

Proposal for Crayfish Surveys of Big Thicket National Preserve

Proposal prepared by:

Zachary J. Loughman, Ph.D.

Assistant Professor of Zoology and Ecology
Department of Natural Sciences and Mathematics
West Liberty University
West Liberty, WV 26074

zloughman@westliberty.edu

Phone: 304-336-8923

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Introduction

Crayfishes are important members of Texas's lentic and lotic ecosystems (Albaugh 1975; Hobbs 1990; Hobbs and Whiteman 1990; Johnson and Johnson 2008). Within ecological systems, crayfishes act as ecosystem engineers (Creed and Reed 2004), increasing stream benthic community complexity and providing subterranean refuges for both aquatic and terrestrial organisms through their burrowing behavior (Loughman and Simon 2011). Several taxa have coevolved alongside crayfishes, and are dependent on burrows created by these animals for key aspects of their life history (Taylor et al. 2007). Given their cosmopolitan diets, crayfishes assimilate a tremendous amount of available nutrients that are passed onto multiple trophic levels they are part of via their predation (Creed and Reed 2004; Taylor et al. 2007; Loughman and Simon 2011).

Economically this group of animals provides an important forage base for several game fish taxa (catfishes and basses, in particular). Robust sport fish populations result in economic gain for regions harboring diverse crayfish communities through license and tourism dollars. Crayfishes also are an important aspect of Texas's culture; many young naturalists first engagement with nature involves catching "crawdads" in the neighborhood stream or slough present where they grew up. This initiation into nature can result in a lifelong appreciation for the natural world and the resources it provides through preservation and conservation. Crayfish conservation ensures these ecological, economic, and cultural aspects of this enigmatic group of animals continue to occur.

Texas's crayfish fauna represents a great void in North America's astacological knowledge (Hobbs 1990; Taylor et al. 2007). First treated by Hobbs and Penn (1958) who noted ## taxa, Texas was again treated by Johnson and Johnson in 2008, who listed 43 species for the occurring in the state. Horton Hobbs Jr., the father of American astacology, recognized the diversity and importance of Texas's crayfish fauna and the role it played in North American astacology late in his career. In an effort to garner attention by North American crayfish workers, Hobbs (1990) published a paper specifically focused on the crayfishes of the Neches River system. This paper's scope was the region currently occupied by Big Thicket National Preserve (BTNP), and highlighted the diversity of crayfishes occurring in the region.

Table 1: Potential Crayfishes of Big Thicket National Preserve and surrounding Nature Conservancy properties

Species	Burrowing Guild	Confirmed (C)/ Possible (P)	Global (G)/ State (S) rank
<i>Cambarellus (P.) puer</i> Hobbs, 1941	TB	C	G5/S5
<i>Cambarus (cf.) diogenes</i> Girard 1852	PB	C	G5/S5
<i>Cambarus (L.) ludovicianus</i> Faxon 1884	PB	C	G5/S5
<i>Fallicambarus (C.) fodiens</i> (Cottle, 1863)	PB	C	G5/S5
<i>Fallicambarus (F.) devastator</i> Hobbs and Whiteman, 1986	PB	C	G3/S3
<i>Fallicambarus (F.) wallsi</i> Johnson, 2011*	PB	P	G2/S2
<i>Fallicambarus (F.) kountzeae</i> Johnson, 2008*	PB	P	G2/S2
<i>Faxonella beyeri</i> Creaser, 1962	TB	C	G5/S5
<i>Orconectes (B.) texanus</i> Johnson, 2010	TB	P	G?/S?
<i>Procambarus (G.) curdi</i> Reimer, 1975	PB	C	G5/S5
<i>Procambarus (G.) nigrocinctus</i> Hobbs, 1990	SB	C	G1G2/S1
<i>Procambarus (G.) kensleyi</i> Hobbs, 1990	SB	C	G3/S3
<i>Procambarus (O.) a. acutus</i> Girard, 1852	SB	C	G5/S4
<i>Procambarus (O.) nechesae</i> Hobbs, 1990	SB	C	G2/S2
<i>Procambarus (P.) dupratzi</i> Penn, 1951	TB	C	G5/S5
<i>Procambarus (S.) clarkii</i> (Girard, 1852)	TB	C	G5/S5

Big Thicket’s geographic placement at the union of three national physiographic regions makes its aquatic communities ripe for potentially high crayfish diversity (Hobbs 1990). Hobbs’s (1990) survey documented 13 species in the Neches River basin, an unusually high number of crayfish for any HUC 8 watershed nationally. Recent work by Johnson (2008; 2010; 2011) in east Texas has resulted in the description of eight taxa, three of which occur in the Neches River system, resulting in 16 crayfish species currently documented in the Neches basin’s waterways (Table 1). Several taxonomically undertreated genera (*Cambarellus*, *Fallicambarus*, and *Faxonella*) have been recorded in BTNP that, pending morphologic and molecular investigation, could harbor undescribed taxa.

Tertiary burrowing crayfishes are species that live in waterways that do not experience drawdown, frequenting both lentic and lotic systems. Across the majority of North America this behavioral guild of crayfishes often maintains the bulk of a given watershed’s diversity. In eastern Texas, and the Neches River basin specifically, this does not appear to be the case (Hobbs 1990). Of special interest is the diversity of burrowing crayfishes Hobbs documented in the region. Most watersheds in North America harbor one or two primary burrowing species, species that spend the

majority of their lives in burrows. The Neches system currently maintains seven primary burrowers, a diversity of which is rarely matched anywhere else nationally or globally.

In addition to primary burrowers, four secondary burrowing species, crayfish that use surface water when available but burrow following drawdown events, reside in the watershed. Combined, 67% of BTNP potential crayfish fauna is capable of burrowing. As stated previously, burrows created by crayfishes are readily used by a myriad of taxa, ranging from snakes to spiders, mice to wrens, and represent an important microhabitat for animals other than crayfishes. Given the diversity of burrowing crayfishes occurring in BTNP, documenting this fauna will not only lead to crayfish conservation, but the conservation of burrow obligate taxa as well.

Big Thicket National Preserve to date has not had a dedicated crayfish survey, though the region harboring the preserve supports a rich crayfish fauna. The potential for undescribed species is high, as well as species worthy of conservation attention. Given the diversity of habitats conducive to crayfishes in BTNP, it is likely undescribed species, as well as globally rare taxa dwell within the confines of the preserve. Herein is a proposal to complete the first dedicated crayfish survey of BTNP. Results from the survey would serve as a foundation for conservation planners, as well as an opportunity to involve the general public in active science on preserve lands.

Historical Account of Crayfish Efforts within BTNP

Hobbs surveyed the Neches River watershed extensively in the late 1980's, producing a small monograph on the basin's crayfishes which contained the description of three new species. Johnson's recent surveys across much of eastern Texas also have resulted in the description of several new species detailed below. Though these efforts have occurred in watersheds maintained with BTNP units, little to no surveys have occurred specifically within the confines of the preserve. Using Hobbs and Johnson's work as a guide, the following section lists (1.) prospective species that could occur in BTNP, and (2.) details species complexes that likely occur in BTNP in need of taxonomic revision, which could lead to the description of new crayfish taxa. Units in the Neches River likely will possess the following species. Trinity River units may ultimately prove more interesting given zero focused astacological effort has occurred in this river's watershed in the past 100 years.

Genus *Cambarus* = Two species of primary burrowers, *Cambarus diogenes* and *Cambarus ludovicianus*, are the only recorded members of the genus *Cambarus* documented in the Neches River basin (Hobbs 1990). Hobbs noted that both species were only “tentatively” assigned to the aforementioned taxa given both *C. diogenes* and *C. ludovicianus* compose large species complexes in need of taxonomic revision. With the exception of Hobbs’s (1990) brief treatment, nothing is known regarding the life history, ecology, taxonomic standing, and conservation status of either species in eastern Texas.

Genus *Cambarellus* = The dwarf crayfish genus *Cambarellus* is represented in the Neches River system by *Cambarellus puer*, a wide ranging species in need of taxonomic attention (Hobbs 1981; Pderaza-Lara et al. 2012). In Hobbs’s (1990) treatment of the Neches River systems crayfishes, the only information provided for *C. puer* were sites and tallies for stations harboring *C. puer*. Nothing was reported on the species ecology, taxonomic status, or life history. Recently Pedraza-Lara et al. (2012) completed a molecular phylogenetic analyses on the majority of extant *Cambarellus* taxa, and determined that one of two centers of *Cambarellus* spp. diversity is the gulf coastal plain of Texas. Given these results, and the lack of sampling in east Texas, the possibility exists that cryptic *Cambarellus* diversity is present in BTNP. A special focus of this survey will be elucidating this possibility with this genera of overlooked crayfishes.

Genus *Fallicambarus* = All *Fallicambarus* species are moderate sized, primary burrowing species that frequent roadside ditches, sloughs, and various other wetland habitats. *Fallicambarus* diversity in Texas has long presented problems to North American astacologists (Hobbs and Penn 1958; Hobbs and Robison 1989). Hobbs and Penn (1958) reported a single species, *Fallicambarus hedgepethi* in eastern Texas in their first checklist of Texas crayfishes. Later work by Hobbs determined his and Penn’s identifications were erroneous, and what they had identified as *F. hedgepethi* was actually *Fallicambarus fodiens*, a wide ranging species present throughout the central United States and Atlantic Coastal Plain. In addition to *F. fodiens*, Hobbs and Whiteman (1987) described *Fallicambarus devastator* from mid to headwater sections of the Neches River Basin. *Fallicambarus devastator* is the largest member of the genus, and is infamous in eastern

Texas for its burrowing capabilities, which are considered to be detrimental to agricultural operations in the region (Hobbs and Whiteman 1987; 1990).

Recent surveys by Johnson (2008; 2011) in eastern Texas have resulted in the description of three new *Fallicambarus* species, two of which likely occur in BTNP. *Fallicambarus kountzeae* was reported from mid to lower reaches of the Neches River basin, and likely occurs in BTNP. *Fallicambarus wallsi* has a much more limited distribution, and possibly occurs in northern BTNP units; both species along with *F. devastator* are Trinity/Neches River endemics. At present, four described species likely occur in BTNP. That being said, it is likely *F. fodiens* populations in BTNP actually represent undescribed taxa. The genus *Fallicambarus* recently underwent molecular phylogenetic analyses (Ainscough et al. 2013), of which special attention was paid to *F. fodiens* across its range. Results from this study indicated that *F. fodiens* is actually a large complex of cryptic species worthy of description. Several independent clades were present in eastern Texas, indicating that undescribed diversity still persists in the regions *Fallicambarus* species. Focused attention will be dedicated to determining if *F. fodiens* populations in BTNP are indeed representative of an undescribed species, or indicative of the nominate form. Should they prove to be unique, every effort will be made to describe them following survey efforts in BTNP by the PI.

Genus *Faxonella* = *Faxonella*, like *Cambarellus*, is a genus composed of small crayfishes that frequent roadside ditches, sloughs, and bayous. A single species, *Faxonella beyeri* has been recorded in the vicinity of BTNP (Hobbs, 1990). *Faxonella clypeatus* is recorded occurring in western Louisiana, and possibly could be present in BTNP. Taxonomically, *Faxonella* has not been treated by any recent crayfish worker, and last was revised by Fitzpatrick (1963). Hobbs (1990) noted that animals from the Neches River were the largest examples of the genus he personally had observed in his career. Whether this is of taxonomic consequence or resultant of ecological conditions present in eastern Texas is unknown. Special attention will be paid to all *Faxonella* species encountered in this survey to ensure the true taxonomic identity of these small, enigmatic species is determined, and all diversity within the genus described.

Genus *Orconectes* = The genus *Orconectes* reaches its highest diversity in the Ozark region of the Central United States; historically very little information exists for the genus in eastern Texas. Recently, Texas *Orconectes* species were treated and examined by Johnson (2010), resulting in

the description of four new species. Hobbs (1990), prior to Johnson work did not document any *Orconectes* species in the greater Neches watershed. Johnson (2010) results differed from Hobbs, resulting in the description of *Orconectes texanus*. Johnson noted that *O. texanus* occurs in the Neches River watershed including the river's mainstem, but did not indicate if any active sampling occurred within the borders of BTNP. Survey efforts in lentic waterways will focus on determining if this recently described Texas endemic occurs in BTNP.

Genus *Procambarus* = *Procambarus* is the most diverse crayfish genera in the world, composing currently of 177 species, and likely the most diverse genus occurring in BTNP. Horton Hobbs paid special attention to this genus when he performed his survey of the Neches River system in the late 1980's. Resultant of Hobbs efforts, three species were described, all of which are endemic to eastern Texas. The majority of likely BTNP *Procambarus* taxa behaviorally are classified as secondary burrowers. When surface waters are present, all likely BTNP *Procambarus* species actively utilize lentic habitats. With drawdown, secondary burrowers excavate burrows following vadose water supplies, and utilize subterranean water for respiration until surface water reappears (Hobbs 1981).

Likely BTNP secondary burrowing *Procambarus* taxa include *Procambarus curdi*, *Procambarus kensleyi*, *Procambarus nigrocinctus*, and *Procambarus nechesae*. All of these taxa were collected by Hobbs (1990) in the region from simple burrows allied with sloughs and roadside ditches. Hobbs alluded that secondary burrowing procambarids in the Neches River system were much more reliant on burrows relative to surface waters than other secondary burrowing members of the genus occurring in other regions of the country. *Procambarus nechesae*, *P. nigrocinctus*, and *P. kinsleyi* all are endemic to the Neches River system and currently tracked by Texas Parks and Wildlife.

Tertiary burrowing *Procambarus* taxa recorded for the region include one stream specialist and two commercially important species. *Procambarus depratzi* occurs in high quality streams with abundant coarse woody debris snags, aquatic vegetation, and other in-stream debris, and requires relatively clean lentic habitats (Hobbs 1990). *Procambarus acutus* and *Procambarus clarkii* are two species frequently farmed by aquaculturists, and support the majority of the Gulf Coastal Plains crayfish fishery. In eastern Texas both species are associated with bayous, sloughs,

lakes, and other more permanent water bodies. Both taxa can burrow, but are most frequently encountered in surface water environments.

Potential Species of Conservation Concern

According to the Texas Parks and Wildlife's list of state imperiled species, 38.7% of the proposed crayfishes of BTNP are currently tracked and considered at least species of special concern (Table 1). Should new species be described by this effort, they almost certainly would be added to this list of taxa given the high likelihood they will possess narrow ranges specific to the Trinity and Neches River systems. Distributional data acquired for these taxa specifically will be shared with TPAW biologists to assist in tracking and discerning the conservation status of these species.

Material and Methods

Field Methods and Time Line

In order to accomplish the above objectives, it is proposed field work for this project is performed over the course of two field seasons. Sampling would commence in the summer of 2014 with a single collecting trip, followed by the majority of efforts (2-4 collecting trips) occurring during the spring and summer of 2015. Citizen scientists will be trained the first year, and strongly encouraged by the P.I. to collect following defined protocols, augmenting WLU's efforts. Final analysis of collected data and description of any undescribed species would be completed in the winter following the second field season. During each year of effort, there will be an attempt to ensure collections occur over four distinct seasons to capture life history parameters for as many species as possible. Site selection will be non-random and targeted; sites suggested by national preserve biologists will receive highest priority. In addition to these sites, bridge crossings, road pull offs, public fishing access points, roadside ditches, sloughs, wetlands, and stream reaches adjacent to roads and trails will make up the majority of sample sites. For more remote reaches hiking and floating into backcountry locations and tent camping will be performed. Efforts for epigeal species will focus on third and fourth ordered streams, and wadeable wetlands. Streams of this size are small enough for headwater taxa, and large enough for riverine species. Sites will

be distributed between the preserves nine units and six river corridors, with special attention given to Beaumont, Lance Rosier, Jack Gore Baygall, Menard Creek and Big Sandy unit. In addition to BTNPS properties, Nature Conservancy lands in the vicinity of BTNP will also be surveyed.

Collection Methods

Determining BTNP's burrowing crayfish fauna is a primary objective of this project, given the high diversity of taxa observed in the region. Burrowing crayfishes will be collected through uses of burrowing crayfish nets (Welsh and Eversole 2006), baited lines (Loughman et al. in press), and when permission granted excavation. Epigeal crayfishes primary collection method will be seining and trapping with crayfish traps; however hand collection, dip netting, snorkel surveys, and nocturnal searches will be employed if needed. To ensure both epigeal and burrowing taxa are sampled, habitats harboring equal numbers of both guilds, such as sloughs, bayous, and roadside ditches will receive the bulk of effort. Large streams will be targeted exclusively for epigeal /tertiary burrowing species, and given at least 20% of each collecting trips effort, with the remaining 80% of time dedicated to aforementioned habitats harboring both crayfish guilds. All crayfishes collected will be vouchered and deposited in West Liberty University's Astacology Collection.

Taxonomic Methods

Pertinent dichotomous keys and species descriptions will be used to identify crayfish. Morphological dichotomies between undescribed and nominate forms will be deduced through meristic analysis. Genetic samples will be collected and deposited in the Carnegie Museum of Natural History's Crayfish Genomics bank curated by Dr. Jim Fetzner. Genetics, zoogeography, and morphology collectively will be used to describe new species of crayfishes encountered in BTNP.

Disposition of specimens

Specimens will be housed in West Liberty University's Astacology Collection or another institution suggested by the park service. At present WLU's crayfish collection has paperwork associated with it to maintain collections on long term loan from the park service. This collection is currently growing, and has internal funding for curation and maintenance of specimens. Should new species be described from this work, all primary type material will be deposited in the Smithsonian Invertebrate Zoology collection. Paratypes will be deposited at Ohio State, Illinois Natural History Survey, and North Carolina Museum of Natural Science if material allows.

Citizen Scientist Programming and Training

The P.I. see's great value in utilization of citizen scientists as field assistants, and successfully created a crayfish collecting protocol that was used in Great Smoky Mountains National Park (GSMNP) to augment crayfish collecting efforts associated with their ATBI, that could easily be initiated in BTNP. The proceeding protocol engaged over 75 individuals, ranging from children to adults, and resulted in an additional 85 collections outside those performed by the P.I., and assisted the greater effort immensely in GSMNP. Training will occur in at least two, 4 hour crayfish workshops during the first collecting trip in the summer of 2014; workshops will be planned alongside BTNP biologists and the Big Thicket Association. Participants will first be introduced to basic crayfish ecology and natural history via a hands-on lecture. Historically this part of the program fosters interest and appreciation for both crayfishes themselves and freshwater conservation. Following the lecture portion, participants will be lead to the field, where both epigean and burrowing crayfish methods will be demonstrated. All participants will be strongly encouraged to attempt to collect crayfishes with the P.I., and ask questions pertaining to possible issues they foresee arising while the P.I. is present. Finally, all participants will be trained in data acquisitions, and given data sheets and field labels to augment their collecting efforts, and encouraged to communicate directly with the P.I. regarding any collections they perform on their own.

Deliverables

Ultimately, a publication will be produced for *Southwestern Naturalist* or *Southeastern Naturalist* with a dichotomous key as well as ecological notes and conservation conclusions on BTNP crayfishes. Should new species be discovered, descriptions will be published in the journals *Zootaxa* or *Zookeys*. Also, an electronic georeferenced database listing species occurrences will be presented to Big Thicket Association.

Budget

We are requesting \$9,880.00 to complete this project. Monies will be used primarily for travel to BTNP (\$6,990.00), collecting equipment (\$1,700.00), canoe rental (\$945.00), and curation supplies (\$245.00). West Liberty University will provide monies for technicians and Zachary Loughman's salary.

Table 2: BTNP Crayfish Survey Budget

TRAVEL	
<i>Travel</i>	(\$850.00 Air fare/Rental Car/Fuel per trip) x 3 trips = \$5,100.00
<i>Food</i>	(\$30.00/day x 2 investigators x 7 days) x 3 trips = \$1,260.00
<i>Lodging</i>	(\$30.00/night x 7 days/trip) x 3 trips = \$630.00
Total Travel	
\$6,990.00	
EQUIPMENT/SUPPLIES	
	Collapsible Crawfish Traps (\$15.00/ trap x 50 traps) = \$1500.00
	Dip Nets (\$40.00/net x 5 nets) = \$200.00
	Kayak/Canoe rental (\$45.00/day x 7 days x 3 trips) = \$945.00
	20 L ETOH = \$245.00
Total Equipment/Supplies	
\$2,890.00	
Grand Total	
\$9,880.00	
	Loughman salary = \$3,000.00
	Technician salary = \$2,000.00
WLU Total = \$5,000.00	

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