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Conservation Assessment and Habitat Notes for Three Rare Alabama Crayfishes: *Cambarus cracens, Cambarus scotti,* and *Cambarus unestami*

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Abstract - Over seventy percent of the world's freshwater crayfish species are found within the United States, and much of this diversity is concentrated in the southeastern United States. Yet many of these species remain understudied. Of particular interest is the conservation status of these understudied taxa. We conducted fieldwork in 2011 across northeastern Alabama and northwestern Georgia to review the occurrence, habitat, and in some cases, local population densities of three crayfish species (*Cambarus scotti, C. unestami,* and *C. cracens*) to determine current distributions in relation to historical surveys. All three species occur in flowing small to medium-sized streams with firm substrates of gravel, cobble, and bedrock. Two species (*C. scotti* and *C. unestami*) have stable populations, occurring at 79% and 90% of sites surveyed, respectively. In contrast, surveys for the third crayfish species (*C. cracens*) indicated a need for conservation action, with this species occurring at a single site.

Introduction

The southeastern United States is well known for aquatic biodiversity (Abell et al. 2000). This area is known as the hotspot for freshwater fish and mussel species in North America and is the most diverse region in the world for freshwater crayfishes (Neves 1999, Taylor 2002, Warren et al. 2000). Because of this diversity, the region is an area of great conservation concern. A review by Taylor et al. (2007) found that nearly half of the crayfish in the Southeast were in need of some level of conservation attention. This concern is of particular importance for the state of Alabama and its 85 currently described species of crayfish, many of which are limited to a single drainage and remain substantially understudied (Taylor et al. 2007). To address conservation concerns, intensive field surveys for target species are often the best available tool, and this method was used in the following conservation assessments.

Cambarus scotti Hobbs (Chattooga River Crayfish), *C. unestami* Hobbs and Hall (Blackbarred Crayfish), and *C. cracens* Bouchard and Hobbs (Slenderclaw Crayfish) have limited ranges and are confined to northeastern Alabama and northwestern Georgia. These species are vulnerable to population declines due to localized catastrophic events and are listed as either threatened (*C. scotti* and *C. unestami*) or endangered (*C. cracens*) according to American Fisheries Society criteria (Taylor et al. 2007). Following conservation priority criteria developed by the Alabama Department of Conservation and Natural Resources, *C. scotti* was classified as P4 (low

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conservation priority), *C. unestami* was classified as P2 (high conservation priority), and *C. cracens* was classified as P1 (highest conservation priority) species (Smith et al. 2011). These three species were the focus of the current study due to the need for distributional data and range-wide status assessments, and/or limited detection rates in past surveys (Smith et al. 2011). The four main objectives were to 1) sample all known historical locations for all three species to determine the presence of each species, 2) find additional populations of these species by sampling other streams with suitable habitat in northeastern Alabama and northwestern Georgia, 3) assess population sizes of the species at locations where appropriate quantitative methods can be employed, and 4) refine the description of suitable habitat for the three species by recording abiotic habitat variables at sites containing the species.

Target species accounts

Cambarus (*Puncticambarus*) *scotti* – The Chattooga River Crayfish is historically known from the Chattooga River basin in Chattooga and Walker counties, GA, and the Coosa River in Calhoun, Cherokee, and St. Clair counties, AL (Hobbs 1989). It occurs in streams with swift water flowing over rocky substrates. Its type locality is Clarks Creek,1.6 km north of Holland, in Chattooga County, GA. First-form males range in size from around 24.5 mm to 41.8 mm carapace length (CL) (Hobbs 1981). This species can closely resemble *Cambarus coosae*, but differs in possessing a long acuminate rostrum without marginal spines or tubercles (Hobbs 1981, Schuster and Taylor 2004). Taylor et al. (1996, 2007) listed this species as threatened.

Cambarus (*Jugicambarus*) *unestami* – The Blackbarred Crayfish is known from tributaries of Chattanooga, Cole City, Lookout, and Long Island creeks of the Tennessee River basin of Walker and Dade counties, GA, and Jackson County, AL and from tributaries of the Little River of the Chattooga-Coosa Basin in Chattooga County, GA (Hobbs 1989). Its entire range is found within the Appalachian Plateau. The type locality for *C. unestami* is Daniel Creek, a tributary of Lookout Creek, 4.02 km west of the Walker County line on State Route 143, Dade County, GA. This species appears to be confined to those streams found on Lookout and Sand mountains between 333 and 500 m in altitude. Preferred streams have moderate to swift current with bedrock or rock-littered substrates for cover (Hobbs 1981). First-form males can range in size from 26.9 mm to 31.3 mm CL (Hobbs 1981, 1989). The species was listed as threatened by Taylor et al. (1996, 2007).

Cambarus (*Exilicambarus*) *cracens* – Except for its original description by Bouchard and Hobbs (1976), very little is known of the Slenderclaw Crayfish; they reported its range to be limited to five sites in southeastern tributaries of Guntersville Lake (Tennessee River) in DeKalb and Marshall counties, AL. The type locality of the species is Short Creek at State Route 75, 1.77 km southwest of the junction with State Route 68 in Marshall County, AL (Hobbs 1989). Bouchard and Hobbs (1976) described the habitat at the type locality as a clear, slow-flowing stream with bedrock and sandy substrate, and large rocks throughout. First-form males range in size from 24.7 mm to 37.3 mm CL (Hobbs 1981, 1989). *Cambarus cracens* was listed as endangered by Taylor et al. (1996, 2007).

Methods

During March, June, and October 2011, we conducted field surveys for the three crayfish species in streams of northeastern Alabama and northwestern Georgia. We chose fifty-five sites for either known historical occurrences or as potentially new occurrences based on the presence of suitable habitat. For *C. cracens*, all sites were repeat visits of localities surveyed in March 2009. We obtained historical site-selection and detailed locality information through museum database queries at the National Museum of Natural History Smithsonian Institution (USNM), Eastern Kentucky University Crustacean Collection (EKU), and Illinois Natural History Survey Crustacean Collection (INHS). We conducted sampling at most sites using a 3-m x 1.5-m kick net (3.2-mm mesh). At sites where a seine was employed, one person held the seine net below groupings of cobble, boulders, or woody debris as one or two others lifted and moved rocks while kicking and shuffling crayfish into the net. We collected all crayfish in that set and kept them in an aerated bucket until the sampling at that site was completed. The number of seine sets employed at sites ranged from 15 to 25 and was in direct relation to the amount of loose gravel or rock and woody debris present at sites. Some small stream sites (<2 m width) required only visual searches, which involved turning over cobble and boulders and hand capturing crayfish or handpicking those crayfish exposed. We sampled all microhabitats (riffle, runs, pools) present at sites during surveys, and recorded presence/absence of target species within those micohabitats. We estimated and recorded general in-stream habitat characteristics (riffle, run, pool presence), dominant substrate type, turbidity, general flow condition (slow, medium, fast), and percent of stream shaded by tree cover for each site. We measured depth at five within-site locations and calculated a site-average depth. We measured stream widths with a tape measure at the widest and narrowest parts of sampling locations. We estimated average substrate size by measuring a minimum of five rocks found across a stream transect.

After we completed collection efforts, all crayfishes collected at the site were identified in the field, if possible, and recorded. We preserved voucher specimens of each species in 70% ethanol and returned the remaining individuals to the stream. At sites where density estimates were taken (see below), specimens were not returned to the stream until after we had made the estimates. We also vouchered specimens not identifiable in the field and transported them to the laboratory to verify identifications. We then catalogued voucher specimens into the INHS Crustacean Collection.

We conducted density estimates at approximately five sampling sites where target species were detected. At each of these sites, we chose a wadeable reach known to contain the target species. We measured the length of that reach and its width at upstream and downstream termini, sampled the reach to depletion for the target species, and calculated the density of individuals/m^2.

Results

The present survey sampled 55 stream sites across northeastern Alabama and northwestern Georgia in 2011(Table 1). Nineteen sites were sampled in March, 15 in June, and 21 in October. Stream sites consisted of both historical localities

Table 1. Alabama and Georgia sampling locations and the number of individuals collected from the 2011 status survey. None = no target species found.

Date	Drainage	State	County	Location	Latitude (°N)	Longitude (°W)	Species	Number
03/22/11	Tenn. River	GA	Dade	Daniel Creek	34.8154	85.4912	*C. unestami*	5+
03/22/11	Tenn. River	GA	Walker	Rock Creek	34.9052	85.4019	*C. unestami*	13
03/22/11	Tenn. River	GA	Dade	Lookout Creek	34.8626	85.5008	*C. unestami*	0
03/22/11	Tenn. River	GA	Dade	Stephens Branch	34.9101	85.5522	*C. unestami*	11
03/22/11	Tenn. River	AL	Jackson	Warren Creek	34.9566	85.6289	*C. unestami*	14
03/22/11	Tenn. River	GA	Dade	Higdon Creek	34.8649	85.5744	*C. unestami*	1
03/23/11	Tenn. River	GA	Dade	Bear Creek	34.8281	85.4591	*C. unestami*	24
03/23/11	Coosa River	GA	Chattooga	Gilreath Creek	34.5679	85.4550	*C. unestami*	16
03/23/11	Coosa River	GA	Chattooga	East Fork Little River	34.5225	85.5049	*C. unestami*	15
03/23/11	Coosa River	AL	DeKalb	Brush Creek	34.5348	85.5320	*C. unestami*	15
03/23/11	Coosa River	GA	Chattooga	Raccoon Creek	34.4537	85.3887	*C. scotti*	40
03/23/11	Coosa River	GA	Chattooga	Mosteller Creek	34.4016	85.4095	*C. scotti*	4
03/23/11	Coosa River	GA	Chattooga	Clarks Creek	34.3679	85.3659	*C. scotti*	27
03/24/11	Coosa River	GA	Chattooga	Chappel Creek	34.5685	85.2860	*C. scotti*	37
03/24/11	Coosa River	GA	Chattooga	Cane Creek	34.5607	85.3105	*C. scotti*	1
03/24/11	Coosa River	GA	Chattooga	Cane Creek	34.5700	85.3084	*C. scotti*	1
03/24/11	Coosa River	GA	Walker	Cane Creek	34.6240	85.2618	*C. scotti*	13
03/24/11	Coosa River	GA	Walker	Chattooga River	34.6788	85.2942	*C. scotti*	11
03/24/11	Coosa River	GA	Walker	Duck Creek	34.7044	85.3260	*C. scotti*	15
06/07/11	Coosa River	AL	Talladega	Choccolocco Creek	33.5430	86.0416	*C. scotti*	1
06/07/11	Coosa River	AL	Talladega	Talledega Creek	33.3782	86.0301	*C. scotti*	0
06/07/11	Coosa River	AL	Calhoun	Choccolocco Creek	33.6000	85.7573	*C. scotti*	7
06/07/11	Coosa River	AL	Calhoun	Choccolocco Creek	33.7899	85.6604	*C. scotti*	4
06/07/11	Coosa River	AL	Cleburne	Cane Creek	33.7514	85.4804	*C. scotti*	0
06/07/11	Coosa River	AL	Cleburne	Terrapin Creek	33.8965	85.4696	*C. scotti*	22
06/08/11	Coosa River	AL	Calhoun	Tallasseehatchee Creek	33.7900	85.9446	*C. scotti*	8
06/08/11	Coosa River	AL	Calhoun	Ohatchee Creek	33.8655	85.9152	*C. scotti*	0
06/08/11	Coosa River	AL	Calhoun	Nances Creek	33.9041	85.6066	*C. scotti*	9

Table 1, continued.

Date	Drainage	State	County	Location	Latitude (°N)	Longitude (°W)	Species	Number
06/08/11	Coosa River	AL	Cherokee	Little Creek	34.0597	85.6256	*C. scotti*	1
06/08/11	Coosa River	AL	Cherokee	Spring Creek	34.2987	85.5879	*C. scotti*	8
06/08/11	Coosa River	AL	Cherokee	Chattooga River	34.2898	85.5088	*C. scotti*	7
06/09/11	Coosa River	AL	St. Clair/Etowah	Little Canoe Creek	33.9725	86.1834	*C. scotti*	20
06/09/11	Coosa River	AL	Etowah	Clear Creek	34.0338	86.1191	*C. scotti*	0
06/09/11	Coosa River	AL	DeKalb	Big Wills Creek	34.2135	85.9470	*C. scotti*	0
10/03/11	Tenn. River	AL	DeKalb	Town Creek	34.5706	85.7049	*C. cracens*	0
10/03/11	Tenn. River	AL	DeKalb	Bengis Creek	34.5734	85.7512	*C. cracens*	0
10/03/11	Tenn. River	AL	DeKalb	Town Creek	34.4775	85.8089	*C. cracens*	0
10/03/11	Tenn. River	AL	Jackson	Bryant Creek	34.6462	85.8437	*C. cracens*	0
10/03/11	Tenn. River	AL	Jackson	Bryant Creek	34.6600	85.8042	*C. cracens*	0
10/04/11	Tenn. River	AL	Jackson	Guntersville Reservoir	34.6325	85.9723	*C. cracens*	0
10/04/11	Tenn. River	AL	DeKalb	Black Oak Creek	34.4348	86.0306	*C. cracens*	0
10/04/11	Tenn. River	AL	DeKalb	Town Creek	34.3789	85.9895	*C. cracens*	0
10/04/11	Tenn. River	AL	DeKalb	Scarham Creek	34.3308	85.9779	*C. cracens*	0
10/04/11	Tenn. River	AL	DeKalb	Scarham Creek	34.3047	85.9924	*C. cracens*	0
10/04/11	Tenn. River	AL	DeKalb	Scarham Creek	34.2950	86.0382	*C. cracens*	0
10/04/11	Tenn. River	AL	DeKalb	Little Scarham Creek	34.3063	86.0655	*C. cracens*	0
10/04/11	Tenn. River	AL	DeKalb	Shoal Creek	34.3480	86.1256	*C. cracens*	11
10/05/11	Tenn. River	AL	Marshall	Short Creek	34.2939	86.1622	*C. cracens*	0
10/05/11	Tenn. River	AL	Marshall	Short Creek	34.2134	86.1145	*C. cracens*	0
10/05/11	Tenn. River	AL	DeKalb	Cross Creek	34.2389	86.0759	*C. cracens*	0
10/05/11	Locust Fork River	AL	Marshall	Clear Creek	34.1284	86.2919	None	
10/05/11	Locust Fork River	AL	Blount	Big Spring Creek	34.2024	86.4232	None	
10/06/11	Locust Fork River	AL	Blount	Calvert Prong	33.9433	86.5588	None	
10/06/11	Locust Fork River	AL	Blount	Chitwood Creek	33.9530	86.5456	None	
10/06/11	Locust Fork River	AL	Jefferson	Gurley Creek	33.7942	86.6867	None	

(n = 21) and new locations that held the potential for harboring any of the three target species. Many of the historical sites referenced in Hobbs (1981) and Smith et al. (2011) for *C. scotti* and *C. unestami* were close in proximity (less than 8 km) to one another; thus not all were revisited.

Cambarus scotti

Of the 55 sampled sites, *C. scotti* was found at 19 locations (Fig. 1), 10 of which were historical. This species tended to occur in streams with sluggish to moderate flow, low turbidity, substrates consisting of mostly gravel and cobble with isolated

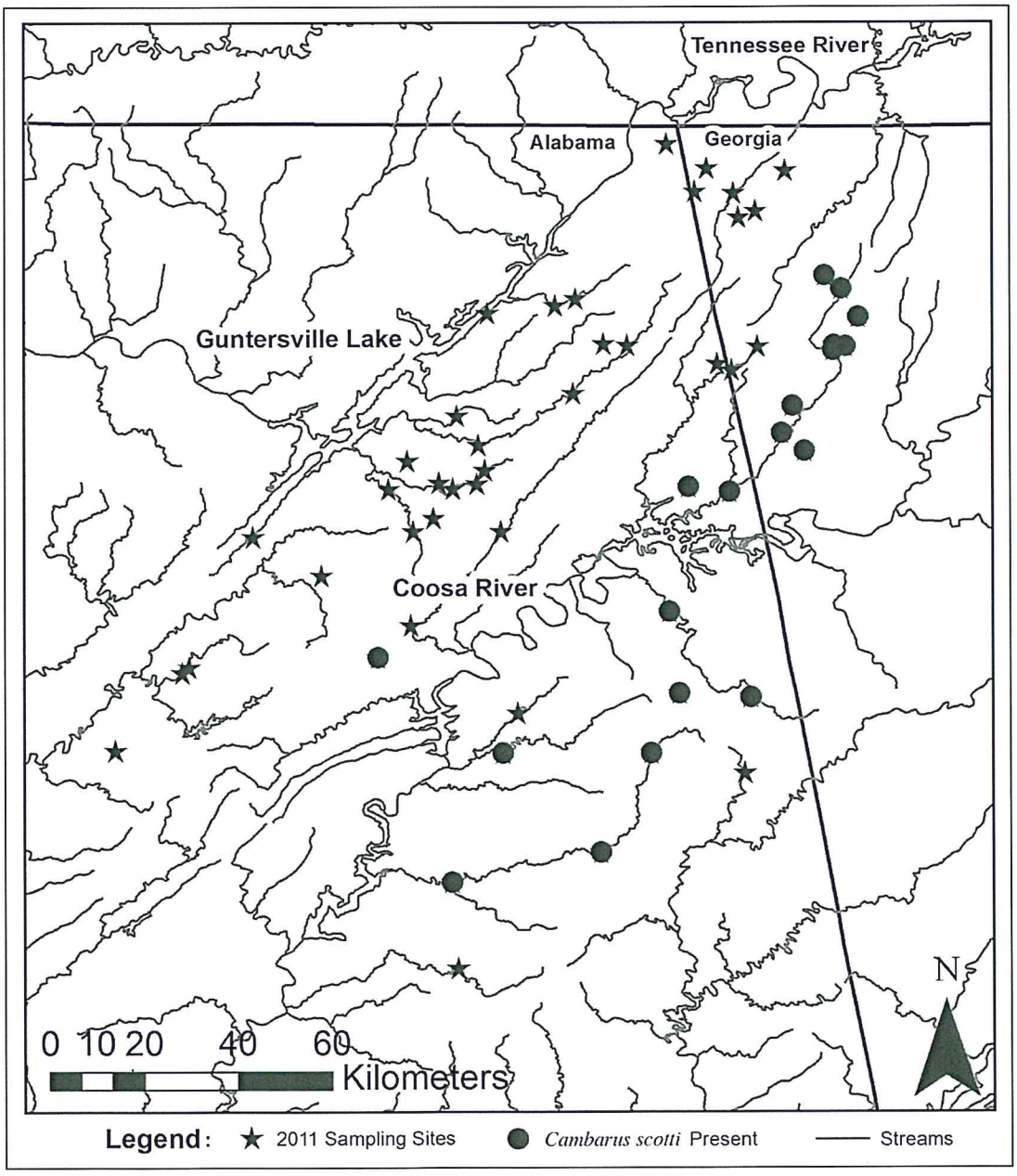

Figure 1. Map representing survey locations where *Cambarus scotti* was currently present (circles) and all 2011 survey sampling locations (stars).

boulder patches, and depths and widths ranging from 0.1 to 0.7 m and 2 to 35 m, respectively. It was also found at some sites that had bedrock substrate. Density estimates made at six sites are presented in Table 2. *Cambarus scotti* occurred most often with *Orconectes erichsonianus* (Faxon) (Reticulate Crayfish).

Cambarus unestami

This species was found to occur at nine of 55 sites (Fig. 2), six of which were historical. Creeks where this species was found had sluggish to moderate current, gravel and cobble or gravel and boulder substrates, and depths and widths of 0.1 to

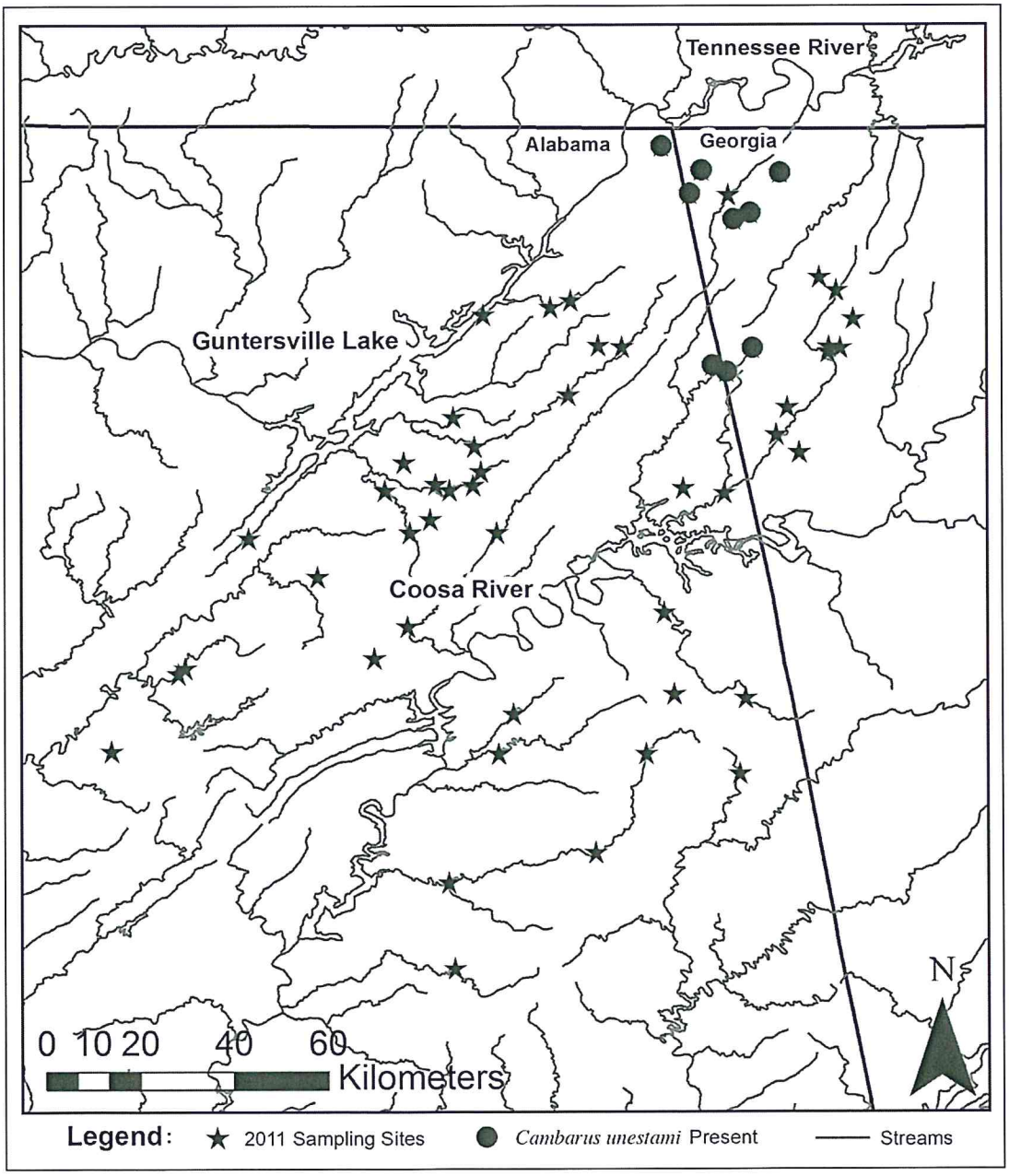

Figure 2. Map representing survey locations where *Cambarus unestami* was currently present (circles) and all 2011 survey sampling locations (stars).

0.5 m and 2 to 12 m, respectively. Density measurements were made at four sites and are presented in Table 2. *Cambarus unestami* occurred with a variety of other species including *Cambarus striatus* Hay (Ambiguous Crayfish), *Procambarus lophotus* Hobbs and Walton (Mane Crayfish), and *Cambarus parvoculus* Hobbs and Shoup (Mountain Midget Crayfish).

Cambarus cracens

The Slenderclaw Crayfish was found at only one of the 55 sampling sites (Fig. 3). None of the five historical sites reported by Bouchard and Hobbs (1976)

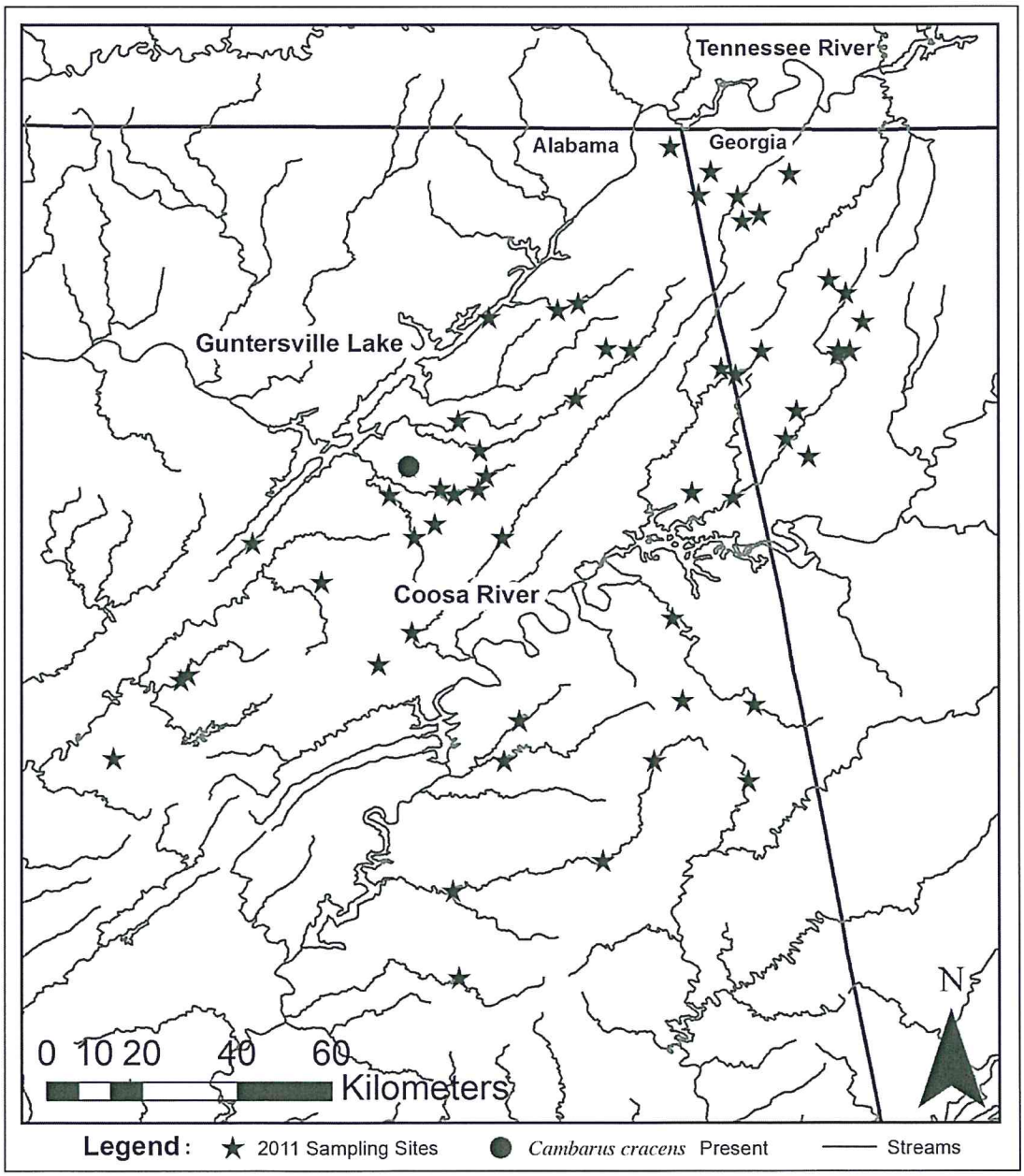

Figure 3. Map representing survey locations where *Cambarus cracens* was currently present (circle) and all 2011 survey sampling locations (stars).

yielded the species. Specimens were found at Shoal Creek at CR 372, which had moderate flow, low turbidity, and a mix of sand, cobble, and boulders, and was 0.1 m to 0.5 m deep and about 6 m wide. The density estimate for the species at this location was 0.037/m^2 (Table 2).

Discussion

The current survey presents evidence that both *Cambarus scotti* and *Cambarus unestami* appear stable across their ranges. Though not all historical locations were visited, sites selected for sampling encompassed the entire native, historical ranges for both species. For example, our sampling efforts document the continued occurrence of *C. scotti* from the upper Chattooga River basin in Chattooga and Walker counties, GA, south to the Choccolocco Creek drainage in Talladega County, AL (Fig. 1). While density estimates were low at some sites, *C. scotti* and *C. unestami* were collected with minimal effort in most cases. No new populations were found for either species during our surveys.

We do not believe that conservation action is warranted for *C. scotti* and *C. unestami*. The range of *C. unestami* is relatively small compared to that of *C. scotti* or other imperiled southeastern aquatic taxa (Hobbs, 1981, Smith et al. 2011, Warren et al. 2000); however, our results suggest that *C. unestami* has not experienced population declines or loss of habitat. At all stream sites containing the species, we observed low levels of turbidity, the absence of stream modifications, and intact riparian corridors. Density estimates for the ranges of each of these species were highly variable, and ranged from 0.04 to 1.06 individuals/m^2. While densities at the lower end of that range suggest that both species are uncommon at many sites, our field observations suggests that these densities are similar to mean densities of other members of the genus *Cambarus* found throughout Alabama.

Habitat for *C. scotti* consisted of a variety of stream sizes, with this species occurring most often in slow to moderate flow streams, from 5 to 10 m wide and 0.1

Table 2. Density estimates from select streams for *Cambarus scotti, Cambarus unestami* and *Cambarus cracens*.

Location	Species	Density
Clarks Creek	*C. scotti*	0.300/m^2
Cane Creek	*C. scotti*	0.104/m^2
Duck Creek	*C. scotti*	0.050/m^2
Choccolocco Creek	*C. scotti*	0.040/m^2
Tallasseehatchee Creek	*C. scotti*	0.080/m^2
Little Canoe Creek	*C. scotti*	0.390/m^2
Daniel Creek	*C. unestami*	1.060/m^2
Stephens Branch	*C. unestami*	0.430/m^2
Bear Creek	*C. unestami*	0.080/m^2
Gilreath Creek	*C. unestami*	0.330/m^2
Brush Creek	*C. unestami*	0.100/m^2
Shoal Creek	*C. cracens*	0.037/m^2

to 0.3 m depth, and possessing substrates made up mostly of gravel with isolated cobble and boulder patches. Some specimens were found in larger streams with widths up to 35 m and depths reaching 1 m. Habitat for *C. unestami* were generally first- or second-order streams in the range of 1 to 5 m in width, though some sites reached 10 m. Flow was sluggish to moderate, and depths ranged from 0.1 to 0.5 m. The substrate was composed of sand and gravel with cobble or isolated boulders interspersed or fractured bedrock.

The failure to find *Cambarus cracens* at any of the five historical sites reported by Bouchard and Hobbs (1976) indicates the need to place this species in a category of utmost concern. These results collaborate the findings of surveys conducted by Schuster in 2005 (unpubl. data) and Taylor and Schuster in 2009 (unpubl. data), which also failed to record the species at historical locations. In addition, the type locality was intensively sampled in 2007, and *C. cracens* was not collected by these efforts (C. Dillman, Virginia Institute of Marine Science, Gloucester Point, VA, pers. com.). Even with the addition of new survey points to supplement historical locations, no other populations have been found. *Cambarus cracens* is now thought to occur at a single site in Shoal Creek (Table 1), and was also found at this site by Taylor and Schuster during a visit in 2009 (Smith et al. 2011). Habitat at this site is comprised of gravel and cobble substrate intermixed with patches of sand and thus closely matched that described at the type locality that had been previously reported (Bouchard and Hobbs 1976). However, at 6 m wide, Shoal Creek is a smaller stream than the type locality. The reasons for the decline of *C. cracens* are unknown, since sampling locations included habitat with proper substrate and low siltation. Riparian vegetation along both banks was in place at all sites, and no obvious signs of high nutrient loads were present. Given these observations, we suggest that water-quality measurements such as nutrient loads, heavy metals, and bacterial levels be examined at sites within the species' range as a possible source of habitat degradation for the species.

We recommend that *C. cracens* be considered for listing under the Endangered Species Act of 1973 (as amended). This recommendation is based on three criteria: 1) the species has experienced a significant reduction of a previously severely restricted native range, 2) the species is now currently thought to exist at only a single site, and 3) intensive field efforts have been expended without success in attempts to collect *C. cracens* across its native range and in other nearby locations with suitable habitat. We recommend that efforts be undertaken to determine possible causes for the apparent decline of the species.

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