

Notes and Discussion

Status and Distribution of the Streamside Salamander, *Ambystoma barbouri*, in Middle Tennessee

ABSTRACT.—Middle Tennessee populations of the Streamside Salamander, *Ambystoma barbouri*, delimit the southern extent of the species' range and are geographically isolated from more northerly populations. Few populations have been discovered in Tennessee, and all of them are located in the Inner Nashville Basin ecological subregion of the Interior Plateau. We surveyed for breeding activity in first- and second-order streams in the southern Inner Nashville Basin to determine the species distribution and to examine the status of and existing threats to extant populations. Streamside salamanders were found at five of 40 localities in southern Rutherford, northern Bedford and northeastern Marshall County, and at only 4 of 6 previously known breeding sites. Continued habitat fragmentation and alteration in association with the urbanization of Rutherford County threaten existing *A. barbouri* populations, which may represent the last remaining populations in the state. We recommend state and local agencies develop a habitat conservation plan to preserve and improve first- and second-order breeding sites and the surrounding forests used by adult Streamside Salamanders.

INTRODUCTION

The Streamside Salamander, *Ambystoma barbouri*, is a stream-breeding member of the family Ambystomatidae (Mole Salamanders). Until recently, *A. barbouri* was considered conspecific with the Small-mouthed Salamander, *A. texanum* (Kraus and Petranka, 1989). Although difficult to distinguish using external morphology, *A. barbouri* and *A. texanum* now are considered sibling species (Petranka, 1998). The Streamside Salamander occurs from southeastern Indiana and southwestern Ohio into central and western Kentucky; geographic isolates are reported from Livingston and Russell counties, Kentucky, Wayne Co., West Virginia and Davidson, Jackson and Rutherford counties, Tennessee (Kraus and Petranka, 1989; Scott *et al.*, 1997; Petranka, 1998; Regester and Miller, 2000). Adult Streamside Salamanders inhabit upland deciduous forests in the vicinity of first- and second-order streams that are ephemeral and have relatively few predatory fish. Populations are found primarily in association with exposed limestone (Petranka, 1998). Throughout their range, adults breed from December to early April and deposit eggs on the undersurfaces of submerged flat rocks (Ashton, 1966; Petranka, 1982; Kraus and Petranka, 1989; Regester and Miller, 2000).

Because of the association with ephemeral streams and hardwood forests, deforestation and development around streams used for breeding are the major causes of population declines throughout the range of *Ambystoma barbouri* (Petranka, 1998; Watson and Pauley, 2005). Of the two West Virginia populations known, one may have recently been extirpated because of land development (Watson and Pauley, 2005). Information on Tennessee populations is limited to that contained in the brief reports of Ashton (1966), Scott *et al.* (1997) and Regester and Miller (2000). Niedzwiecki (2005) included specimens from Rutherford County, Tennessee, in a phylogenetic analysis of *A. barbouri* and *A. texanum*. Tennessee specimens possess a unique mtDNA haplotype and form a distinct clade from other *A. barbouri* populations and are sister to all *A. texanum* populations. However, *A. barbouri* from Tennessee possess similar haplotypes to other *A. barbouri* populations at two nuclear loci examined. Additionally, Niedzwiecki (2005) found that all populations from Rutherford County, Tennessee, showed reduced mean size and developmental stage at hatching.

Because of the limited distribution and lack of information on natural history, *Ambystoma barbouri* is listed as “deemed in need of management” by the Tennessee Wildlife Resources Agency (TWRA) (Withers *et al.*, 2004). This state listing is analogous to the “Special Concern” category of other states and is used by the TWRA when the executive director believes that a taxon should be investigated so that a database can be created on distribution, demography, habitat needs, limiting factors and other pertinent natural history information (Withers *et al.*, 2004). The database is then used to develop management measures required to ensure the taxon's survival. No current data exist on the status of *A. barbouri* populations within Rutherford County, Tennessee. This county includes the rapidly

expanding city of Murfreesboro and is recognized as one of the more rapidly developing counties in the state (Green, 2003). The objectives of the current study were to: (1) determine the status and distribution of *A. barbouri* within middle Tennessee by sampling both previously known breeding localities and other first- and second-order streams within the Inner Nashville Basin and (2) document potential threats to existing or newly discovered populations.

MATERIALS AND METHODS

Study site description.—Since the discovery during the mid 1990s that *Ambystoma barbouri* occurs in the Nashville Basin, one of us (BTM) has searched from December through April for breeding adults, eggs or larvae in first- and second-order streams at road crossings throughout Rutherford and southern Wilson counties. During these preliminary surveys, *A. barbouri* was found in only six streams (hereafter referred to as historic sites), all located in southern Rutherford County. During the current study, we searched for eggs, larvae and adults in 40 first- and second-order streams in southern Rutherford, northern Bedford and northeastern Marshall County from 16 February to 14 April 2005 (Fig. 1). All streams surveyed were located within the Inner Nashville Basin (INB) ecological subregion of the Interior Plateau in the Stones, Duck and Harpeth River watersheds (Griffith *et al.*, 1997). These streams were selected based on similarity of habitat, proximity to historic breeding sites in the southeastern section of the INB and site access. The INB is a region characterized by gently rolling terrain with shallow soils and outcrops of Ordovician-age limestone. Streams within the INB typically are of low gradient and flow over large expanses of exposed bedrock. Many of these streams are clear and ephemeral, becoming reduced to isolated pools or flowing underground during late summer and fall. Much of the area lies within cedar glades, although a small percentage lies within mixed mesophytic forest (Kuchler, 1964).

Survey techniques.—Streams were sampled ca. 100 m upstream and downstream from county road crossings. Rocks within both pool and riffle habitat were carefully lifted to locate eggs or larvae, and rocks and other cover objects were lifted adjacent to streams to locate adults. Lifted rocks and other cover objects were returned to their original positions to minimize habitat disturbance. Dipnets were used to sample for larvae in pools at select locations.

RESULTS

Ambystoma barbouri was observed at 12.5% (5 of 40) of all localities sampled and at 66.7% (4 of 6) of the historic breeding sites. Eggs or larvae were observed at four of the historic sites and an adult also was observed at one of these streams (Table 1). Larvae were found at Buzzard Branch, which represents a new breeding locality for the species. Several larvae from Buzzard Branch were reared in the laboratory through metamorphosis and their identification was confirmed by examining tooth morphology.

DISCUSSION

Within Tennessee, *Ambystoma barbouri* is historically known from only two other regions outside of Rutherford County, both within the Outer Nashville Basin: several breeding aggregations were observed during the mid-1960s from the Green Hills area within metropolitan Nashville in Davidson County (Ashton, 1966; Scott *et al.*, 1997) and two juveniles were collected in 1973 from Hix Hollow in Jackson County (Scott *et al.*, 1997). The Davidson County population is presumed extirpated because of significant urbanization of the area since the time of collection. The status of the Jackson County population remains unknown. Historically, *A. barbouri* may have been more widely distributed throughout the Nashville Basin, perhaps continuous with populations in Kentucky. However, the occurrence of *A. barbouri* outside the Nashville Basin in middle Tennessee is unlikely. Steep-sloping valleys with moderate gradient and down-cutting streams characterize the Highland Rim, which borders the eastern and western edges of the Nashville Basin. The Barrens region, with gently sloping terrain, low relief and a fragipan in the soils causing season wetlands (DeSelm, 1994), lies on the Rim and lacks habitat suitable for *A. barbouri*. Herpetofaunal surveys of the Barrens indicate that the Small-mouthed Salamander (*Ambystoma texanum*), rather than *A. barbouri*, occurs in this physiographic region (Miller *et al.*, 2005, Niemiller, 2005).

In the current study, only 12.5% of the localities sampled within Rutherford, Bedford and Marshall county with seemingly suitable habitat possess eggs, larvae or adult *Ambystoma barbouri*. Populations are

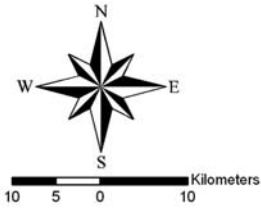
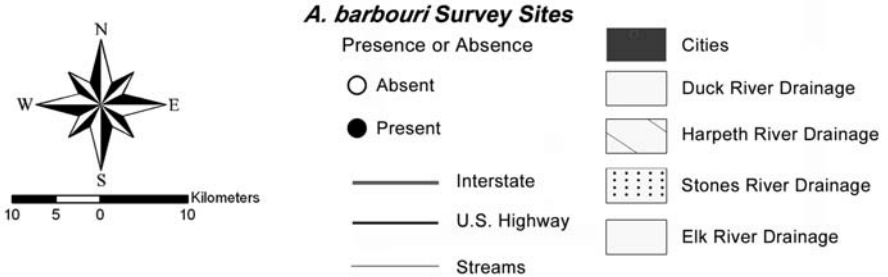
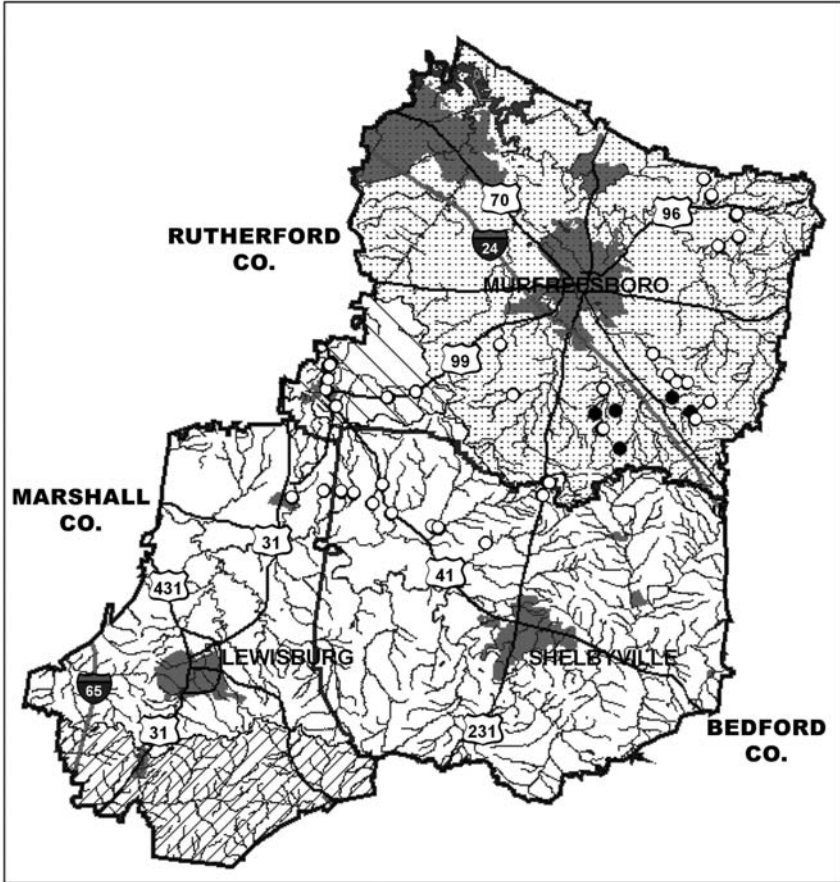


FIG. 1.—First- and second-order stream localities surveyed for the Streamside Salamander, *Ambystoma barbouri*, between 16 February and 14 April 2005 within the Inner Nashville Basin of Rutherford, northern Bedford, and northeastern Marshall County, Tennessee

restricted to first- and second-order streams surrounded by or adjacent to forests south of Murfreesboro and east of the town of Christiana in Rutherford County. The existing populations encompass an area ca. 8.8 km by 6.9 km (ca. 60.7 km²) that is heavily dissected by roads, including Interstate 24, State Highways 41 and 269 and more than a dozen county roads. The network of roads in the area inhabited

TABLE 1.—Observation of egg masses larvae or adults during surveys for the Streamside Salamander, *Ambystoma barbouri*, from first- and second-order streams within the Inner Nashville Basin of middle Tennessee

Locality	Historic	Eggs	Larvae	Adults
Long Creek at Rucker Rd	•			
Long Creek tributary at Lowe Rd	•	•		•
Short Creek at Christiana Rd	•			
Middle Fork Stones River tributary at Broyles Rd	•	•		
Dry Creek at Cobb Rd	•	•		
Hurricane Creek tributary at Jacobs Rd	•	•	•	
Buzzard Branch at Epps Mill Rd			•	

by *A. barbouri* effectively fragments the metapopulation into isolated breeding localities with little chance of recruitment occurring across major thoroughfares (Gibbs, 1998). The isolated populations east of Interstate 24 appear particularly vulnerable to extirpation as few suitable streams exist for reproduction and the city of Murfreesboro is rapidly expanding into the region. Another breeding site reported by Regester and Miller (2000) exists ca. 8 km southwest of downtown Murfreesboro in the southernmost section of Puckett's Creek. The status of this population was not ascertained during this study; however, its fate is uncertain as both residential and commercial development continues to expand along State Highway 99 towards Puckett's Creek [D. Withers, Tennessee Department of Environment and Conservation (TDEC), pers. comm.].

Although one new locality was discovered during this study, two of the six documented breeding sites are either extirpated or have declined significantly during the past decade as we could not locate any evidence of breeding activity (eggs, larvae or adults). Possible reasons for this decline include alteration of adult terrestrial habitat and degradation of aquatic breeding habitat associated with the conversion of small remnant forest tracts along streams used by *Ambystoma barbouri* for breeding to pasture and lawns. Although the effects of forest alteration (*i.e.*, clearcutting for timber harvest, clearing for alternative land use) on *A. barbouri* populations have not been directly investigated, several studies have shown that forest alteration has a negative impact on the abundance of many amphibian species, in particular salamanders (Means *et al.*, 1996; Mitchell *et al.*, 1997; Calhoun and Hunter, 2003; Dodd and Smith, 2003). As forests are cleared, air and soil temperatures increase, humidity decreases and the abundance of prey within leaf litter may change, reducing both salamander biomass and diversity (Ash, 1995; Harper and Guynn, 1999). Removal of canopy and streamside vegetation around headwater streams negatively affects stream habitat by increasing insolation, water temperature and exposure to ultraviolet radiation (Corn *et al.*, 2003). In addition, streams in cleared areas experience increased sedimentation and silt load, degrading amphibian habitat by reducing the availability of cover sites, inhibiting the attachment of eggs to the substrate and adversely affecting embryo development (Corn and Bury, 1989; Corn *et al.*, 2003).

Water quality data exist for one of the historic stream sites, Hurricane Creek. The TDEC, Division of Water Pollution Control, uses this stream to monitor water quality within the INB (Arnwine *et al.*, 2003). Hurricane Creek is rated as "partially supporting" because of high nutrient levels, siltation and low dissolved O₂. The relatively low water quality results from land development, road and bridge construction and an industrial point source located nearby. Although *Ambystoma barbouri* still uses Hurricane Creek as a breeding site, as evidenced by the presence of eggs and larvae during this study, degrading water quality might have adverse consequences for this and other sites. For example, a monitoring site at Henry Creek, located ca. 8.1 km southwest of the Hurricane Creek monitoring site, is only 0.9 km northwest of the Short Creek historic site. Henry Creek, which flows into Short Creek, was also rated as "partially supporting" because of siltation associated with pasture grazing. No indication of *A. barbouri* reproduction was observed at Short Creek during 2005.

Based on satellite imagery from 1992, 55% of the land area within the INB had been cleared for agriculture, whereas 2% was categorized as urban; 44% of the land remained undeveloped (Arnwine

et al., 2003). Recently, however, this region has experienced rapid population growth and land alteration. The population of Rutherford County has increased 53.5% from 1990 to 2000 (118570 to 182023, respectively) making it the fastest growing county in the state. These figures are expected to rise as the population of Rutherford County is predicted to reach nearly 319000 by 2025, an increase of 75% since 2000 (Green *et al.*, 2003). The rapid land development within the region has the potential to adversely affect local streams and, consequently, Streamside Salamander populations, as more land is developed to cope with an ever growing human population. Existing populations will likely become more isolated because of continued fragmentation of habitat.

The Rutherford County *Ambystoma barbouri* localities may represent the last remaining populations of the species in the state. These populations form a clade distinct from other *A. barbouri* localities at one mitochondrial DNA marker and individuals from these populations are smaller and significantly less developed at hatching than those from other *A. barbouri* populations (Niedzwiecki, 2005). To ensure the survival of this species in Tennessee, we recommend that state and local agencies develop a habitat conservation plan to preserve and improve first- and second-order breeding sites and the surrounding forests used by adult Streamside Salamanders. Populations should be monitored annually to assess populations and research should be conducted to determine reproductive output and survivorship of eggs and larvae.

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