The conservation status of *Cambarus (Puncticambarus) veteranus,* Big Sandy Crayfish and *Cambarus (Jugicambarus) parvoculus,* Mountain Midget Crayfish in Kentucky

MBI Technical Report MBI/2010

May 25, 2010

Submitted by:

Center for Applied Bioassessment & Biocriteria
Midwest Biodiversity Institute, Inc.
P.O. Box 21561
Columbus, OH 43221-0561
Chris O. Yoder, Research Director
mbi@rrohio.com

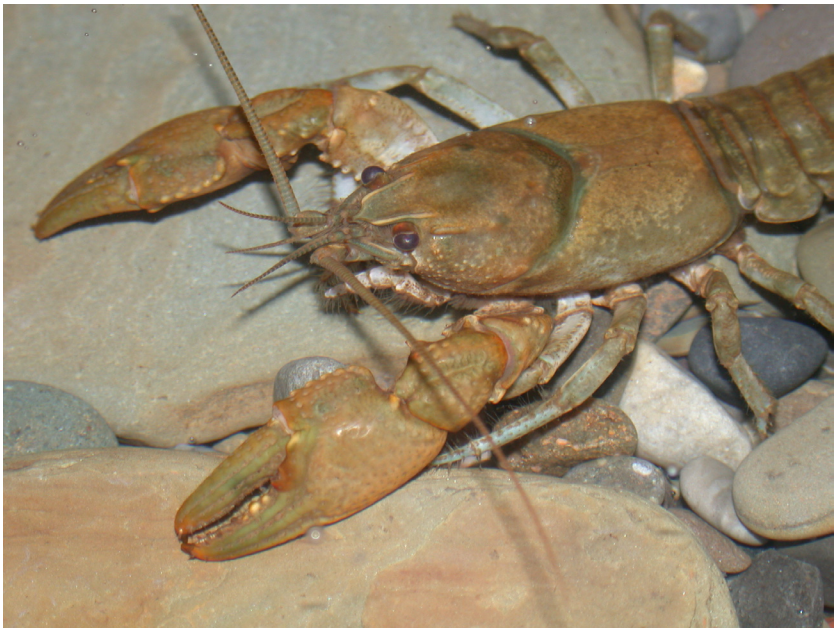
For

Roger F. Thoma, Principal Investigator
bartonii@roadrunner.com

To:

Kentucky Department of Fish & Wildlife Resources
#1 Sportsman's Lane
Frankfort, KY 40601

Cambarus (J.) parvoculus, mountain midget crayfish, unnamed tributary Island Creek, Catoosa Wildlife Management Area, Morgan County, Tennessee (photo Zac Loughman).



Cambarus (J.) distans, boxclaw crayfish, unnamed tributary of Cooper Creek, McCreary County, 23 July 2009.

Cambarus (J.) jezerinaci, spiny scale crayfish,

Recently molted *Cambarus (P.) veteranus*, Big Sandy Crayfish; Russell Fork, Dickenson Co., Virginia.

Table of Contents

Project Summary

Data compiled in this study demonstrates that *Cambarus (Punciticambarus) veteranus* (Big Sandy crayfish), and *Cambarus (Jugicambarus) parvoculus* (mountain midget crayfish), have restricted distributions within Kentucky and warrant elevated conservation status as State Endangered, State Threatened species respectively.

Cambarus veteranus is a large, low gradient stream/river species restricted to the Russell Fork, Levisa Fork, and Tug Fork basins of Floyd and Pike Counties in Virginia. Other populations are found in VA and WV. The species requires low levels of urban, industrial, and non-point pollution impacts plus abundant boulder/cobble cover that is not embedded. Evidence of reproduction was recorded in September. Populations in Kentucky are declining and over half its Kentucky range has been lost, primarily in the Levisa Fork and the Tug Fork mainstem.

Cambarus parvoculus occupied a high gradient, clean, cold, headwater streams of the Obey River basin in Clinton County, Kentucky. Reproductive behavior was observed in the one documented population. Populations are not declining in the State. Its overall range in KY is extremely limited.

The conservation status of *Cambarus (Puncticambarus) veteranus,* Big Sandy Crayfish and *Cambarus (Jugicambarus) parvoculus,* Mountain Midget Crayfish

INTRODUCTION

This document reports on the conservation status, distribution, habitat preferences, and life history of two crayfish species found in Kentucky; *Cambarus (Puncticambarus) veteranus*, and *Cambarus (Jugicambarus) parvoculus*, . The work was conducted by Mr. Roger F. Thoma, Midwest Biodiversity Institute during 2009. The principle areas of focus for the study were the Big Sandy River basin in Pike, Floyd, Martin and Letcher Counties where *C. veteranus* is found and the Cumberland River basin of Whitley, McCreary, Wayne and Clinton Counties where *C. parvoculus* has been reported.

MATERIALS & METHODS

Field work:
One year's field work was conducted in Pike, Floyd, Martin Letcher, Whitley, McCreary, Wayne and Clinton Counties, Kentucky. Two allopatric species of crayfish were studied. Sample site selection for each species is detailed as below.

Cambarus (*P.*) *veteranus*;
Known areas of occurrence were sampled first, then third order or larger tributaries to streams with existing populations were sampled. Sampling focused on the Big Sandy River basin (Pike, Floyd, Martin and Letcher Counties) where museum and literature records indicated the presence or possible presence of the species in Kentucky. Thirty collections were made in July and September.

Cambarus (*J.*) *parvoculus*;
This species is known to favor small, headwater streams so sampling focused on the most upstream reaches of streams and nearby areas downstream. Since a recent study (Thoma & Fetzner, 2008) the Cumberland River basin (Whitley, McCreary, Wayne and Clinton Counties) is the only remaining stream system reported to harbor this species in Kentucky.

Each sample site was georeferenced with a hand held GPS unit. Locality information and habitat quality were recorded on Ohio EPA QHEI (Qualitative Habitat Evaluation Index) data sheets and OSUMC (Ohio State University Museum of Biological Diversity Crustacean Collection) Stream Inventory field data sheets (Appendix D). The QHEI records data on stream substrate composition, in-stream cover, channel morphology, riparian zone & erosion, and pool/glide & riffle/run quality.

Data analysis was conducted with Statistica 8 and ArcView 9.0 computer programs. Statistical analysis employed principle component analysis, correlation analysis, regression analysis, and t-test.

Lab work: Voucher samples were collected at each site and identities verified in lab. All collected material was deposited at OSUMC.

RESULTS

Life History

Reproduction:

Cambarus (*P.*) *veteranus* (Figs. , & Table 1);
First form males, second form males, juveniles, and females were present in both months sampled. Females carrying eggs (ovigerous) were recorded in the month of September. *Cambarus veteranus* has a late summer reproductive cycle (Thoma 2009). Thoma (2009) reported in Virginia the species primarily laid eggs and reared young from July through October. The results of this study conform to that observation. Thoma (2009) also observed mating related behavior in June.

Cambarus (*J.*) *parvoculus* (Figs. & Table);
Only one collection of *C. parvoculus* was made during this study in Clinton County, the most western portion of the State sampled. The collection came from Pickens Branch of Illwill Creek, a tributary of the Obey River system. All males observed (5) were first form. Also observed were 2 females and 2 juveniles (female). A male and female were observed in amplexus (mating). Three ovigerous females (housed at The National Museum of Natural History (USNM) and The Ohio State University Museum of Biological Diversity (OSUMC), 5 and 3 respectively) have been recorded in March and April. First form males have been recorded from March thru November (USNM & OSUMC). It is likely first form males are present year round. These data indicate *C. parvoculus* likely mates in the fall and early spring (as seen in its closest relative *Cambarus jezerinaci*) and lays eggs in early and mid spring.

Habitat Preference:

Cambarus (*P.*) *veteranus*;
The Big Sandy crayfish has been found to show strong correlations with habitat measurements in Virginia (Thoma, 2009). In Kentucky background habitat conditions are similar to those seen in Virginia but with a greater influence of strip mining on stream habitats. *Cambarus veteranus* has responded to this negatively. The species' aversion to elevated sediment levels is evident when sampling sediment impacted streams. As in Virginia, the species was most strongly associated with clean, third order or larger streams, low in bedload sediments, with moderate gradient, and an abundance of boulder/cobble substrate. Many of the streams visited were high in bedload sediments and were not sampled.

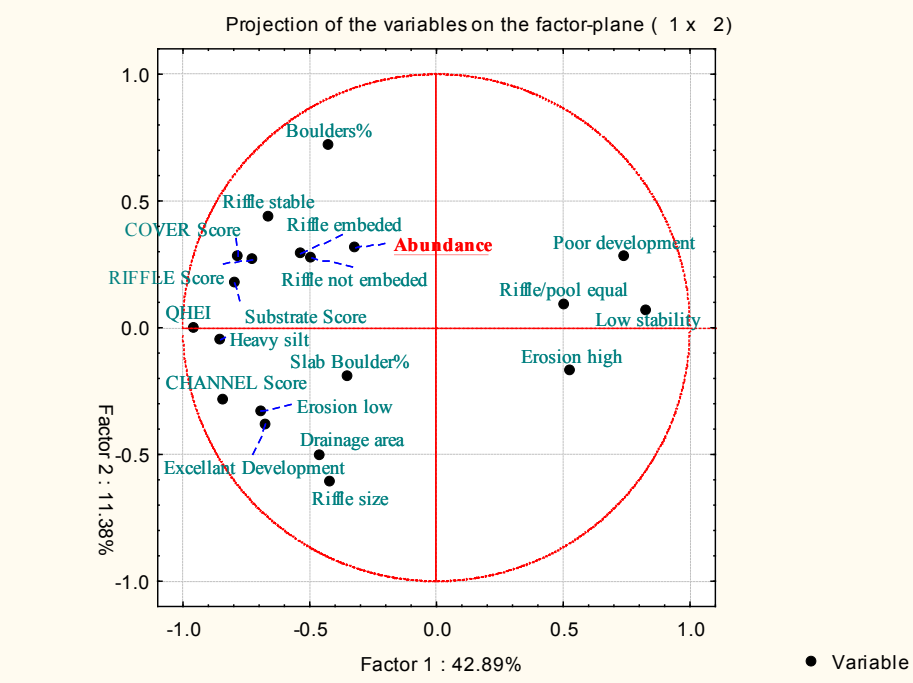


Figure 1. Plot of Factor 1 & 2 for Principle Component analysis of select habitat factors related to the abundance *Cambarus veteranus* in Kentucky streams. Variation explained = 65.55%.

Principle component analysis of habitat data collected in this study showed a strong relationship between *C. veteranus* abundance and general habitat quality (QHEI), riffle quality, and percent boulders. Figure 1 projects factors 1 & 2. The two factors explain 65.55% of variation seen in the data (Table 1). Variables falling within

the upper-left quadrate are most closely related to the abundance of *C. veteranus* while those in the lower-right are least. The association of riffle embedded to abundance is the result of a negative variable scored with a negative number resulting in an apparent positive relationship. A clearer representation of the relationship of the two variables is given in Figure 2. Those sites lacking *C. veteranus* had statistically significantly lower riffle embeddedness scores than those with *C. veteranus*. The other statistically significant relationship with abundance was Substrate score, a number reflecting general quality of riffle habitat. Correlation analysis results show Riffle Embeddedness to be the only habitat variable significantly correlated with *C. veteranus* abundance (Apendix Table B).

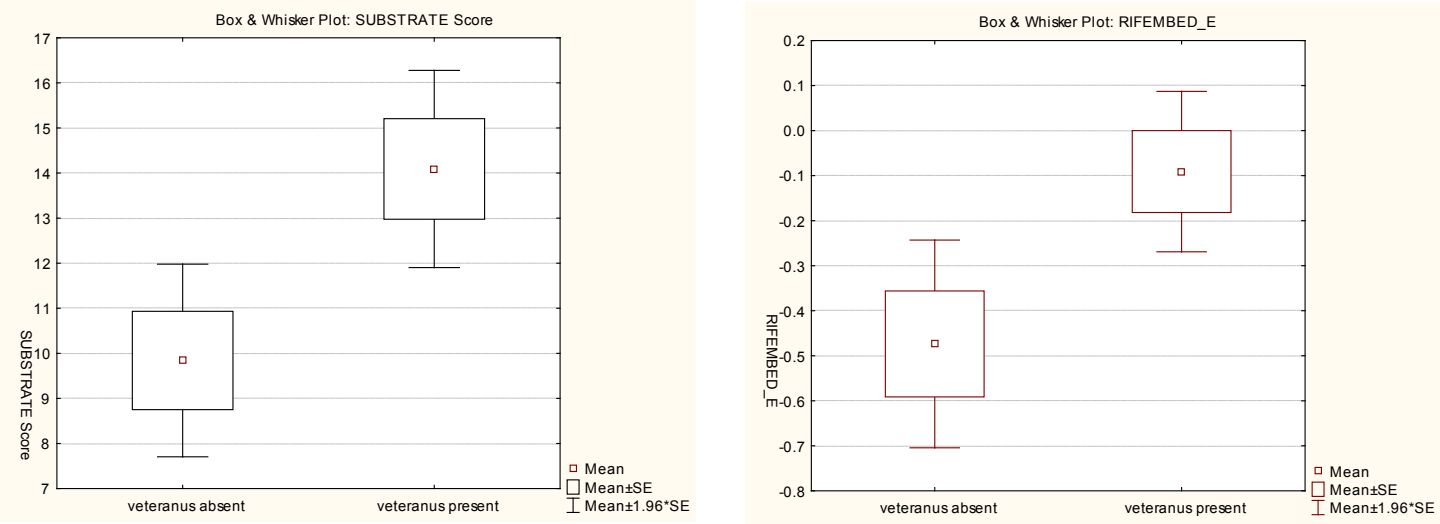


Figure 2. T-test of sites grouped by *C. veteranus* presence/absence for Substrate Score and Riffle Embeddedness, two variables found to show statistically significant differences.

Table 1. Eigenvalues of correlation matrix, and related statistics. Active variables only.

	Eigenvalue	% Total-variance	Cumulative-Eigenvalue	Cumulative - %
1	3.959247	49.49058	3.959247	49.4906
2	1.285178	16.06473	5.244425	65.5553
3	0.966028	12.07535	6.210453	77.6307
4	0.660678	8.25848	6.871131	85.8891
5	0.427391	5.34239	7.298522	91.2315
6	0.363829	4.54786	7.662351	95.7794
7	0.337649	4.22061	8.000000	100.0000

Cambarus (*J.*) *parvoculus*;
Due to the fact that only one site harboring *C. parvoculus* was found in this study it is not possible to analyze the habitat preferences of this species in Kentucky. Discussion of habitat preferences will be based on observations of Tennessee populations previously studied by the author. In Tennessee, the center of the species' distribution, it is found in small cool water streams with closed canopies, moderate to high gradients, abundant cobble/boulder substrate originating from sandstone bedrock. The Kentucky site fits this description.

Kentucky Distributions

Cambarus (*P.*) *veteranus*;

Taylor and Schuster (2004) reported *C. veteranus* from 4 sites in Kentucky, one in Knox Creek of Tug Fork, one in Levisa Fork and two in Russell Fork. This study confirmed continued existence at all four sites and added seven more localities. Most significant is a new population recorded in Shelby Creek of Pike County (3 sites). The 4 other new sites were: two additional tributaries of Tug Fork (Blackberry Creek, Peter Creek), 1 more Levisa Fork site (between the historic most downstream site and the confluence of Russell Fork), and the remains of a dead individual in the lower portion of Elk Creek.

Cambarus (*J.*) *parvoculus*;
As stated previously, only one site harboring a population of *C. parvoculus* was found during this study. *Cambarus parvoculus* sites previously reported by Taylor and Schuster (2004) from the Cumberland River basin in the vicinity of Pine Mountain and upstream have been found to be most closely related to *Cambarus jezerinaci* (Thoma and Fetzner, 2008). The areas sampled in this study were those sites reported for the Big South Fork basin and Cumberland River basin downstream Pine Mountain and its western flank. The most commonly encountered species was *Cambarus distans* (17 sites), a close relative of *C. parvoculus* and *C. jezerinaci*. The three sites reported to be *C. parvoculus* within the 4 county study area were sampled and found to harbor *C. distans*.

DISCUSSION

Life History

Cambarus (*P.*) *veteranus*;
Thoma (2009) reported on the life history of *C. veteranus* and found the species' reproduction was focussed on mid summer to late fall with some late spawning females still carrying young in early spring. In general mating occurs in mid summer, egg laying occurs in late summer and fall, and young are independent by early spring of the next year. Observations in this study conformed to that scenario. It was also reported that fresh molted individuals were very common in late spring/early summer. Kentucky populations also show this phenomenon. It appears the general life cycle pattern for *C. veteranus* is 2 to 3 years growth, maturation in the 3rd year, and first mating in mid summer of the 3rd or 4th year. After mating a series of years characterized by mid summer mating, late summer/fall spawning, spring release of young, and late spring/early summer molting ensues. How many years of reproduction an individual can experience is not clear. It is speculated (using best professional judgement) that at least 2 or 3 years minimum could be expected. In early spring samples during previous studies/sampling efforts dead individuals were more commonly found. These individuals were almost always the largest individuals from the previous summer. *Cambarus veteranus* likely lives 5 to 7 years though it should not be discounted that fortunate individuals may live approximately 10 years.

Other crayfish species collected with Kentucky *C. vetranus* populations were *Cambarus* (*C.*) *sciotensis*, Teays River crayfish, *Cambarus* (*C.*) *angularis*, angled crayfish, *Cambarus* (*P.*) *robustus*, big water crayfish, and *Orconectes* (*P.*) *cristavarius*, spiny stream crayfish.

Cambarus (*J.*) *parvoculus*;
Because there are very few *C. parvoculus* collections it is difficult to draw an accurate picture of the species' life history. It appears the species' reproductive cycle is similar to that observed in many other headwater stream species: mating in late summer and fall, egg laying in late fall and early spring, and fledging in late spring and early summer. This is the pattern observed in *C. jezerinaci*, the most closely related species. In describing C. jezerinaci Thoma (2000) referred to it as a sister species of *C. parvoculus*. Thoma and Fetzner (2008) confirmed this relationship.

Other crayfish species collected with the one Kentucky *C. parvoculus* population were *Cambarus* (*E.*) *tenebrosus*, cavespring crayfish, and *Orconectes* (*P.*) *placidus*, bigclaw crayfish.

Kentucky Distributions

Cambarus (*P.*) *veteranus* Fig. 3; It is reasonable to assume all of the Big Sandy River basin upstream the Tug Fork - Levisa Fork confluence was once occupied by *C. veteranus*. This is an area of 3,974 square miles (includes all 3 states). The Kentucky portion of this drainage basin is approximately 2,975 square miles. Much of this area is no longer occupied by the species. In the Tug Fork basin *C. veteranus* is confined to 3 tributaries. No populations could be found in Tug Fork proper. The stream was severely polluted and heavily impacted by excess sediment. Very few crayfish were found inhabiting the stream and all were tolerant species of *Orconectes* (*O. cristavarius* & *O. rusticus*). The survival of the Tug Fork tributary populations is highly tenuous. They are confined to the lower portions of the streams and display low abundance.

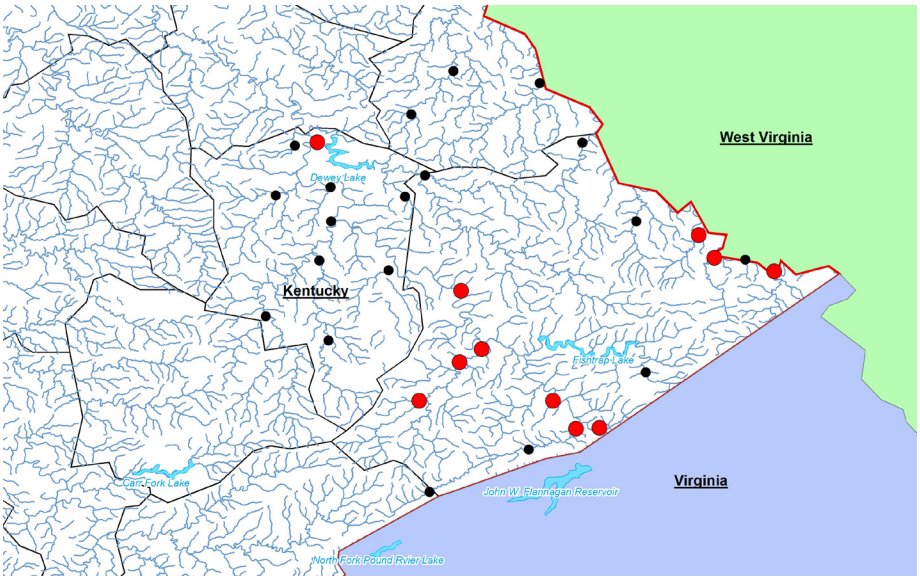


Figure 3. Distribution of *Cambarus veteranus* in Kentucky. Red dots: *C. veteranus* present, black dot: *C. veteranus* absent.

In Levisa Fork proper the species is found in very low numbers. The populations of the stream are obviously stressed and specimens collected were in poor condition. Any increase in pollution load could easily eliminate the species (similar to Tug Fork). Only 2 tributaries of Levisa Fork harbored populations of *C. veteranus*. Shelby Creek in Pike County has one of the healthiest populations in Kentucky. Populations in the lower and upper portions of the stream are very healthy while the middle section of the stream's population is stressed, primarily by nearby strip mining and associated sediment loads. Russell Fork, just upstream Shelby Creek, is the last stream with *C. veteranus* populations. The populations of Russell Fork healthiest upstream near the Virginia State line. In the Levisa Fork basin upstream Russell Fork no extant populations could be found.

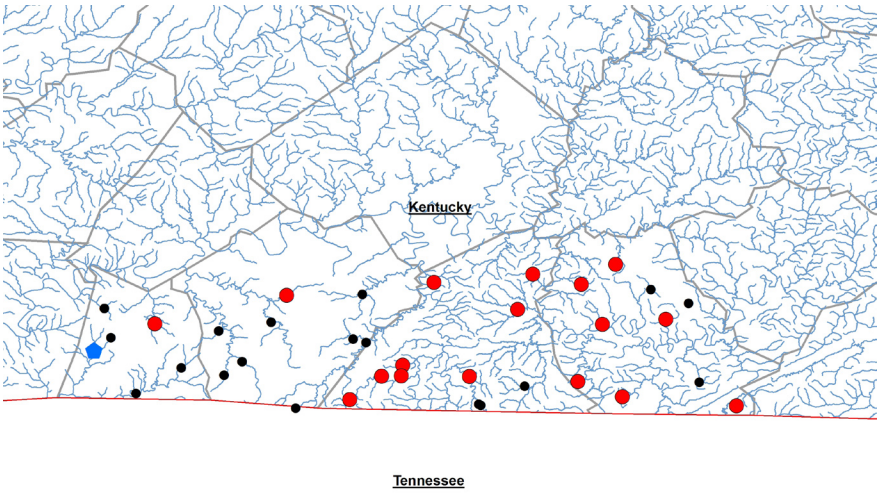


Figure 4. Distribution of *Cambarus parvoculus* in Kentucky. Red dots: *C. distans* present, blue pentagon: *C. parvoculus* present black dot: neither species present.

Cambarus (*J*.) *parvoculus* Fig. 4;
In hind thought it is not surprising to find that *C*. *parvoculus* was found in the Obey River system. The type locality of the species is from the Hurricane Creek basin, a tributary of the Obey River. The surprising result of this study was the lack of *C parvoculus* found in the remaining portions of the Cumberland River basin. It was tacitly assumed at the beginning of this project that *C*. *parvoculus* would be found in the study area and likely at numerous new locations. Half way through the collecting effort it became apparent that this would not be the case. All of the localities reported by Taylor and Schuster (2004) turned out to be occupied by *C*. *distans*. Two sites in the Spring Creek basin of Clinton County were reported to harbor *C*. *distans*. Collecting at two Spring Creek sites failed to yield any members of the subgenus *Jugicambarus*. At the time of collecting the area was experience very dry conditions and most of the small headwater streams (all on limestone bedrock) suitable for the subgenera's occupation were dry. This stream system may harbor *C*. *parvoculus*. Further collecting will have to be conducted to make this determination.

Conservation Status

Cambarus (*P*.) *veteranus*;
Current conservation designations are IUCN: Vulnerable, Taylor et al. (2007): Threatened, Kentucky: Special Concern. This report recommends Kentucky elevate *C veteranus* to Endangered conservation status. This recommendation is made based on the extreme loss of range within Kentucky and the fact that only two populations have been found to be healthy (Shelby Creek & upper Russell Fork) one of which (Shelby Cr.) is experiencing stress from strip mining activities within its basin.

Recommended conservation actions are, in order of importance, control of activities and conditions resulting in increased erosion and sedimentation, rehabilitation of habitats damaged by stream modification, and reduction of nutrient inputs. Many area streams are currently overwhelmed with heavy bed loads of sand and silt. If some of these in stream sediments could be removed, downstream reaches could be spared future impacts and impacted stream could recover sooner. In habitat modified streams, riffle structure has been damaged by removal of slab shaped boulders. Habitat for *C*. *veteranus* in these areas would be greatly enhanced by placing slab boulders in the riffles of these streams (as long as bed load sediments are not excessive). The downstream reaches of Russell Fork and Levisa Fork were noticably impacted by elevated nutrient levels. This enrichment is impacting much of the streams ecological structure. At those sites with high enrichment impacts few individuals of *C*. *veteranus* were observed and those seen appeared to be stressed. Also, few, if any, young individuals were seen.

Cambarus (*J*.) *parvoculus*;
Current conservation designations are IUCN: Least Concern, Taylor et al. (2007): Currently Stable, Kentucky: Threatened. This report recommends Kentucky consider elevating *C parvoculus* to Endangered conservation status. This recommendation is made based on the finding that the species has a highly restricted range within Kentucky.

Recommended conservation actions are establishing conservation easements or other conservation measures in the Illwill Creek basin of Clinton County. Though the species was not recorded there, consideration should be given to the Spring Creek and Sulpher Creek basins of Clinton County. Little other action seems needed at this point in time.

Other Findings

The finding of *C*. *angularis* in Kentucky (Fig. 5) was the most significant unintended finding of this study. This

is the first record of the species in Kentucky. The species has also been documented in the Big Sandy River basin of West Virginia by Mr. Zac Loughman (personal communication). It may be that this population forms a unique genetic pool. A study of its relationship to the nominate population in the Clinch and Powell Rivers of Virginia should be undertaken. Because of the limited range and the high levels of environmental stress in the Tug Fork Basin the species should be classified Endangered by Kentucky.

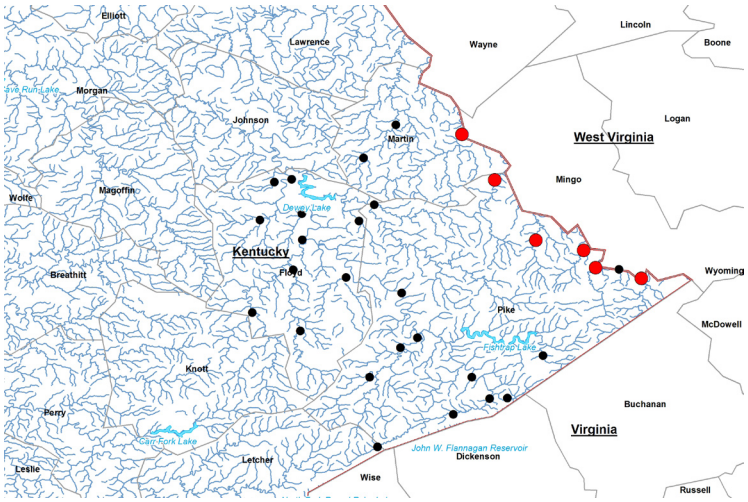


Figure 5. Distribution of *Cambarus angularis* in Kentucky. Red dots: *C. angularis* present, black dot: *C. angularis* absent.

RELEVANT LITERATURE

Channell, K.B. 2004. Implementation of a Spacial-Temporal Focus to Predict Habitat Locations and Distribution of *Cambarus veteranus*. MS Thesis, Marshal University, Huntington, WV. 79 pp. + viii.

Hobbs, H.H., Jr. 1981. The Crayfishes of Georgia. Smithsonian Contributions to Zoology No. 318.

------. 1989. An Illustrated Checklist of the American Crayfishes (Decapoda: Astacidae, Cambaridae, and Parastacidae). Smithsonian Contributions to Zoology No. 480.

----- and C.S. Shoup. 1947. Two New Crayfishes (Decapoda: Astacidae) from the Obey River Drainage in Tennessee. Journal of the Tennessee Academy of Science. 22(2):138-145.

Jezerinac, R.F., G.W. Stocker, & D.C. Tarter. 1995. The Crayfishes (Decapoda: Cambaridae) of West Virginia. Ohio Biological Survey Bulletin New Series 10(1).

Simmons, J.W. and S.J. Fraley. 2008. Distribution, Status, and Life History Observations of Crayfishes in Western North Carolina. North Carolina Wildlife Resources Commission, Raleigh, North Carolina. 109 pg. + v.

Taylor, C.A. and G.A. Schuster. 2004. The Crayfishes of Kentucky. Illinois Natural History Survey Special Publication.

------, G.A. Schuster, J.E. Cooper, R.J. DiStefano, A.G. Eversole, P. Hamr, H.H. Hobbs III, H.W. Robison, C.E. Skelton, and R.F. Thoma. 2007. A Reassessment of the Conservation Status of Crayfishes of the United States and Canada after 10+ Years of Increased Awareness. Fisheries. 32(8): 372-389.

Thoma, R.F. 2000. *Cambarus (Jugicambarus) jezerinaci* (Crustacea: Decapoda: Cambaridae), a new species of crayfish from the Powell River drainage of Tennessee and Virginia. Proceedings of the Biological Society of

Washington 113(3):731-738.

----- & J.W. Fetzner. 2008. Taxonomic Status of *Cambarus (Jugicambarus) jezerinaci,* Spiny Scale Crayfish, Powell River Crayfish. Midwest Biodiversity Institute, Columbus, Ohio. 69 pp. + iv.

-----, 2009. The conservation status of *Cambarus* (*Puncticambarus*) *veteranus*, Big Sandy Crayfish; *Cambarus* (*Jugicambarus*) *jezerinaci*, Spiny Scale Crayfish; and *Cambarus* (*Cambarus*) sp. A, Blue Ridge Crayfish. Midwest Biodiversity Institute, Columbus, Ohio. 20 pp. + iii.