

Eastern Spadefoots (*Scaphiopus holbrookii*) and Other Herpetofauna Inhabiting an Industrial Fly-Ash Disposal Site in Southern Ohio

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Abstract: Eastern Spadefoots (*Scaphiopus holbrookii*) were once common in southern Ohio but are now rare, with most populations threatened by habitat loss. In 2010, we observed an Eastern Spadefoot breeding migration out of a raised fly-ash disposal site to a small depressional wetland in South Point (Lawrence County), Ohio. We used a series of drift fences and pitfalls to confirm adult and juvenile spadefoot occupancy at the fly-ash site as well as document the presence of nine additional species of herpetofauna. This is the first documentation of Eastern Spadefoots inhabiting a fly-ash disposal site in Ohio. We suggest further investigations to assess long-term population persistence and to address toxicological concerns.

Key Words: Spadefoot, *Scaphiopus*, fly-ash, coal, herpetofauna, Ohio, Lawrence County

Introduction

In a world that is increasingly altered by human activity, it is important to note when organisms utilize unnatural, unexpected, or contaminated habitat. This is especially vital when the species, the Eastern Spadefoot (*Scaphiopus holbrookii*), is state-endangered (ODNR, 2012) and the habitat is a byproduct of one of our nation's largest methods of energy production, the combustion of coal (EIA, 2012). Eastern Spadefoots are Ohio's rarest anuran (Davis and Menze, 2002) and only occur as scattered populations along major river drainages in the southern portion of the state (Davis and Menze, 2000; 2002). They were first reported from Lawrence County Ohio in 1946 and from The Point industrial park in South Point (then referred to as the South Point chemical grounds) in 1947 by Green (1948). Green described spadefoots as "abundant and widespread along the Ohio River in Lawrence County" after witnessing a large breeding chorus on the South Point chemical grounds, three additional choruses in South Point, four choruses northwest of South Point along the Ohio River, and a calling male southeast of South Point along the Ohio River. Spadefoots are no longer as abundant in Lawrence County as Green reported, with most known Ohio populations threatened by habitat loss (Davis and Menze, 2000; 2002). Delis et al. (1996) reported that spadefoots are more sensitive than other amphibians to urbanization, with such development causing population reductions and extinctions. Nevertheless, in 2001 spadefoots were found in The Point industrial park (CMC H09219-09227) and in an urbanized area of South Point (CMC H07920). The closest known extant Eastern Spadefoot populations to those in South Point now occur across the Ohio River at Kenova (Johnson, 2003; Wayne County), Beech Fork State Park (A.C. Gooley and T.K. Pauley, unpublished data; Wayne County), and Milton (Johnson, 2003; Cabell County), West Virginia, where they are listed as critically imperiled (WVHP, 2012), and to the northeast at Franklin Furnace (CMC HP5156-HP5159; Scioto County), Ohio.

Eastern Spadefoots are primarily a species of the American southeast and Atlantic coast (Conant and Collins, 1998), where they inhabit loose, friable, sandy soils that allow for burrowing (Conant and Collins, 1998; Pearson, 1955). Adult spadefoots spend the majority of their lives in burrows and breed sporadically (Pearson, 1955), which can make populations difficult to detect (Davis and Menze, 2002); however, they can be captured by drift fences and pitfall traps when they emerge to feed on moist nights (Pearson, 1955) or during explosive breeding events (Greenberg and Tanner, 2004; 2005; Wells, 1977). Breeding occurs in ephemeral ponds and is triggered by heavy rains combined with large changes in barometric pressure (Greenberg and Tanner, 2004; Gosner and Black, 1955; Pearson, 1955; Wells, 1977). Tadpoles are capable of rapid temperature-driven development (Richmond, 1947); however, Greenburg and Tanner (2005) report that less than a quarter of breeding events result in substantial recruitment.

On 2 May 2010, during a large rain event in South Point, we observed an anuran breeding migration out of a fly-ash mound to a small depressional wetland at the north side of The Point industrial park. While walking a road bisecting the fly-ash mound and depressional wetland periodically between 8:15 PM and 11:00 PM, we counted 37 Eastern Spadefoots (mostly gravid females), Spring Peepers (*Pseudacris crucifer*), gray treefrogs (*Hyla versicolor/chrysoscelis*; species not distinguishable in the

field), and Eastern American Toads (*Anaxyrus a. americanus*) crossing from the fly-ash mound to the depressional wetland. In the depressional wetland, we observed a full chorus of Eastern Spadefoots, calling males and mating pairs of the other species mentioned, and a Northern Water Snake (*Nerodia sipedon*). Multiple pairs of spadefoots were in amplexus and male spadefoots were also amplexing female Eastern American Toads. In addition to the aforementioned breeding congregation, we also detected one or two chorusing male spadefoots and located a single roadkilled spadefoot on the south side of the industrial park grounds. The following morning, numerous double-stranded egg strings were present in the depressional wetland and that evening, spadefoots were observed migrating back across the road toward the fly-ash mound. On 12 May, we found countless Eastern Spadefoot tadpoles in the depressional wetland and found numerous metamorphs 19 days later, after the standing water had evaporated. The following year, we again observed Eastern Spadefoot tadpoles (24 May and 1 June 2011) and metamorphs (1 June 2011) at the depressional wetland.

The fly-ash mound was located at The Point industrial park and was the product of coal combustion waste disposal from 1955 through 1985. It was elevated above the surrounding landscape and contained by a clay retaining wall. Surface structure consisted mostly of woodland with scattered open herbaceous areas, dense Japanese Knotweed (*Polygonum cuspidatum*) stands, briars, and rail-road tie piles. The fly-ash mound represented an artificial habitat for the herpetofauna and other organisms that colonized it. The depressional wetland was also artificial, having been created by a sunken and partially buried section of an abandoned concrete road. Our objective was to confirm Eastern Spadefoot occupancy of the fly-ash mound and document the presence of any additional herpetological fauna.

Methods

On 21 and 22 May 2010, we installed eight drift fences, each with six pitfall traps, along the southern side of the fly-ash mound. Two of the drift fences were 9 m in length and six were 6 m in length. The pitfalls consisted of buried 19 L buckets that were kept covered when not in use. We placed leaves in the pitfalls to provide captured animals with shelter. The pitfalls were opened during rainy, humid, or misty nights for 631 trap nights (trap nights = number of pitfalls opened × number of nights they were open; several pitfalls that failed to drain rainwater sufficiently were not operated on all sampling occasions) between 22 May and 22 June 2010. The pitfalls were occasionally left open for daytime sampling as well. We checked the pitfalls for captures the following morning for nocturnal sampling and in the evening for diurnal sampling. Captured animals were promptly released from the pitfalls and their date and location of capture recorded. We also noted any other reptiles or amphibians observed in the fly-ash mound as we traversed between drift fences. Animals were not individually marked; thus, we only reported the number of captures instead of total number of individuals captured. We deposited select photographs of captured or encountered animals at the Cincinnati Museum Center, Cincinnati, Ohio.

Results

We recorded five adult and 32 juvenile Eastern Spadefoot captures, 114 Northern Green Frog (*Lithobates clamitans melanota*) captures, two metamorph *Lithobates* (either *L. pipiens* or *L. palustris*) captures, two Wood Frog (*L. sylvaticus*) captures, 15 Eastern American Toad captures, two Fowler's Toad (*A. fowleri*) captures, one Eastern American × Fowler's Toad capture, six Five-lined Skink (*Plestiodon fasciatus*) captures, and one Eastern Gartersnake (*Thamnophis s. sirtalis*) capture at the pitfall traps. Numerous arthropods and several small mammals were also incidentally captured at the pitfalls. While traveling between pitfalls, we observed juvenile Eastern Spadefoots 17 times, a Northern Green Frog once, Eastern American Toads five times, a Fowler's Toad once, an Eastern American × Fowler's Toad once, Five-lined Skinks seven times, and an Eastern Box Turtle (*Terrapene c. carolina*; shell unusually elongated) once. We also heard gray treefrogs calling from trees in the fly-ash mound. Additionally, we encountered juvenile Eastern Spadefoots five times on the clay retaining wall of the fly-ash mound and heard chorusing American Bullfrogs (*L. catesbeianus*) and Northern Cricket Frogs (*Acris crepitans*) in the vicinity of the fly-ash mound. We deposited photographs of Eastern Spadefoots (CMC HP7090-7098), Green Frogs (CMC HP7099, HP7104), an Eastern American Toad (CMC HP7093), an Eastern Gartersnake (CMC HP7105), and an Eastern Box Turtle (CMC HP7089) at the Cincinnati Museum Center.

Discussion

We documented 10 species of herpetofauna inhabiting the fly-ash mound during our short sampling period. Operating the pitfalls for a longer duration may have yielded additional species, although some snakes and anurans can scale drift fences and bucket walls, thus avoiding detection by this sampling method (Dodd, 1991; Enge, 2001). Our study was not the first

to show amphibian and reptile use of a fly-ash contaminated site. Researchers at the Savannah River Ecology Laboratory in South Carolina also have documented numerous reptile and amphibian species inhabiting both aquatic and terrestrial areas contaminated with coal combustion waste (e.g. Lance et al., 2012), although many suffer from sub-lethal deleterious effects.

While the presence of coal combustion waste did not so severely impact herpetofauna as to prevent occupancy of the fly-ash mound, sub-lethal deleterious effects are a possibility for amphibians and reptiles inhabiting this site. Potential impacts of coal combustion waste exposure on herpetofauna include elevated levels of certain trace metals (Lance et al., 2012, Nagle et al., 2001; Roe et al., 2005; Ward et al., 2009), changes in hormone levels (Hopkins et al., 1997), decreased weight gain (Ward et al., 2006), increased metabolic rates (Hopkins et al., 1999a), lessened ability to respond to stressors (Hopkins et al., 1999b), deformities (Hopkins et al., 2000; Rowe et al., 1996), and failed recruitment (Rowe et al., 2001). The negative effects of coal combustion wastes are further reviewed by Rowe et al. (2002), and the effects of environmental contaminants on reptiles and amphibians are reviewed by Sparling et al. (2010). There is, however, evidence that amphibians can acclimate to polluted environments (Ward and Mendonca, 2006). Despite the aforementioned concerns, the South Point fly-ash mound has been colonized by many species of herpetofauna, with the Eastern Spadefoot completing a successful reproductive cycle.

Our findings represent the first documentation of Eastern Spadefoots inhabiting a fly-ash disposal site in Ohio. In South Carolina, Eastern Spadefoots were also found to inhabit a fly-ash contaminated site and were more numerous there than at a nearby reference site (Lance et al., 2012). Spadefoots preferred soils that facilitated easy borrowing in laboratory experiments (Jansen et al., 2001) and the industrial park landscape surrounding the South Point fly-ash mound was highly altered in ways that would have severely restricted burrowing activity. All exposed sandy soils in the industrial park were moved from their original locations and compacted with an industrial tamper (B. Dingus, personal conversation). The rest of the landscape consisted of razed buildings, slag fields, cement, asphalt, other industrial waste disposal and contaminated sites, railroad tracks, mowed grass, and small woodlots. While Eastern Spadefoots have been documented utilizing the cinder bed of a railroad track (Green and Pauley, 1987), sods formed by thick grass are impenetrable to them (Jansen et al., 2001). Given the various surface types of the industrial park, the surface material of the fly-ash mound was likely appealing to spadefoots because the loose composition would facilitate burrowing. The fly-ash was in fact so easy to dig that while excavating holes for pit traps, we only needed to step on our shovels when a root was encountered. Likewise, spadefoots released from our pitfalls easily burrowed into the substrate and were able to disappear completely within seconds. While we suggest that fly-ash might be attractive to spadefoots because of their burrowing habits, we do not imply that fly-ash is a replacement for natural habitat or that fly-ash exposure is not potentially detrimental to herpetofauna.

Coal is an important energy source and the impacts of its combustion on the environment and wildlife are of continuing concern. The presence of a state-endangered species at a fly-ash disposal site and the possible attractiveness of such a site in a highly altered landscape emphasize the need for additional investigations into the ecology of organisms at such sites. Our brief study's purpose was to document the herpetofauna inhabiting a fly-ash disposal site; it was not designed to compare contaminated and uncontaminated sites, assess long-term population persistence, or examine the toxicological effects of coal combustion waste on herpetofauna. We suggest further investigations to address these concerns.

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