Identification and Distribution of Crayfishes in South Carolina

A South Carolina State Wildlife Grants Project

Final Report

Prepared by

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Introduction

Freshwater crayfish reach their greatest diversity in the southeastern United States, totaling more than 375 species with new species being described each year (Taylor et al. 2007, Crandall and Buhay 2008). Crayfish serve important functions in aquatic systems as processors of energy (Nystrom et al. 1996), as a keystone species in community structure (Usio and Townsend 2004), as prey organisms (Correia 2001) as well as support a viable bait and human food industry (Huner 2002). In the United States crayfish have a higher percentage of vulnerable species than amphibians, freshwater fish, reptiles, mammals, and birds (Primack 1998). Despite their diversity, function and overall imperilment, surprisingly little is known about most crayfish species (Schuster 1997).

Current records indicate 37 native species of crayfish are found in South Carolina, of which 24 species are considered 'priority conservation species' in the state (A. Smith, SC DNR, personal communication). Species range, one of the five criteria used by the AFS Endangered Species Committee to assess crayfish species imperilment (Taylor et al. 2007), information is seriously lacking for South Carolina species. Since a state-wide survey of South Carolina crayfish has not been done, distribution information needs to be gathered from historic records and existing collections.

South Carolina Department of Natural Resources (SC DNR) collected crayfish as a by-catch of water and stream sampling programs for eventual identification and convergence with existing crayfish distribution records. The

objectives of this project were: 1. to enumerate, sexual stage and identify to the greatest extent possible 407 unidentified crayfish samples; 2. once identified add the data to the State's spread sheet database; 3. to construct crayfish distribution maps with the available date; and 4. to return the samples to SC DNR.

Methods and Materials

The alcohol preservative in sample jars were decanted, specimens were separated according to subgenera then individuals were identified using Bouchard (1978), Hobbs (1981), Cooper (2001, 2004a, b), Eversole and Jones (2004), and Cooper and Price (2010). Specimens were identified to species if possible, while a genus or "cf." species epitaph was used for those individuals not identified to species. Samples that proved difficulty were re-evaluated a second and on some occasions a third time. Named individuals were sexed, staged and recorded before returning to collection jars. The number of form I males, form II males, adult females, ovigerous females, juvenile males, juvenile females and unsexed juveniles were recorded for each taxa. Each taxa in a collection was provided an unique spread sheet entry (row) per collection event (number).

Collection events with crayfish identified to species and geo-located collection sites were merged to existing crayfish distribution data (A. Eversole and J. Foltz, unpublished data). Species distribution maps were generated using ArcGIS 10 software program and stored in jpeg files.

Results and Discussion

Crayfish were collected from all 46 South Carolina counties and one site in North Carolina. Data from North Carolina collection is not summarized in this report. Collections were not evenly distributed across the state, some counties are

represented with a disproportionate number of samples (e.g., Aiken, Bamberg, Colleton, Greenville, Laurens, and Orangeburg counties) while other counties were poorly represented in the overall collection (e.g., Beaufort, McCormick, Union, and Williamsburg counties). Selected watercourses also appear to have been sampled more frequently than other water courses (e.g., Salkehatchie and Little Salkehatchie rivers). Eversole and Foltz (2012) spatial analysis of the historic crayfish collection records indicate that collections are clumped in those counties adjacent to research institutions and survey localities (e.g., Francis Marion National Forest). The uneven survey effort underscores the need for a state-wide crayfish survey.

A total of 2,883 crayfish specimens were contained in the 406 collection jars (Table 1). Nearly all the collections were made in wadeable waterways; the exceptions include specimens from a burrow, two fish stomachs and an aquaculture facility. The collections varied considerably in specimen composition and condition, in some cases limiting species identification. Crayfish identification to species for some taxa relied on collecting adult (large) specimens, particularly mature (form I) males (Hobbs 1981). Unfortunately adult crayfish comprised only 40.5% of the samples of which only 9.5% were form I males. The other adults in the collection were form II males (11.0%), and females (20.0%). A small percentage of the adult females (3.6%) were ovigerous or had attached early instars. Small crayfish classified as juveniles (59.5%) were frequently too small using existing diagnostic characters to identify beyond genus. A higher percentage of specimen species identifications have resulted if a selective sampling protocol for larger mature individuals was used.

Three of the five genera known to occur in South Carolina were encountered in the collection. Specimens in *Procambarus*, *Cambarus* and *Fallicambarus* accounted for 52.8%, 47.1% and < 0.1% of the samples, respectively. *Faxonella*

and none of the four species of *Distocambarus* were collected. The distocambarids, the most terrestrial of our crayfish species (Welch and Eversole 2006), are unlikely to be collected while electrofishing wadeable streams (Welch and Eversole 2006). Also the probability of collecting *Faxonella* and any *Distocambarus* species is less because of their restricted distributions (Welch and Eversole 2006, Eversole and Welch 2010, Eversole and Foltz 2012).

Of the 26 species encountered 14 species were *Procambarus*, 11 species *Cambarus*, and one species a *Fallicambarus*. The most frequently identified species *P. troglodytes*, *P. hirsutus*, *P. echinatus*, *C. latimanus*, and *C. acuminatus* occurred in 21.8%, 16.9%, 6.8%, 8.8%, and 7.9% of the samples, respectively. The exotic *P. clarkii* was encountered in three samples. Eleven South Carolina crayfish species were not represented in the collections. In addition to the five species in *Distocambarus* and *Faxonella* genera, representatives of *P. barbatus*, *P. pearsei*, *C. nodosus*, *C. carolinus*, *C. diogenes*, and *C. reduncus* were not collected. Seven of these species are primary burrowers therefore are less likely to be collected sampling fish in wadeable streams (Welch and Eversole 2006, Eversole and Welch 2010). The distocambarids and some of these other species have restricted distributions, e.g., *D. youngineri* occurs only in a few locations in one county (Eversole and Welch 2010). The probability of a random encounter of limited range species is less than those species found across broader landscape patches and another reason why a fish survey failed to collect representatives of the state's crayfish.

Spatial distribution of 4000^{+} South Carolina crayfish museum and collection records is displayed in Figure 1. Crayfish identified to species collected at geo-referenced locations in this study added 6.8% to the total state-wide distribution records. Maps of all 38 described species in the state are displayed in Figures 2 – 39. The crayfish found in the state include seven endemic species, all the

distocambarid species, *P. echinatus*, *P. hirsutus*, and *P. lepidodactylus* (Figs. 17-20, 30, 31, 35) and one introduced species, *P. clarkii* (Fig. 39). *Cambarus latimanus* and *P. troglodytes* were the two widest distributed species while the four *Distocambarus* species have the narrowest distributions (Figs. 4, 17-20, 38). Most of the records of *Cambarus* were from above the fall line whereas *Procambarus* records occurred mostly below the fall line; the exceptions include the primary burrowers *C. diogenes* and *C. reflexus* (Figs. 5, 11), and the stream dwelling *P. raneyi* and *P. spiculifer* (Figs. 36, 37). Crayfish species restricted to single river systems or watershed units were *C. chaugaensis*, *C. nodosus*, *C. spicatus*, and *P. echinatus* (Figs. 10, 13, 14, 35).

The recent updated Comprehensive Wildlife Conservation Strategy of South Carolina (A. Smith, SC DNR, personal communication) indicates seven species listed as “highest priority” and three species as “high priority” conservation species. These two conservation categories include all four of the *Distocambarus* species (Figs. 17-20), four *Cambarus* species (Figs. 5, 9, 13, 14) and two *Procambarus* species (Figs. 27, 35). In addition to having limited ranges, these priority conservation species occupy specific habitats - e.g., *P. chaugaensis* occur in high gradient good water streams in the Blue Ridge ecological zone, and *D. youngineri* burrows in those soils with a seasonal perched water table within the species’ range (Eversole and Welch 2010). Species with more specialized habitat requirements and narrower ranges are at more risk and buffered less than those widely distributed generalist species. The conservation status of the newly described *C. hobbsorum* and *C. aldermanorum* has yet to be determined; however, recent distribution records suggest that a priority ranking may be necessary (Figs. 15, 16).

Recommendations

It is clear from the work on this project many research opportunities exist for crayfish identification and distribution in the state. Historic distribution records indicate disproportionate sampling of the state crayfish fauna, both across the landscape and taxonomic groups which a state-wide survey would help remedy. Furthermore, a state-wide survey would provide an opportunity to examine the distributional limits of conservation priority species and those species with disjunct distribution patterns (e.g., Fig. 22). A state crayfish survey would help flush out the distribution records necessary for the conservation status assessment of the newly described species. A survey targeted for crayfish would also increase the probability of collecting specimens living in specialized habitat (e.g., terrestrial burrows) and increase the number of collected mature crayfish. Recommended are survey records that include detailed descriptions of specimen color and precise site locations for improved species identification and the spatial coverage of the state's crayfish fauna.

In addition to a comprehensive crayfish survey, there is a need to address several taxonomic issues – e.g., the occurrence of two species complexes and at least one species undescribed species in the state (Jones 2012). Also there are two newly described species found in the state and a species resembling the description for *C. howardi* by Hobbs (1981) and species "A" by Cooper (2004a). Although species descriptions and clarification of species complexes are long term research objectives, an immediate need is a workable key for South Carolina crayfish fauna. The recommended initial step is revision of Eversole and Jones (2014) key with updated species content and distribution ranges. Alternative recommendation instead of a comprehensive state-wide key is a series of river drainage based keys which are more user friendly for the casual crayfish

enthusiast. In either case, the content of SC DNR crayfish web site should also be considered at this time, new information added and expanded to include interactive features (e.g., links from species to distribution maps).

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Appendices

Table 1. Truncated list of the identified crayfish by collection code. The total specimens are the sum of all the sexual stages for each taxon per collection code. Unabridged spread sheet available upon request.

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
1000783	Procambarus	O.	chacei	14	1	1	4	2	1	5		
1000794	Procambarus	P.	spiculifer	5	2	1	2					
1000795	Cambarus	D.	latimanus			2	3		2	3		
1000795	Procambarus	P.	raneyi	21		2	4			5		
1000946	Cambarus	D.	latimanus	2			1			1		
1000975	Procambarus	S.	troglodytes	12		2	2		5	3		
1000980	Cambarus	J.	asperimanus	1	1							
1000981	Cambarus	J.	asperimanus						1			
1000981	Cambarus	C.	bartonii	18	3	6	5				3	
1001002	Cambarus	D.	latimanus	6		3	1		1	1		
1001003	Cambarus	P.	acuminatus	7		2	1		1	3		
1001004	Cambarus	P.	acuminatus	5			1		1	3		
1001005	Procambarus	O.	acutus	1		1						
1001006	Procambarus	S.	troglodytes	2	1		1					
1001007	Procambarus	O.	cf blandingii				4					
1001007	Procambarus	S.	troglodytes	7		1	1			1		
1001008	Procambarus	S.	troglodytes	1						1		
1001009	Cambarus	P.	cf acuminatus	9		2	3		2	2		
1001010	Cambarus	P.	acuminatus				1		1	1		
1001010	Procambarus	O.	acutus	7	1	1	1			1		
1001011	Cambarus	P.	cf hobbsorum	3			3					
1001012	Cambarus	P.	cf hobbsorum			1	1		2	3		
1001012	Procambarus	O.	sp.	9					1	1		
1001013	Procambarus	S.	troglodytes	5	3	1	1					
1001014	Cambarus	D.	latimanus	13		4	3		4	2		
1001015	Cambarus	P.	cf acuminatus						1	1		
1001015	Procambarus	O.	lepidodactylus	4				2				

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
1001016	Cambarus	P.	hobbsorum				1					
1001016	Procambarus	O.	sp.	2						1		
1001017	Procambarus	O.	acutus				3		1	2		
1001017	Procambarus	S.	troglodytes	8			1			1		
1001020	Cambarus	D.	latimanus	3		1	1		1			
1001021	Cambarus	D	cf latimanus	5					3	2		
1001023	Procambarus	O.	blandingii	4			1		2	1		
1001025	Cambarus	C.	bartonii	13	3	6	4					
1001026	Cambarus	C.	bartonii	9	2	1	6					
1001027	Cambarus	J.	asperimanus				1					
1001027	Cambarus	P.	chaugaensis	19	1	5	7		1	4		
1001028	Cambarus	C.	bartonii	10		5	1			4		
1001029	Cambarus	C.	bartonii	3		1	2					
1001031	Cambarus	C.	bartonii	7			2		2	3		
1001032	Cambarus	C.	bartonii	11	3	1	2		3	2		
1001033	Cambarus	C.	howardi	15			6		2	2		
1001033	Cambarus	P.	spicatus							4	1	
1001036	Procambarus	S.	troglodytes	16			1		8	7		
1001037	Procambarus	S.	troglodytes	7					4	3		
1001038	Cambarus		sp.	6					2	1	3	
1001039	Procambarus	P.	echinatus						7	4		
1001039	Procambarus	O.	hirsutus	18					2			
1001039	Procambarus	S.	troglodytes						3	2		
1001040	Procambarus		sp.	15					1	1	13	
1001041	Procambarus	O.	sp.	8					1	7		
1001042	Procambarus	O.	hirsutus	6			1		2	3		
1001043	Cambarus	P.	sp.	8					3	5		
1001044	Procambarus	S.	troglodytes	20			1		2	2	15	
1001045	Procambarus	O.	cf hirsutus						2			

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
1001045	Procambarus	P.	echinatus	6				1	1			
1001045	Procambarus		sp.						2			
1001046	Procambarus	O.	hirsutus	9			2		1	2	4	
1001047	Procambarus	S.	troglodytes	9					1	8		
1001048	Procambarus	S.	troglodytes	14					1		13	
1001049	Procambarus	P.	echinatus	7		1			1		1	
1001049	Procambarus	O.	sp.						1		3	
1001050	Cambarus	D.	sp.						1	2		
1001050	Procambarus	O.	cf chacei	5						2		
1001051	Cambarus	D.	latimanus	3		1	1		1			
1001052	Procambarus	O.	cf chacei	3					1	2		
1001053	Procambarus	S.	troglodytes	10			1		1	2	6	
1001054	Procambarus	O.	hirsutus	4					3	1		
1001055	Procambarus		sp.	1						1		
1001056	Procambarus		sp.	1						1		
1001057	Procambarus	S.	troglodytes	2					1	1		
1001058	Procambarus		sp.	5						4	1	
1001059	Cambarus		sp.	2					1	1		
1001060	Cambarus		sp.	4					1			
1001060	Procambarus		sp.								3	
1001061	Procambarus		sp.	4						1	3	
1001062	Procambarus	O.	hirsutus	4					2	2		
1001063	Cambarus		sp.	2					1		1	
1001064	Procambarus		sp.	4					1	2	1	
1001065	Cambarus	P.	aldermanorum	2			1			1		
1001066	Procambarus		sp.	2							2	
1001067	Procambarus		sp.	3						1	2	
1001068	Procambarus		sp.	18					15	3		
1001069	Procambarus	S.	troglodytes	3					2	1		

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
1001070	Cambarus	D.	cf striatus	7			1				6	
1001071	Procambarus		sp.	6					2	3	1	
1001072	Procambarus		sp.	19					6	7	6	
1001073	Procambarus	O.	cf chacei	7		2				5		
1001074	Procambarus	S.	troglodytes	11					3	4	4	
1001075	Procambarus	O.	cf hirsutus	9			1				1	
1001075	Procambarus	S.	sp.								7	
1001076	Procambarus	P.	echinatus	6					2			
1001076	Procambarus	O.	hirsutus						1	3		
1001077	Procambarus		sp.	7					1	1	5	
1001078	Procambarus		sp.	3						3		
1001079	Procambarus	S.	cf troglodytes	6					1	2	3	
1001080	Procambarus		sp.	2					1		1	
1001081	Cambarus		sp.	3					1	2		
1001082	Procambarus		sp.	4					2	2		
1001083	Cambarus		sp.							2		
1001083	Procambarus		sp.	3					1			
1001084	Procambarus	S.	troglodytes	4					1	3		
1001085	Procambarus	P.	echinatus	8					1	2		
1001085	Procambarus	O.	hirsutus							5		
3100005	Cambarus	P.	aldermanorum	3	2							
3100005	Cambarus	D.	cf latimanus				1					
3100006	Cambarus	C	howardi	8	1				3	4		
3100074	Cambarus	P.	aldermanorum	8	6							
3100074	Cambarus	D.	latimanus		1	1						
3100078	Procambarus	P.	raneyi	1			1					
3100079	Procambarus	S.	troglodytes	1	1							
3100080	Cambarus	D.	reflexus	1	1							
3100081	Procambarus	S.	troglodytes	1	1							

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
3100082	Procambarus	O.	hirsutus		3		1					
3100082	Procambarus	S.	troglodytes	13	4	2	1		2			
3100083	Procambarus	S.	troglodytes	14	7	3	4					
3100084	Procambarus	P.	echinatus			1	2					
3100084	Procambarus	O.	hirsutus	31	4	5	8				1	
3100084	Procambarus	S.	troglodytes		1	5	4					
3100085	Procambarus	O.	hirsutus	6	4	2						
3100086	Procambarus	P.	echinatus	4	1		2			1		
3100087	Cambarus	P.	aldermanorum				1					
3100087	Procambarus	O.	acutus	2			1					
3100088	Procambarus	O.	pubescens	8	3	1	2		1	1		
3100089	Procambarus	S.	clarkii	3		3						
3100090	Procambarus	O.	hirsutus	62	3	1	12		13	18	15	
3100091	Procambarus	O.	hirsutus	21	1	5	5		7		3	
3100092	Cambarus	D	latimanus	2	1		1					
3100093	Cambarus	P.	acuminatus	12	2				1	1		
3100093	Procambarus	O.	lepidodactylus				1		1	6		
3100094	Cambarus	D.	latimanus	24		1	2		8	12		
3100094	Cambarus	P.	sp.							1		
3100095	Procambarus	O.	lepidodactylus	3	1		2					
3100096	Cambarus	D.	latimanus	8		2	1			2		
3100096	Cambarus	P.	sp.							3		
3100097	Procambarus	P.	echinatus	1		1						
3100098	Procambarus	S.	troglodytes	1	1							
3200101	Procambarus	O	hirsutus	3	1	2						
3200102	Cambarus	D	latimanus	1		1						
3200103	Procambarus	S.	troglodytes	2	1	1						
3200104	Procambarus	O	hirsutus	1			1					
3200105	Procambarus	S.	cf troglodytes							1		

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
3200105	Procambarus	O	hirsutus	2	1							
3200106	Cambarus	P.	acuminatus	2					1	1		
3200108	Procambarus	P.	echinatus	1		1						
3200109	Procambarus	O.	hirsutus	8		1	3		1	3		
3200110	Procambarus	P.	echinatus	1						1		
3200111	Procambarus	O.	hirsutus	3	2		1					
3200112	Procambarus	P.	echinatus	1	1							
3200113	Procambarus	S.	troglodytes	1	1							
3200114	Procambarus	P.	echinatus	1		1						
3200115	Cambarus		sp.	3					3			
3200116	Procambarus	O.	lepidodactylus	1				1				
3200117	Procambarus	O.	lepidodactylus	10					3	7		
3200118	Procambarus	O.	hirsutus	18		1	1		7	8		
3200118	Procambarus	S.	troglodytes						1			
3200121	Procambarus	S.	troglodytes	4	1	1	2					
3200122	Procambarus	S.	troglodytes	12	2	1	8			1		
3200123	Procambarus	S.	troglodytes	2	2							
3200124	Procambarus	S.	troglodytes	3	2		1					
3200127	Cambarus	D.	latimanus	3			3					
3200128	Procambarus	S.	troglodytes	2	2							
3200129	Cambarus	P.	acuminatus	3	1			1	1			
3200130	Cambarus	P.	acuminatus	3	1				1	1		
3200131	Cambarus	P.	acuminatus	1	1							
3200132	Cambarus	P.	acuminatus	1			1					
3200133	Cambarus	P.	acuminatus	4	1		2			1		
3200134	Cambarus	P.	acuminatus	2		1	1					
3200135	Cambarus	P.	sp.	1			1					
3200136	Cambarus	P.	acuninatus	1		1						
3200138	Procambarus	P.	raneyi	1	1							

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
3200145	Procambarus	P.	echinatus	1		1						
3200155	Cambarus	D.	sp.	1						1		
3200156	Cambarus	D.	sp.	1					1			
3200157	Procambarus	P.	echinatus	7		1	2		1	2	1	
3200158	Procambarus	P.	echinatus	11		3	1		5	2		
3200159	Cambarus	D.	striatus	1			1					
3200160	Cambarus	D.	striatus	2		1	1					
3200161	Cambarus	D.	striatus	2	1	1						
3200162	Procambarus	P.	echinatus	1					1			
3200163	Procambarus	P.	echinatus	1					1			
3200166	Procambarus	S.	troglodytes	4		2	1		1			
3200167	Procambarus	S.	troglodytes	3		1	1			1		
3200168	Procambarus	S.	troglodytes	3	2		1					
3200169	Procambarus	S.	troglodytes	7	2	2	3					
3200171	Procambarus	O.	hirsutus	8		1	2		3	2		
3200172	Cambarus	P.	acuminatus	30	3	11	5		6	5		
3200174	Procambarus	O.	hirsutus	14	4	2	5		1	2		
3200175	Procambarus	P.	echinatus	9		1	3		1	4		
3200176	Procambarus	P.	echinatus	2			1			1		
3200177	Cambarus	C.	howardi	1	1							
3200178	Cambarus		sp.	3					3			
3200180	Procambarus	O.	hirsutus	11	2	2	3		2	2		
3200181	Procambarus	O.	hirsutus	4	3	1						
3200182	Procambarus	O.	hirsutus	4	2							
3200182	Procambarus	S.	troglodytes		1		1					
3200184	Procambarus	O.	hirsutus	1	1							
3200185	Procambarus	O.	hirsutus	2	1	1						
3200186	Procambarus	O.	hirsutus	2	1							
3200186	Procambarus	S.	troglodytes			1						

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
3200187	Procambarus	P.	echinatus	3		1	2					
3200188	Procambarus	O.	hirsutus	1	1							
3200189	Procambarus	O.	hirsutus	3		2			1			
3200190	Cambarus	D.	reflexus	1	1							
3200191	Procambarus	O.	hirsutus	2	1	1						
3200192	Procambarus	O.	hirsutus	17		2	2		9	4		
3200193	Procambarus	O.	hirsutus	1	1							
3200194	Procambarus	O.	hirsutus	1	1							
3200195	Procambarus	O.	hirsutus	1			1					
3200196	Procambarus	P.	echinatus	6			1			1	4	
3200197	Procambarus	O.	hirsutus	12	1	1	4		3	3		
3200198	Procambarus	S.	troglodytes	13	6	1	6					
3200199	Procambarus	O.	hirsutus	3	3							
3200200	Procambarus	S.	troglodytes	8	4	2	2					
3200201	Procambarus	P.	echinatus			1						
3200201	Procambarus	O.	hirsutus	2	1							
3200202	Procambarus	S.	troglodytes	17	6	3	7			1		
3200203	Procambarus	O.	hirsutus	2	2							
3200204	Procambarus	S.	troglodytes	15	5	4	6					
3200205	Procambarus	O.	hirsutus	7	5	1					1	
3200206	Procambarus	S.	troglodytes	16	8	6	2					
3200207	Procambarus	O.	hirsutus	4	3		1					
3200208	Procambarus	S.	troglodytes	17	10	6	1					
3200209	Procambarus	O.	hirsutus	5	1	1						
3200209	Procambarus	S.	troglodytes				2				1	
3300227	Procambarus	O.	chacei	6			1			5		
3300248	Fallicambarus	C.	fodiens							3		
3300248	Procambarus	S.	troglodytes	15		2	8		2			
3300249	Procambarus	O.	ancylus	3		1					2	

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
3300250	Procambarus	S.	troglodytes	1					1			
3300251	Procambarus		sp.	10					4	6		
3300252	Procambarus		sp.	48					24	24		
3300254	Cambarus	C.	howardi	8		4	2		2			
3300256	Cambarus	P.	spicatus	1						1		
3300257	Cambarus	P.	aldermanorum	1	1							
3300258	Cambarus	D.	latimanus	29		1	5		10	12		
3300258	Cambarus	D.	striatus				1					
3300259	Cambarus	D.	reflexus	1			1					
3300260	Cambarus	D.	latimanus	131	1		3					claws
3300260	Cambarus		sp.						7	5	115	
3300261	Procambarus	S.	troglodytes	9		3	2		2	2		
3300262	Procambarus	S.	troglodytes	1	1							
3300263	Cambarus	D.	latimanus	10			10					
3300264	Procambarus	S.	troglodytes	1	1							
3300265	Procambarus	O.	cf acutus	5		1			2	2		
3300266	Cambarus	P.	aldermanorum				3		4	4		
3300266	Cambarus	D.	cf latimanus				1			1		
3300266	Cambarus	C.	howardi	14			1					
3300267	Cambarus	P.	aldermanorum	6		1	1		2	2		
3300268	Cambarus	D.	latimanus	3	1		2					
3300269	Cambarus	P.	aldermanorum	3	2	1						
3300270	Cambarus	P.	aldermanorum						2	2		
3300270	Cambarus	C.	howardi	6					1			
3300270	Cambarus	P.	sp.							1		
3300272	Cambarus	P	aldermanorum	16	1	1	3		3	8		
3300273	Cambarus	D.	cf latimanus	2			1			1		
3300274	Cambarus	C.	howardi	13		4	2		2	5		
3300275	Cambarus	P.	aldermanorum	20		3	2		7	8		claw

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
3300276	Cambarus	C.	howardi	19		3	6		5	5		
3300277	Cambarus	D.	latimanus	3		1				2		
3300278	Cambarus	P.	hobbsorum	1			1					
3300279	Cambarus	P.	aldermanorum				1		4			
3300279	Cambarus	C.	howardi	16		2						
3300279	Cambarus		sp.						3	6		
3300280	Cambarus	P.	acuminatus	7		1	3		2	1		
3300281	Cambarus	P.	cf acuminatus						2	2		
3300281	Procambarus	P.	raneyi	5			1					
3300282	Procambarus	O.	sp.	1					1			
3300283	Procambarus	O.	ancylus	1	1							
3300284	Procambarus	O.	hirsutus	10	1		1		1	7		
3300285	Cambarus	C.	bartonii	5	3		1			1		
3300288	Cambarus	P.	aldermanorum			1	2		1			
3300288	Cambarus	D.	latimanus				1					
3300288	Procambarus	S.	clarkii	6	1							5 claws
3300289	Cambarus	D.	latimanus	2				2				
3300290	Cambarus	D.	latimanus	1				1				
3300292	Procambarus	O.	pubescens	5			3			2		
3300294	Cambarus	P.	hobbsorum			3	2		1	3		
3300294	Cambarus	C.	howardi	10				1				1 claw
3300296	Cambarus	D.	striatus	2		1				1		
3300297	Cambarus	D.	striatus	1			1					
3300299	Cambarus	D	cf latimanus				1		2	1		
3300299	Procambarus	O.	cf enoplosternum							1		
3300299	Procambarus	O.	chacei	18		1	2		4	2		
3300299	Procambarus		sp.						3	1		
3300300	Cambarus	P.	aldermanorum	5					3	1		

Code	Genus		Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv
3300300	Cambarus		sp.						1			
3300301	Procambarus	O.	chacei	7	1				5	1		
3300302	Cambarus	P.	aldermanorum	3					3			
3300303	Cambarus	D.	reflexus	1	1							
3400312	Cambarus	D.	latimanus	5		1	1		1	2		
3400313	Procambarus	O.	acutus	1	1							
3400314	Cambarus	P.	acuminatus	15		2	1		9	3		
3400315	Procambarus	S.	troglodytes	11	3	4	2			2		
3400317	Cambarus	D.	latimanus			1				4		
3400317	Procambarus	O.	acutus	6	1							
3400318	Procambarus	O.	acutus	2	1		1					
3400319	Procambarus	O.	lepidodactylus	1	1							
3400320	Cambarus	P.	cf acuminatus			1			1			
3400320	Procambarus	O.	acutus	3	1							
3400321	Procambarus	O.	blandingii	3	1							
3400321	Procambarus	S.	cf troglodytes							2		
3400322	Procambarus	O.	cf acutus	1			1					
3400323	Procambarus	O.	blandingii	4	1		2			1		
3400331	Procambarus	S.	troglodytes	1	1							
3400333	Cambarus	P.	sp.	3					2	1		
3400336	Procambarus	O.	hirsutus	36	1	1	2		12	16	4	
3400337	Procambarus	O.	hirsutus	7	2		2	2		1		
3400339	Cambarus	C.	howardi	1		1						
3400340	Procambarus	S.	troglodytes	22		3	4		6	9		
3400341	Procambarus	O.	hirsutus	6		2	2		1	1		
3400345	Procambarus	O.	cf hirsutus	2					1	1		
3400346	Procambarus	S.	cf troglodytes	2					2			
3400347	Procambarus	O.	hirsutus	4		1	2			1		
3400355	Procambarus	O.	cf acutus	3					2	1		

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
3400356	Cambarus	D	cf latimanus	8			1		4	3		
3400361	Cambarus		sp.	1							1	1 claw
3400363	Cambarus	P.	acuminatus	1					1			
3400371	Procambarus	O.	hirsutus	3			2	1				
3400372	Procambarus	O.	hirsutus	6	3			1	1	1		
3400373	Cambarus	C.	howardi	1					1			
3400376	Cambarus	J.	asperimanus	1	1							
3400377	Cambarus		sp.						1		2	
3400377	Procambarus	O.	cf hirsutus	11						3	5	
3400379	Cambarus	P.	chaugaensis	18	1	3	1		5	6		
3400379	Cambarus	P.	sp.				2					
3400382	Cambarus	P.	cf acuminatus	4			4					
3400383	Procambarus	O.	blandingii	2	1		1					
3400387	Cambarus	P.	cf chaugaenesis	5			2		1	1		
3400387	Cambarus	P.	sp.							1		
3400388	Cambarus		sp.	1					1			
3400394	Procambarus	P.	spiculifer	3	1	2						
3400395	Procambarus	P.	spiculifer	2	1		1					
3400398	Procambarus	O.	hirsutus	4		1			1			
3400398	Procambarus		sp.							2		
3400405	Cambarus	D.	latimanus	1		1						
3400410	Cambarus	D.	striatus	3	1	1	1					
3400411	Cambarus	D.	striatus	9	2		4			3		
3500421	Cambarus		sp.	1						1		
3500425	Cambarus	P.	cf chaugaensis	5		1	1		1			
3500425	Cambarus	D.	sp.						2			
3500428	Procambarus	O.	braswelli	13			5		1	3		
3500428	Procambarus	O.	cf blandingii				1			2		

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
3500428	Procambarus	S.	troglodytes			1						
3500431	Procambarus	O.	cf braswelli	9					6	3		
3500436	Cambarus	P.	cf acuminatus	2				1	1			
3500436	Cambarus	C.	sp.	0								chela
3500441	Procambarus		sp.	1					1			
3500442	Cambarus	P.	cf acuminatus	4		2	2					
3500445	Cambarus	P.	chaugaensis	21		2	2		8	6	3	
3500446	Cambarus	P.	cf acuminatus	1						1		
3500453	Cambarus	D.	latimanus	1			1					
3500458	Cambarus		sp.						3	2		
3500458	Procambarus		sp.	8					1	2		
3500463	Cambarus	D.	cf latimanus	5		1	1			2		not SC
3500465	Procambarus	S.	troglodytes	2		1				1		
3500473	Procambarus	S.	troglodytes	17		2	1		5	9		
3500475	Cambarus	C.	howardi	4		1				3		
3500476	Procambarus	P.	spiculifer	4	1	1			1	1		
3500477	Cambarus	D.	latimanus	11		1	1		5	4		
3500478	Procambarus	O.	blandingii	1	1							
3500484	Cambarus	C.	howardi	3		1	1		1			
3500487	Procambarus	O.	acutus	8		2	1		4	1		
3500491	Procambarus	O.	hirsutus	10	1	1	5		2	1		
3500492	Cambarus	D.	latimanus			1						
3500492	Procambarus	O.	hirsutus	13	1	1	7	3				
3500493	Cambarus	D.	latimanus		1	2				1		
3500493	Procambarus	O.	hirsutus	29	1		4		3	7		
3500493	Procambarus	S.	troglodytes			5	3		1		1	
3500494	Procambarus	S.	troglodytes	1		1						
3500495	Cambarus	P.	acuminatus	1						1		
3500496	Cambarus	C.	bartonii	2			1		1			

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
3500497	Procambarus	S.	troglodytes	1			1					
3500502	Cambarus	P.	acuminatus	3		1	2					
3500503	Cambarus	P.	sp.	9					5	4		
3500504	Cambarus	P.	cf acuminatus	2			1		1			
3500507	Cambarus		sp.	4					3	1		
3500508	Cambarus	J.	asperimanus				1					
3500508	Cambarus	C.	bartonii	17	1	1	7		1		6	
3500509	Cambarus	P.	acuminatus	3			1		2			
3500510	Procambarus	O.	hirsutus	10	1		2		2	5		
3500511	Procambarus	O.	lunzi	11	2	2			2	5		
3500512	Procambarus	O.	lunzi	24	1	2	4		8	9		
3500513	Cambarus	C.	howardi			2	2					
3500513	Cambarus	P.	sp.				1		1	2	1	
3500513	Cambarus	P.	spicatus	11		1	1					
3500514	Cambarus	P.	chaugaensis	2		1	1					
3500515	Procambarus	O.	hirsutus	4			1			3		
3500517	Cambarus	P.	aldermanorum	3	1				1	1		
3500519	Cambarus	P.	cf acuminatus	1					1			
3500520	Procambarus	O.	acutus	2			2					
3500521	Cambarus	P.	aldermanorum	23			5		12	6		
3500522	Cambarus	C.	howardi	1			1					
3500523	Cambarus	P.	sp.	9					4	5		
3500524	Cambarus	P.	aldermanorum	12			1		4	7		
3500525	Procambarus	O.	acutus	3	2		1					
3500526	Cambarus	D.	cf latimanus	7		1	1		1	3		
3500526	Cambarus	C.	sp.							1		
3500528	Cambarus	D.	latimanus			2			1	2		
3500528	Procambarus	O.	enoplosternum	18		1	1		7	3	1	
3500530	Cambarus	D.	cf latimanus			1	2		2	5		

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
3500530	Procambarus	O.	cf chacei							4		
3500530	Procambarus	P.	raneyi	15		1						
3500531	Cambarus	P.	cf chaugaensis				2					
3500531	Cambarus	C.	howardi			3	5		1		3	
3500531	Cambarus	P.	spicatus	17		1			1	1		
3500532	Procambarus	S.	troglodytes	2			2					
3600534	Procambarus	S.	spiculifer	1			1					
3600535	Cambarus	P.	acuminatus			1	1		3			
3600535	Cambarus	C.	howardi	7		1	1					
3600536	Cambarus	P.	acuminatus			2	4		1			
3600536	Procambarus	P.	spiculifer	8	1							
3600538	Cambarus	D.	sp.						2			
3600538	Cambarus	P.	sp.							1		
3600538	Procambarus	S.	troglodytes	4			1					
3600539	Cambarus		sp.	3						3		
3600540	Cambarus	P.	acuminatus	2			1			1		
3600541	Cambarus	P.	sp.	7					3	4		
3600542	Cambarus	P.	acuminatus	5			2		1	2		
3600543	Cambarus	P.	sp.	2					2			
3600544	Cambarus	P.	acuminatus		1	2			2	3		
3600544	Procambarus	S.	troglodytes	10		1	1					
3600545	Cambarus	P.	acuminatus				1		3	7		
3600545	Procambarus	S.	troglodytes	17	2		4					
3600546	Cambarus	P.	cf acuminatus			1			2			
3600546	Cambarus	P.	cf aldermanorum						4	3		
3600546	Cambarus	D.	latimanus	14		1	1			2		
3600547	Cambarus	P.	cf acuminatus				1		1	2		
3600547	Cambarus	D.	cf latimanus						1	2		
3600547	Procambarus	S.	troglodytes	11	1	1	1		1			

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
3600548	Cambarus	P.	cf aldermanorum				3		4	7		
3600548	Cambarus	D.	sp.	19					3		2	
3600549	Cambarus	P.	cf acuminatus	18		2	1		6	2	2	
3600549	Cambarus	D.	sp.				1		1	3		
3600550	Cambarus	D.	cf latimanus	13						1		
3600550	Cambarus		sp.						8	4		
3600551	Cambarus	P.	acuminatus	16	1	1	1		5	3		
3600551	Cambarus	D.	cf latimanus				1		2		2	
3600552	Cambarus	P.	cf aldermanorum	21		2	1					
3600552	Cambarus		sp.						10	8		
3600553	Cambarus	P.	cf acuminatus				1					
3600553	Cambarus	D.	cf latimanus			1	2		3			
3600553	Cambarus		sp.						7	8		
3600553	Cambarus	D.	striatus				1					
3600553	Procambarus	S.	troglodytes	26			2		1			
3600554	Cambarus		sp.	4						1	3	
3600557	Cambarus	D.	latimanus	2					1	1		
3600558	Cambarus	P.	acuminatus	2						2		
3600573	Cambarus	P.	acuminatus	4	2		1			1		
3600585	Procambarus	O.	hirsutus	16	5	2	9					
3600587	Cambarus	C.	bartonii	2		1						
3600587	Cambarus	P.	chaugaensis			1						
3600593	Procambarus	O.	acutus	5	5							
3600594	Cambarus	P.	hobbsorum	32	1	8	9		6	8		
3600600	Cambarus	D.	sp.	2			1					
3600600	Cambarus	P.	sp.						1			
3600606	Procambarus	O.	hirsutus	11	4		5		1	1		
3600621	Cambarus	C.	bartonii	2		2						

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
3600622	Cambarus	P.	sp.	5					3	2		
3600623	Cambarus	P.	cf acuminatus	1			1					
3600624	Cambarus	P.	chaugaensis	12		1	1		3	6		
3600624	Cambarus	P.	sp.				1					
3600626	Procambarus	S.	troglodytes	1		1						
3600627	Procambarus	O	hirsutus	55	6	3	12	2	14	18		
3600628	Procambarus	P.	raneyi	2	1		1					
3600635	Procambarus	S.	troglodytes	1			1					
3600636	Procambarus	O.	hirsutus	9	2		6			1		
3600645	Procambarus	O.	hirsutus	18	2	2	7		4	3		
3600646	Procambarus	S.	troglodytes	1	1							
3600647	Procambarus	S.	troglodytes	1		1						
3600648	Procambarus	P.	echinatus	16		1	3		5	7		
3600655	Procambarus	O.	hirsutus	4			4					
3700660	Cambarus		sp.	3					2	1		
3700662	Cambarus	P.	cf acuminatus	3					2	1		
3700663	Cambarus		sp.	1							1	
3700665	Cambarus	C.	howardi	3		1	2					
3700669	Cambarus	D.	cf latimanus	1						1		
3700670	Cambarus	P.	cf acuminatus	1					1			
3700673	Cambarus	P.	cf acuminatus	4			1		1	2		
3700675	Cambarus	C.	cf howardi	1			1					
3700676	Cambarus	P.	sp.	1						1		
3700677	Procambarus		sp.	1							1	
3700678	Cambarus		sp.	2					1	1		
3700681	Cambarus	P.	cf acuminatus	2					2			
3700696	Procambarus	S.	troglodytes	4		1			1	2		
3700697	Procambarus		sp.	1							1	
3700698	Procambarus	S.	troglodytes	1					1			

Code	Genus	Sub gen.	Species	Total specimens	F1 Males	F2 Males	Females	Ovigerous	Juv Male	Juv Female	Juv	etc.
3700699	Procambarus	S.	troglodytes	10					2	4	4	
3700700	Procambarus	O.	cf chacei	2					1	1		
3700701	Procambarus	S.	troglodytes	2					1	1		
3700705	Procambarus	O.	cf hirsutus	1			1					
3700706	Procambarus		sp.	4					2	2		
3700707	Procambarus	S.	troglodytes	3					1	1	1	
3700709	Procambarus	S.	cf troglodytes	2					1	1		
3700713	Cambarus	D.	cf latimanus	3		1	2					
3700714	Procambarus	S.	troglodytes	1						1		
3700715	Procambarus	O	echinatus	12			1		2	3		
3700715	Procambarus		sp.						4		1	
3700715	Procambarus	S	troglodytes						1			
3700716	Cambarus	P.	aldermanorum	6						3		
3700716	Cambarus	P.	sp.			1			1	1		
3700717	Procambarus		sp.	4					1	2	1	
3700718	Cambarus	D.	latimanus			1				1	6	
3700718	Procambarus	O.	hirsutus						1			
3700718	Procambarus	S	troglodytes	10					1			
3700720	Cambarus		sp.	1						1		
3700721	Procambarus	S.	troglodytes	3					2	1		
3700751	Procambarus	S.	clarkii	32	2	5	15		1	9		
3700754	Cambarus	P.	sp.	1						1		
3700759	Procambarus	O.	acutus	9	6		3					
Totals				2883	273	319	557	21	653	755	304	

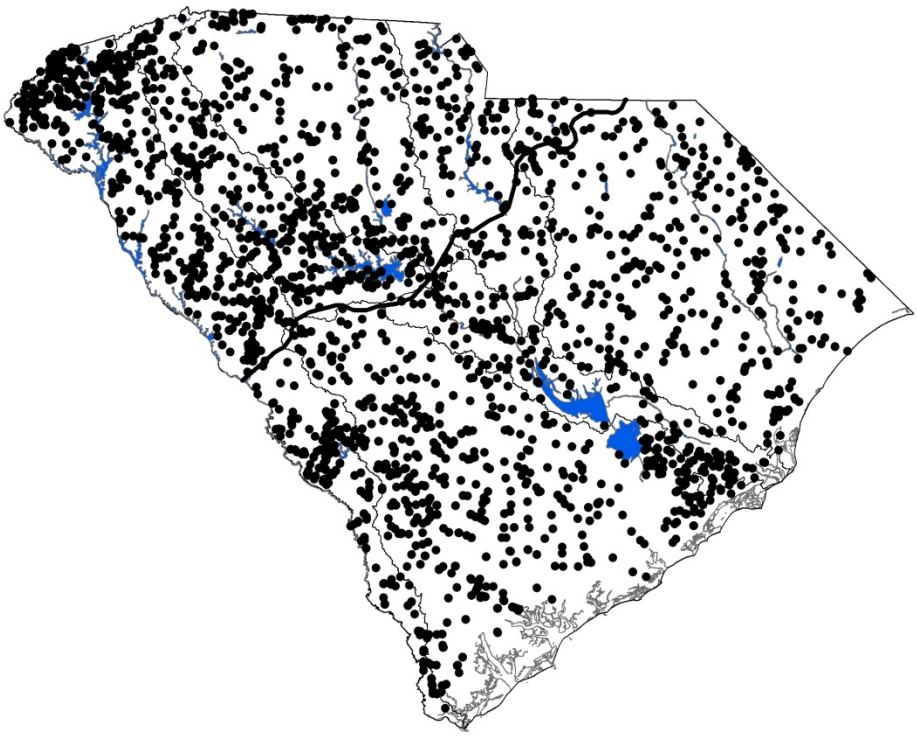

Figure 1. Distribution of 4000+ crayfish records.

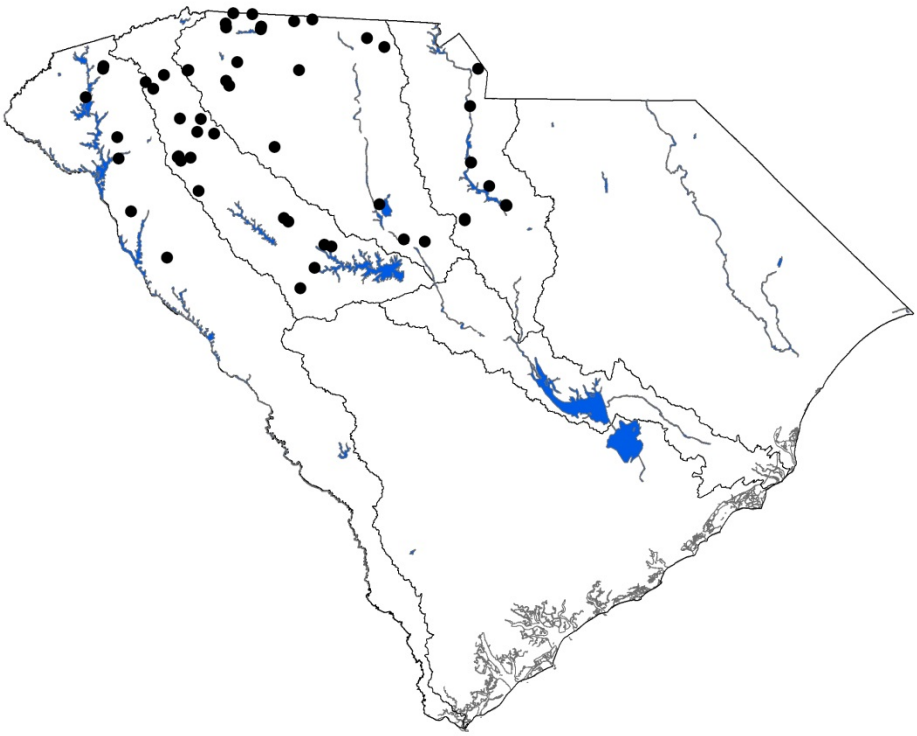

Figure 2. Spatial distribution of *Cambarus howardi*.

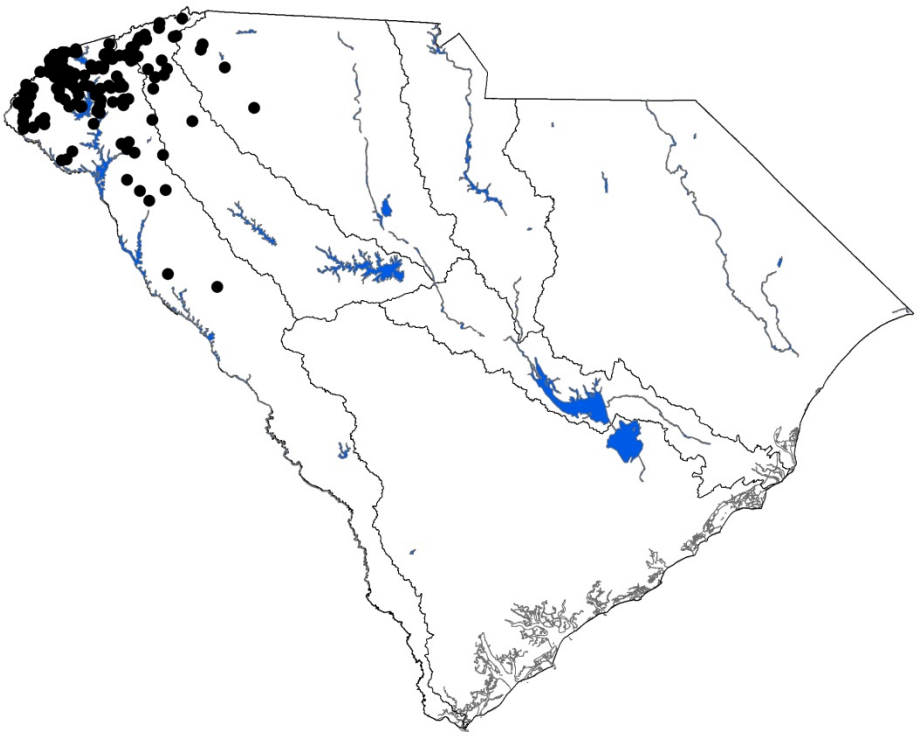

Figure 3. Spatial distribution of *Cambarus bartonii*.

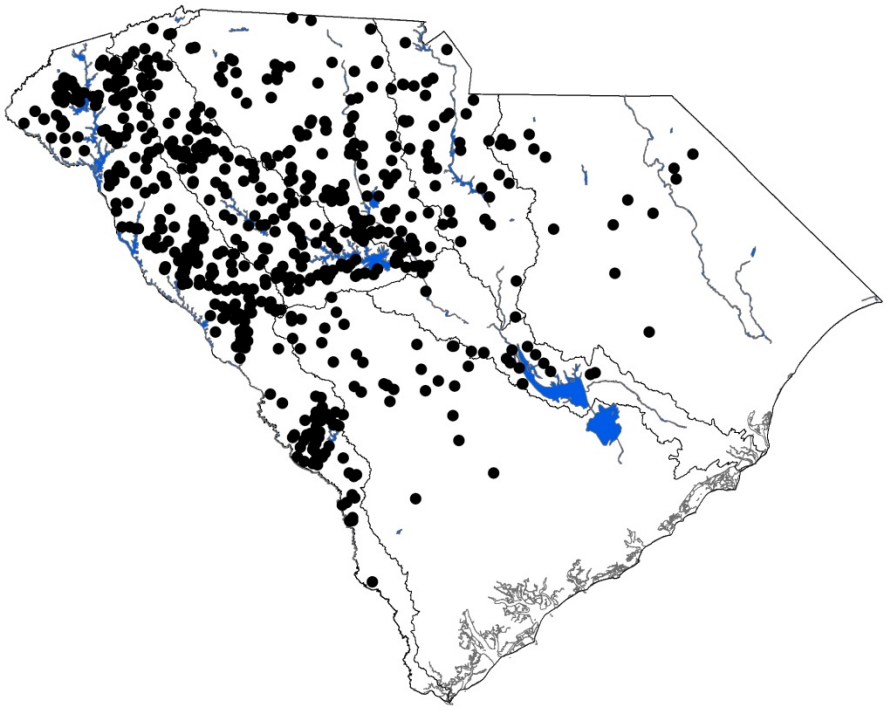

Figure 4. Spatial distribution *Cambarus latimanus***.**

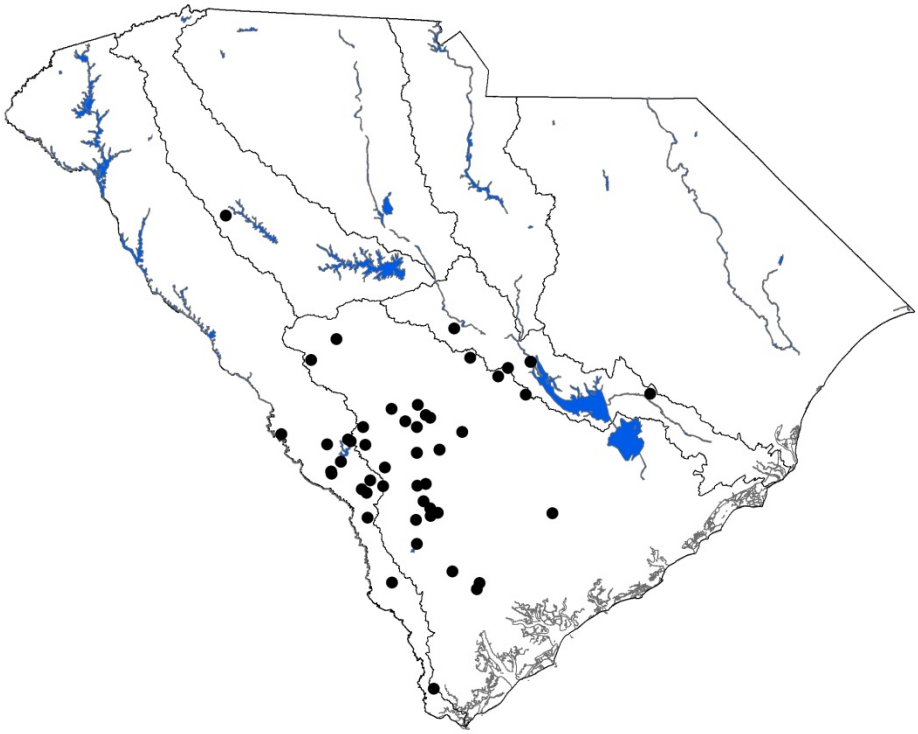

Figure 5. Spatial distribution of *Cambarus reflexus*.

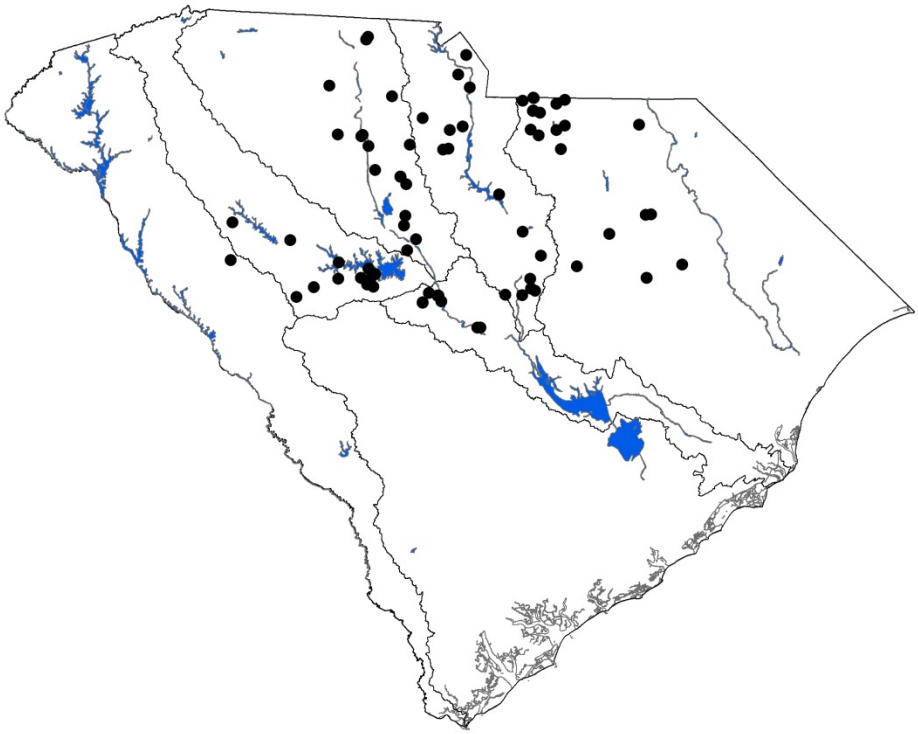

Figure 6. Spatial distribution of *Cambarus reduncus*.

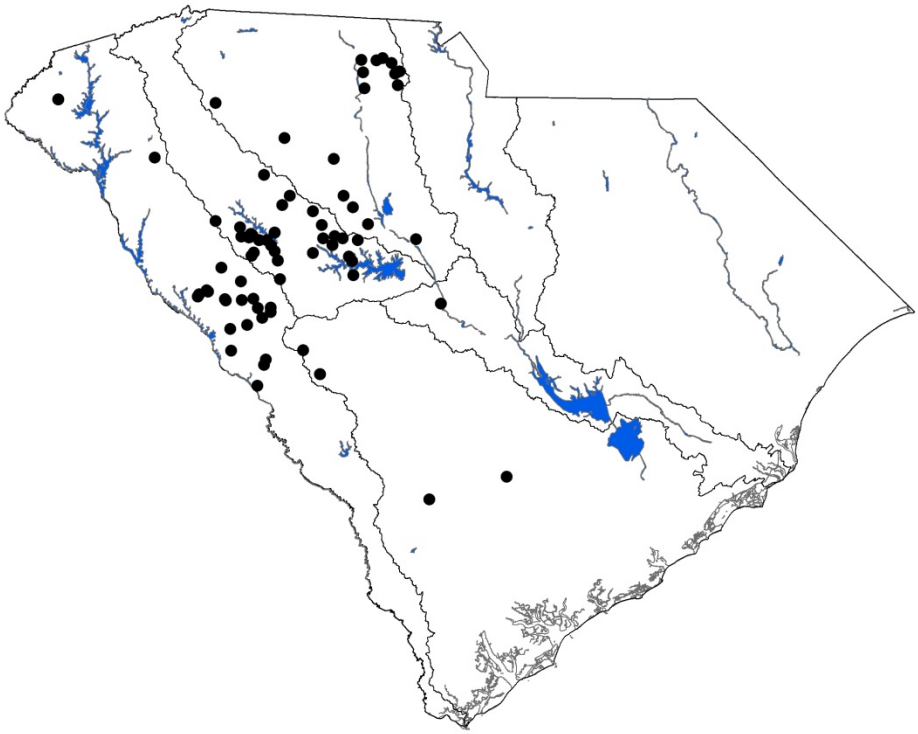

Figure 7. Spatial distribution of *Cambarus striatus*.

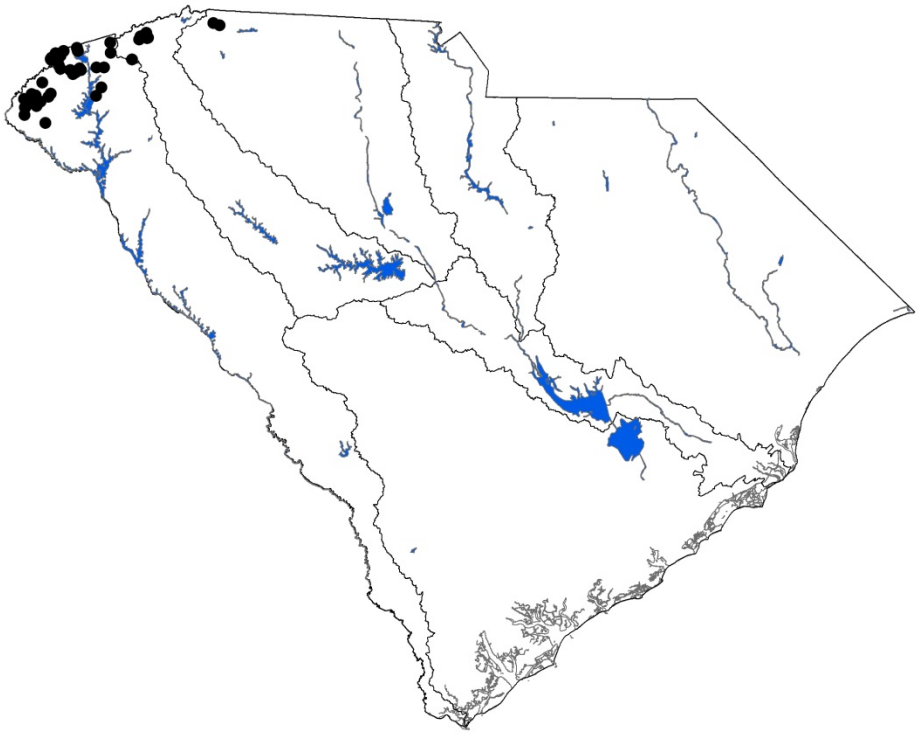

Figure 8. Spatial distribution of *Cambarus asperimanus*.

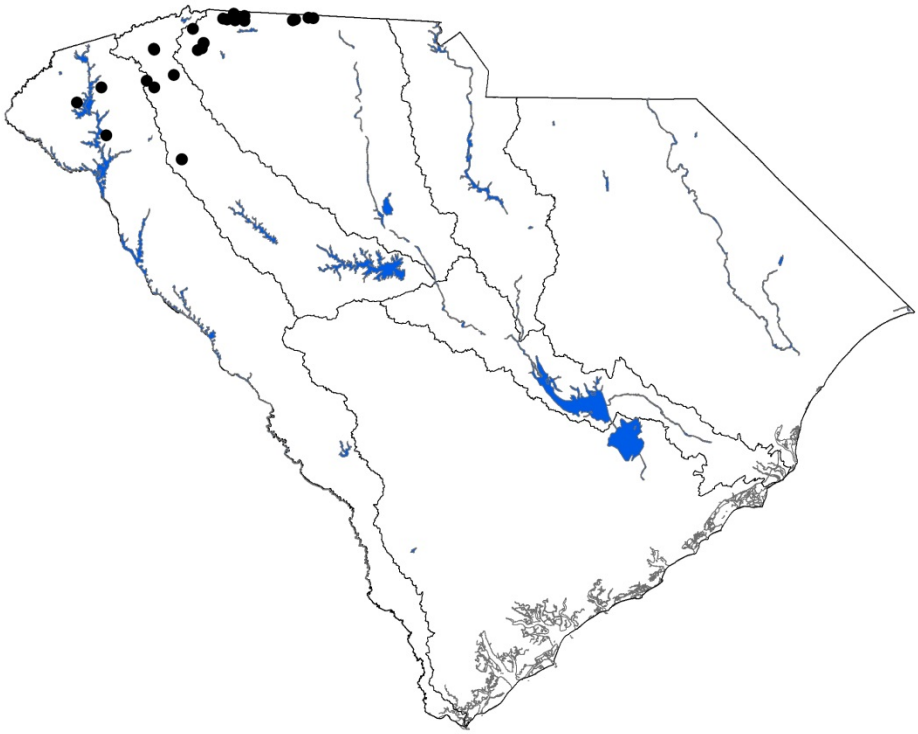

Figure 9. Spatial distribution of *Cambarus carolinus*.

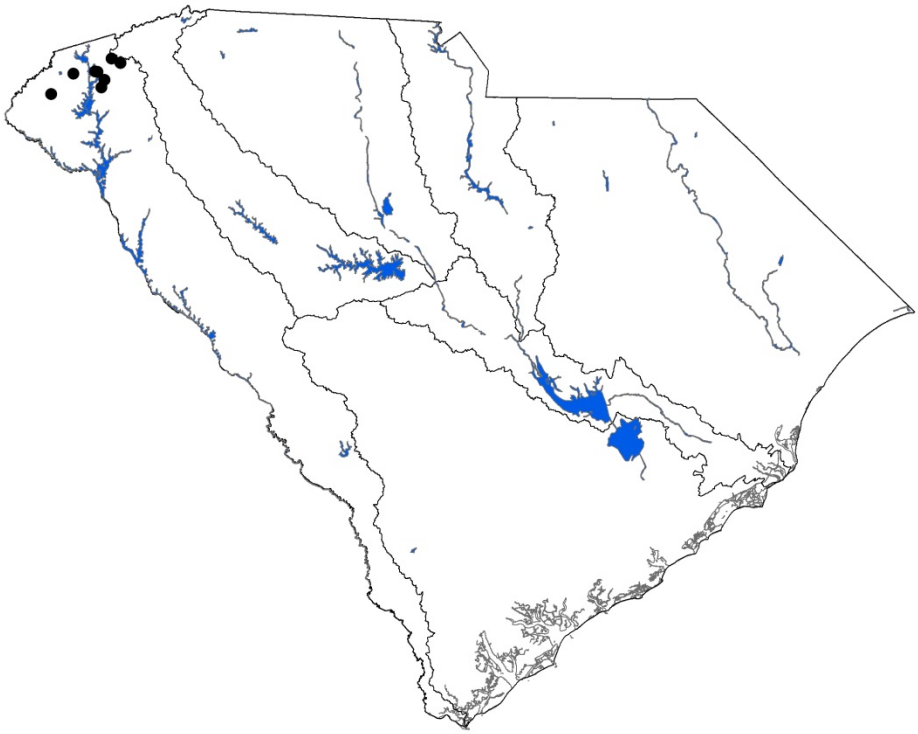

Figure 10. Spatial distribution of *Cambarus nodosus*.

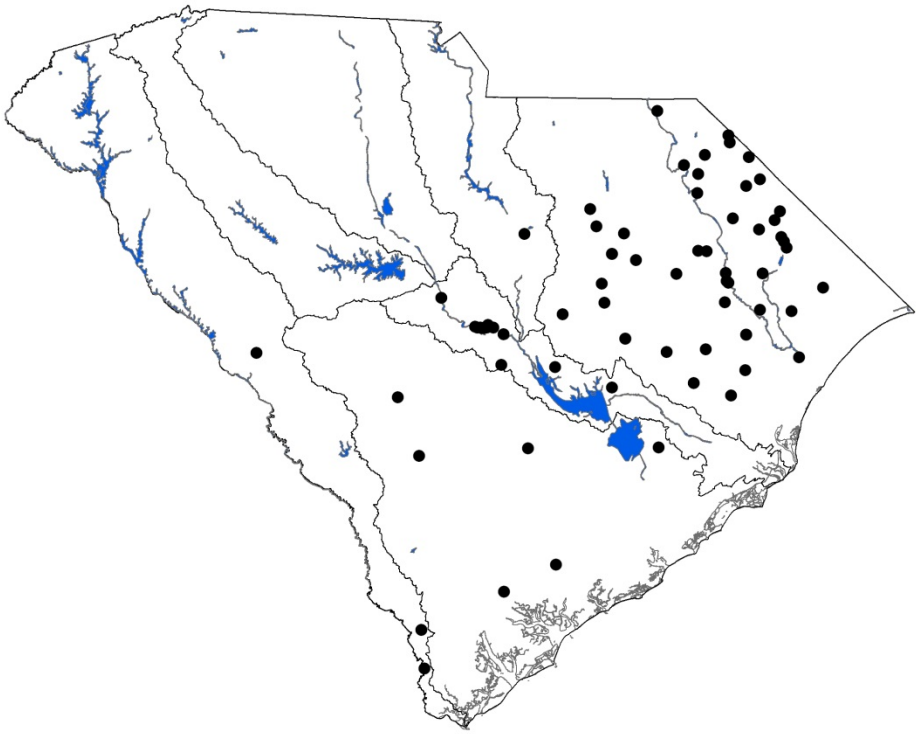

Figure 11. Spatial distribution of *Cambarus diogenes*.

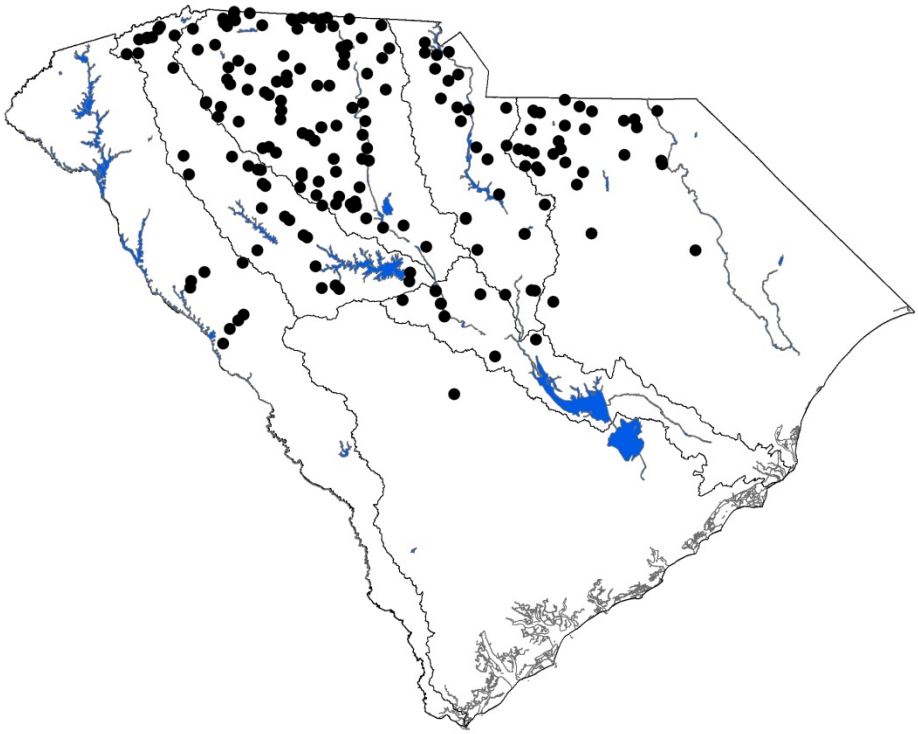

Figure 12. Spatial distribution of *Cambarus acuminatus*.

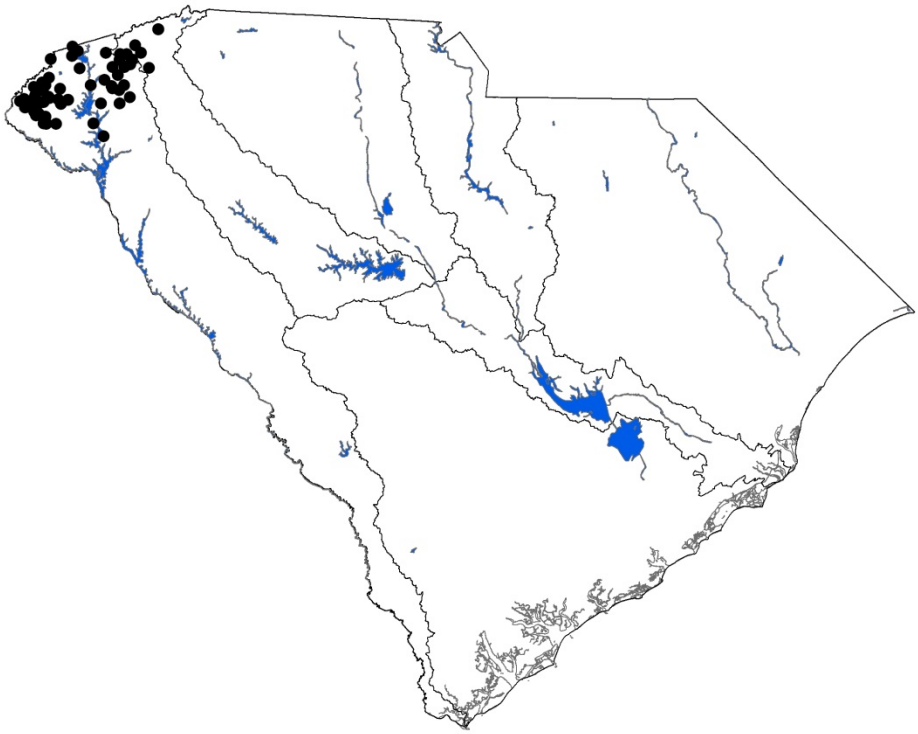

Figure 13. Spatial distribution of *Cambarus chaugaensis*.

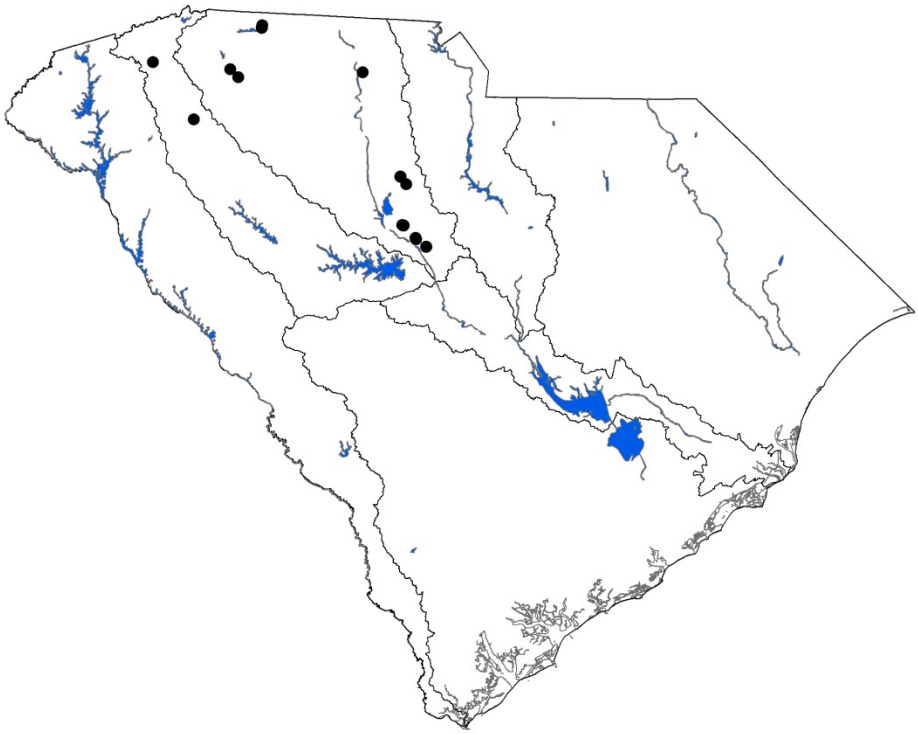

Figure 14. Spatial distribution of *Cambarus spicatus*.

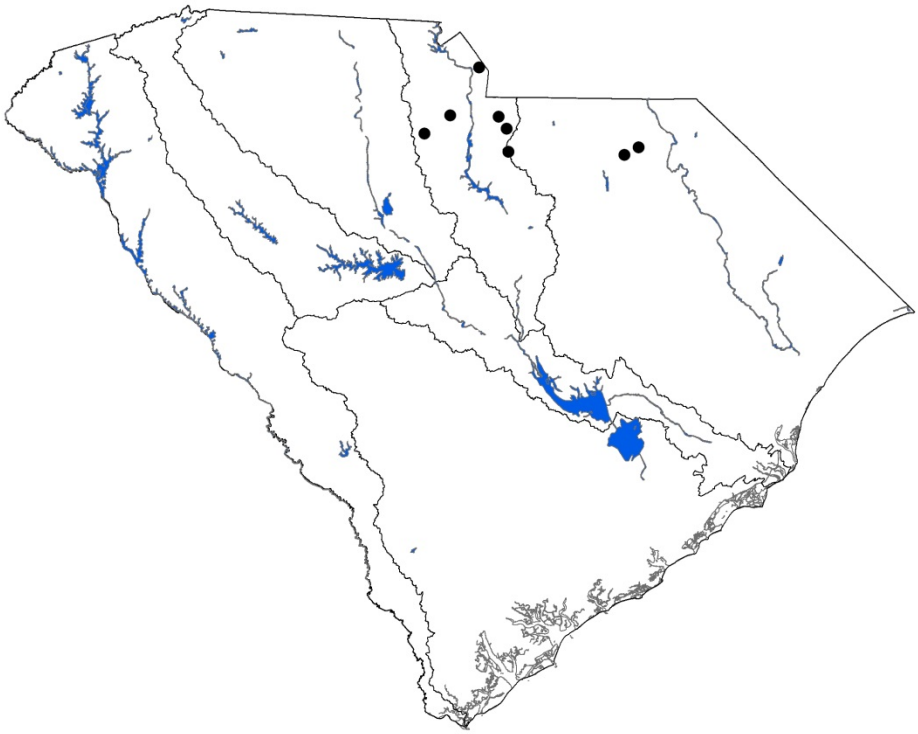

Figure 15. Spatial distribution of *Cambarus hobbsorum*.

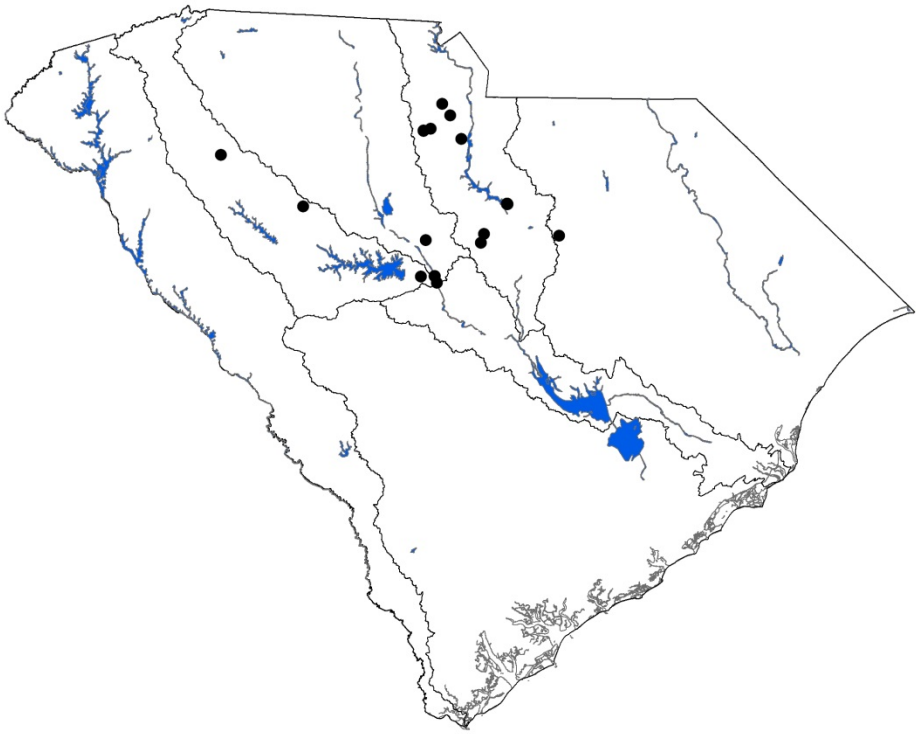

Figure 16. Spatial distribution of *Cambarus aldermanorum*.

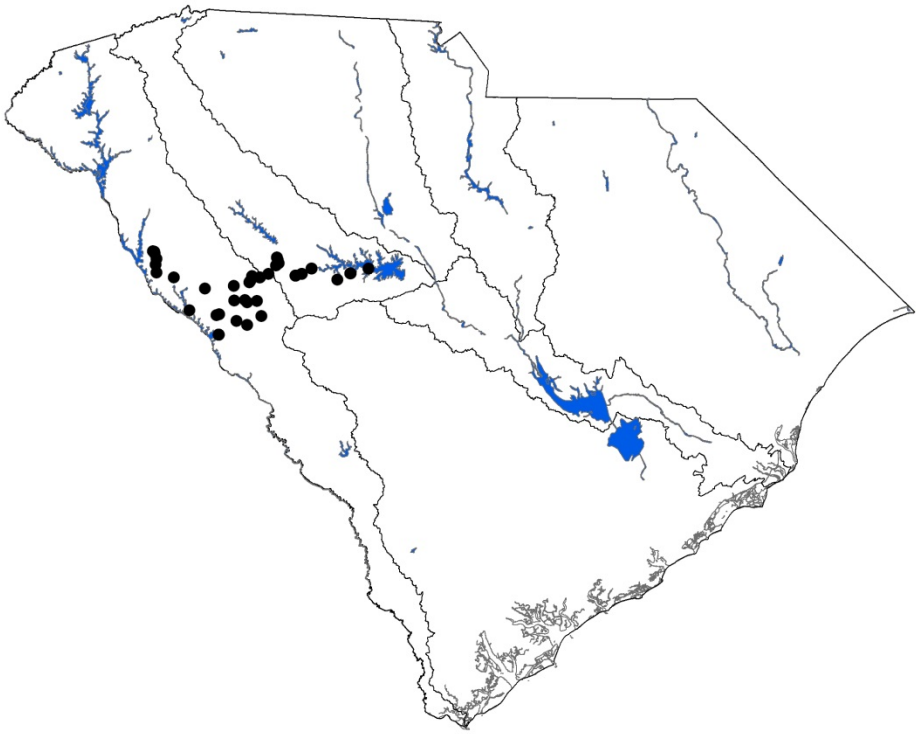

Figure 17. Spatial distribution of *Distocambarus crockeri.*

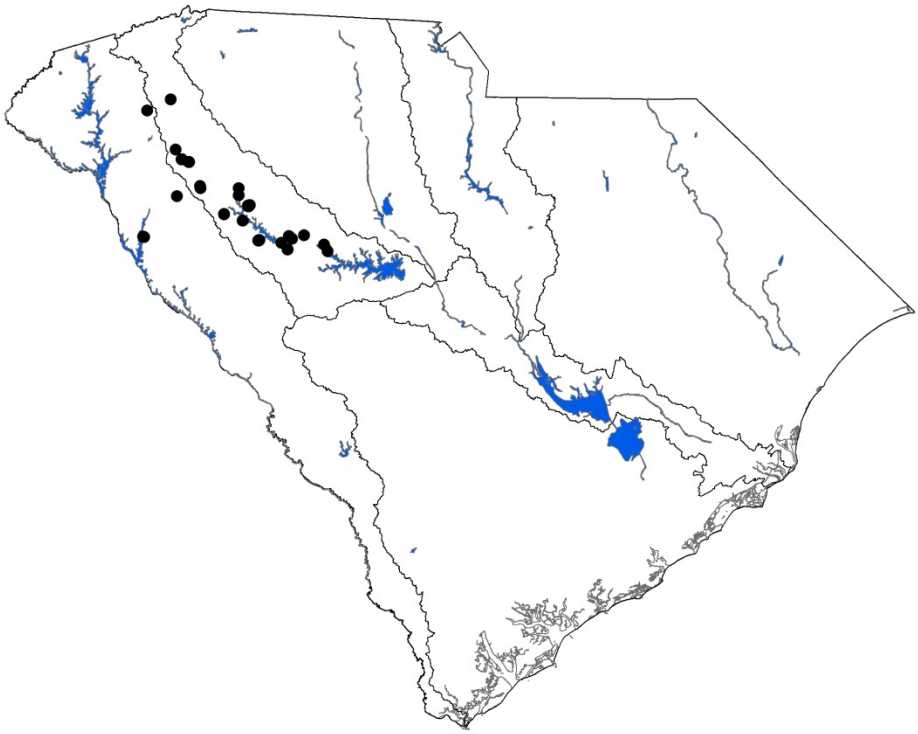

Figure 18. Spatial distribution of *Distocambarus carlsoni*.

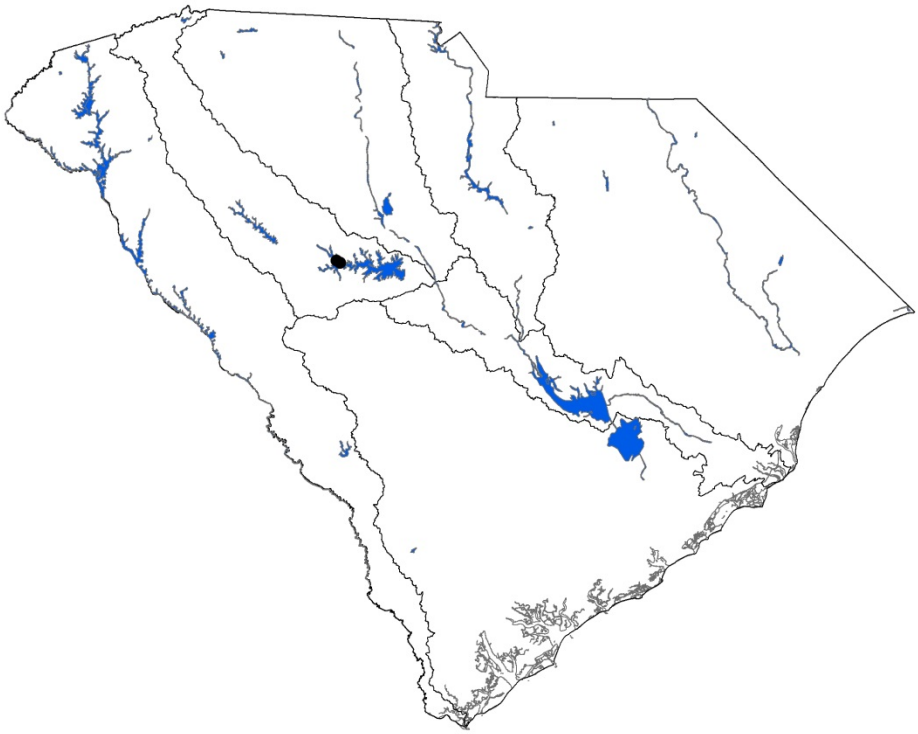

Figure 19. Spatial distribution of *Distocambarus hunteri*.

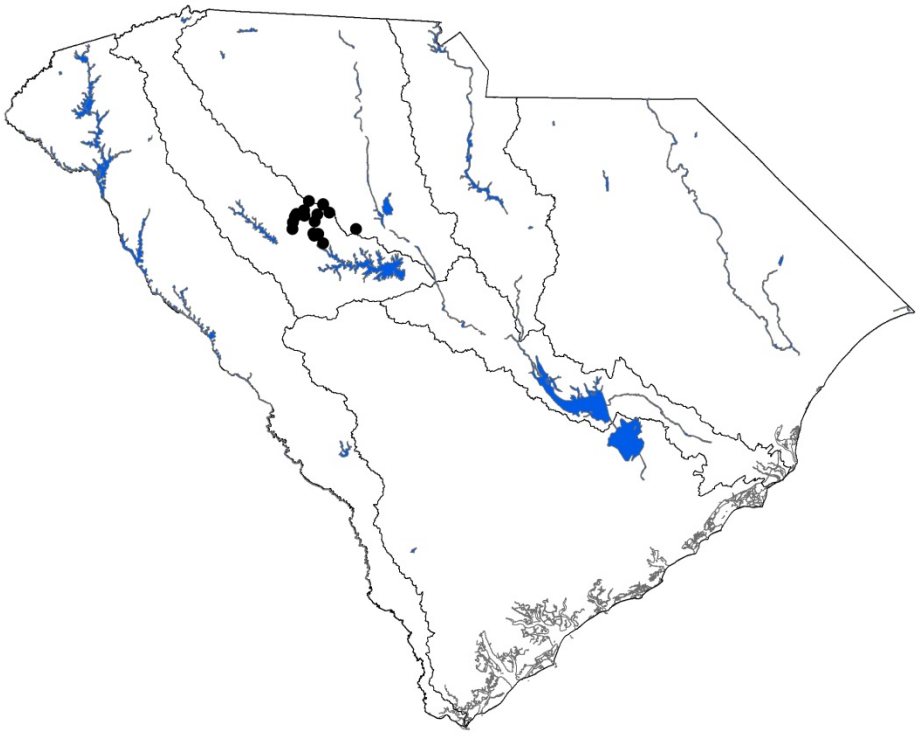

Figure20. Spatial distribution of *Distocambarus youngineri.*

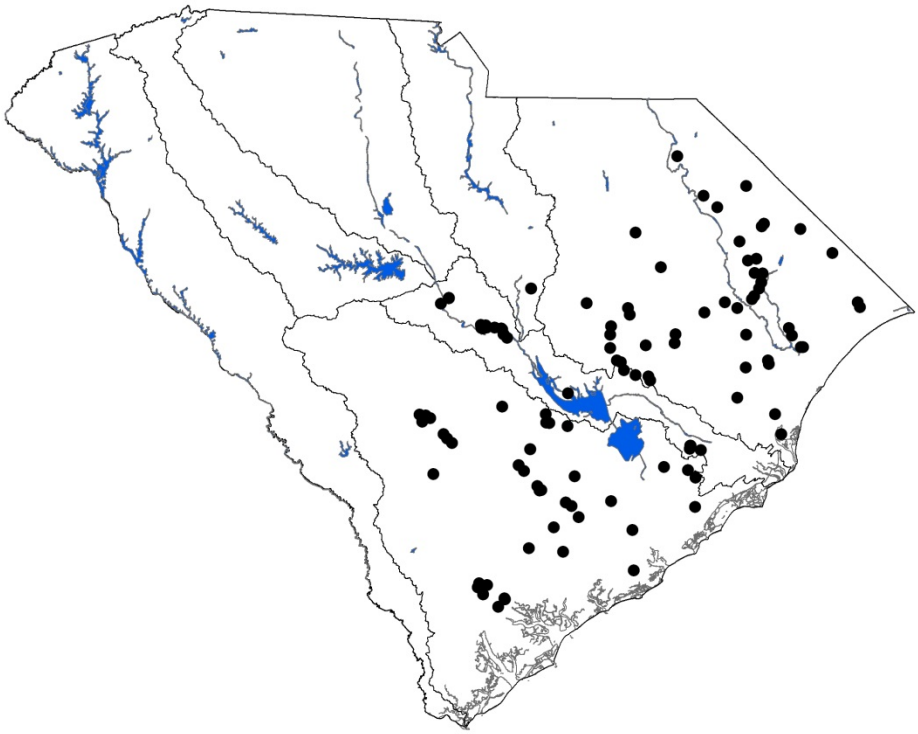

Figure 21. Spatial distribution of *Fallicambarus fodiens*.

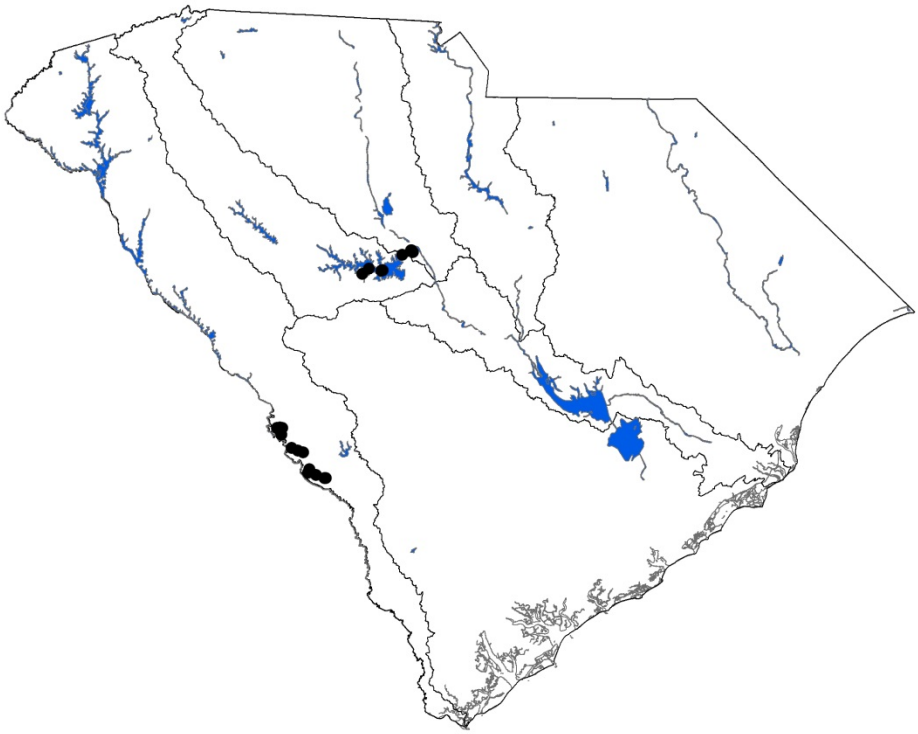

Figure 22. Spatial distribution of *Faxonella clypeata*.

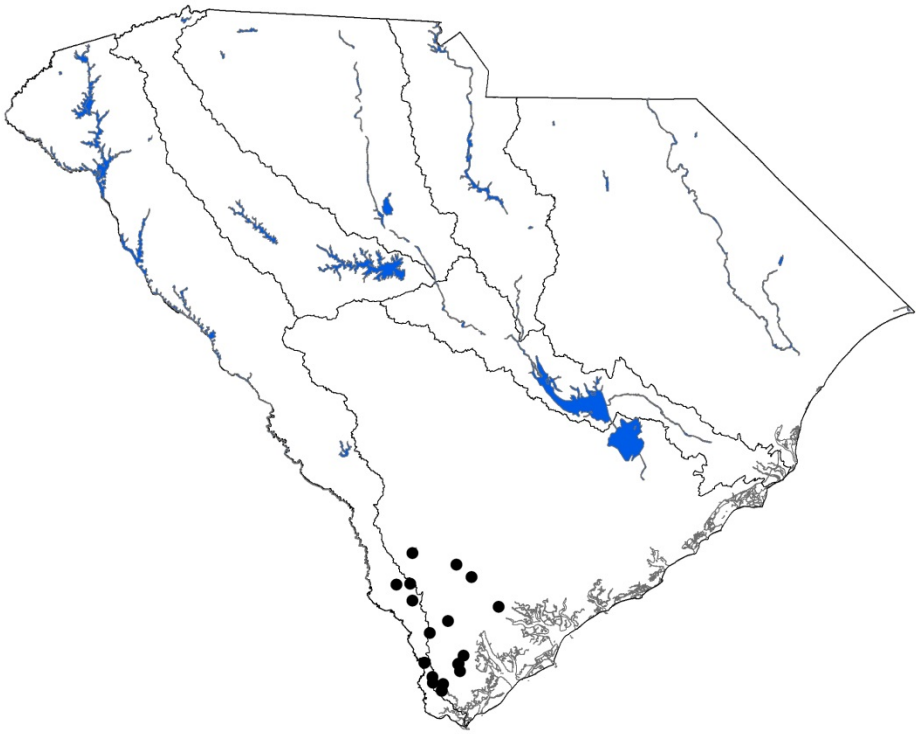

Figure 23. Spatial distribution of *Procambarus barbatus.*

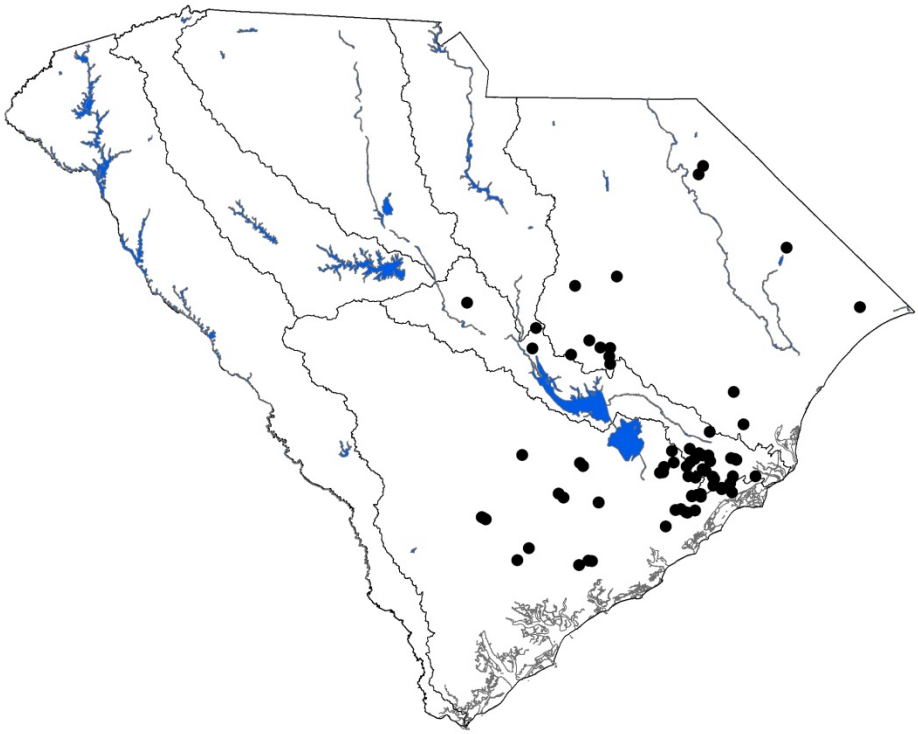

Figure 24. Spatial distribution of *Procambarus ancylus.*

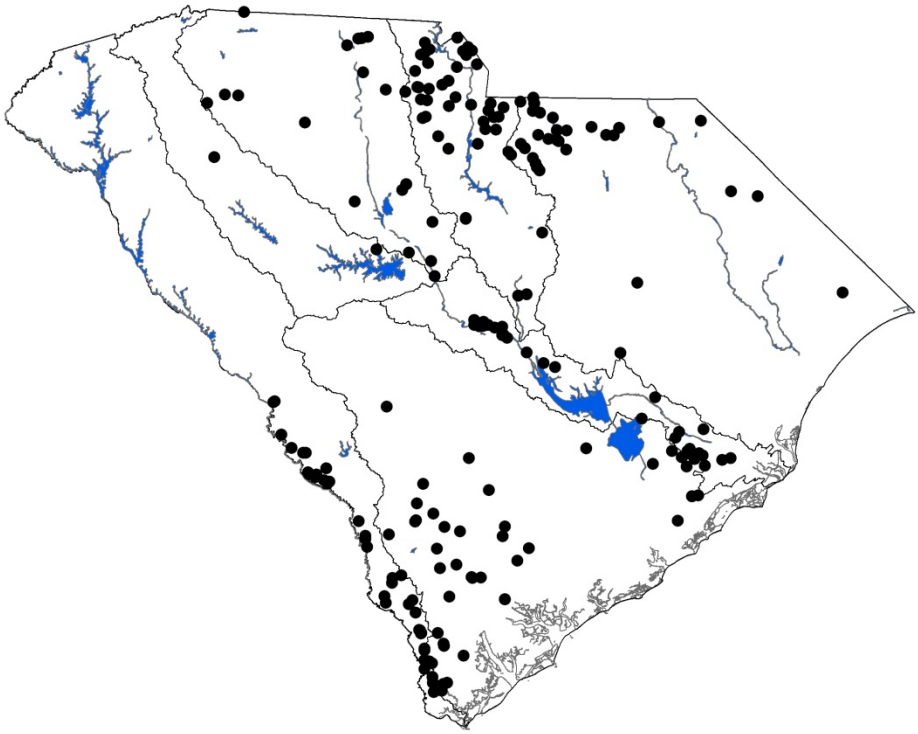

Figure 25. Spatial distribution of *Procambarus acutus.*

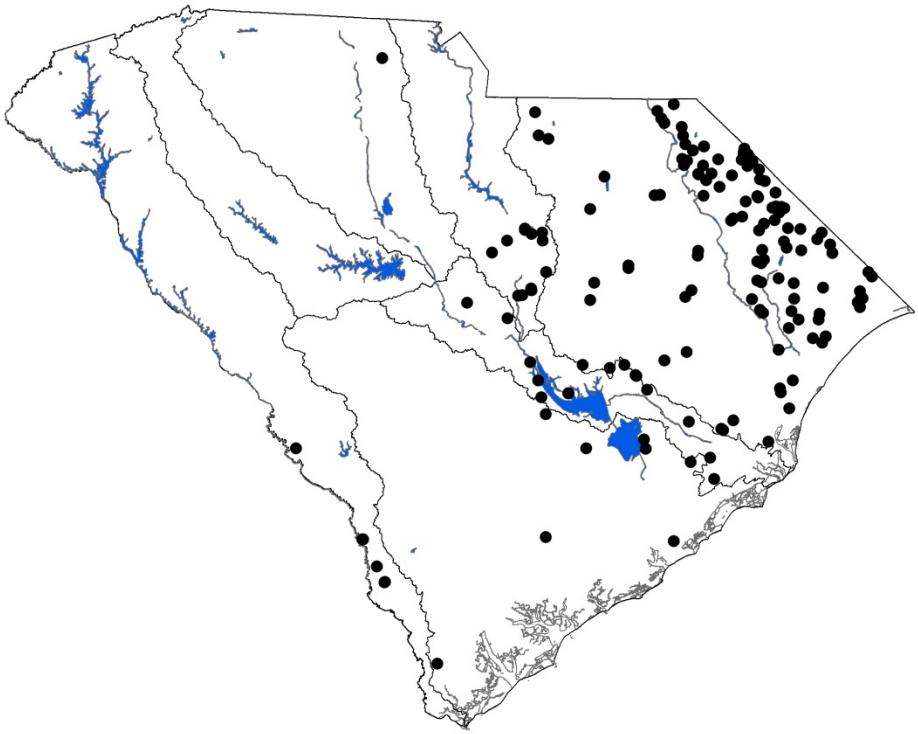

Figure 26. Spatial distribution of *Procambarus blandingii*.

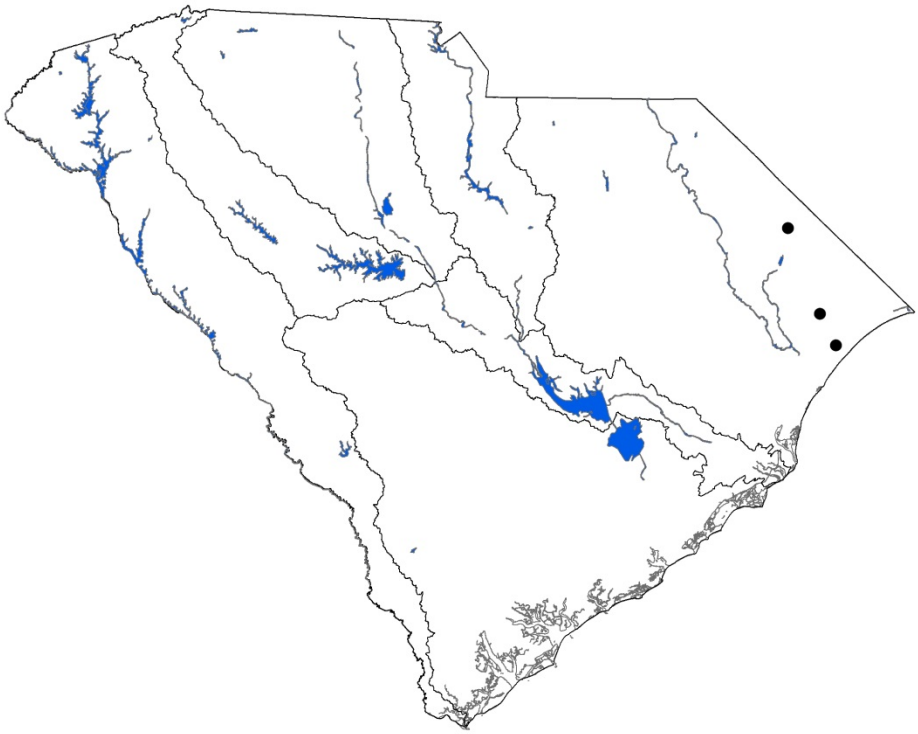

Figure 27. Spatial distribution of *Procambarus braswelli.*

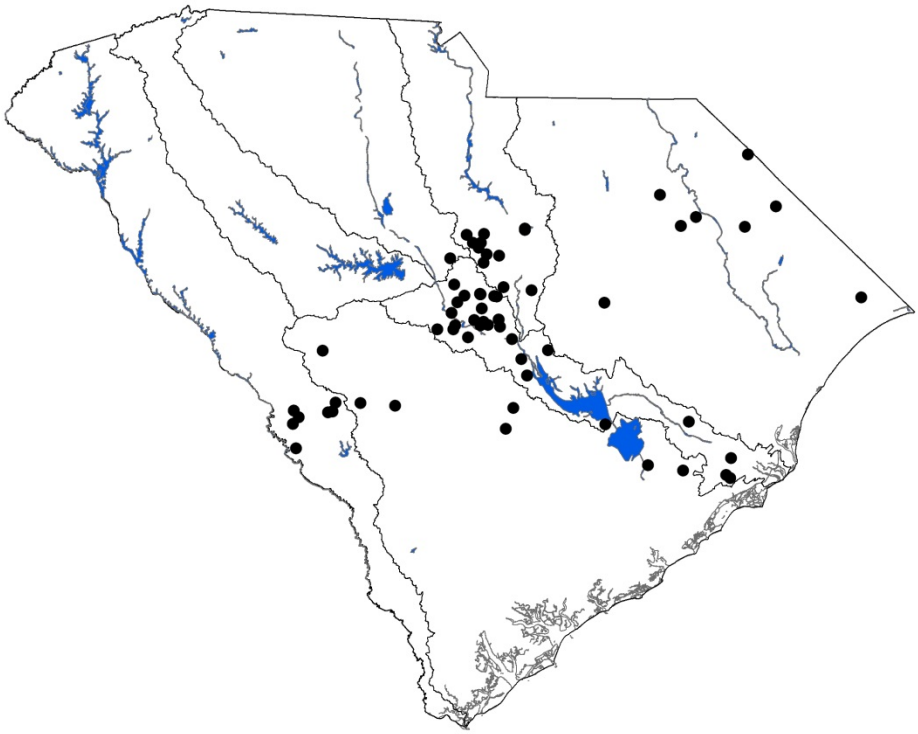

Figure 28. Spatial distribution of *Procambarus chacei*.

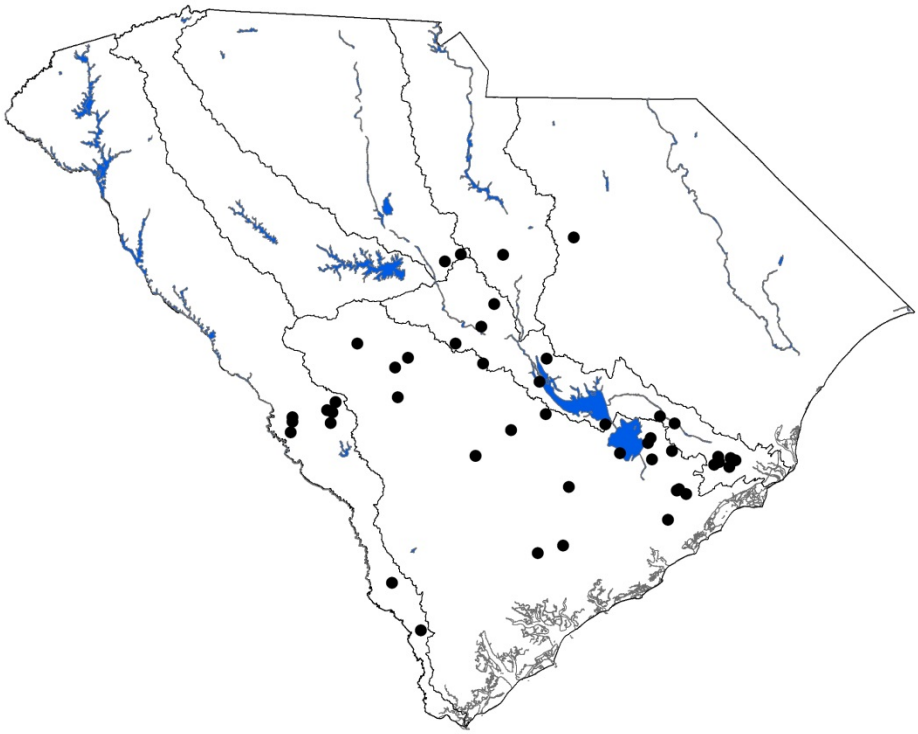

Figure 29. Spatial distribution of *Procambarus enoplosternum.*

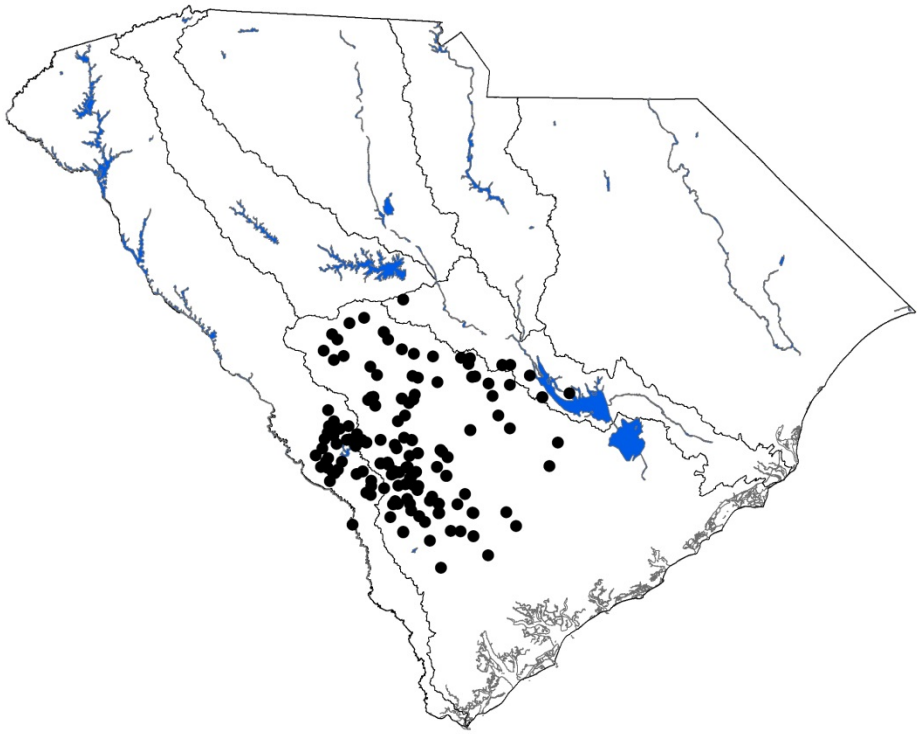

Figure 30. Spatial distribution of *Procambarus hirsutus.*

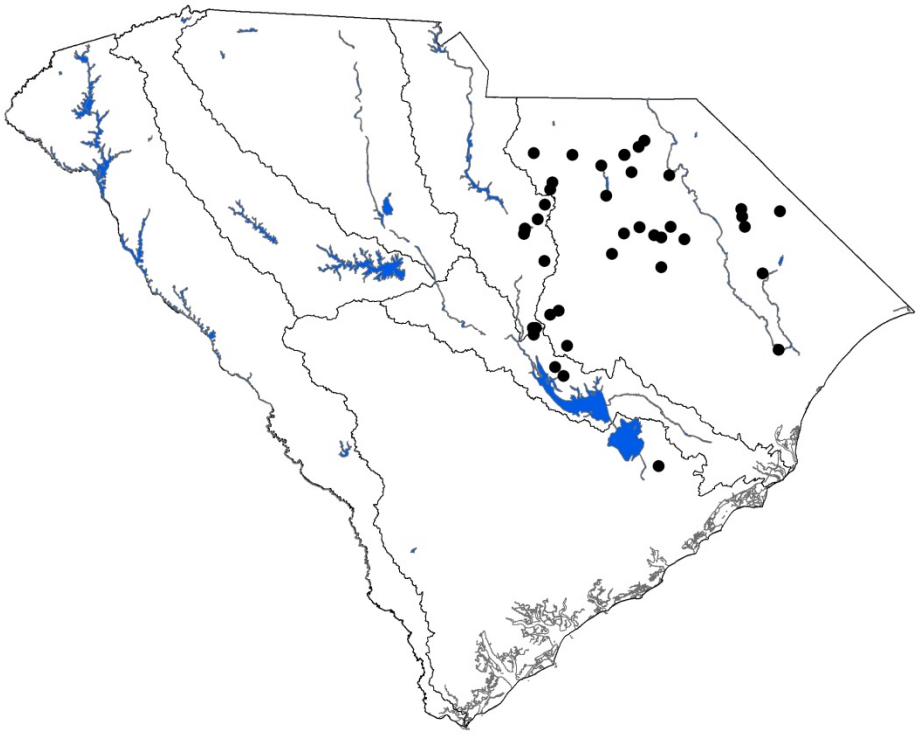

Figure 31. Spatial distribution of *Procambarus lepidodactylus.*

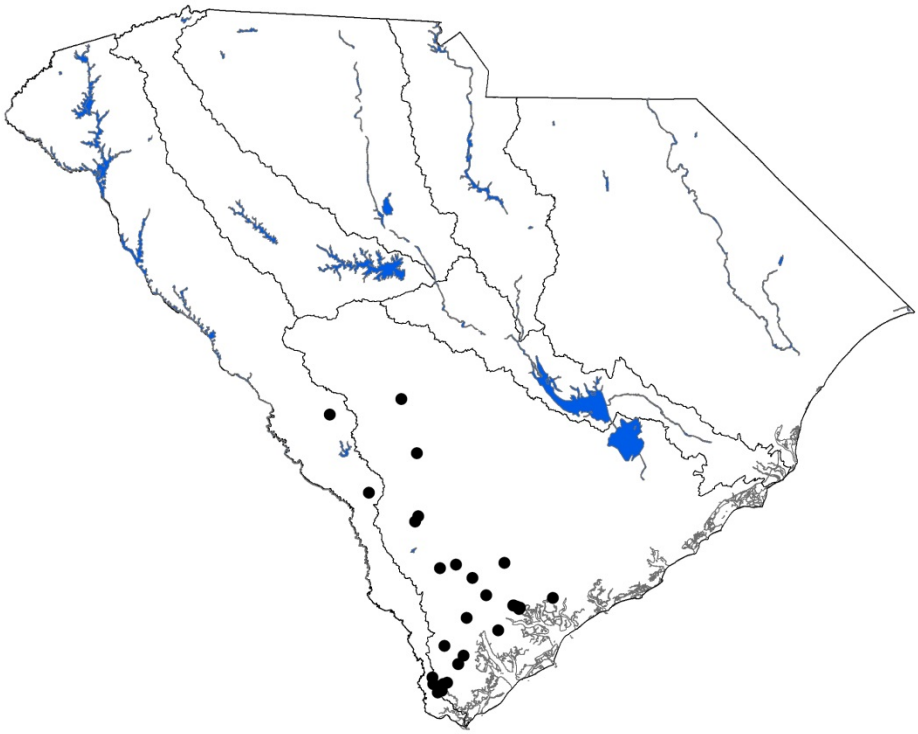

Figure 32. Spatial distribution of *Procambarus lunzi*.

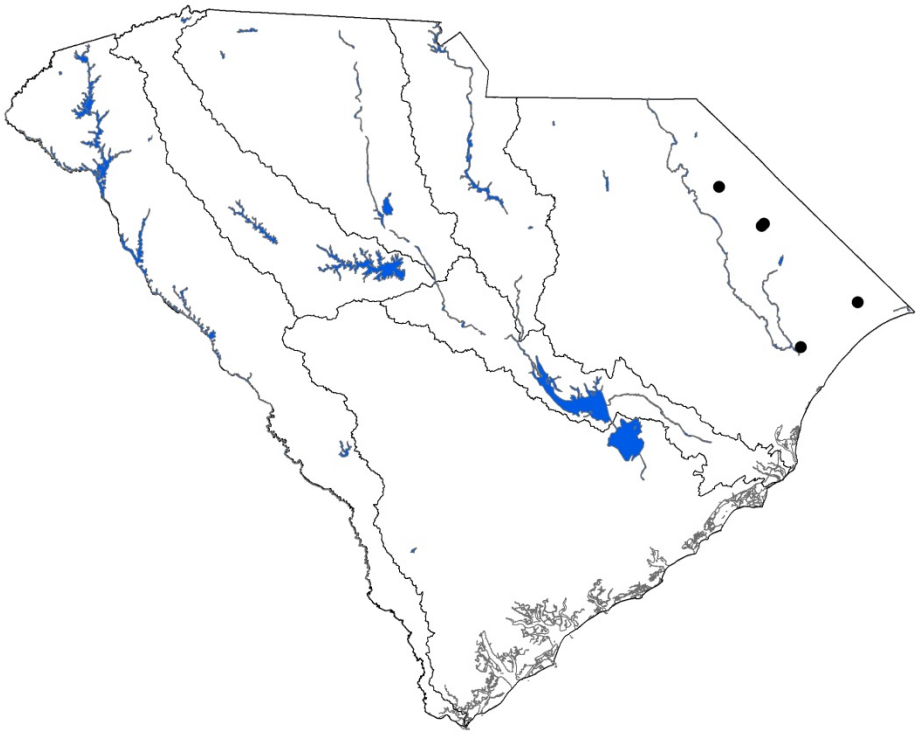

Figure 33. Spatial distribution of *Procambarus pearsei*.

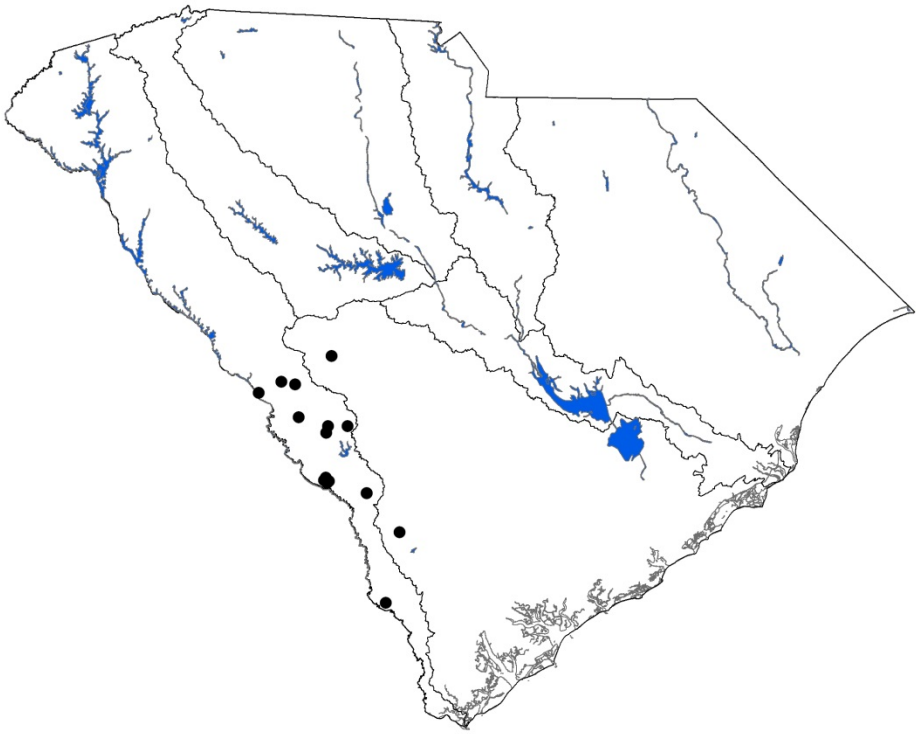

Figure 34. Spatial distribution of *Procambarus pubescens*.

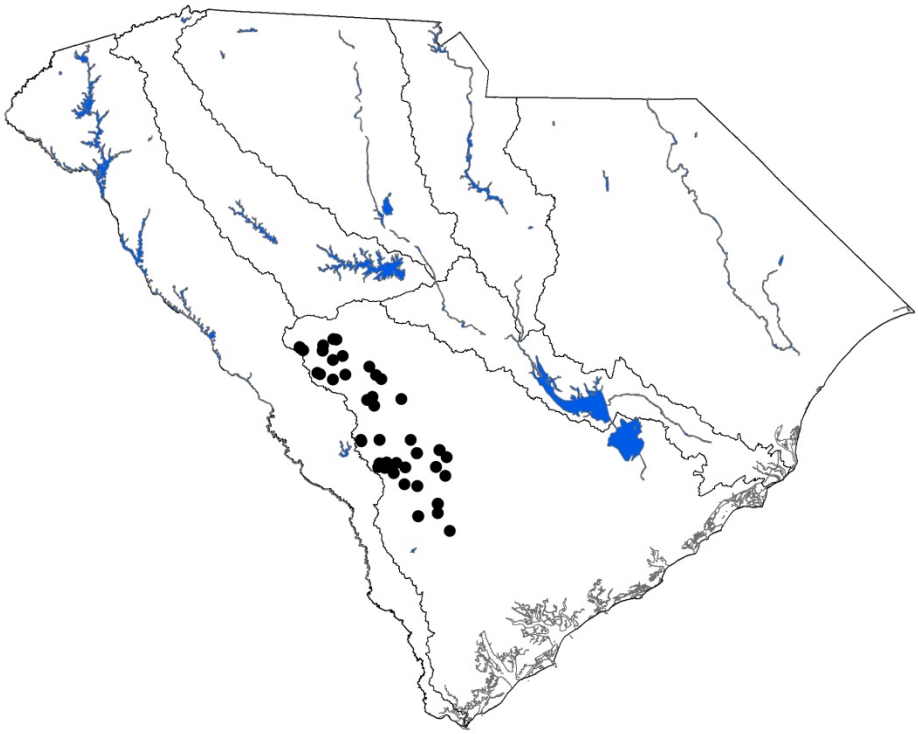

Figure 35. Spatial distribution of *Procambarus echinatus.*

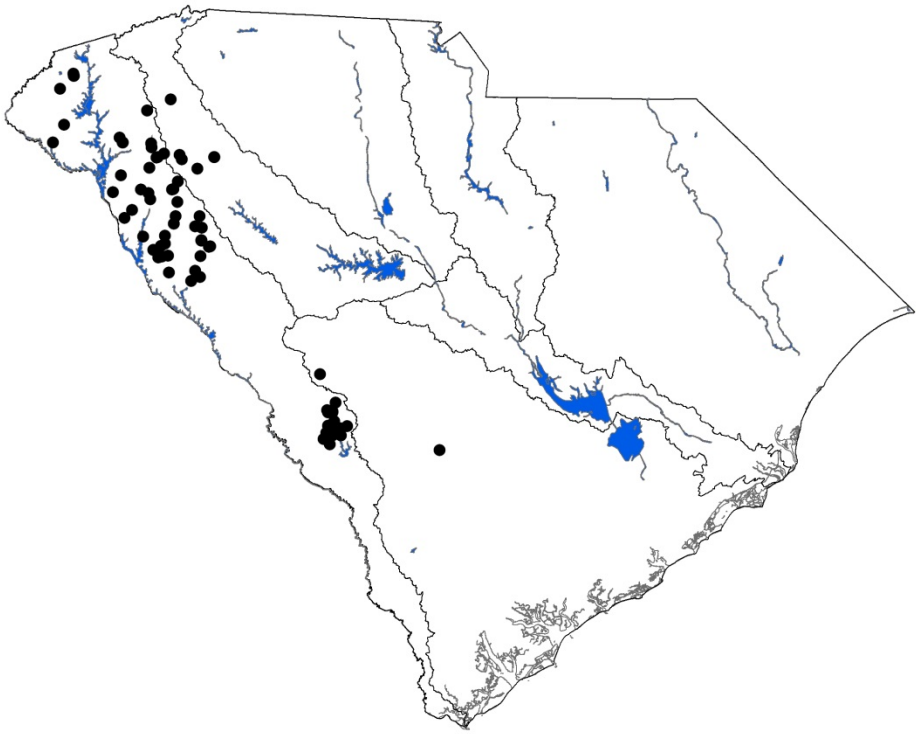

Figure 36. Spatial distribution of *Procambarus raneyi*.

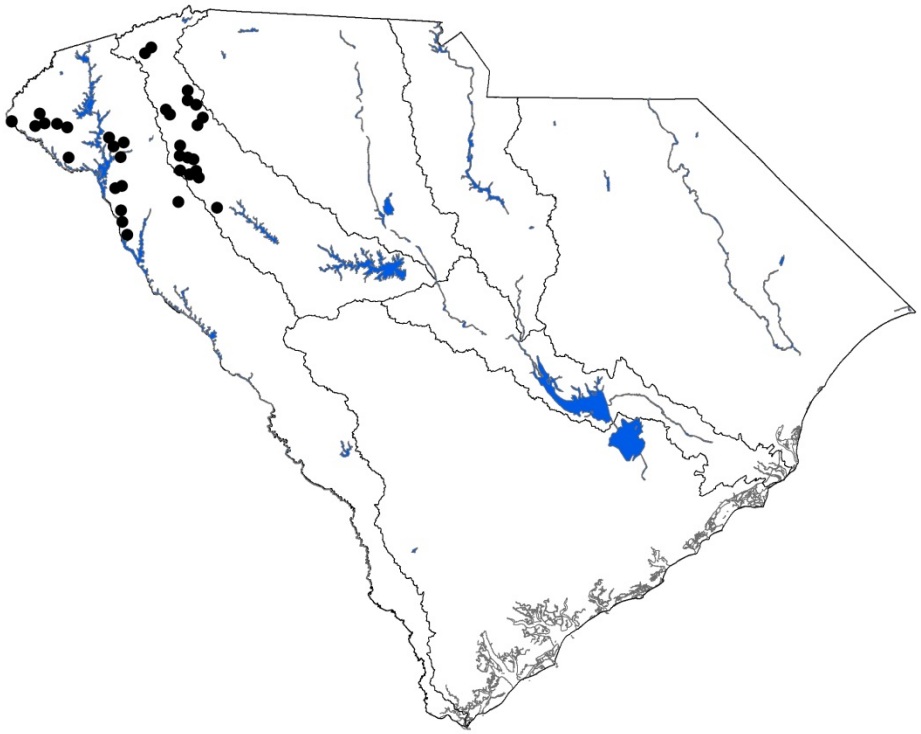

Figure 37. Spatial distribution of *Procambarus spiculifer*.

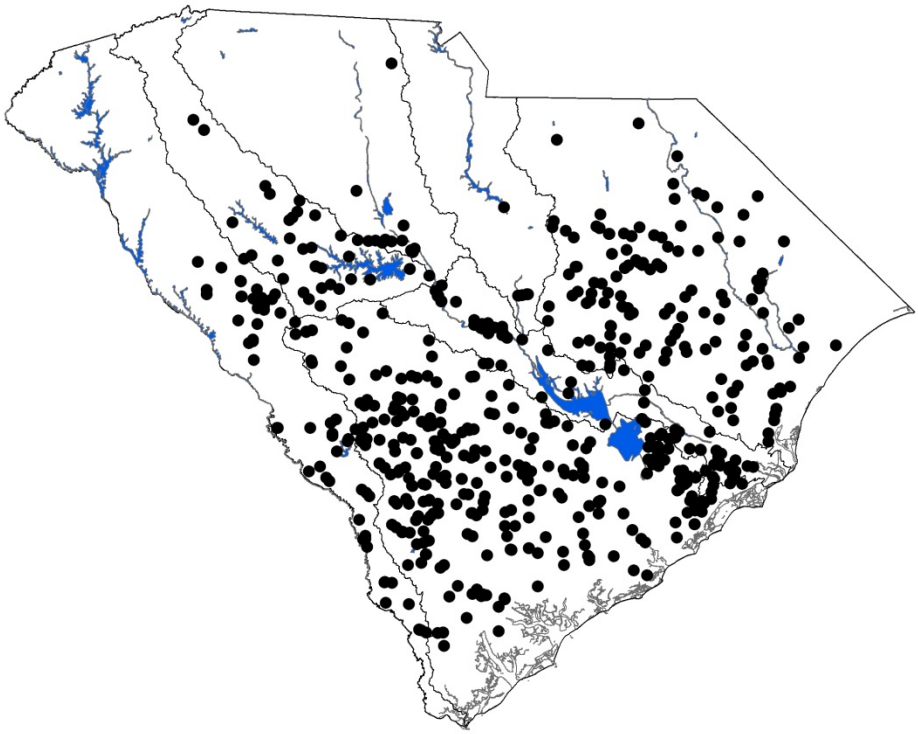

Figure 38. Spatial distribution of *Procambarus troglodytes.*

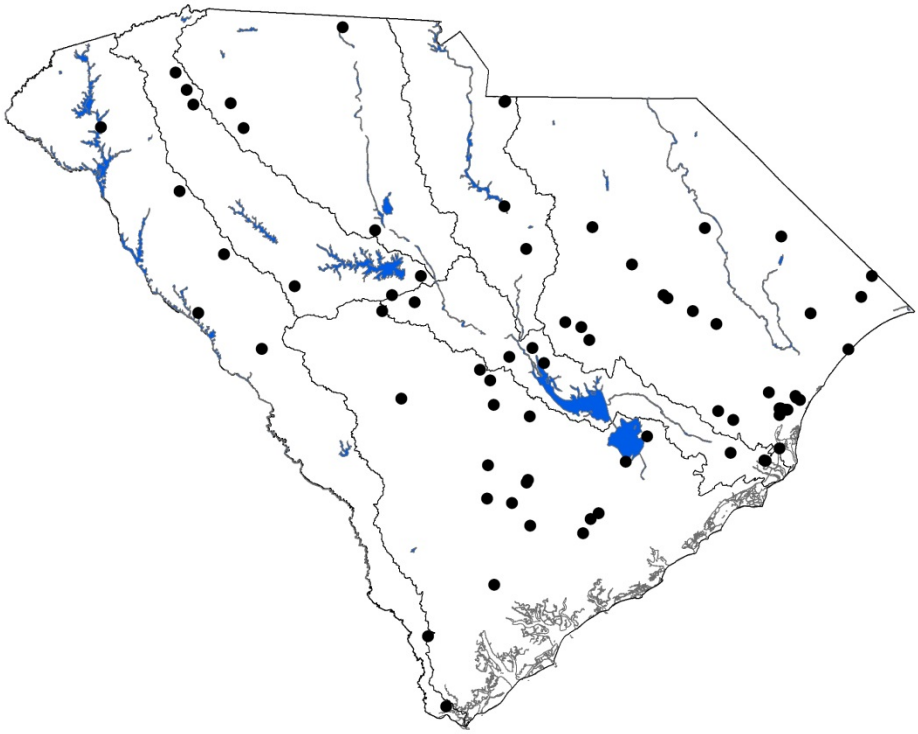

Figure 39. Spatial distribution of *Procambarus clarkii*.