

Continuing Distributional Surveys for  
the Nashville Crayfish,  
*Orconectes shoupi*  
an Endangered Crayfish in Tennessee

Final Report



Agreement #401814J013

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## **Introduction and Summary**

The Division of Natural Areas (DNA) was contracted by the U.S. Fish and Wildlife Service (USFWS) to conduct distributional surveys for the federally endangered Nashville crayfish, *Orconectes shoupi*. Much of the work under this contract was presented in an earlier report (Withers, 2005). Additional surveys for the species were undertaken between fall 2005 and winter 2008-09, and were primarily directed at first and second order tributaries throughout the Mill Creek watershed in Davidson & Williamson Counties, Tennessee. The purpose of these inventories was to produce a more comprehensive understanding of the distribution of the species, particularly in the most upper reaches of the watershed.

*Orconectes (Crockerinus) shoupi* Hobbs was described by Fleming in 1939 as *Cambarus propinquus sanborni* (Fleming, 1938-9), from specimens collected in Mill Creek (Miller *et al.*, 1990, O'Bara *et al.*, 1985). Hobbs reassigned the species to the genus *Orconectes* in 1948 and renamed it in honor of Dr. Charles S. Shoup, a Vanderbilt University biology professor of the time (Hobbs, 1948). The species was later assigned to the subgenus *Crockerinus* (Fitzpatrick, 1987).

The Nashville crayfish was listed as Endangered by the USFWS on October 27, 1986, due to its apparent restriction to the Mill Creek watershed and continuing threats from development to the same. The species was subsequently listed as Endangered under state law by the Tennessee Wildlife Resources Agency (TWRA). The federal Recovery Plan for the species was completed in 1988 (USFWS, 1988).

Early accounts suggested that the species was limited solely to Mill Creek and its largest tributaries (including Sevenmile Creek), but research over the last 20 years has documented the species in progressively smaller waters. Many of the recent surveys are in direct response to certain regulatory requirements either directly or indirectly following from the listing of the species and its protection under the Endangered Species Act (O'Bara, 1999, *in part*, by inference). Though often not abundant in the most minor of Mill Creek tributaries, *O. shoupi* has managed to eke out an existence at many locations despite an overwhelming abundance of competing species.

The species is still believed to be limited to the Mill Creek basin in Davidson & Williamson counties, where its preferred habitat includes free-flowing waters dominated by a slabrock on bedrock substrate.

The Nashville crayfish was reported from eighteen primary (directly connected) and six secondary Mill Creek tributaries prior to the initiation of this study (Withers, 2005). The current survey has documented the species from additional streams including two primary and five secondary tributaries. Fifteen Mill Creek main stem and eighteen tributary sites were reconfirmed. Rather than present these data as wholly separate entries in the DNA Biotics database, numerous newly reported sites are merged into appropriate existing nearby records. These details are presented in each element occurrence. Certain tributary populations are presented as separate occurrences when evidence suggests that reproduction independent of downstream populations has occurred.

## **Species Description and Habitat**

Hobbs (1948) described *Orconectes shoupi* following close examination of a series of crayfishes from the Nashville area (Bouchard, 1984, from Barrociere, 1986). Many authors have addressed the particular characters that distinguish the species from others in Mill Creek and the region (Hobbs, 1948; O'Bara *et al.*, 1985; USFWS, 1988; Williams, 2001). The most distinguishing features include elongate pincers with red tips and adjacent narrow black banding, a usually light-colored "saddle" on

the carapace extending from the posterior to the anterior and terminating as lateral stripes on either side, and distinctive gonopods markedly different from any of its congeners. Larger females can be easily identified by the sigmoidal cleft of the annulus ventralis (AV, sperm receptacle) under minimal magnification, and occasionally by the naked eye. Such identification presumes that the AV is not occluded by debris or is particularly melanic. *O. shoupi* can be a rather large crayfish, ranging from young-of-the-year (YOY) at ~0.6 cm total length (TL) to adults ~17.8 cm (O'Bara *et al.*, 1985).

Other *Orconectes* reported from the Mill Creek watershed, including *O. rhoadesi* and *O. durelli*, can be easily distinguished from *O. shoupi* by gonopod structure and body coloration. As noted by Bouchard (1984a), *O. placidus*, a Central Basin species strongly resembling *O. shoupi*, has never been reported from the Mill Creek watershed. As such, even YOY crayfish from the Mill Creek drainage often can be comfortably identified as *O. shoupi*, as no other saddle-bearing species are present in the system. That idea was borne out during the current survey, as the only adult *Orconectes* from the Mill Creek system with the characteristic saddle was *O. shoupi*. Saddled YOY observed in the Mill Creek drainage, by inference, are likely *O. shoupi* as well. A single stream outside the Mill Creek watershed was sampled in 2008 but revealed only *O. placidus*.

*Orconectes shoupi* appears to be restricted to the bedrock- or cobble-dominated streams in the Mill Creek drainage. Preferred habitat includes slabrock over bedrock or cobble substrates in free-flowing streams, although at least three exceptions involving impoundments have been reported (Carpenter, 2004; DNA Biotics, 2009; Walton, 2008). Several authors have noted the apparent absence of the species outside of the drainage, and have indicated that historic accounts outside of the basin were either in error or represented short-lived introductions (Barrociere, 1986; Bouchard, 1984; Miller *et al.*, 1990; O'Bara *et al.*, 1985; USFWS, 1988).

## **Methods & Materials**

Prior to initiation of the current project, all recent data sources for the species were evaluated, and relevant records were incorporated into DNA Biotics. Site selection in part was based on historical but also recent distribution. Certain stations on Mill Creek were sampled in concert with the survey of an adjoining tributary.

Sites evaluated during the study included those streams that intersected a public right-of-way, or which crossed private properties for which DNA was granted landowner permission to conduct the survey. A few properties in the uppermost part of Indian Creek could not be accessed, as staff of the Tennessee Natural Heritage Program (TNHP) could not obtain landowner permission. In certain cases accessing adjoining lands with friendly landowners abated this situation, and surveys were conducted in segments abutting those that were off-limits.

Surveys were conducted throughout Davidson and Williamson counties, including 85 segments of 39 tributaries. A single stream segment outside of the Mill Creek watershed was examined for comparative purposes.

Stream surveys were conducted during daylight hours, and with a few exceptions only during base flow of each stream examined (e.g. not following storm events). Sample crews ranged from 1-3 individuals, though the author conducted significant sampling singly. Each segment was sampled using appropriately sized dipnets for the habitat in question. Potential *O. shoupi* streams were sampled by overturning rocks and slabrocks and quickly netting beneath them. This was

accomplished either individually by each crewmember, or as appropriate, by 2-3 crewmembers jointly. Sometimes individuals exposed atop the substrate were netted or captured by hand.

During the course of the investigations a few non-*shoupi* specimens were collected, as necessary, as voucher specimens. A few deceased *O. shoupi* and molted exoskeletons were also collected and preserved in 70-75% ethanol. All crayfish not collected as reference specimens were returned at or near the point of capture. Particular care was given to the handling of female specimens in berry or with early instar young, and to YOY as well. No ovigerous female crayfish (bearing eggs or young) were collected for any taxa.

For each site, approximate stream dimensions (width, depth) and basic descriptions of the habitat were recorded. Digital photographs were taken at each sample site, including close-ups of occupied habitat, as appropriate, and photographs of representative specimens caught at each location.

Vouchered specimens will be offered to the TWRA Reference Collection of Crayfish, with duplicates remaining in the DNA.

### **DNA Biotics Database Records**

DNA Biotics records resulting from the conduct of these surveys are presented in Appendix 1 of the electronic version of this report. Each record includes the stream name, directions, latitude and longitude, USGS topographic quadrangle name, county, species information, and site description. Tentative species identifications are preceded with “cf.”

### **Results & Discussion**

*Orconectes shoupi* was documented from an additional seven tributaries (four in Davidson and three in Williamson County) in the Mill Creek watershed. Several new sites were documented in main stem Mill Creek, and were merged with and used to update existing records.

Several sites were revisited, allowing for *O. shoupi* to be reconfirmed at fifteen sites in Mill Creek and at eighteen tributary sites as well. The species is now known from 110 occurrences across the Mill Creek watershed (Figures 1-3).

From the current surveys and those presented in the 2005 report, three drainages in particular emerged as having a high conservation priority based on the relative abundance of *O. shoupi* and apparent integrity of the system: 1) Indian Creek, 2) Mill Creek upstream of downtown Nolensville, and 3) the unnamed Nolensville tributary (Bittick Creek) to Mill Creek that originates near Burke Hollow Road and flows north. Each of these streams, at least at present, is in relatively good condition compared to much of the Mill Creek watershed. Other populations, though having relatively few *O. shoupi* in comparison to its congeners, occur in the least disturbed tributary segments (e.g. West Fork Owl Creek). These most headwater segments in many ways present the most efficacious opportunities for stream restoration and habitat enhancement, based in part on the reduced size of the watershed relative to stream length.

Two remarkable discoveries occurred concurrent to but independent of these surveys. Chip Walton, a graduate student at Tennessee Technological University, discovered the first known occurrence of *O. shoupi* in Holt Creek upstream of its confluence with Mill Creek. All previous surveys had found

Holt Creek to be void of the species, dominated rather by *O. durelli*. Walton also investigated a borrow pit or detention basin straddling Owl Creek in Williamson County, finding an apparently reproducing population of *O. shoupi*. This latter site was confirmed by the author.

The primary threat to *O. shoupi* populations comes from siltation associated with poor land-use practices. The entire Mill Creek basin is being rapidly developed, and streams without obvious impacts from development are becoming scarce. Farmlands of the Mill Creek headwaters lying southeast of downtown Nolensville are poised to be converted for residential development in the next few years. The greater Nolensville area is experiencing considerable residential growth and a concomitant increase in the construction of new or improved utilities to service that growth.

During these surveys certain stream segments were inadequately protected from sediment transported from nearby developments and associated infrastructure. Proper best management practices for erosion control would help maintain *O. shoupi* habitats in more of a natural state. This continues to be a pervasive problem despite increasing regulatory oversight.

### **Conclusions and Recommendations for further study**

As anticipated, *O. shoupi* does inhabit several additional streams falling within the limits of Mill Creek watershed, including several that at first appear to offer hydrologically marginal habitats at best. The species also has demonstrated a certain resiliency in the upper tributaries of Mill Creek and Owl Creek, apparently surviving in portions of these systems that routinely stop flowing at times each summer - and this despite the pervasive drought of 2007-08.

Much of this area is soon to be converted from agricultural to residential uses, with the expectation that the bedrock base of Mill Creek will be crossed numerous times to service buried utilities necessary for these developments. Such activities potentially pose a severe threat to the survival of the species in the area, and inappropriate fracturing of bedrock could easily result in the loss of still pools occupied by the species during much of the summer.

Williamson County recently adopted a minimum 50' setback buffer for developments near streams. The Town of Nolensville has adopted a similar standard within their corporate limits, although no buffers are required of headwater areas (Town of Nolensville Floodplain Regulations, 2006). One remaining concern is whether or not the setback requirement will apply to utility construction, or if utilities will be allowed unfettered access within the buffer. Ideally, utilities will be kept outside of the buffer, or will at least be consolidated to the maximum extent practicable. Such measures should help protect the integrity of the most upstream portions of the Mill Creek watershed.

The current study identifies several tributary segments that appear to represent the upstream limit of *O. shoupi* in these systems. These apparent limits are likely transitory, however, depending upon long-term weather patterns and hydrologic conditions, since for many tributaries apparently suitable physical habitat is plentiful. Other headwater systems, likewise with appropriate physical habitat, may be supported seasonally by perennial springs - allowing *O. shoupi* to occupy at least a portion of these tributaries. However, near-spring and spring habitats are often dominated by competing species, notably *Orconectes durelli* and *Cambarus tenebrosus*, respectively.

Although the current project has documented *O. shoupi* at headwater locations of several tributaries, several segments of interest were not sampled fully during this study. The following tributary segments should be investigated, when possible, to further clarify the upstream limit of the species:

- Bittick Creek upstream of Artesian Road
- Holt Creek from Walton study site upstream
- Indian Creek upstream of Metro Nashville Parks parcel (former Couch Farm)
- Snake Creek (Kidd Road tributary to Mill Creek) upstream of McFarlin Woods development
- West Fork Owl Creek upstream of Pleasant Hill Road
- Unnamed tributary to Owl Creek upstream of Bluff Road
- Unnamed tributary to Mill Creek upstream of Sunset Middle School
- Unnamed tributary to Mill Creek at Lenox Village (former Resha Lake tributary)

In light of the Walton discovery of the *O. shoupi* population in the Owl Creek detention basin, renewed interest should be given to all remaining ponds or other water bodies in the Mill Creek watershed. Highest inventory priority should be afforded those in closest proximity to known populations of the Nashville crayfish. A large pond draining to Owl Creek, approximately 0.5 air mile southwest of the Walton detention basin is slated for development currently. This site needs thorough study prior to its development.

Additionally, the Walton pond presents a unique opportunity to study the use of still water bodies by *O. shoupi* and the relationship between seasonally isolated populations and their putative adjoining parent populations. This opportunity also has presented itself at the unnamed tributary to Mill Creek that bisects the new Sunset Middle School near Nolensville. In fall 2008 the author was contacted by Brandon Rowe, a sixth grade science teacher at Sunset Middle School. He was aware of the relationship between *O. shoupi* and Mill Creek, and wanted to include information about the species in material presented to his classes. He also wanted to involve his students in restoration and enhancement activities to protect the species in that portion of Mill Creek abutting school property. The unnamed tributary on the school grounds was investigated for *O. shoupi* prior to school construction and the species was not documented. Concurrent with school construction, portions of this tributary were then realigned and re-contoured under a stream mitigation agreement.

In January 2009 Mr. Rowe provided photographs of some saddled crayfish beneath one of two bridges crossing the unnamed tributary. The author visited the site the following day and confirmed these as *O. shoupi*. Mr. Rowe subsequently contacted the USFWS and Nashville Zoo and has begun discussing potential partnerships to involve his students in the study of the crayfish and further enhancement of this tributary. The apparent recent colonization of this tributary by *O. shoupi* presents several potential study opportunities. Because this tributary stops flowing to Mill Creek each summer, the USFWS now has an opportunity to learn about winter migration of the species into this system with little need to handle individual specimens. Mr. Rowe has demonstrated that near daily observations of the crayfish are possible with no disturbance of its habitat. We encourage the USFWS to continue the dialogue with Mr. Rowe and to explore means by which to answer many questions about the habits, behaviors, and habitat tolerances of *O. shoupi*.

## Conservation Need

Conservation opportunities for the Nashville crayfish are many. In addition to protecting the headwaters of Mill Creek, several tributaries appear to be imperative conservation targets based on the relative density of *O. shoupi*. Several tributaries occupied by *O. shoupi* are relatively undisturbed and pastoral, particularly in Williamson County. We encourage the USFWS to evaluate ongoing land use in the upper Mill Creek watershed and engage priority landowners in measures that protect and enhance the integrity of these streams. Conservation of these aquatic habitats could provide insurance for the survival of *O. shoupi* should main stem Mill Creek suffer a catastrophic loss of the species. To that end, we also encourage the USFWS to review the potential sales of farms and larger tracts that adjoin streams occupied by the species, in order to bring a portion of the occupied range into public ownership.

Ideally, and in order to facilitate recovery goals for the species, population segments from main stem Mill Creek and each of the major tributaries should be targeted for all appropriate conservation measures, including conservation easements and other deed restrictions. For the time being certain of the more rural segments should prove viable candidates for enrollment in local Natural Resources Conservation Service programs. The following segments are offered for consideration by the USFWS and its partners:

➤ Bittick Creek upstream of Nolensville, Williamson County

Bittick Creek contains a robust and reproducing *O. shoupi* population in an area not yet overly developed. Several friendly landowners exist in this segment that are not interested in seeing extensive development of the area. The potential exists for stream buffer improvements and easements in this largely pastoral setting.

➤ Collins Creek, Davidson County

Despite being in a predominantly commercial area, and bisected by I-24, Collins Creek continues to support a large number of *O. shoupi*. This system presents a great opportunity for establishment of riparian cover, improvements to storm water quality, and demonstration of property management conducive to stream health. Proximity to I-24 and Bell Road will allow for significant public exposure to restoration and enhancement activities while involving relatively few landowners.

➤ Indian Creek upstream of Pettus Road, Metro Nashville Parks, Davidson County

This property was recently donated to Metro Parks and at present contains the most upstream known occurrence of *O. shoupi* in Indian Creek. Though the stream is generally shaded, the forest buffer separating the creek from surrounding hay fields is relatively narrow. Expansion of this buffer with appropriate native trees is needed to further enhance this site. The USFWS should investigate Metro Parks' intended use of this property, and use this opportunity to discuss conservation needs and habitat enhancement measures at this and other Metro properties supporting the crayfish (Ezell Park/greenway – Mill Creek, Antioch Park/greenway – Whittemore Branch and Mill Creek; Caldwell Park – Sevenmile

Creek). This also presents an opportunity to enter into a habitat conservation plan (HCP) with the Metro Nashville government.

➤ Owl Creek detention basin at Concord Road, Williamson County

The origins of this pond are unclear, but it may represent a compensatory cut for nearby fill activities associated with residential development. A small cut in the right-descending bank of Owl Creek on the upstream side of the pond apparently allows floodwaters to enter the pond periodically. Presumably *O. shoupi* followed suit. Because of the apparent use of this site for fishing, the USFWS is encouraged to contact the landowner and ensure that management of the site does not conflict with needs of the crayfish. The author is concerned that sport fishing management of the pond could include periodic use of rotenone to control undesirable fish species. To improve habitat for *O. shoupi*, additional slab rock could be added to the pond as cover objects.

➤ West Fork Owl Creek upstream of Splitlog Road, Williamson County

At present this approximately 0.3 mile segment contains the most upstream known reproducing population of *O. shoupi* in the Owl Creek watershed. The stream is well shaded but the forested buffer on the left-descending bank provides only a marginal separation from the abutting meadow. The current owners (M/M Rufus Tindall) are retired and concerned about encroaching development, and may prove interested in conservation programs and easements. Mr. Tindall explained to the author how his grandfather had relocated the stream from the center of the field circa 1890, east to the adjoining hillside where it remains. This was apparently a common practice in the upper part of the Mill Creek watershed.

➤ Unnamed tributary to Mill Creek, Sunset Middle School, Williamson County

As noted above, this tributary segment was believed devoid of *O. shoupi* prior to construction of the school. Due to the recent discovery of the species in the tributary, and with the current interest in the crayfish by the science faculty, the USFWS has an opportunity to ensure that continued restoration of this tributary is fruitful. Beyond study of *O. shoupi*, Mr. Rowe would like the school to participate directly in the improvement of in-stream habitats for the crayfish (e.g. adding slab rock cover where needed). Additional tree plantings and riparian restoration may ensure that this stream contains enough water seasonally to allow *O. shoupi* to reproduce and thrive. The USFWS should consider this opportunity to enter into an HCP or conservation easement with the government of Williamson County to further protect this site.

We also ask the USFWS to evaluate binding conservation measures at currently developed sites with previously documented *O. shoupi* populations so that those segments are demonstrably protected and enhanced (e.g. Governor's Club, Williamson County; Lenox Village, Davidson County).

Staff from the DNA are available to assist with prioritization of sites for conservation action or further inventory.



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## Selected References

- Barrociere, Leo Joseph, 1986. The Ecological Assessment & Distribution Status of the Nashville Crayfish, *Orconectes shoupi*. Masters thesis, Tennessee Technological University, Cookeville, TN, 68 pp.
- Bouchard, Raymond W., 1984a. Untitled summary & assessment of status of *Orconectes shoupi* submitted to the U. S. Fish & Wildlife Service, 4 pp.
- Bouchard, Raymond W. 1984b. Distribution and status of the endangered crayfish *Orconectes shoupi* (Decapoda: Cambaridae). U.S. Fish and Wildlife Service, Tennessee Cooperative Fishery Research Unit, Tennessee Tech University, Cookeville, Tennessee. 27 pp.
- Carpenter, Jim, 2004. 7 September 2004 email to David Withers (DNH) concerning occurrence of Nashville crayfish (*Orconectes shoupi*) in Collins Creek, Nashville, Davidson County, TN, 2 pp.
- DNA Biotics GIS Data System, Division of Natural Areas, Tennessee Department of Environment & Conservation, Nashville.
- Fitzpatrick, Joseph F., Jr., 1987. The Subgenera of the Crawfish Genus *Orconectes* (Decapoda: Cambaridae). *Proceedings of the Biological Society of Washington*, 100(1):44-74, figures 1-18.
- Fleming, Robert S., 1938-9. The larger Crustacea of the Nashville region. *Journal of the Tennessee Academy of Science*. 13(4): 296-314 (1938); 14(2): 261-264 (1939); 14(3): 299-324 (1939).
- Hobbs, H. H., Jr., 1948. On the Crayfishes of the Limosus Section of the Genus *Orconectes* (Decapoda, Astacidae). *Journal of the Washington Academy of Sciences*, 38(1):14-21, figures 1-28.
- Hobbs, H. H., Jr. 1989. An illustrated checklist of the American Crayfishes (Decapoda: Astacidae, Cambaridae, and Parastacidae). *Smithsonian Contributions to Zoology*, No. 488.
- Miller, A. C. and P. D. Hartfield. 1985. A study of *Orconectes shoupi*, Mill Creek Basin, Tennessee, 1985. U.S. Army Corps of Engineers, Nashville, TN. 25 pp.
- Miller, A.C., P.D. Hartfield, L. Rhodes. 1990. An investigation of *Orconectes shoupi* in Mill and Seven Mile creeks, Tennessee. *Journal of the Tennessee Academy of Science* 65(1): 21-24.

O'Bara, C. J., A. J. Korgi, and G. J. Stark, 1985. Final report, status survey of the Nashville crayfish (*Orconectes shoupi*). Report to U.S. Fish and Wildlife Service, Asheville, NC. 17 pp.

O'Bara, Christopher J., 1999. The distribution & current status of the Nashville crayfish *Orconectes shoupi*, Tennessee Technological University, Cookeville, TN, 17 pp.

Stark, Gregory Jay. 1987. Microhabitat use by the crayfish community of the Mill Creek Basin. Thesis, Tennessee Technological University, Cookeville, TN. 44 pp.

Town of Nolensville, 2006. Zoning Ordinance Article 5 – Floodplain Regulations. Nolensville, TN 27 pp.

U.S. Fish and Wildlife Service, 1986. Endangered and threatened wildlife and plants; determination of endangered status for the Nashville crayfish. 51 Federal Register 34412.

U.S. Fish and Wildlife Service, 1988. Nashville crayfish Recovery Plan (1st revision). U.S. Fish and Wildlife Service, Atlanta, Georgia, 16 pp.

Walton, Charles F. Jr. 2008. Habitat Characterization of the Nashville Crayfish (*Orconectes Shoupi*) in Mill Creek Watershed, Tennessee. M.S. Thesis, TN Tech University, 88 pp.

Williams, Carl E. and Rick D. Bivens, 2001. Key to the Crayfishes of Tennessee, abstracted from H.H. Hobbs Jr. 1976, H.H. Hobbs Jr. 1981, and Bouchard 1978, and an Annotated List of the Crayfishes of Tennessee by Carl E. Williams and Rick D. Bivens. Tennessee Wildlife Resources Agency, 72 pp.

Withers, David Ian, 2005. Distributional Surveys for the Nashville Crayfish, *Orconectes shoupi*, an Endangered Crayfish in Tennessee, Final Report. Tennessee Division of Natural Heritage, Nashville, 11 pp + appendix.

Figure 1

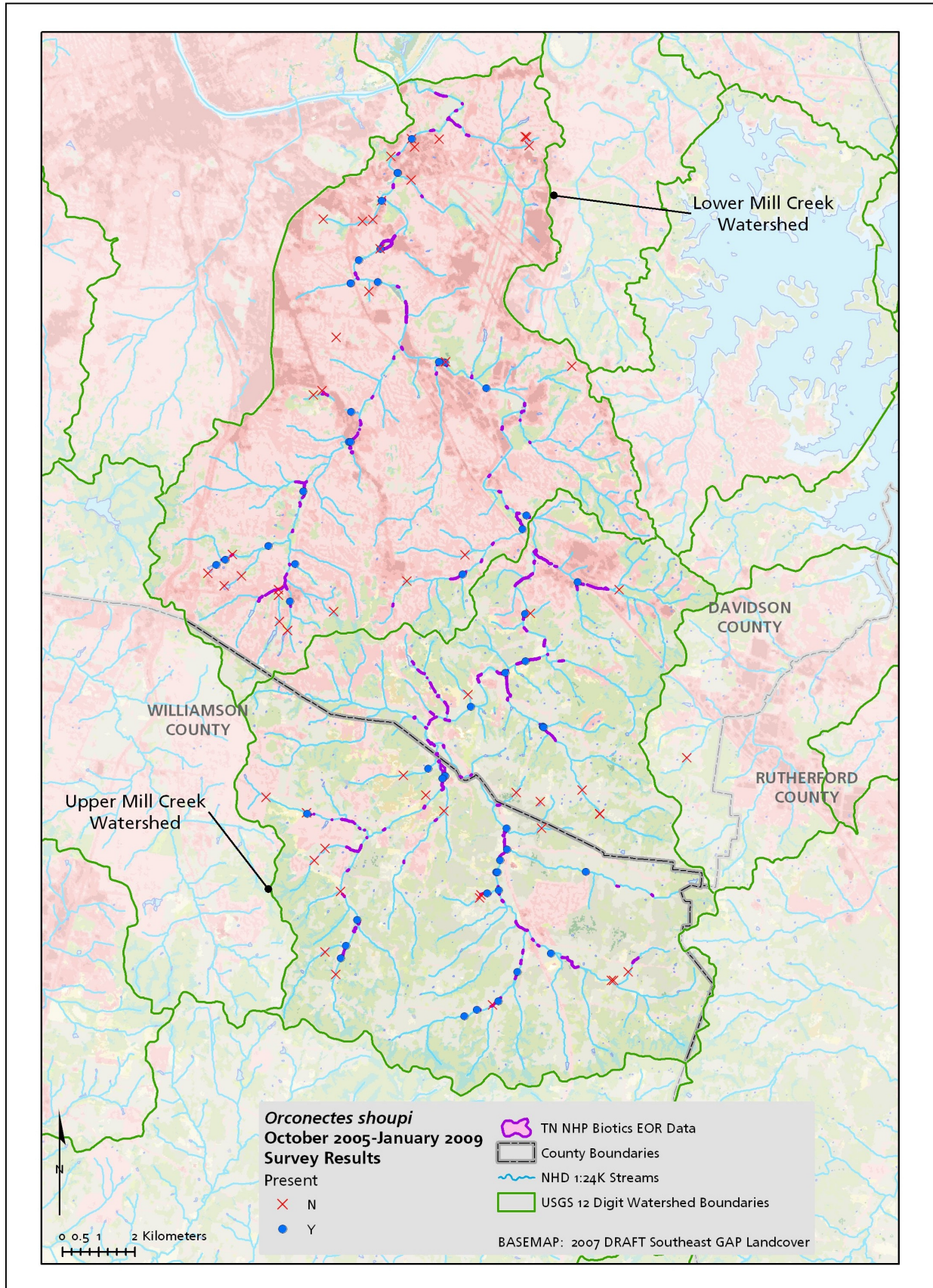


Figure 2

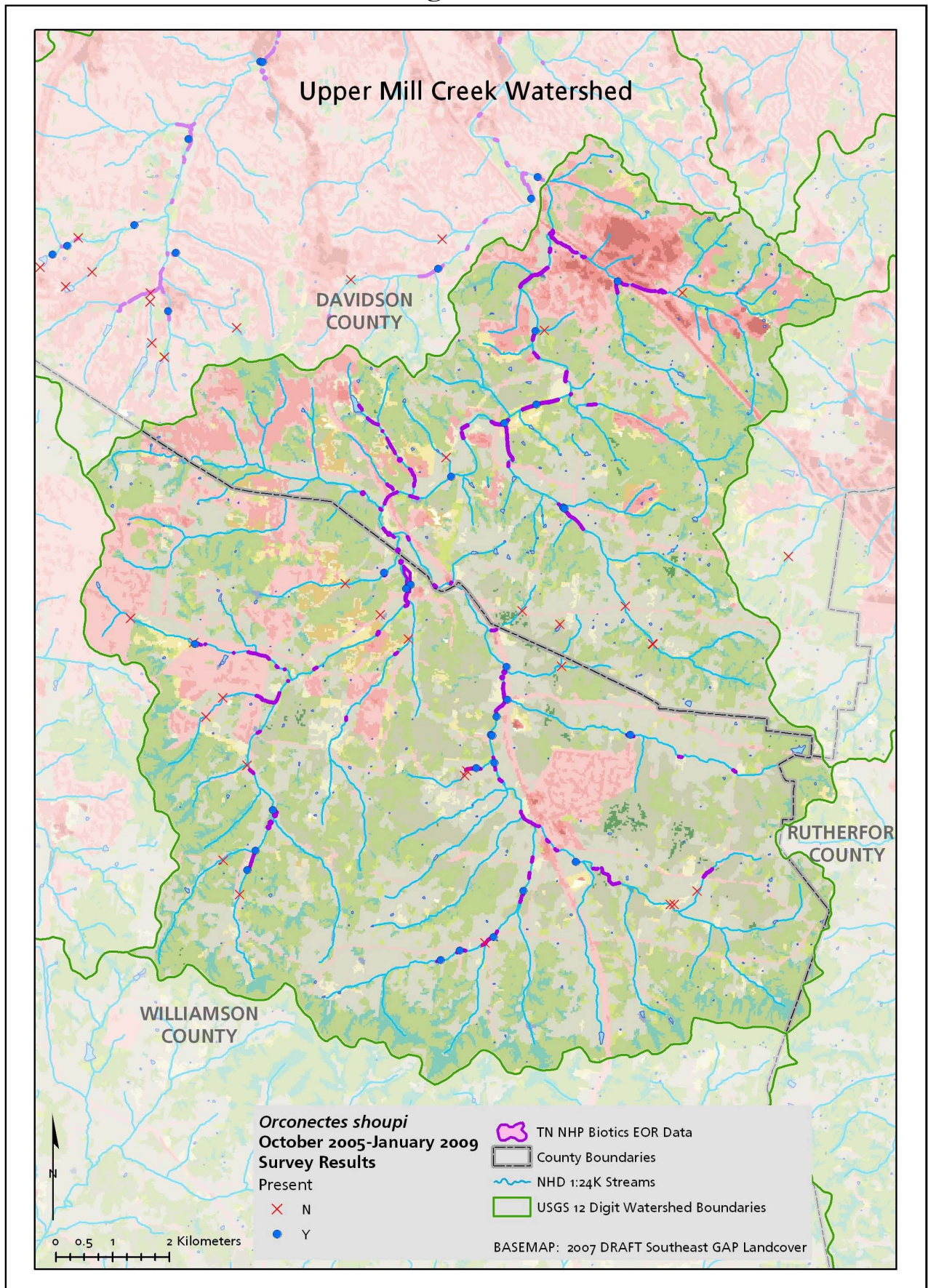


Figure 3

