intermedia nettingi*
Small-mouthed salamander	*Ambystoma texanum*
Many-ribbed salamander	*Eurycea multiplicata multiplicata*
Western slimy salamander	*Plethodon albagula*
Woodhouse's toad	*Bufo woodhousii woodhousii*
Great Plains narrow-mouthed toad	*Gastrophryne olivacea*
Alligator snapping turtle	*Macrochelys temminckii*
Common musk turtle	*Sternotherus odoratus*
Ornate box turtle	*Terrapene ornata*
Midland smooth softshell	*Apalone mutica mutica*
Western spiny softshell	*Apalone spinifera pallida*
Eastern collared lizard	*Crotaphytus collaris*
Southern coal skink	*Eumeces anthracinus pluvialis*
Southern prairie skink	*Eumeces obtusirostris*
Western slender glass lizard	*Ophisaurus attenuatus attenuatus*
Northern scarlet snake	*Cemophora coccinea copei*
Ring-necked snake	*Diadophis punctatus*
Prairie kingsnake	*Lampropeltis calligaster calligaster*
Speckled kingsnake	*Lampropeltis getula holbrooki*
Milksnake	*Lampropeltis triangulum*
Plain-bellied watersnake	*Nerodia erythrogaster*
Graham's crayfish snake	*Regina grahamii*
Ground snake	*Sonora semiannulata*
Flat-headed snake	*Tantilla gracilis*
Orange-striped ribbon snake	*Thamnophis proximus*
Common garter snake	*Thamnophis sirtalis*
Rough earthsnake	*Virginia striatula*
Western smooth earthsnake	*Virginia valeriae elegans*
Species detected in this survey, not previously recorded in Atoka County	
Central newt	*Notophthalmus viridescens*
Marbled salamander	*Ambystoma opacum*
Eastern narrow-mouthed toad	*Gastrophryne carolinensis*
Green treefrog	*Hyla cinerea*
Northern spring peeper	*Pseudacris crucifer crucifer*
Western chicken turtle	*Deirochelys reticularia miaria*
Green anole	*Anolis carolinensis carolinensis*

that each lake is currently holding < 10% of the volume they previously had. Both lakes previously had substantial areas of floating vegetation mats, interspersed with open water. The basin of Boehler Lake, partially drained for ca. 2-6 years, has become largely inundated by emergent aquatic vegetation, especially cattail *Typha latifolia*. The basin of Hassell Lake, drained within a much more recent time period, is largely mud flats, but is rapidly becoming colonized by riparian and terrestrial vegetation, including button bush *Cephalanthus occidentalis*, river birch *Betula nigra*, and blackberries *Rubus spp*. Accordingly, a substantial portion of the habitats for aquatic and semi-aquatic herpetofauna and other taxa on BSSP have been lost, and it can be expected that these lake basins will continue to undergo ecological succession towards a more terrestrial state unless water is impounded within the basins again.

CONSERVATION RECOMMENDATIONS

Based on survey results and observations at BSSP, recommendations are provided for the following four areas: (1) continued herpetofaunal monitoring efforts, (2) expanded preservation efforts for BSSP, (3) rehabilitation/reconstruction of the dams on Hassell and Boehler Lakes, and (4) development of a more effective movement corridor between Hassell and Boehler Lakes.

While survey efforts are time consuming and potentially costly, they represent an integral component of conservation efforts. With this in mind, it is recommended that the herpetofauna of BSSP continue to be monitored over time, and note that the monitoring protocols recommended here could be used in other areas. Annual surveys as comprehensive as the one conducted herein would be optimal, but may not be practical. More practical alternatives may include (1) an equally comprehensive survey at some broader time interval, e.g., the same protocol used here at 3-5 year intervals, or (2) a somewhat less comprehensive effort at a less frequent time interval; e.g., seasonal surveys (spring, summer, and fall, or spring and summer) every 1-2 years. For either of these options, and to ensure maximum species detection across taxa, a recommendation is to utilize the same five sampling protocols (VES, ACS, pitfall trapping, turtle trapping, and opportunistic detection) employed in this survey, and spanning the broadest temporal period that resources allow, e.g., a full activity season.

The BSSP represents a unique and diverse assemblage of herpetofauna and other taxa. Outside of McCurtain County, we know of no other similar habitat in the region that receives the level of protection that BSSP receives. Based on distribution maps provided by Sievert and Sievert (2006) and the new Atoka County distribution records reported herein, the BSSP also represents the margin of westward distribution for several species of amphibians and reptiles. While there are similar habitats in the region, virtually all are private property and subject to a variety of impacts. In this regard, BSSP provides important refugia; however, at <500 acres, the preserve is small. Surrounding lands may provide additional habitat and have the potential to serve as source populations for BSSP, but their subjectivity to impacts makes them vulnerable, and may cause them to serve as sinks for a variety of taxa. With this in mind, a recommendation is to look for opportunities to make land acquisitions that would expand the size of BSSP. This is particularly recommended for the north end of the preserve. The north end of Hassel Lake, including the entirety of the beaver dam, is not on preserve property. This makes the dam, and therefore the entire lake, vulnerable to impacts at the whim of the landowner.

Many of the unique habitat characteristics and concomitant unique flora and fauna are due to the presence of the soil types and the associated wetlands: Hassell and Boehler Lakes. The activities of American beaver have undoubtedly altered the hydrologic regime of these lakes, and have likely

made them a more reliable source of water than they would be in the absence of beaver. Further, topographic maps indicate that the lakes have been present at least as far back as the early 20th century. In this regard, beaver dams have played an integral role in the unique and diverse characteristics of BSSP over ecological time. It is also likely that beaver activity has waxed and waned on BSSP over ecological time; at times there was probably a lot of water held by beaver dams and at other times there was probably less. However, the fluctuating reliability of water in these lakes likely played less of a role to overall species diversity and available refugia when there was more intact habitat in the region. With increased human impacts in the region over time, BSSP represents an increasingly important remnant of a unique habitat. For these reasons, a recommendation is to put effort into reconstruction of the dams on both lakes. Both are breached over a relatively short portion of their total length (personal observation), and could likely be "patched" at relatively little cost. Patching the dams in a manner that would allow them to impound more water would likely attract more beaver back into the lakes, and would also likely "encourage" the beaver to make repairs on the existing dams (personal communications: Pat Whitley, wildlife specialist, U.S. Department of Agriculture, Wildlife Services, and Steven Barner, wetland specialist, Natural Resource Conservation Service).

The BSSP is bisected by county road N4010. This county road is paved and, accordingly, has speed limits and traffic frequency that is similar to state highways in the area. The point at which the road bisects the preserve is the low point along the approximate hydrologic divide between Hassel and Boehler Lakes (Figure 1). In this regard, the adjacent forests and the paved road at that point likely serve as the primary travel corridor for species moving between the north 1/3 and south 2/3 of the preserve, and between Hassel and Boehler Lakes and the associated riparian forests. The paved road likely creates a barrier to movement for several species (in the form of a habitat barrier, thermal barrier, or moisture content barrier), or places species at risk of automobile strikes. With this in mind, a recommendation is to seek funding to construct a wildlife-friendly culvert, such as a poured concrete box culvert with natural substrate, under the county road, thereby providing a movement corridor that would provide suitable substrate and moisture, and not involve crossing the road.

In conclusion, Boehler Seeps and Sandhills Preserve provides a unique and diverse habitat and floral and faunal communities. The present study indicatea the area is particularly important to a variety of amphibian and reptile species, perhaps more so than was originally thought. However, the area is not immune to the effects of surrounding anthropogenic and natural impacts and disturbances. For these reasons, a final recommendation is to continue monitoring efforts, seek ways to insure greater protection of the preserve, and address specific habitat improvement projects that may make relatively immediate and positive impacts.

ACKNOWLEDGEMENTS

Assistance with field work was provided by Joseph McAllister, Christopher Cheek, Dan Moore, Christina Newman, Chance Whitely, Matt Horner, Clayton Porter, Michael Zimmerman, Lonny Robertson, Joseph Dyer, and Dr. Tim Patton's Fish and Wildlife Techniques Class (Southeastern Oklahoma State University). Useful suggestions and support regarding the survey and this manuscript were provided by J. Tucker, The Nature Conservancy. J. Pruett (The Nature Conservancy) provided technical support and suggestions regarding the survey. Funding for this project was provided by grants from The Nature Conservancy, the Louis Stokes- Oklahoma Alliance for Minority Participation (National Science Foundation), and Southeastern Oklahoma State University Organized Research.

LITERATURE CITED

Blaustein, AR, Wake DB, and Sousa WP. 1994. Amphibian declines: judging stability,
persistence, and susceptibility of populations to local and global extinctions. Cons Biol 8:6-71.

Boehler Seeps and Sandhills Preserve, 2009. [on-line]. Available from: http://www.nature.org./
wherewework/northamerica/states/Oklahoma/preserves/boehler.html. (Accessed September 21, 2009).

Browne, CL, Hecnar SJ. 2007. Species loss and shifting population structure of freshwater turtles despite habitat protection. Biol Cons 138:421-429.

Chen, X, Roberts KA. 2008. Roadless areas and biodiversity: a case study in Alabama, USA. Biodiv Cons 17(8):2013-2022.

Crosswhite, DL, Fox SF, Thrill RE. 1999. Sampling methods for monitoring reptiles and amphibians in upland forests of the Ouachita Mountains. Proc Okla Acad Sci 79:45-50.

Ditchkoff, SS, West BC. 2007. Ecology and management of feral hogs. Hum Wildl Confl 1(2):149-151.

Doan, TM. 2003. Which methods are best for surveying rain forest herpetofauna? 2003. J Herp 37(1):72-81.

Fahrig, L, Pedlar JH, Pope SE, Taylor PD, Wegner JF. 1995. Effect of road traffic on amphibian density. Biol Cons 73(3):177-182.

Frog Call Survey Protocol. Undated web site. [on-line] Available from: http://www.dnr.cornell. edu/arnot/acep/elrose/frogwatch%20protocol.pdf (Accessed September 21, 2009)

Gibbons, JW, Scott DE, Ryan TJ, Buhlmann KA, Tuberville TD, Metts BS, Greene JL, Mills T,
Leiden Y, Poppy S, and Winne CT. 2000. The global decline of reptiles, deja vu amphibians. Biosci 50:653-666.

Gibbs, JP, Shriver WG. 2002. Estimating the effects of road mortality on turtle populations. Cons Biol 16(6):1647-1652.

Gipson, PS, Hlavachick B, Berger T. 1998. Range expansion of feral hogs across the central United States. Wildl Soc Bull 26(2):279-286.

Heyer, WR, Donnelly MA, McDiarmid RW, Hayek LC, and Foster MS (eds). 1994.
Measuring and monitoring biological diversity: standard methods for amphibians. Smithsonian Institution Press, Washington, D. C. 364 p.

Jolley, DB. 2007. Reproduction and herpetofauna depredation by feral hogs at Fort Benning,
Georgia [MSc thesis]. Auburn (AL): Auburn University. 56 p. Available from: Auburn University library.

Marsh, DM, Page RB, Hanlon TJ, Corritone R, Little EC, Seifert DE, Cabe PR. 2008. Effects of roads on patterns of genetic differentiation in red-backed salamanders, Plethodon inereus. Cons Gen 2008(9):603-613.

Nelson, GL, Graves BM. 2004. Anuran population monitoring: comparison of the North American Amphibian Monitoring Program's calling index with mark-recapture estimates for Rana clamitans. J Herp 38(3):355-359.

Oklahoma Biological Survey. Undated. [on-line]. Available from: www.biosurvey.ou.edu. (Accessed September 21, 2009).

Oklahoma Comprehensive Wildlife Conservation Strategy. 2005. [on-line]. Available from:http://www.wildlifedepartment.com/CWCS.htm. (Accessed September 21, 2009).

Plummer, MV. 1979. Collecting and Marking. In: Harless M, Morlock H, editors. Turtles: perspectives and research. 1989, Reprint. Robert E. Kreiger Publishing Company, Inc., Malabar (FL). p 45–60.

Ribeiro-Junior, MA, Gardner TA, Avila-Pires TCS. 2008. Evaluating the effectiveness of
herpetofaunal sampling techniques across a gradient of habitat change in a tropical forest landscape. J Herp 42(4):733-749.

Riedle, JD, Shipman PA, Fox SF, Leslie DM, Jr. 2004. Status and distribution of the alligator snapping turtle, Machrochelys temminckii, in Oklahoma. SW Nat 50:79-84.

Sievert, SN, Sievert L. 2006. A field guide to Oklahoma's amphibians and reptiles. Oklahoma Department of Wildlife Conservation, Oklahoma City. 205 p.

Steen, DA, Aresco MJ, Beilke SG, Compton BW, Condon EP, Dodd, Jr CK, Forrester H, Gibbons JW, Greene JL, Johnson G, Langen TA, Oldham MJ, Oxier DN, Saumure RA,
Schueler FW, Sleeman JM, Smith LL, Tucker JK, Gibbs JP. 2006. Relative vulnerability of female turtles to road mortality. Animal Cons (2006)9:269-273.

Stuart, SN, Chanson JS, Cox NA, Young BE, Rodriguez ASL, Fischman DL, and Waller RW. 2004. Status and trends of amphibian declines worldwide. Sci 306:1783-1786.

Taylor RB. 1999. Seasonal diets and food habits of feral swine. Proc 1st National Feral Swine Conference. 1:58-66.

The Nature Conservancy. 2009. Checklist of Oklahoma preserve amphibian and reptile species. [on-line]. Available from: http://www.oklanature.com/jfisher/tnc-ok_herp_list.pdf (Accessed September 21, 2009).

Received: October 14, 2009; Accepted November 5, 2009.