

**The conservation status of  
*Cambarus (Puncticambarus) veteranus*, Big Sandy Crayfish;  
*Cambarus (Jugicambarus) jezerinaci*, Spiny Scale Crayfish;  
and *Cambarus (Cambarus) sp. A*, Blue Ridge Crayfish**

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Possible undescribed species, *Cambarus* sp. A, from East Fork Chestnut Creek of the New River basin, near Galax, Virginia.



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



*Cambarus (J.) jezerinaci*, White Branch, Powell River basin,  
Lee County, Virginia.

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## Project Summary

Data compiled in this study demonstrates that *Cambarus (Punciticambarus) veteranus* (Big Sandy crayfish), *Cambarus (Jugicambarus) jezerinaci* (spiny scale crayfish), and *Cambarus (Cambarus) sp. A* (Blue Ridge crayfish: proposed common name) all have restricted distributions within Virginia and warrant elevated conservation status as State Endangered, State Threatened, and State Endangered respectively.

*Cambarus veteranus* is a large, low gradient stream/river species restricted to the Russell Fork and Levisa Fork basins of Wise, Dickenson and Buchanan Counties in Virginia. Other populations are found in KY and WV. It requires low levels of urban, industrial, and non-point pollution impacts and abundant boulder/cobble cover. The species is best classified a carnivore. Its reproductive life cycle is focused on mating and reproducing during the warmer summer months (July & Aug.) with young released in the early fall (Sept. & Oct.). Populations in Virginia are declining and nearly half its Virginia range has been lost, primarily in the Levisa Fork basin.

*Cambarus jezerinaci* occupies high gradient, clean, cold, headwater streams of the Powell River basin draining from Cumberland Mountain in Lee and Wise Counties, Virginia. Elevated bed-load sediments of sand and silt negatively impact the species' population numbers. It is here-in classified an interstitial lithophyle (occupying the spaces between rock/rubble substrates), a life style that makes it particularly vulnerable to sedimentation. Its preferred food is insect larvae and small amounts of plant material. The reproductive life cycle is concentrated in the spring of the year with females carrying eggs from Jan. thru June and young in June. Populations have been lost or are declining in streams experiencing deforestation and urbanization. Its overall range in VA has not declined.

*Cambarus* species A has a highly restricted distribution in Virginia being found in only three small, high elevation streams of the New River basin located in the Blue Ridge Plateau Physiographic Province of Grayson County, Virginia. It is not known why the species' distribution is restricted in this manner. The streams are densely forested and silt loads are low. Its preferred food is insect larvae and it appears to be highly intolerant of environmental disturbance. The reproductive life cycle remains unknown. Its Virginia distribution does not appear to have declined but populations in deforested areas with grazing activity show signs of distress.

# **The conservation status of *Cambarus (Puncticambarus) veteranus*, Big Sandy Crayfish; *Cambarus (Jugicambarus) jezerinaci*, Spiny Scale Crayfish; and *Cambarus (Cambarus) species A*, Blue Ridge Crayfish**

## **INTRODUCTION**

This document reports on the conservation status, distribution, habitat preferences, food preferences, and life history of three crayfish species found in Virginia; *Cambarus (Puncticambarus) veteranus*, *Cambarus (Jugicambarus) jezerinaci*, and *Cambarus (Cambarus) species A*. The work was conducted by Mr. Roger F. Thoma, Midwest Biodiversity Institute during the years of 2007, 2008, and 2009. The principle areas of focus for the study were the Big Sandy River basin in Dickenson and Buchanan Counties where *C. veteranus* is found, the Powell River basin of Lee and Wise Counties where *C. jezerinaci* is found, and the New River basin of Grayson County where *Cambarus* sp. A is found.

## **MATERIALS & METHODS**

*Field work:* Three years field work were conducted in Buchanan, Carroll, Dickenson, Grayson, Lee, Patrick, Tazewell, and Wise Counties, Virginia and Ash, Catawba, Cherokee, Clay, Spartinburg, and Surry Counties, North Carolina in 2007, 2008, and spring of 2009. Three allopatric species of crayfish were studied. Sample site selection for each species was as follows:

*Cambarus (P.) veteranus;* Known areas of occurrence were sampled first. All reaches downstream of known localities were sampled. Upstream known localities, samples were taken until the species no longer could be found. Tributaries to streams with existing populations that were at least third order were sampled. Sampling focused on the Big Sandy and Bluestone River basins (Buchanan, Dickenson, Tazewell, and Wise Counties) where museum records indicated the presence or possible presence of the species in Virginia.

*Cambarus (J.) jezerinaci;* This species is known to favor small, headwater streams so sampling began in the most upstream reaches of streams and progressed downstream until the species was no longer found. The Powell River basin (Lee and Wise Counties) is the only stream system in Virginia known to harbor this species so sampling was focused on this area. Suitable sites to the east, in the Clinch River basin, were also sampled to check for the presence of *C. jezerinaci*.

*Cambarus (C.) species A;* The Virginia population of this crayfish is the northern most known population of this form, a species complex associated with *Cambarus howardi*. Only one stream in Virginia, Chestnut Creek, was previously known to harbor the species. Sampling focused around the known population. Favorable habitat in streams to the east, west, north, and south of the known locality were sampled to discern the range of the species. Small, high mountain streams were selected for sampling. Stream sections with abundant hemlock/rhododendron cover and aquatic moss growth were targeted.

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. A subset of sites for each species were sampled multiple times to assess seasonality.

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 material collected was deposited at OSUMC. Food studies were conducted on all three species. A single crayfish was placed in an individual container. Each container had a rock shelter under which the crayfish could sequester. A variety of food items were placed in the container with the crayfish and daily observations were made to monitor their consumption. Food items were selected to broadly represent food items each species could potentially encounter. Food items used were meal worm (insect fauna), raw fish (minnows & darters), earth worm (other invertebrates), crayfish (other crayfish species), carrot (roots), lettuce (fresh plants), pecan (nuts such as acorns), apple (fresh fruit), and dried silver maple leaf (decomposing plant material). Ten individuals of each species were tested two times. Records were kept on extent of consumption for each item each day until all of an item was consumed or one week had passed.

Supplemental data was obtained from the United States National Museum (USNM), The Ohio State University Museum of Biological Diversity (OSUMC), Eastern Kentucky University (EKU), and Illinois Natural History Survey (INHS) for use in elucidating seasonality of reproductive cycles. These data were employed in creating Tables 1, 2, & 3 and Figure 17. Because of the uncertainty of collection methodology these external data could

not be used in other data assessments as percentage relationships can not be determined from what may represent presence/absence data. All other figures, tables and analyses in this document are based on data collected specifically for this project during the years of 2007, 2008, and 2009.



Left: Food preference testing chambers. Each individual plastic container housed an individual crayfish. The large blue container at the bottom served as a filter. Water was pumped from the filter to the top of the four columns of containers. A series of overflows connected to containers below allowed the pumped water to cascade through the system and eventually return to the filter. Crayfish did not survive well in this configuration. Removal of the filter and cessation of pumped water and its associated flow created an environment in which survival was much higher. In its final configuration ten individuals of each of the three species could be tested at the same time.



## RESULTS

### Life History Studies

#### Reproduction:

*Cambarus (P.) veteranus* (Figs. 1-3, & Table 1);

First form males, second form males, and juveniles were present during all months sampled during the study period of 2007 thru 2009. Females were present during all months sampled and all other samples reported from external data. Females carrying eggs (ovigerous) were recorded for the months of July, August, & October. Females carrying instars were observed in September, October, & March. *Cambarus veteranus* has a late summer reproductive cycle. During the month of July first form males and females were observed cohabiting rocks. It is likely they were in some stage of mating.

Two ovigerous females (carrying eggs) were observed with 90 and 142 eggs each, and with carapace lengths of 42 and 46 mm respectively. Numerous freshly molted

Table 1. Reproductive seasonality of *C. veteranus*. Blue boxes - reproductive form recorded, red boxes - reproductive form not recorded, non colored boxes - no samples available. Data taken from this study and USNM, OSUMC, EKU, & INHS collections.

Month	Male 1	Male 2	Female	Female ovig.	Female instars	Juveniles
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						

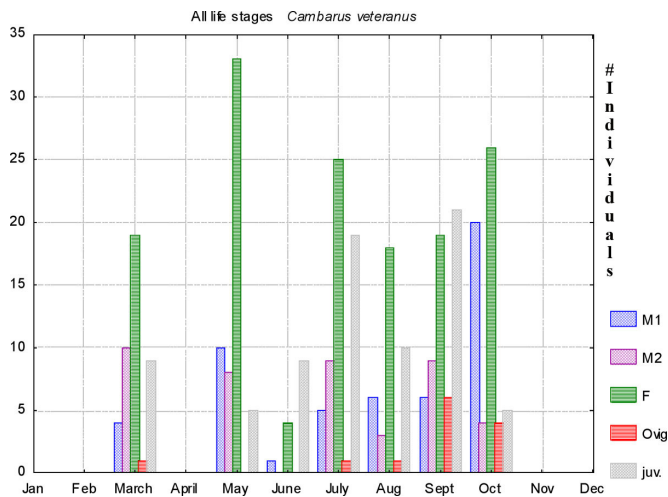


Figure 1. Total number of individuals observed by reproductive/life cycle stage for *Cambarus veteranus*.

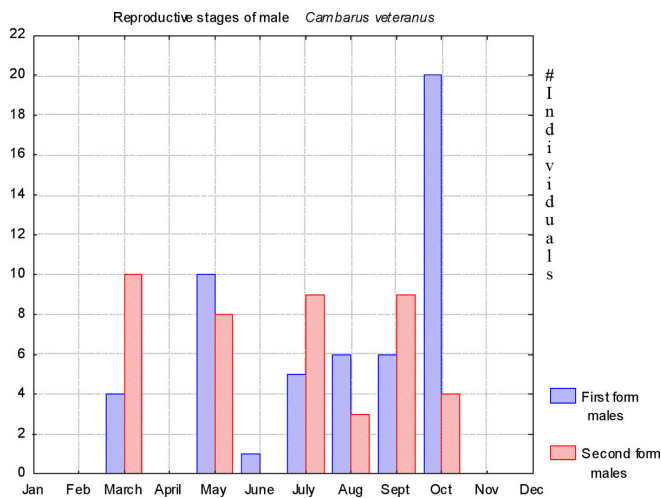


Figure 2. Total number of individual male *Cambarus veteranus* observed by month.

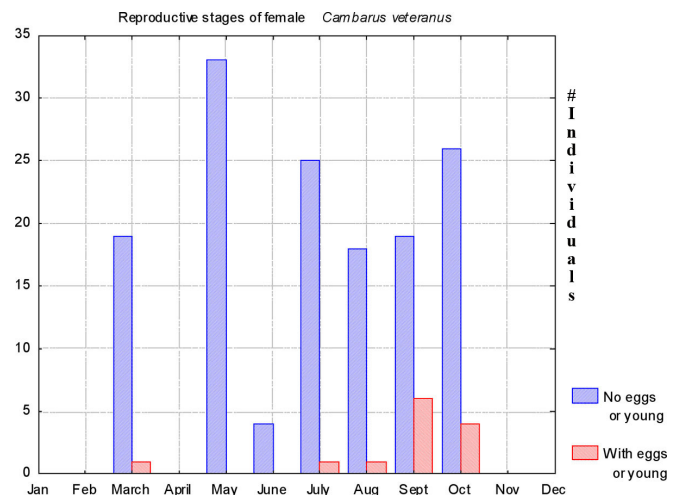


Figure 3. Total number of individual female *Cambarus veteranus* observed by month.

individuals were observed in May at several sites.

*Cambarus (J.) jezerinaci* (Figs. 4 - 7 & Table 2); Life history data is not available for the months of February, September, November, and December. Only one collection was made in March and July making those months' data less reliable. First form males were observed in all months in which more than one collection was made. It may be that first form males are present all year round. Second form males were present at all times collections were made. Females were present at all times. Females carrying eggs were present in the spring months of March, April, and May and into the early summer in June. Juveniles were present

Table 2. Reproductive seasonality of *Cambarus jezerinaci*. Blue boxes - reproductive form recorded, red boxes - reproductive form not recorded, non colored boxes - no samples available. Data from this study and USNM, OSUMC, EKU, & INHSS.

Month	Male 1	Male 2	Female	Female ovig.	Female instars	Juveniles
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						

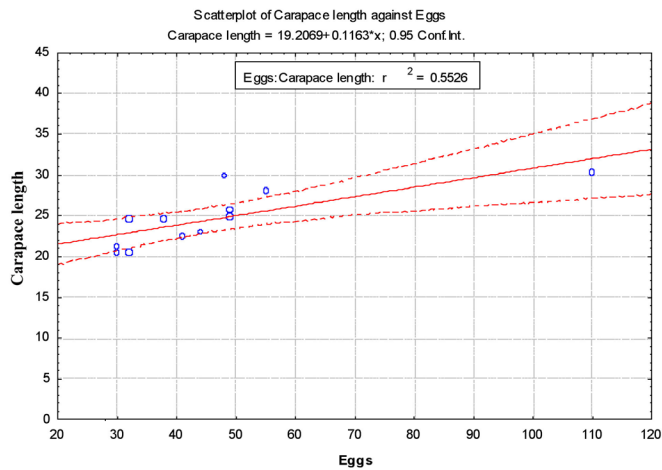


Figure 4. Regression of eggs by carapace length with 95% confidence bands for *Cambarus jezerinaci*.

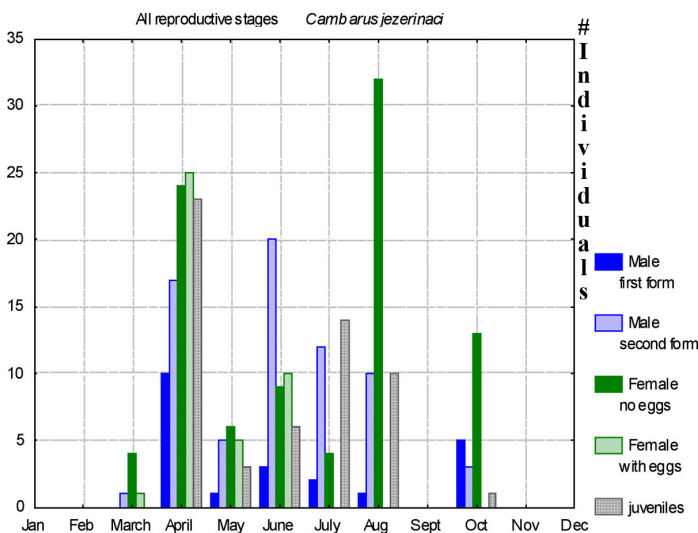


Figure 5. Total number of individuals observed by reproductive/life cycle stage for *Cambarus jezerinaci*.

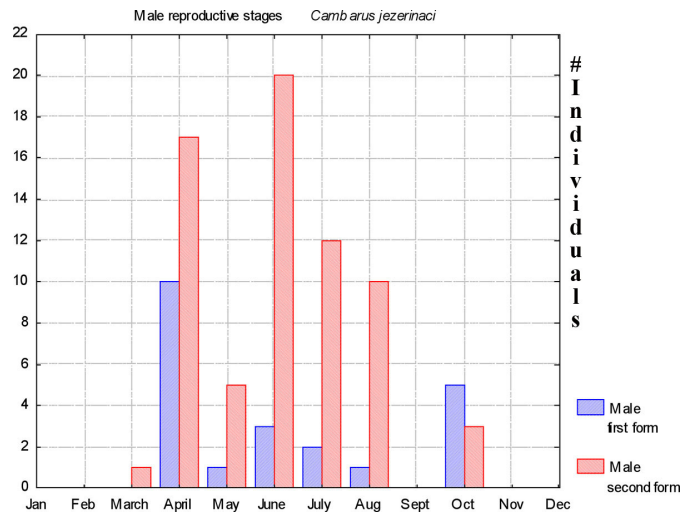


Figure 6. Total number of individual male *Cambarus jezerinaci* observed by month.

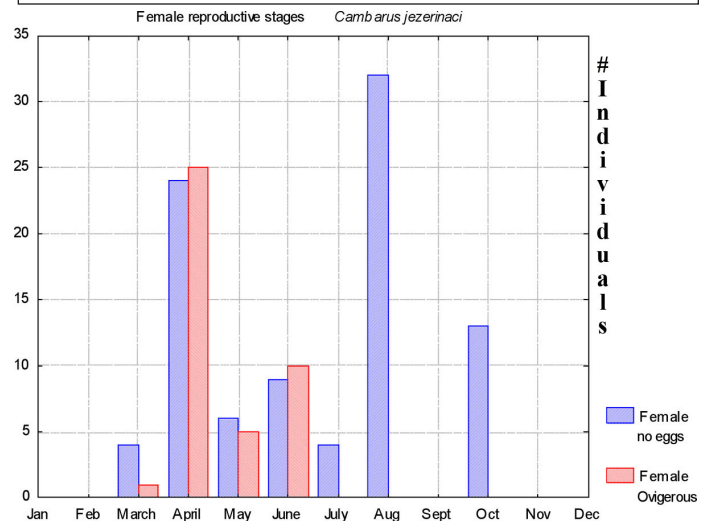


Figure 7. Total number of individual female *Cambarus jezerinaci* observed by month.

in all months sampled except the single March collection. No females carrying instars were observed. These data indicate that the thrust of *C. jezerinaci*'s reproduction occurs in the spring months of the year. The average number of eggs observed was 46.5 and the average gravid female size was 24.6 mm carapace length.

*Cambarus (C.)* sp. A (Figs. 8 - 10 & Table 3);

Collections of this species are available from April through October (Figs. 8 - 10, Table 3). First form males were recorded for all months except July, second form males were present in all months except June, and females were collected in all months. Only one gravid female, 25.54 mm carapace length, was observed in June carrying 80 eggs. Juveniles were observed in almost all collections except August and September. Because of the taxonomic uncertainty of this taxon it has not been possible to include data compiled by other researchers.

Table 3. Reproductive seasonality of *Cambarus* sp. A. Blue boxes - reproductive form recorded, red boxes - reproductive form not recorded, non colored boxes - no samples available. Data from this study and USNM, OSUMC, EKU, and INHS.

Month	Male 1	Male 2	Female	Female ovig.	Female instars	Juveniles
January						
February						
March						
April	Blue	Blue	Blue	Red	Red	Red
May	Blue	Blue	Blue	Red	Red	Blue
June	Blue	Red	Red	Blue	Blue	Blue
July	Red	Blue	Blue	Red	Red	Blue
August	Blue	Blue	Blue	Red	Red	Blue
September	Blue	Blue	Blue	Red	Red	Red
October	Blue	Blue	Blue	Red	Red	Blue
November						
December						

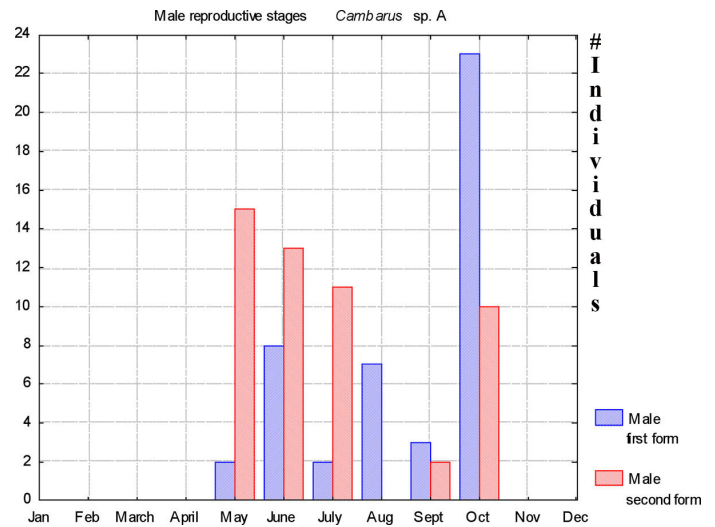


Figure 9. Total number of individual male *Cambarus* sp. A observed by month.

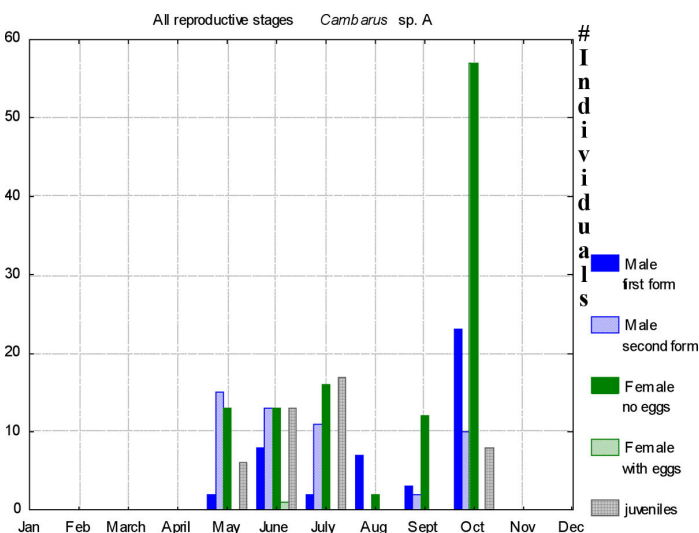


Figure 8. Total number of individuals observed by reproductive/life cycle stage for *Cambarus* sp. A.

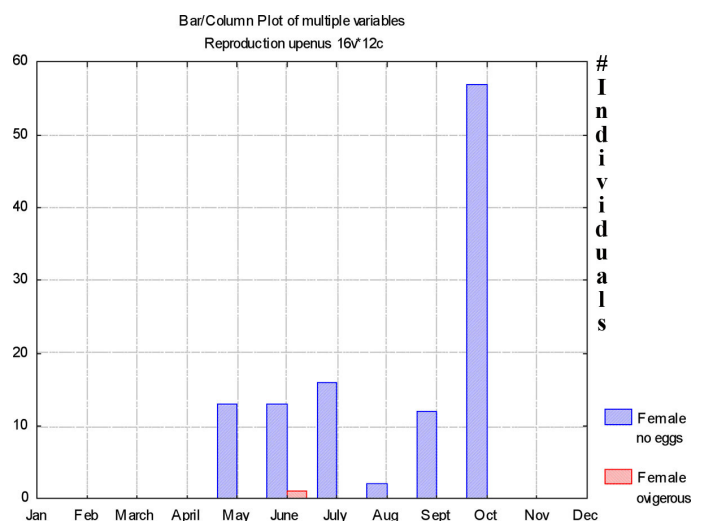


Figure 10. Total number of individual female *Cambarus* sp. A observed by month.

**Habitat Preferences:**

*Cambarus (P.) veteranus*; The Big Sandy crayfish was found to show strong correlations with habitat measurements. Principle component analysis revealed positive relationships (numbers increased as quality increased) between the total individuals observed at a site and all 5 habitat attributes (substrate, cover, channel morphology, riparian/bank erosion, pool/riffle quality) measured by the QHEI (Fig. 11). Elevated levels of pollution, fines (sand, gravel, silt), and gradient were negatively related to total individuals. Box & whisker plots illustrate habitat conditions at sites with and without *C. veteranus* present and scatter plots with mean regression line and 95% confidence interval lines illustrate relationships of *C. veteranus* numbers to habitat factors (Figures Appendix A-1 to A-24).

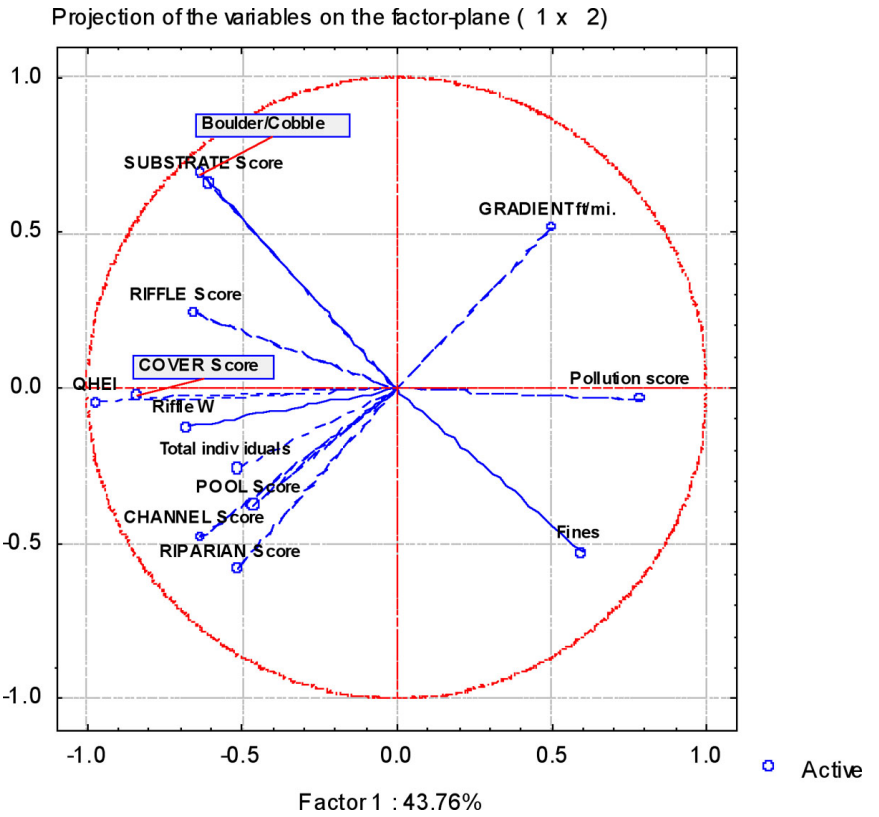


Figure 11. Factor analysis plot of factors 1 and 2 for *C. veteranus*. Total variation explained 61.61%.

The strongest documented relationship of *C. veteranus* with recorded habitat values was between total number and the final QHEI score (0.475). The QHEI score is a numeric compilation of site habitat quality as measured by five suites of metrics (substrate quality, instream cover, riparian zone & bank erosion, and pool/glide & riffle/run quality). The strongest negative relationship was with pollution score (-0.576).



Left: Russel Fork area - considered to be optimal *Cambarus veteranus* habitat. Below: Close up view of boulder strewn stream bed preferred by *Cambarus veteranus*.



*Cambarus (J.) jezerinaci*; The spiny scale crayfish was positively correlated with all positive measures of habitat quality (Fig. 12). Pollution and %fines, both negative metrics, were negatively correlated with spiny scale crayfish abundance. Box & Whisker plots illustrate habitat conditions at sites with and without *C. jezerinaci* present and scatter plots with mean regression line and 95% confidence interval lines illustrate relationships of *C. jezerinaci* numbers to habitat factors (Figures Appendix A-25 to A-44).

The strongest documented relationship of *C. jezerinaci* with recorded habitat values was between total number and gradient (0.590). No negative metric had a significant relationship. The strongest relationship was with % fines (-0.355).

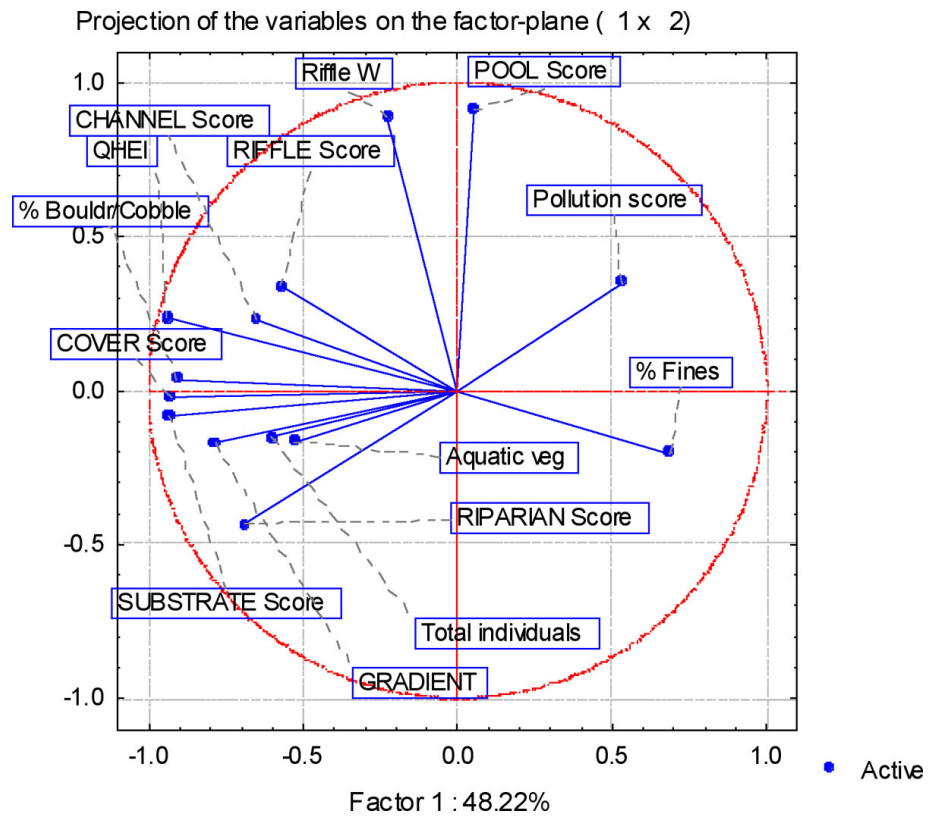


Figure 12. Factor analysis plot of factors 1 and 2 for *C. jezerinaci*. Total variation explained 64.52%.



Left: Unnamed tributary draining to Powell River on east slope of Cumberland Mountain. Typical high quality habitat for *Cambarus jezerinaci*. Note mosses growing on instream rocks and abundant growth of Rhododendron. Stream sizes are usually small for this species and instream sediments loads are low.

*Cambarus* (*C.*) species A; *Cambarus* sp. A was positively correlated with all positive measures of habitat quality (Fig. 13). Pollution and %fines, both negative metrics, were negatively correlated with *Cambarus* sp. A abundance. Box & Whisker plots illustrate habitat conditions at sites with *Cambarus* sp. A or *C. bartonii* cf. present. *Cambarus bartonii* cf. is a species that was always present at sites where *Cambarus* sp. A was not. It is believed *C. bartonii* cf. is an ecological equivalent of *C. sp. A* and is used in the analysis to assess potential competition between the two species. Scatter plots with mean regression line and 95% confidence interval lines illustrate relationships of *Cambarus* sp. A numbers to habitat factors (Figures Appendix A-45 to A-68).

*Cambarus* sp. A was not significantly correlated with any individual habitat measure. The strongest documented relationship of *Cambarus* sp. A with recorded habitat values was between total number and riffle score (0.317). The strongest negative metric relationship was with % fines (-0.410).

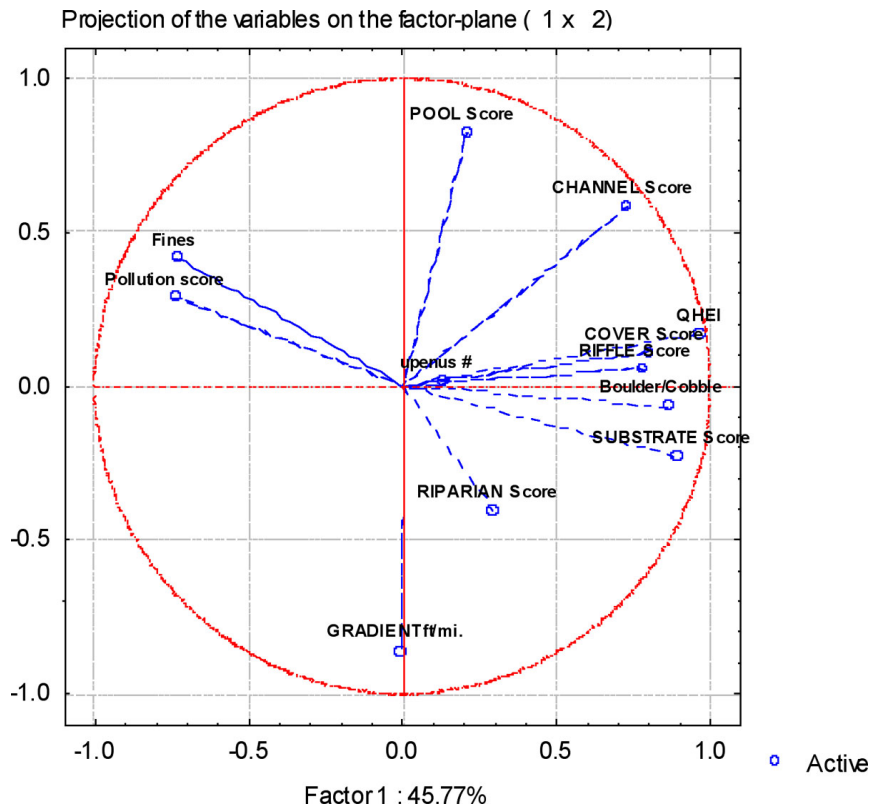


Figure 13. Factor analysis plot of factors 1 and 2 for *Cambarus* sp. A. Total variation explained 64.76%.



Left: East Fork Chestnut Creek upstream VA SSR 613. High quality habitat for *Cambarus* sp. A. Wooded riparian and herbacious shoreline vegetation creates low sediment, silt free environs favored by the species. Substrates are primarily boulder/cobble underlain by gravel and sand.

## Virginia Distributions

*Cambarus (P.) veteranus*; In Virginia, *C. veteranus* is confined to the Big Sandy River basin in Dickenson, Buchanan, and parts of Wise Counties (Fig. 14). In Buchanan County, (drained primarily by Levisa Fork) only one population remains and is found in Dismal Creek. One site in the most upstream portion of Dismal Creek harbored *Cambarus sciotensis* and no *C. veteranus*. All other sites sampled in the larger downstream sections of Dismal Creek harbored *C. veteranus*. *Cambarus sciotensis* typically replaced *C. veteranus* in smaller streams of the Big Sandy basin in Virginia.

In Dickenson and Wise Counties (drained by Russell Fork), populations were found throughout the drainage in streams of sufficient size. During sampling for this study a total of 18 sites in eight individual streams harbored the species. In order of abundance, defined as total individuals observed, the streams are Russell Fork including Lick and Prater Creeks (101 individuals), Dismal Creek (97 individuals), Crane Nest River including Birchfield Creek (70 individuals), McClure River (41 individuals), and Pound River (35 individuals). Streams tributary to the above five streams are included in their respective stream's abundance calculation since they were so closely (geographically) associated with the mainstem population. Dismal Creek and Russell Fork, on average, had more individuals per site than the other streams.

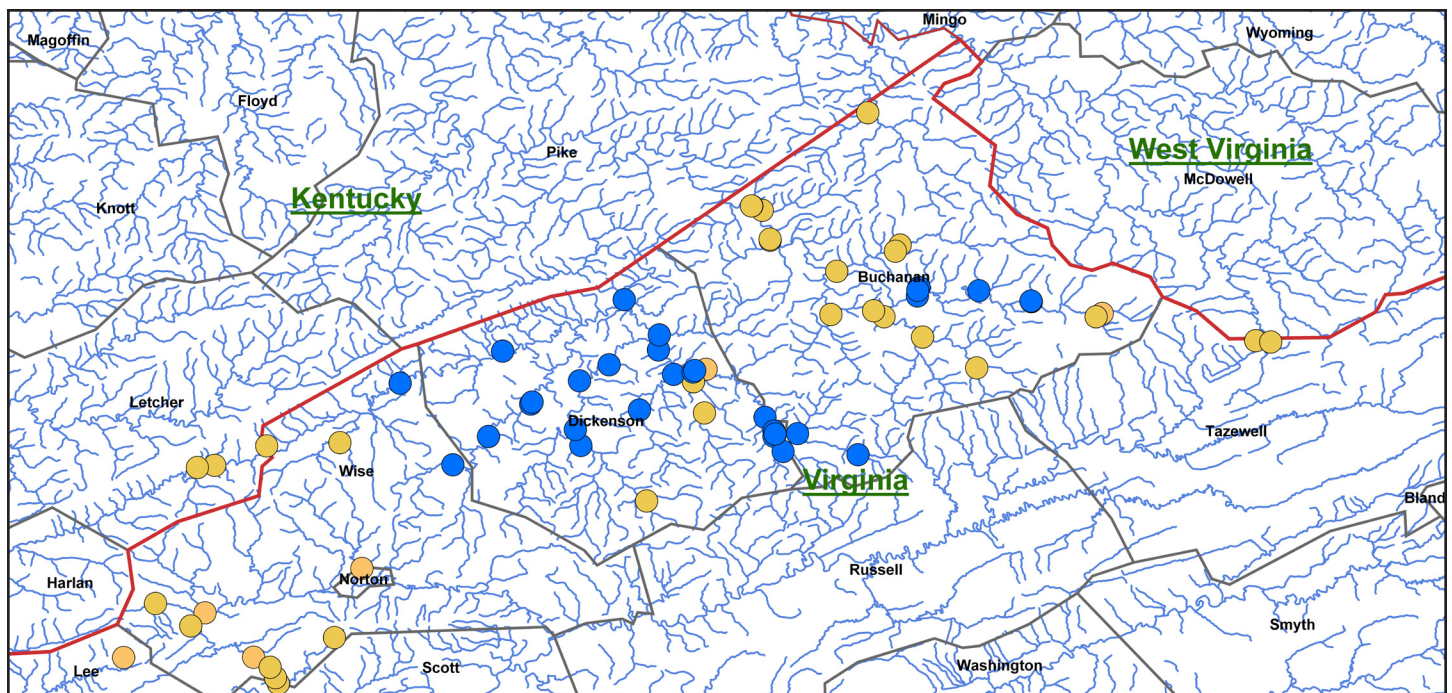


Figure 14. Distribution of *C. veteranus* in Virginia. Blue dots, species present; yellow dots species not found.

*Cambarus (J.) jezerinaci*; Within Virginia, *C. jezerinaci* is confined to those streams draining directly from Cumberland Mountain in Lee County tributary to the Powell River (Fig. 15). Smaller, higher gradient streams are its preferred habitat. A total of 12 sites in Virginia harbored the species in six general basins. In order of abundance, defined as average individuals observed per site, the streams are White Branch (21.8 individuals), Cane Creek (13.7 individuals), Dry Branch (12.5 individuals), Hardy Creek (7 individuals), Rocklick Branch (6 individuals), and Poor Valley Creek (5 individuals). The species is likely found in all permanent headwater streams draining Cumberland Mountain in Lee County that are not impacted by silt from mining or silviculture.

It is not known why the species has not expanded its range eastward across the Powell River in Virginia. In Claiborne County, Tennessee, *C. jezerinaci* has crossed to tributaries east of the Powell River. On the northern edge of Lee County and in Wise County streams that should have or could have harbored populations were heavily impacted by silt from mining and timber harvest operations. In Kentucky the species is found throughout the Cumberland River basin from Pine Mountain upstream in Bell and Harlan Counties. It is also found in parts of the Kentucky River basin in Clay and Leslie Counties. Tennessee populations are primarily confined to Claiborne County.

*Cambarus (C.)* species A; This undescribed species is confined to the New River basin in Virginia, being found

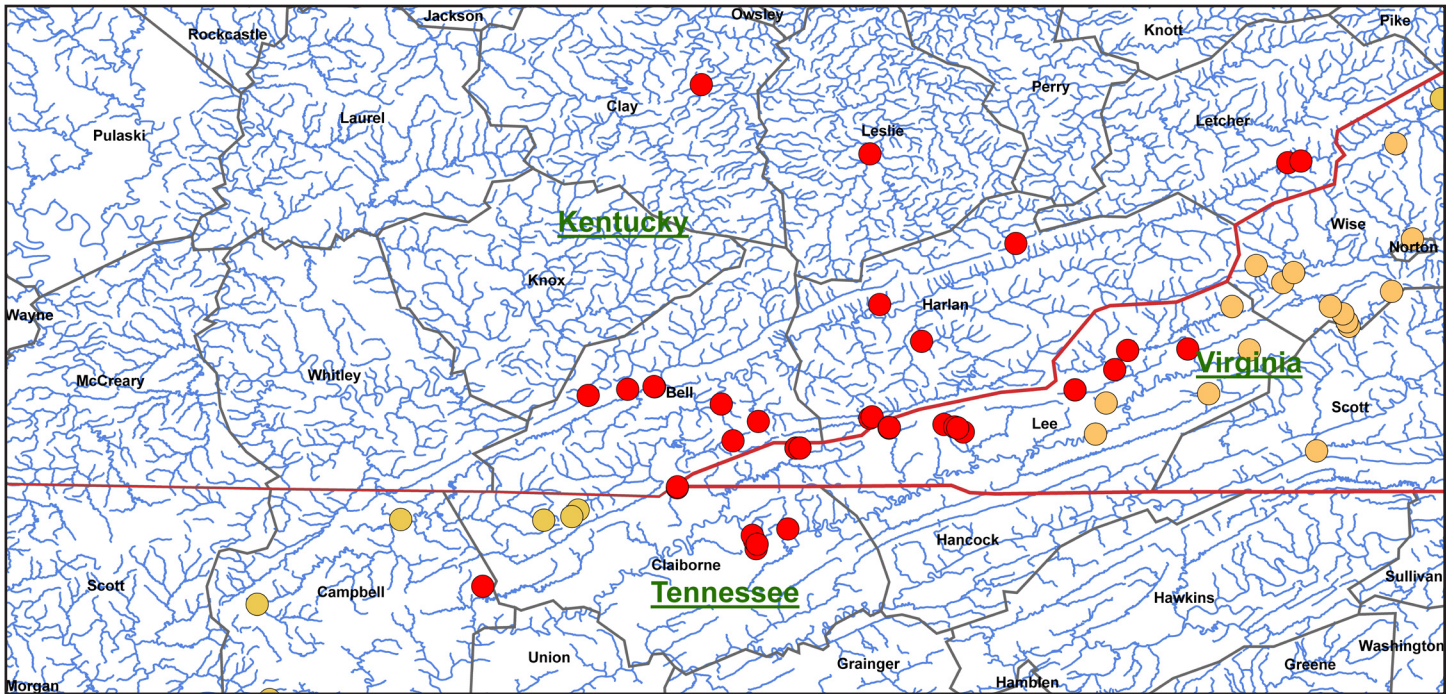


Figure 15. Distribution of *C. jezerinaci* in Virginia. Red dots, species present; tan dots species not found.

in three small tributaries draining westward on the Blue Ridge Plateau in Grayson County only (Fig. 16). A total of four sites harbored the species in three basins. In order of abundance, defined as average individuals observed, the streams are unnamed tributary of Little River (33.3 individuals), East Fork Chestnut Creek (29.7 individuals), and Meadow Creek (12 individuals). In addition, two collections from Chestnut Creek yielded an average of 14 individuals. Three collections from North Carolina yielded an average of 16.7 individuals. In North Carolina the species is found in small, cold water streams of the South Fork New River. The exact distribution in North Carolina is ill defined as little work was conducted in the state. Simmons and Fraley (2008) reported six sites in the New River basin of North Carolina that harbored a *Cambarus (C.)* sp. A that is likely this taxa. Examination of other populations outside the New River basin leads this investigator to the conclusions that the New River population is a separate species from other forms believed related to *Cambarus howardi*. Taxonomic analysis is underway for *Cambarus* sp. A and will be completed by spring 2010.

Figure 17 shows the total distribution of the of three study species in context to each other and the multi-state setting they are found in.



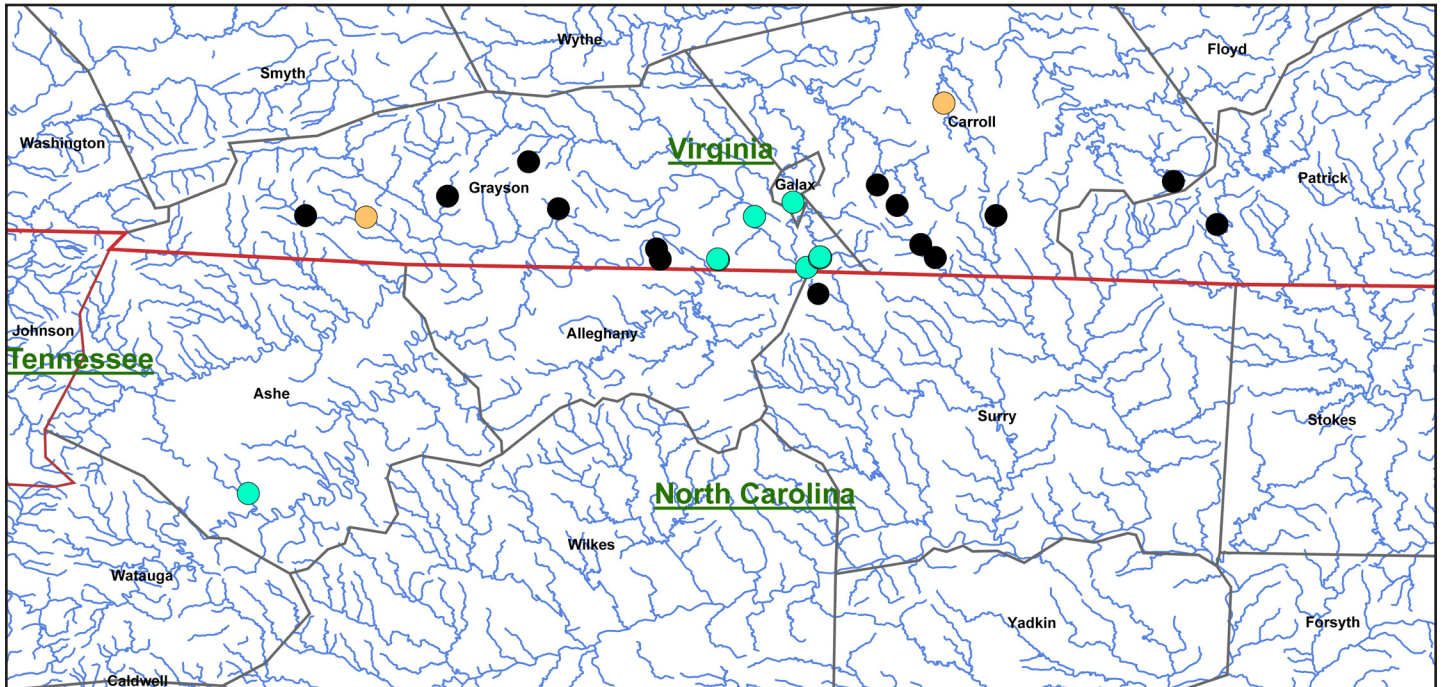


Figure 16. Distribution of *Cambarus* sp. A in Virginia. Green dots, species present; black dots species replaced by *C. bartonii* cf.

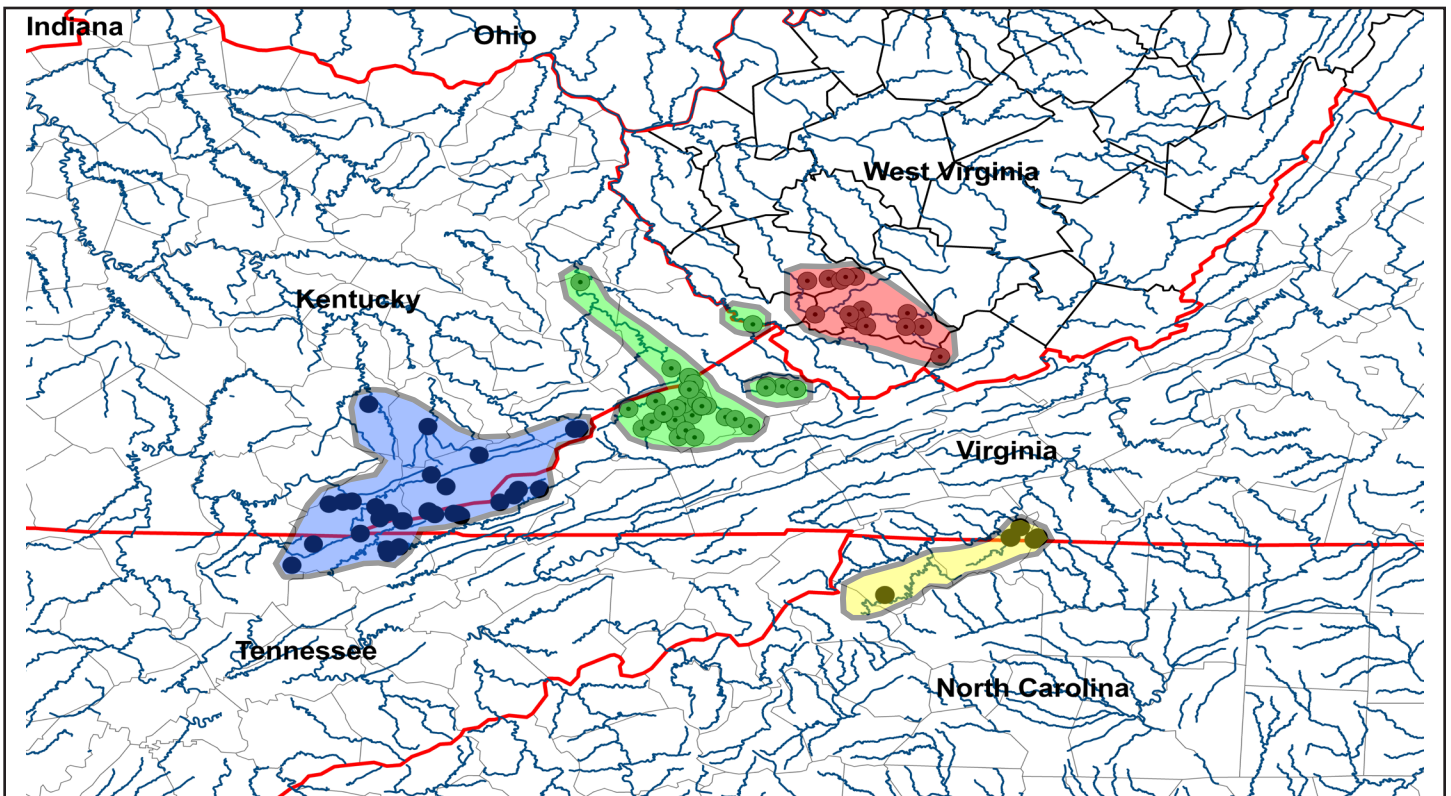


Figure 17. Complete (world) distribution of *Cambarus veteranus* (green = extant populations, red = possibly extirpated populations), *Cambarus jezerinaci* (blue), and *Cambarus* sp. A (yellow) within a multi state setting.

**Food Preferences:**

*Cambarus (P.) veteranus*; None of the test organisms of this species died, molted, or laid eggs during the study. A distinct preference for animal tissue was evident in feeding studies of this species. Test specimens primarily consumed all fish, insect, worm, and pecan before beginning to eat any plant material (Figure 18). The species is best classified as a carnivore. In 20 tests (2/specimen) most of the fish, insect, and worm was consumed within 48 hours. In 17 tests all crayfish tissue was consumed, one took 72 hours, two took 168 hours, and three did not eat the crayfish material. Seventeen test organisms ate all of the pecan, 12 did not consume all of the leaf, 10 did not consume all of the carrot, six did not consume all of the apple, and 10 did not consume all of the lettuce. Figure 19 gives a multivariate analysis of food preferences for the species. Fish, insect, worm, and pecan clustered together in a grouping and lettuce, carrot, and apple in another while leaf and crayfish showed less association with the other food items.

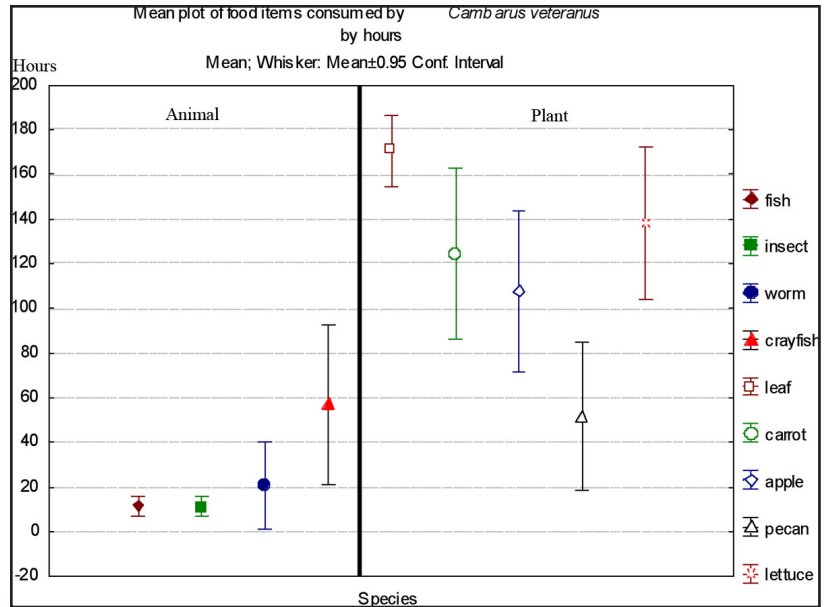


Figure 18. Box & Whisker plot of *C. veteranus* food consumption by hours of time taken to consume item.

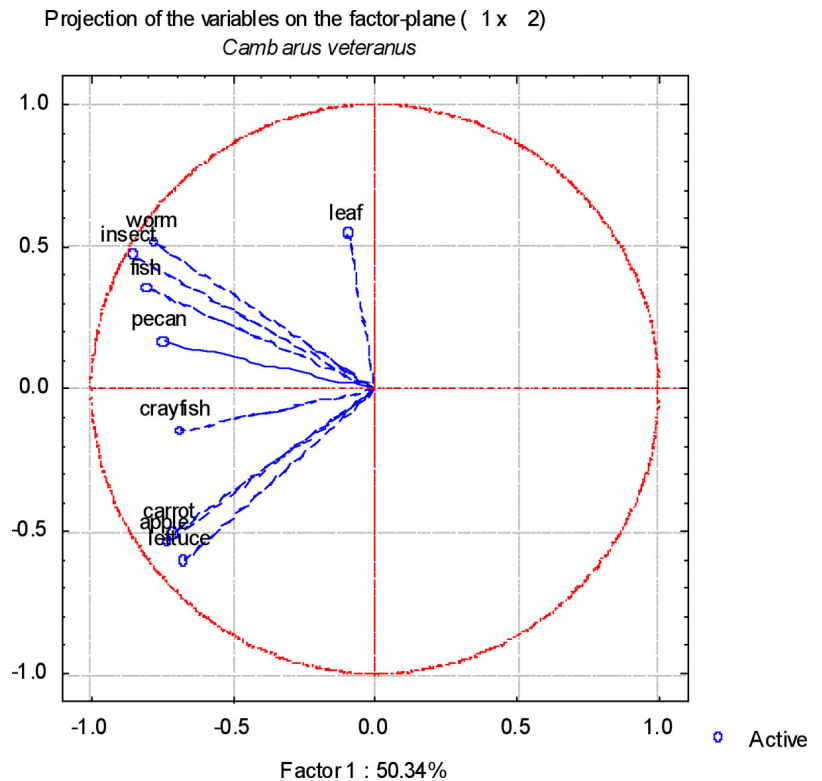


Figure 19. Principle Component Analysis of *C. veteranus* food consumption patterns.

*Cambarus (J.) jezerinaci*; Fish, insect, and worm tissue were the most frequently consumed food items for this species. Least consumed items were leaf, lettuce and crayfish (Figure 20). The species is best classified as an insectivore. It is interesting to note that few of the test specimens consumed crayfish flesh while fish flesh was more readily consumed indicating the species is not a general scavenger of dead animals. Many of the specimens ate less of the non pecan plant material provided. Figure 21 gives a multivariate analysis of food preferences for the species. In the PCA plot the upper left quadrant contains those food items *C. jezerinaci* was likely to consume and those items clustering in the lower left quadrant are those items least likely to be consumed.

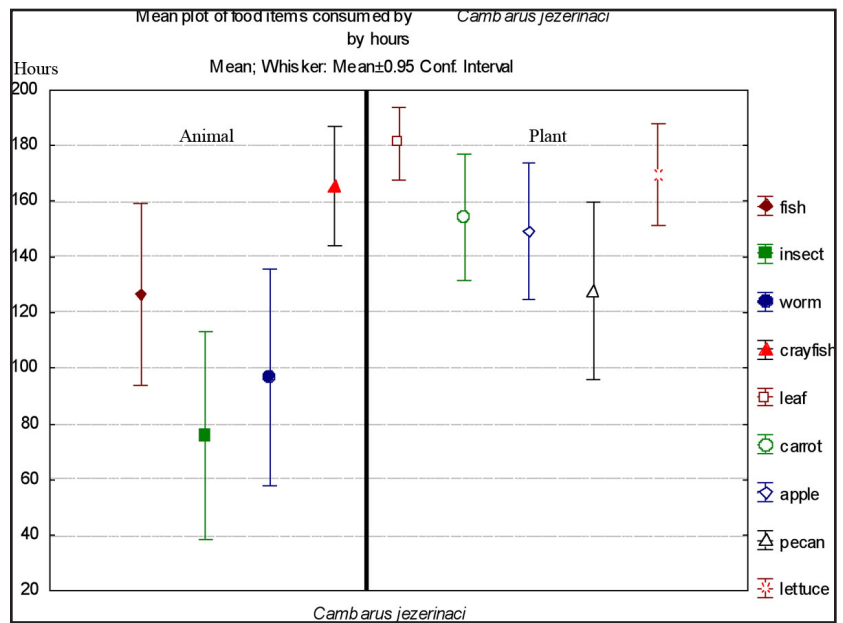


Figure 20. Box & Whisker plot of *C. jezerinaci* food consumption by hours of time taken to consume item.

The largest of the female specimens laid eggs between the two food preference experiments. It was thought that egg laying could have an influence on food consumption behavior. Either consumption would be higher before egg laying as energy would be needed to form eggs or consumption would be higher after as egg laying is an energy intensive activity. Consumption rates for this individual were similar before and after the event. Comparison to the other test organisms did not yield a discernible difference either. If egg production and laying does require a period of increased energy consumption it is possible that such a period occurred prior to the period of this study.

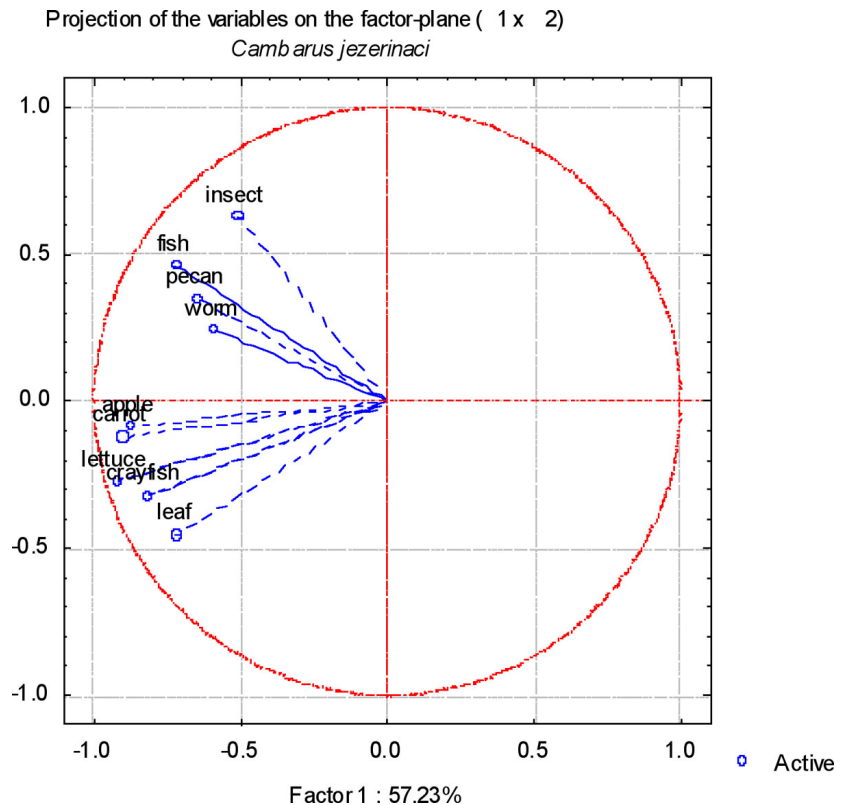


Figure 21. Principle Component Analysis of *C. jezerinaci* food consumption patterns.

*Cambarus (C.)* species A; Five of the study specimens for this species died during the feeding experiments. Of the 15 remaining individuals the top three preferred food items, in order of preference, were insect, pecan, and worm with insect being far preferred than other food items (Fig. 22). Three items in order of least preference were leaf, lettuce, and carrot. In food preference *Cambarus* sp. A is somewhat similar to *C. jezerinaci*. It differed in that insect was significantly preferred over all other food items. Fourteen trials resulted in no leaf consumption, 13 did not consume the lettuce, and 11 did not consume the carrot. Seven consumed the apple. Figure 23 gives a multivariate analysis of food preferences for the species. In the wild the species likely functions as an insectivore. The PCA plot for *Cambarus* sp. A has three clusters of food items: pecan, fish, and insect; apple, crayfish, and carrot; and (loosely) leaf, lettuce, and worm. Pecan, fish, and insect were the food items most likely to be consumed in the fewest hours. Leaf, lettuce, and worm were the items most likely to not be consumed or to take the longest to be consumed.

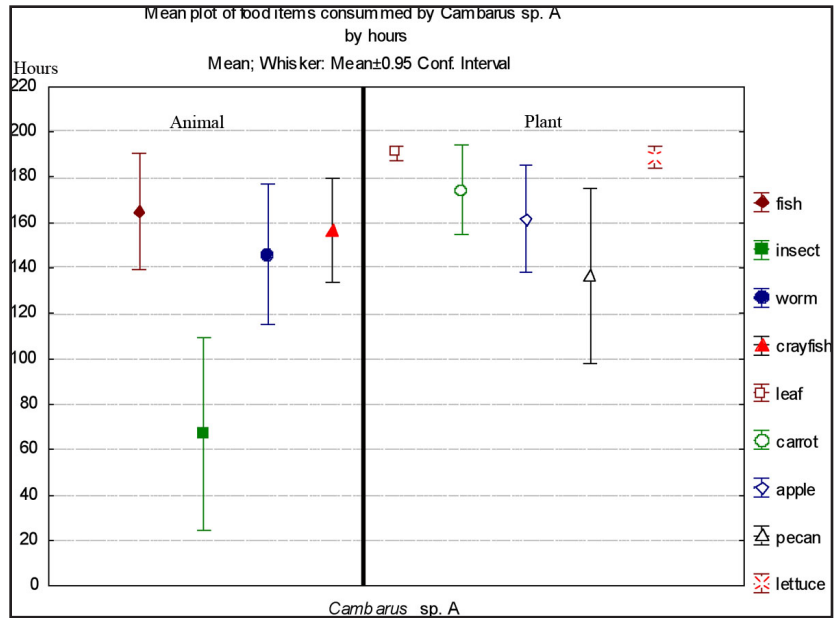


Figure 22. Box & Whisker plot of *Cambarus* sp. A food consumption by hours of time taken to consume item.

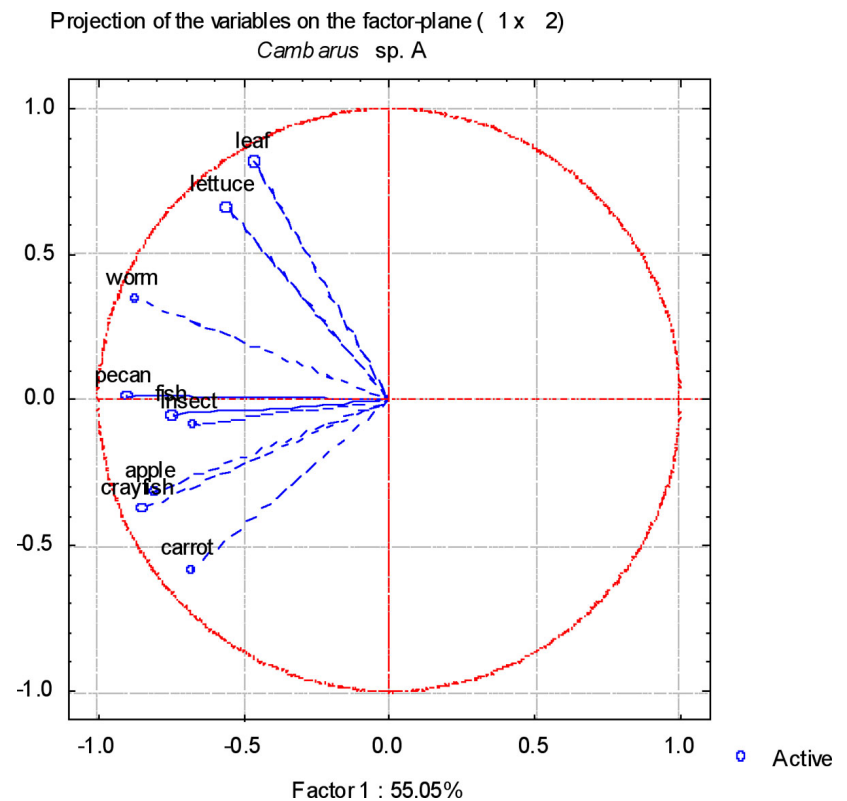


Figure 23. Principle Component Analysis of *Cambarus* sp. A food consumption patterns.

## DISCUSSION

### *Life History*

*Cambarus (P.) veteranus*; Combination of the distribution, habitat, reproductive life cycle, and food preference data indicates *C. veteranus* is a species with narrow environmental tolerances and a specialized life cycle. It is best described as a large river, warm-water, top carnivore. The species clearly prefers to feed higher in the food chain. In the wild it likely obtains most of its energy resources from insect larvae but may also capture small fish such as darters and also feed on recently dead fish or other crayfish. The habitat preferences of the species place it in the more environmentally vulnerable portions of its occupied stream systems.

*Cambarus veteranus* has a reproductive life history that spans a wide range of the year. The earliest month in which some form of reproductive activity begins is in June when first form males are seen cohabiting boulders with females displaying developed glare glands. In July females begin laying eggs. Egg laying is at a peak from July through August and continues at a reduced level into October. Most young have departed from the females by the end of November though some late reproducing females can carry young into early spring. The thrust of the reproductive cycle for this species should be considered July thru September and special protective measure should be focused on that period. This timing of the reproductive cycle, primarily mid summer, places a critical life stage in the midst of a period in which stream water quality conditions, especially dissolved oxygen, are more easily and likely to be degraded by increased human activity.

*Cambarus (J.) jezerinaci*; This species is a small woodland stream, insectivore. Its healthiest populations were found in small, high gradient streams dominated by hemlock/rhododendron riparian and abundant moss growth. Water temperatures were always cool, in part as a result of the extensive shading. Observations in the field indicate the species lives within interstitial spaces of stream side rock rubble piles. The species is herein termed an “interstitial lithophyle”. *Cambarus jezerinaci* was rarely captured from under mid-stream boulders where *Cambarus (C.) angularis*, *Cambarus (C.) bartonii cavatus* cf., or *Cambarus (P.) robustus* cf. were encountered.

Reproduction is focused on early spring with most young dispersed by the start of summer. First form males are most commonly seen in the fall and spring months, though some first form males were seen in all but two of the collecting months (Fig. 6). Gravid females were only seen in the spring and early summer and females with instars were only seen in June (Fig. 7). No cohabiting male and female pairs were observed nor any individuals in amplexus. These observations clearly indicate the critical months of reproduction are January thru June and that protective measures should be focused on those six months.

*Cambarus (C.)* species A; Of the three species studied herein, this undescribed species is the most perplexing. Only one gravid female was observed and no recently released young-of-year individuals were encountered. Reproductive form I males were encountered in almost all collections. Glare gland development (a precursor to egg laying in females) was recorded for only one collection (April 2009) during this study. Several females collected in April displayed developed glare glands. It may be that the species has a spring associated reproduction cycle. More data is needed to confirm this. It is speculated that females of this species are seeking out a sheltered environment for egg laying and rearing of young that was not sampled during this study. Possibly bank burrows, a habitat utilized by other species, are being employed. Such environs were not explored in this study. The most closely related taxonomically certain species to *Cambarus* sp. A is *Cambarus howardi* from Georgia. Hobbs (1981), in *The Crayfishes of Georgia*, reported females with eggs or young in April, May and June. *Cambarus howardi* occupies a different habitat than *C. sp. A*, utilizing warmer, lower elevation, and

larger streams so its reproductive life style may not accurately reflect that of *C. sp. A*. *Cambarus sp. A* may have a reproductive period shifted more into the summer when stream temperatures are warmer. At this point in time it is suggested that more study be conducted before restrictions on instream activity are established.

*Cambarus sp. A*'s preferred habitat type was small, headwater, abundantly wooded streams. As stated in the Results section, no particular habitat character was significantly correlated with the species' abundance. In streams where *C. sp. A* was not found, *Cambarus (C.) bartonii* cf. was. No difference in habitat preference could be discerned between the two species. It is not known how the two species are dividing the streams of the area. The two species have not been found to be sympatric. If one species is present the other is absent, at least in the upper headwater areas. What mediates this phenomenon is unknown. Unlike *C. jezerinaci*, *C. sp. A* was a mid stream inhabitant sharing large flat rocks with *C. robustus* and *C. (H.) chasmodactylus*.

### ***Conservation Status***

*Cambarus (P.) veteranus*; The range of this species is the Big Sandy River basin where it is confined to the Russell and Levisa Fork basins and Guyandotte River basin of West Virginia, Kentucky and Virginia. Recent collection efforts by the author and others (Channell, 2004) have failed to find the species in its West Virginia range. Mr. Zac Loughman, of West Liberty University, has reported finding the species in very low numbers in Pinnacle Creek of Wyoming County, WV (personal communication, June, 2009). It now appears nearly extirpated from West Virginia. The Kentucky population appears, based on Taylor and Schuster (2004), to be primarily derived from upstream populations in Virginia. The Virginia populations in the Russell Fork basin and Dismal Creek of the Levisa Fork basin are the only known healthy, self sustaining populations. Channell (2004) reported a collection from the mainstem Levisa Fork downstream of the Dismal Creek confluence but follow-up sampling in spring 2009 failed to find the species in that area. It seems likely that any individuals in Levisa Fork downstream Dismal Creek would likely be derived from the Dismal Creek population and not represent a permanent, viable population. Garden Creek, also in the Levisa Fork basin, was historically known to harbor *C. veteranus* but efforts to find the species there failed. The stream is heavily impacted by bedload sediments derived from coal mining activities.

*Cambarus veteranus* is currently classified as Threatened by Taylor et al. 2007. Consideration should be given to elevating its status to Endangered in light of recent distributional losses. Virginia should continue to accord the species State Endangered status. If possible, West Virginia, Guyandotte River basin material should be brought into captivity and efforts made to maintain the population. Its genetic status should be determined as the two known populations may represent unique genetic units of the species.

*Cambarus veteranus* is a mainstream species and is consequently down stream of most potential environmental impacts. This makes the species vulnerable to extirpation. Much of its former range in Virginia is subject to dense, stream side urbanization (Levisa Fork). These areas have been subjected to elevated non-point run off, especially from roads, and, in unsewered areas, elevated nutrient loads from septic systems. Many streams no longer impacted by septic input have been channelized during installation of instream sewer lines. These stream reaches now have degraded habitat quality not suitable to supporting the species. In Virginia, unlike West Virginia, coal mining impacts are limited. Few sampled sites had significant loads of coal in the stream bed though some, like Garden Creek, were impacted by heavy bedload sediments derived from coal mining. Only a few sites were found that lacked *C. veteranus* as a consequence of coal mining impacts. The presence of a coking facility at the mouth of Dismal Creek with Levisa Fork may, in part, explain the absence of the species in Levisa Fork. Also, considerable coal transportation by truck occurs adjacent Dismal Creek and spills (coal & diesel fuel) resulting from wrecks could negatively impact *C. veteranus* in its only habitat in the Levisa Fork basin. Since the Dismal Creek population is the last viable population in the Levisa Fork basin (along with numerous

fish species) special attention should be accorded to protecting of this stream system.

In Russell Fork and its basin *C. veteranus* populations are very healthy. Some impacts in parts of McClure River and Pound River associated with urbanization can be seen. Below the town of Pound, sewage is negatively impacting Pound River for at least six miles. A site 5.5 miles downstream of the town was noticeably suffering the effects of excess sewage and only two *C. veteranus* could be found after an extended search period. Sludge and excess algal growth was abundantly evident and the substrate was heavily imbedded with fine sediment. In McClure River, downstream of McClure, heavy bed load sediments, primarily of sand, have eliminated much of the favorable habitat and substrates are heavily imbedded. *Cambarus veteranus* populations are consequently suppressed. Populations in Cranes Nest River are healthy but available habitat is less than in Pound and McClure Rivers and Russell Fork. The healthiest populations are found in Russell Fork proper. Three other small tributaries in the Russell Fork basin harbored the species, Lick Creek (two sites), Prater Creek, near its mouth with Russell Fork, and Birchfield Creek, near its mouth with Cranes Nest River

*Cambarus (J.) jezerinaci*; This species is found in Kentucky, Tennessee, and Virginia. The Virginia and Tennessee populations are found in the Powell River basin and the Kentucky populations is found throughout the Cumberland River basin upstream of Pine Mountain. Its overall conservation status should be considered Stable following Taylor et al. 2007. In Virginia it is confined to streams draining directly off of Cumberland Mountain. Its range within the State is limited and its conservation status should be State Threatened.

Because of its preference for higher gradient, higher elevation streams *C. jezerinaci* is less likely to be impacted by human activities such as urbanization, agriculture, and enrichment (especially from sewage). In small streams with adjacent roads *C. jezerinaci* populations were either suppressed or completely absent. Roads resulted in increased nutrient loads from adjacent lawns and septic systems associated with houses. Bed load sediments also tended to be higher in such streams. The best populations were found in streams such as White Branch that drained directly from Cumberland Mountain in a west to east direction. These streams have steep narrow valleys and afford little opportunity for human habitation or road building. They are also heavily wooded. The greatest threat to the species is thought to be timbering activities, especially clear cutting and associated road building that would result in increased bedload sediments. Unregulated grazing on steep terrain also has negative effects on instream sediment and consequently *C. jezerinaci* populations.

*Cambarus (C.)* species A; The range of this undescribed species is the Blue Ridge Physiographic Province within the South Fork New River basin in North Carolina and New River in Virginia. Its overall conservation status should be classified as Stable following Taylor et al. 2007. Within Virginia its range is highly restricted being found only in the Chestnut Creek, Meadow Creek, and Little River basins of Grayson County. The State should accord the species elevated conservation status as State Endangered.

Virginia populations are restricted to the higher elevations of smaller tributaries. The healthiest numbers are found in streams with low levels of non-point pollution and abundant woodland riparian. In Meadow Creek grazing activities have resulted in increased sediment and nutrient loads with consequent reductions in *Cambarus* sp. A populations. In the species' favor is the presence of the Blue Ridge Parkway and its associated undisturbed lands. Virginia should accord the species an elevated conservation status and explore the possibility of securing conservation easements on wooded streams harboring the species. East Fork Chestnut Creek is the best quality stream harboring the species and attention should be focused in that stream basin if possible.

It is not possible, using the data collected in this study, to explain why this species' distribution is restricted in the manner observed. *Cambarus* sp. A does not cohabit with *Cambarus bartonii* cf. and the presence of *C. bartonii* cf. in other streams may explain *C. sp. A*'s absence. The factor that makes some streams better suited to *C.*

*bartonii* cf. and others better for *C. sp. A* is unknown and needs further study.

### ***Food preferences***

*Cambarus veteranus* was decidedly more likely to eat all animal material presented in this study and less plant material. The species is most likely a predator of aquatic organisms in the wild. It is not proven from this study that *C. veteranus* does not function as some form of omnivore but the fact that many individuals during the two test runs ate none of some plant items is a strong indication that the species likely only uses plant material as a survival food source. It is extrapolated from other personal observations of other species that *C. veteranus* actively attempts to capture small fishes that enter or come near their hiding places. Also, populations of *Orconectes cristavarius* tended to be lower at sites with high *C. veteranus* numbers. It is tempting to speculate that predation of *O. cristavarius* by *C. veteranus* is occurring. No data exist to support such a speculation. In the wild the species likely derives much of its food requirements from invertebrate populations, especially insects. This is likely contributing to the lower abundance of *C. veteranus* observed in sediment impacted streams. Areas high in fine bed-load sediments (sand & silt) have a lower abundance of insect populations.

Of the three species, *Cambarus jezerinaci* is the most omnivorous taxa. None-the-less, a strong preference for insects was shown. In the streams this species is found in, insect populations are abundant. The area of stream occupied by the species (shoreline rock-rubble piles) tends to be high in insect larvae so it is likely *C. jezerinaci* derives much of its food requirements from resident aquatic insect larvae. Two other potential in-stream food sources common in the streams inhabited by *C. jezerinaci* were leaf litter and aquatic moss. Tree leaf was the least consumed food item and very little of the other plant material was consumed. The most frequently consumed plant item was pecan, a high energy food item high in protein. This type of food item can be found in the form of acorns in the streams occupied by *C. jezerinaci*.

*Cambarus sp. A* was the most particular feeder of the three species, focusing on insect larvae with little attention given to other foods. It is here-in considered an insectivore. Also, it is interesting to note that *C. sp. A* suffered the highest mortality rate during the food studies. These results lead to the conclusion that the species is sensitive to environmental disturbance and should be classified as intolerant, though it is not as habitat specialized as *C. veteranus* and *C. jezerinaci*, occupying all parts of the stream reaches they are found in. Insect larvae are abundant in the streams in which *C. sp. A* lives.

## **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.

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.

## **Appendix A**

Habitat preference plots: Box & Whisker and Regression Analysis

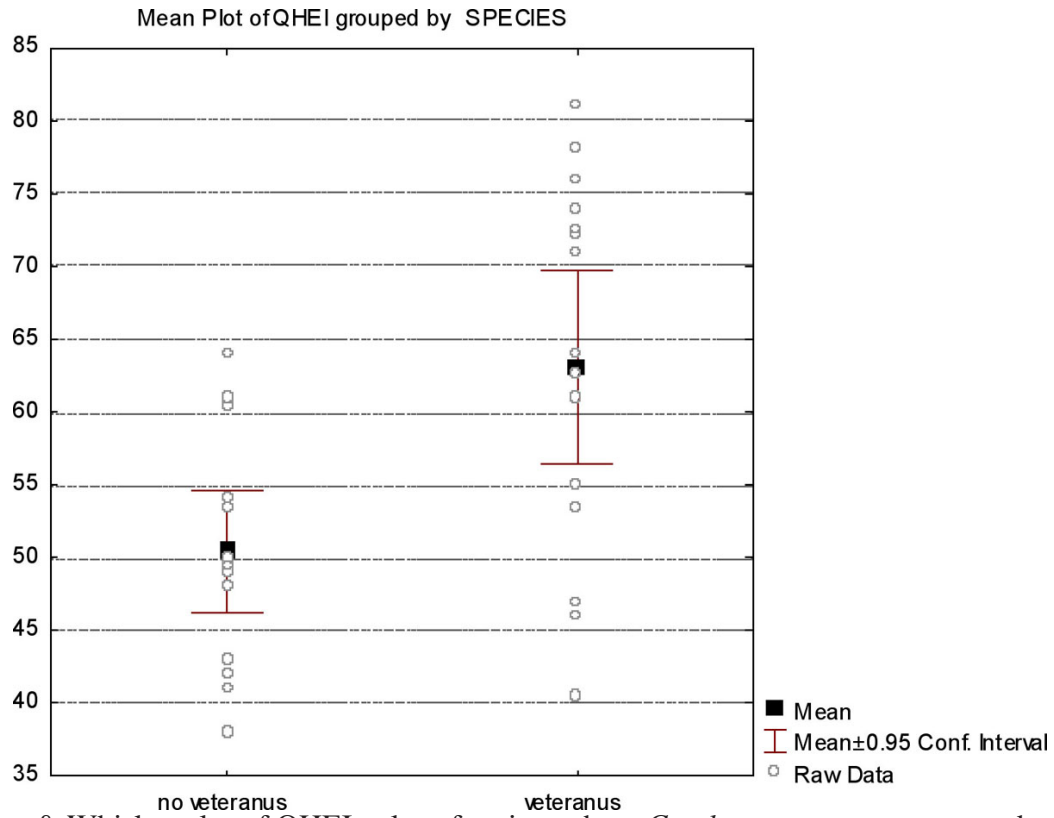


Figure A-1. Box & Whisker plot of QHEI values for sites where *Cambarus veteranus* was and was not found.

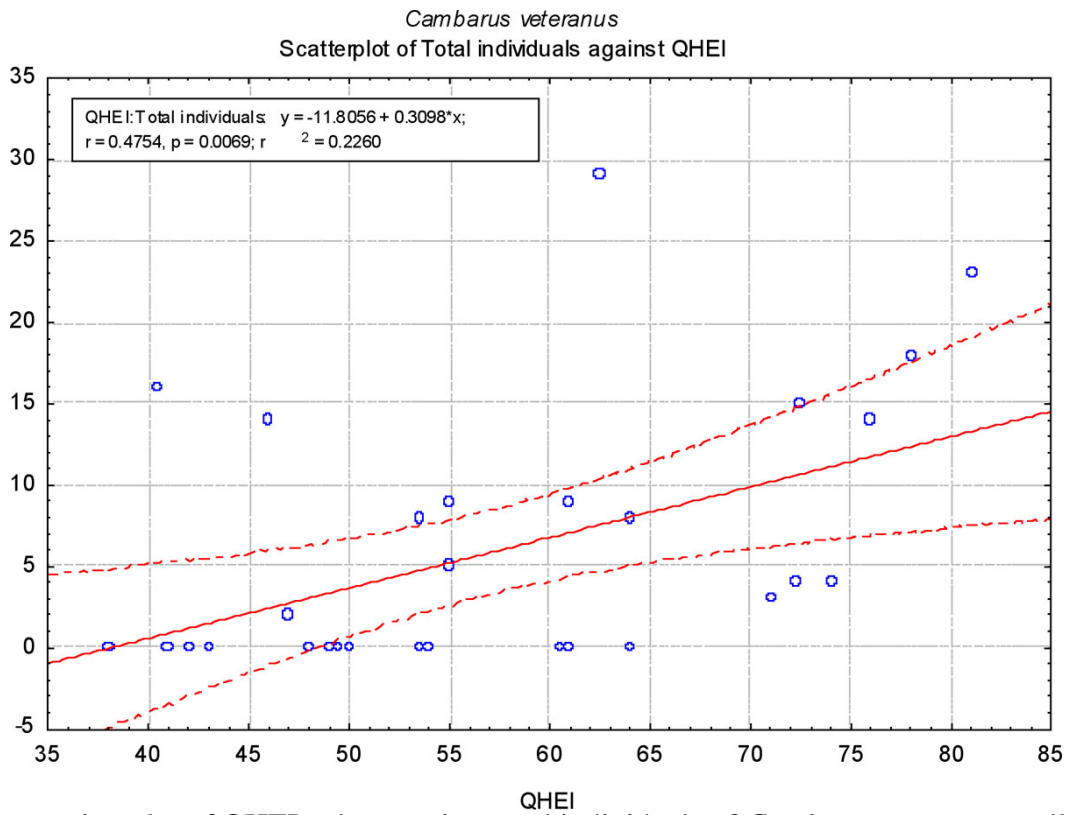


Figure A-2. Regression plot of QHEI values against total individuals of *Cambarus veteranus* collected at all sites sampled.

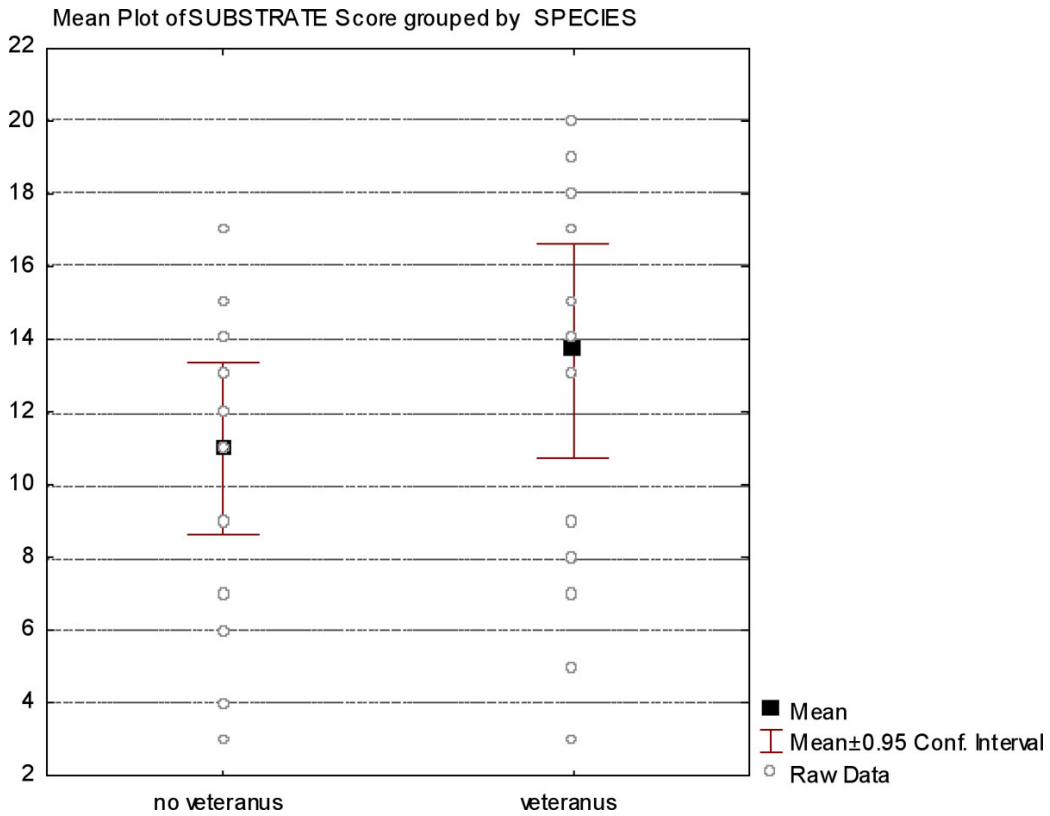


Figure A-3. Box & Whisker plot of Substrate score values for sites where *Cambarus veteranus* was and was not found.

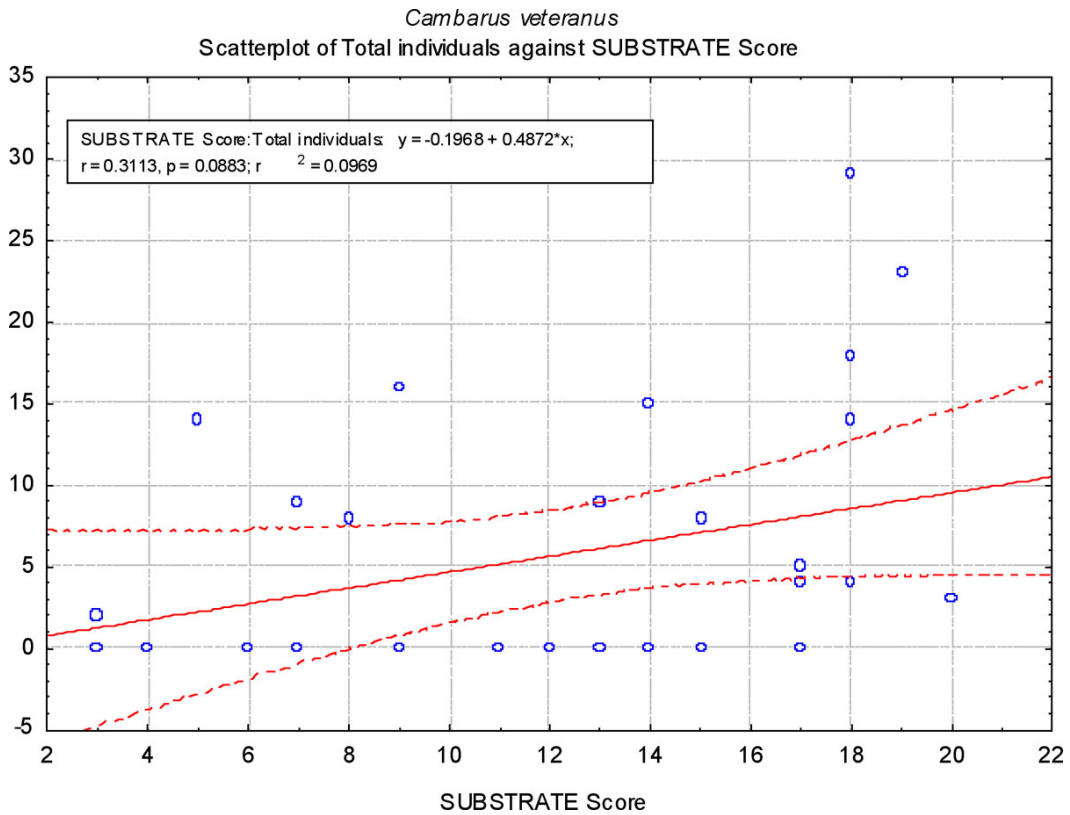


Figure A-4. Regression plot of Substrate score values against total individuals of *Cambarus veteranus* collected at all sites sampled.

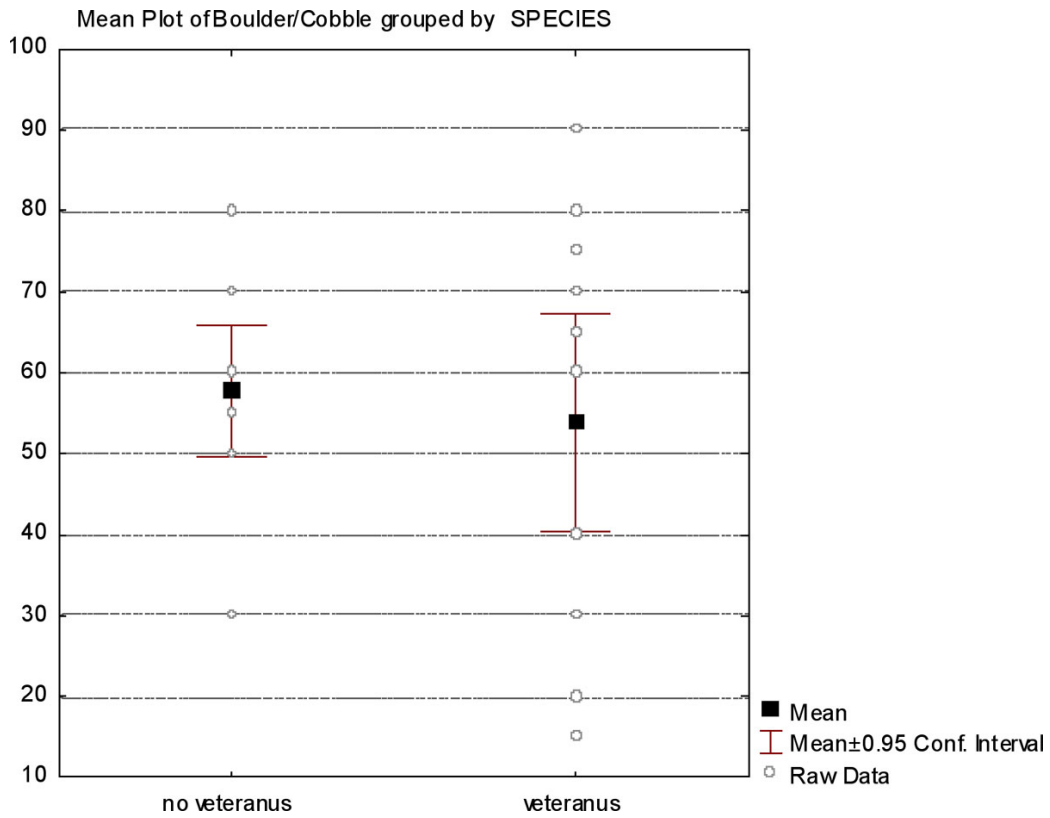


Figure A-5. Box & Whisker plot of % boulder/cobble substrate compositions for sites where *Cambarus veteranus* was and was not found.

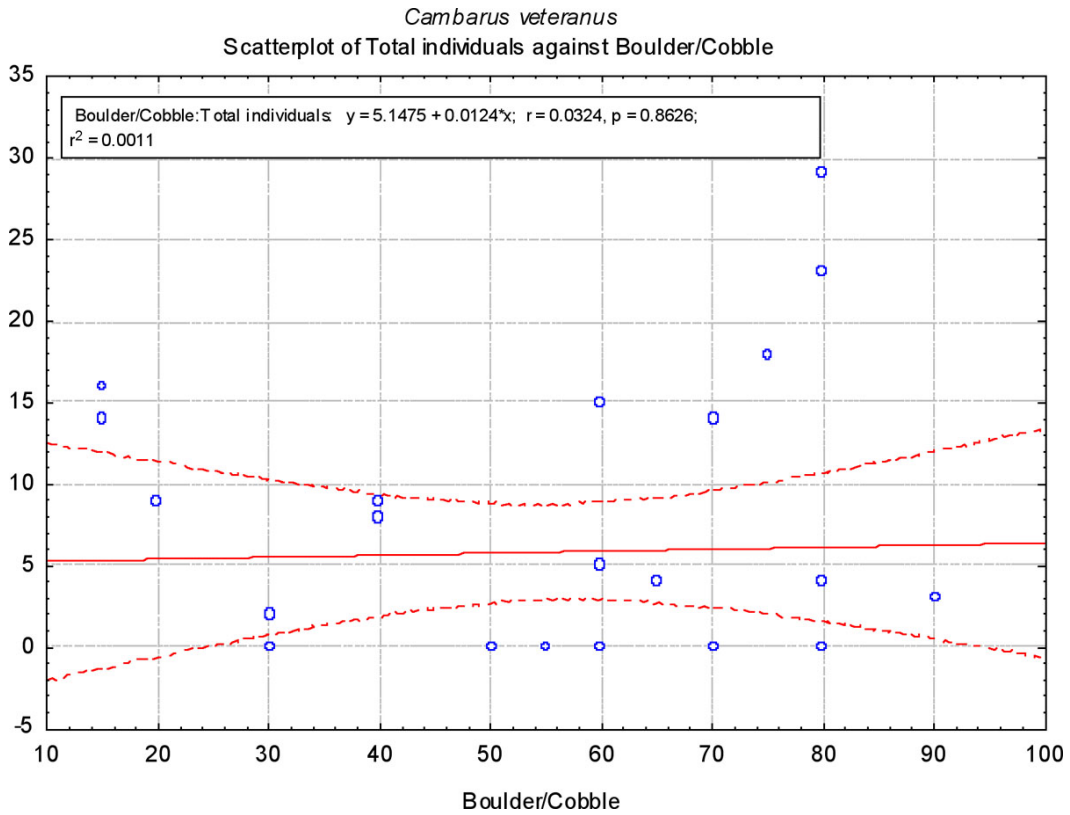


Figure A-6. Regression plot of % boulder/cobble against total individuals of *Cambarus veteranus* collected at all sites sampled.

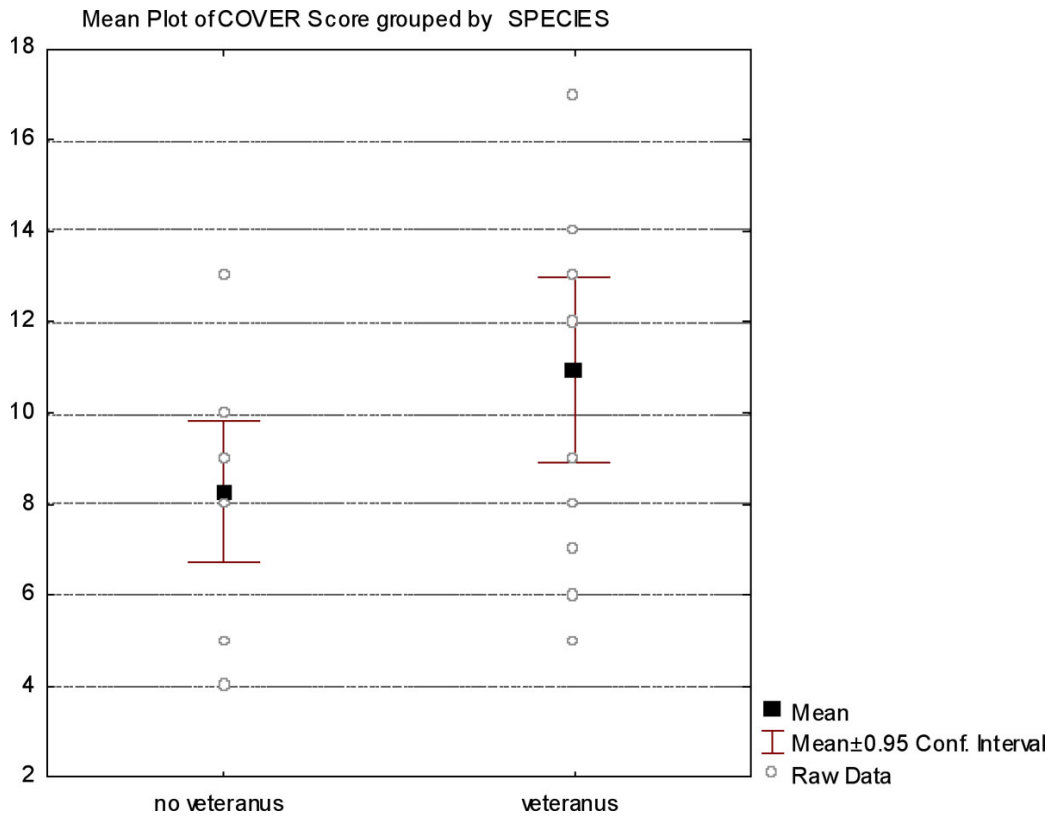


Figure A-7. Box & Whisker plot of Cover score values for sites where *Cambarus veteranus* was and was not found.

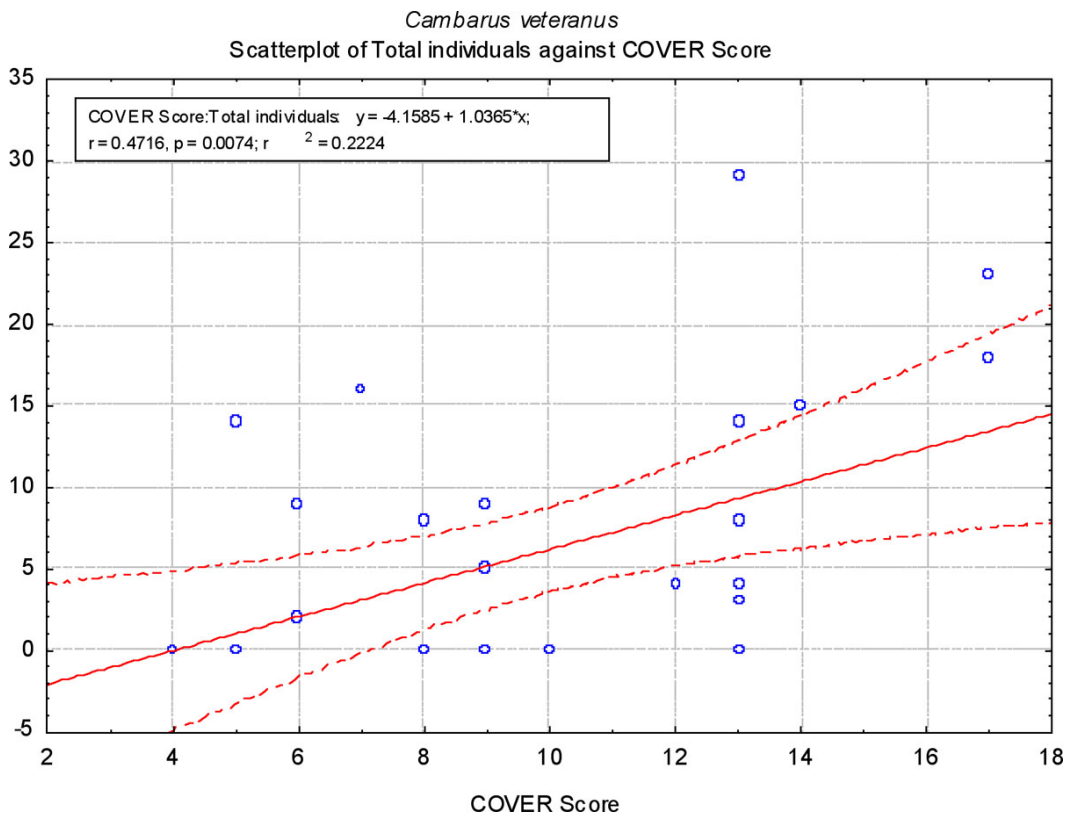


Figure A-8. Regression plot of Cover score values against total individuals of *Cambarus veteranus* collected at all sites sampled.

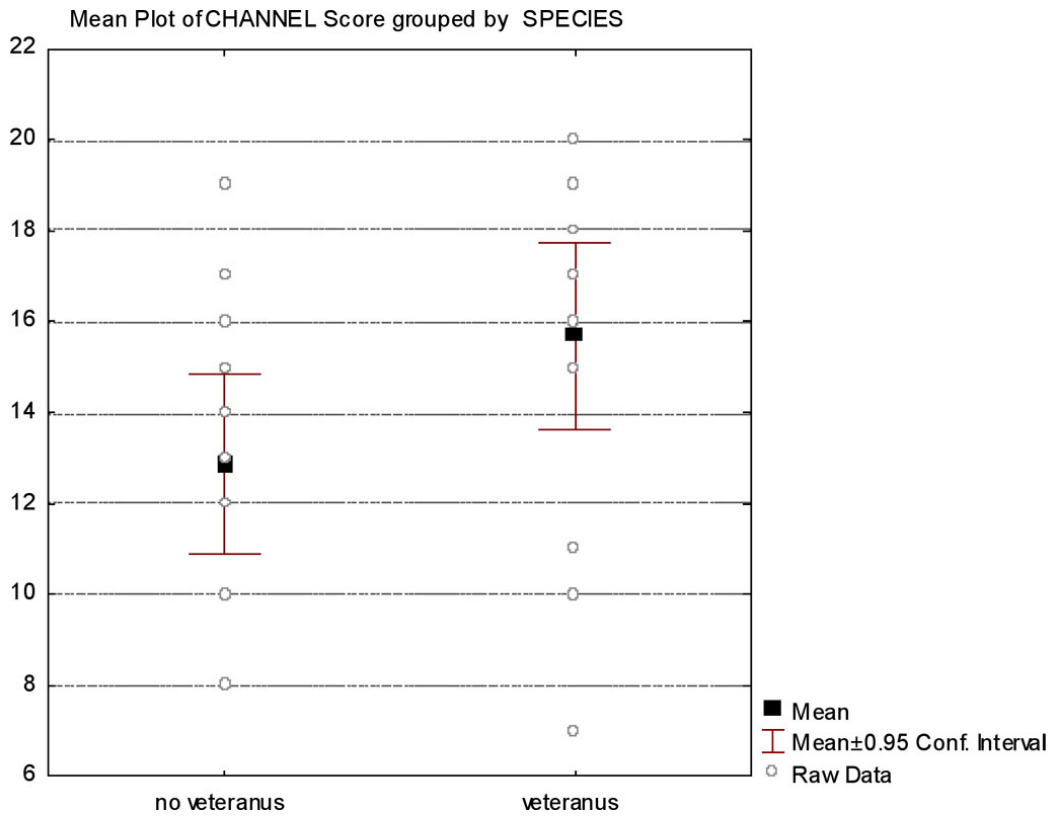


Figure A-9. Box & Whisker plot of Channel score values for sites where *Cambarus veteranus* was and was not found.

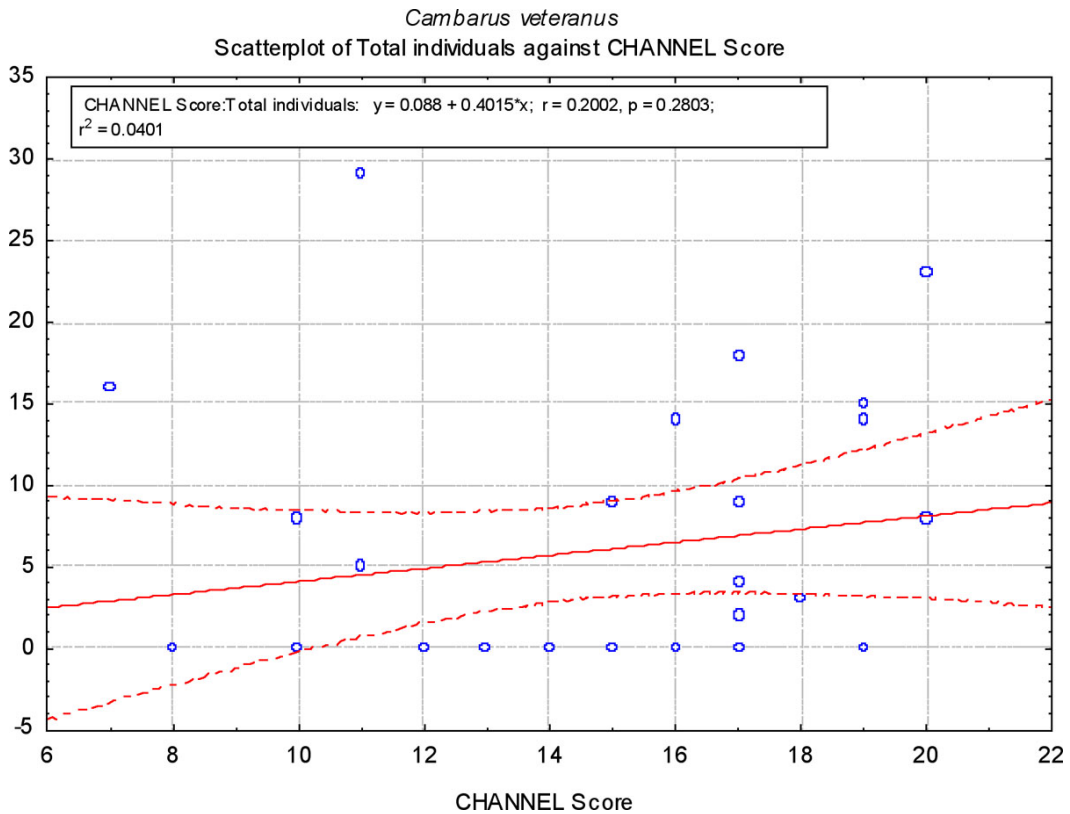


Figure A-10. Regression plot of Channel score values against total individuals of *Cambarus veteranus* collected at all sites sampled.

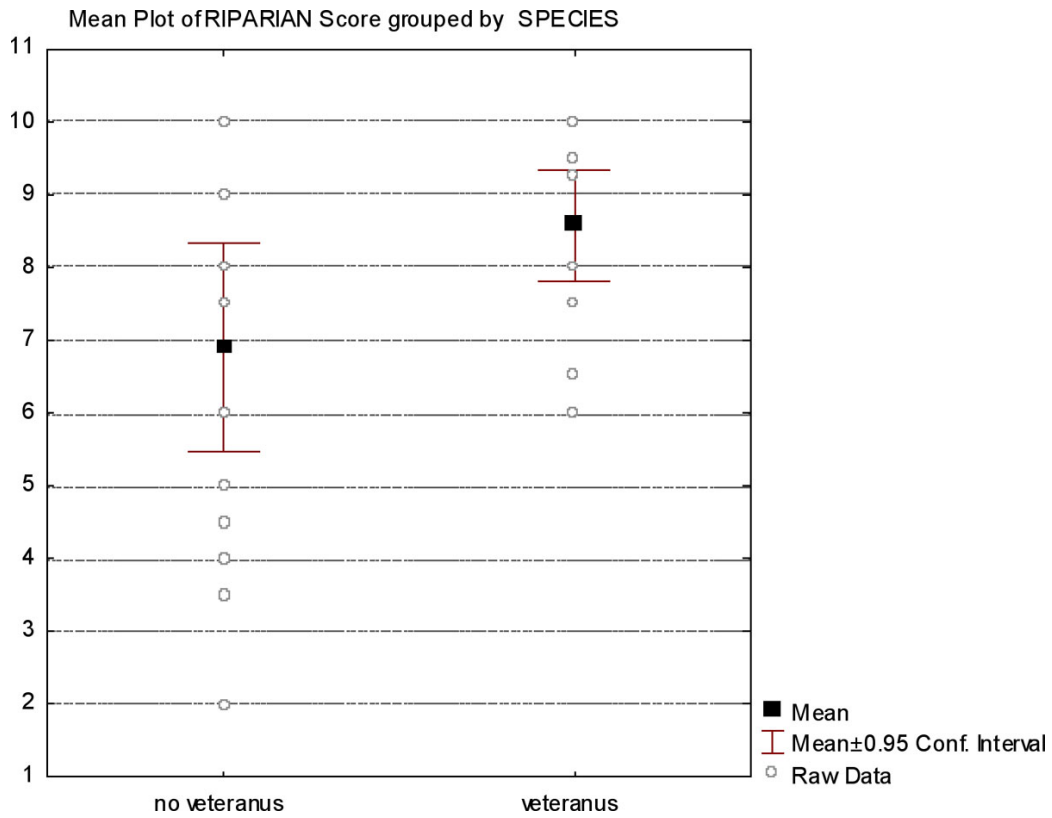


Figure A-11. Box & Whisker plot of Riparian score values for sites where *Cambarus veteranus* was and was not found.

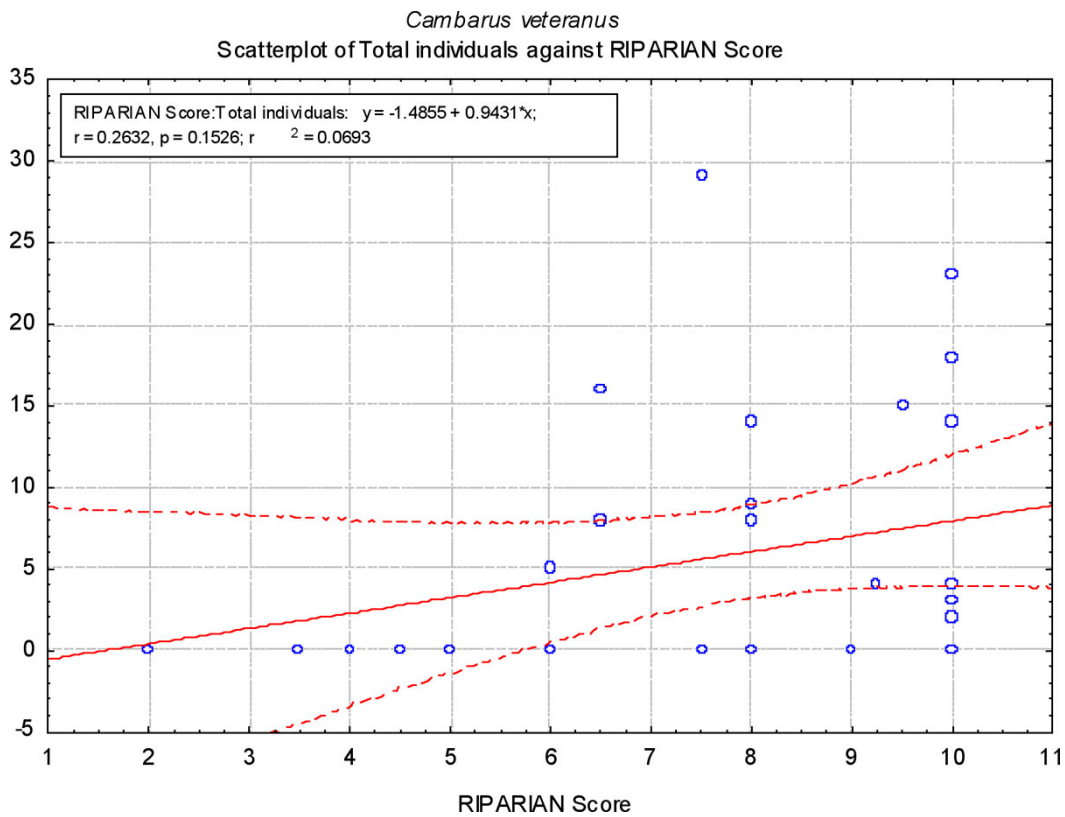


Figure A-12. Regression plot of Riparian score values against total individuals of *Cambarus veteranus* collected at all sites sampled.



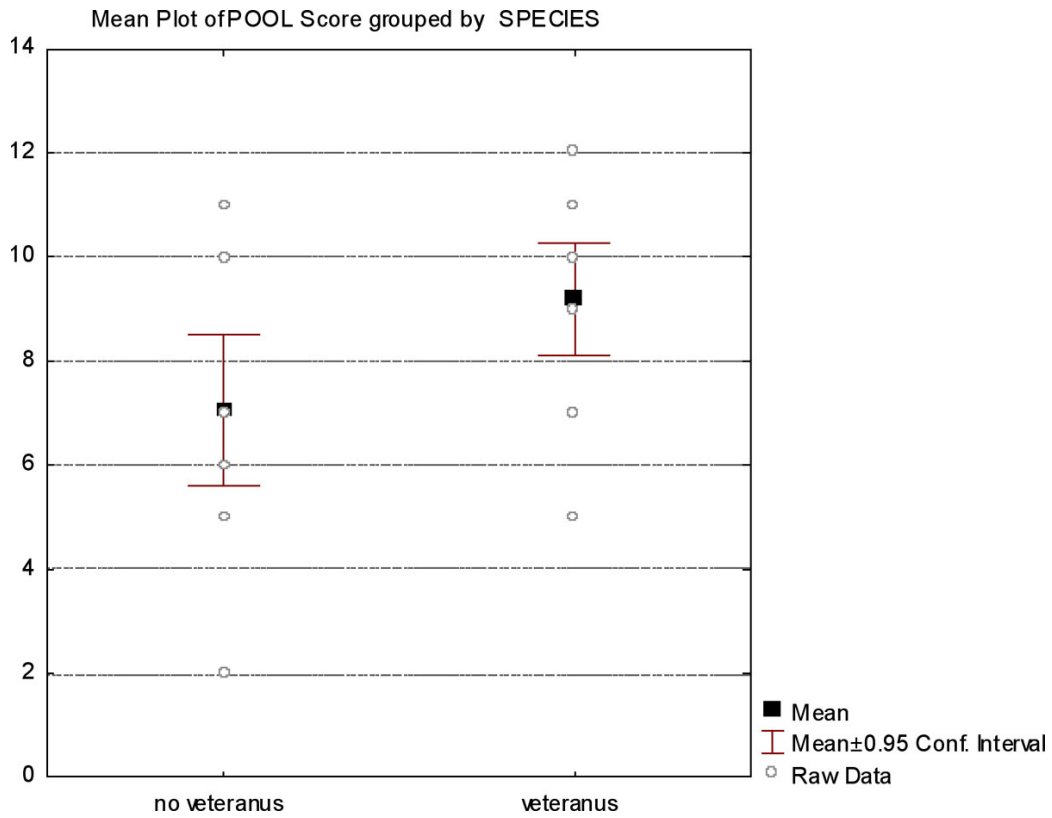


Figure A-13. Box & Whisker plot of Pool score values for sites where *Cambarus veteranus* was and was not found.

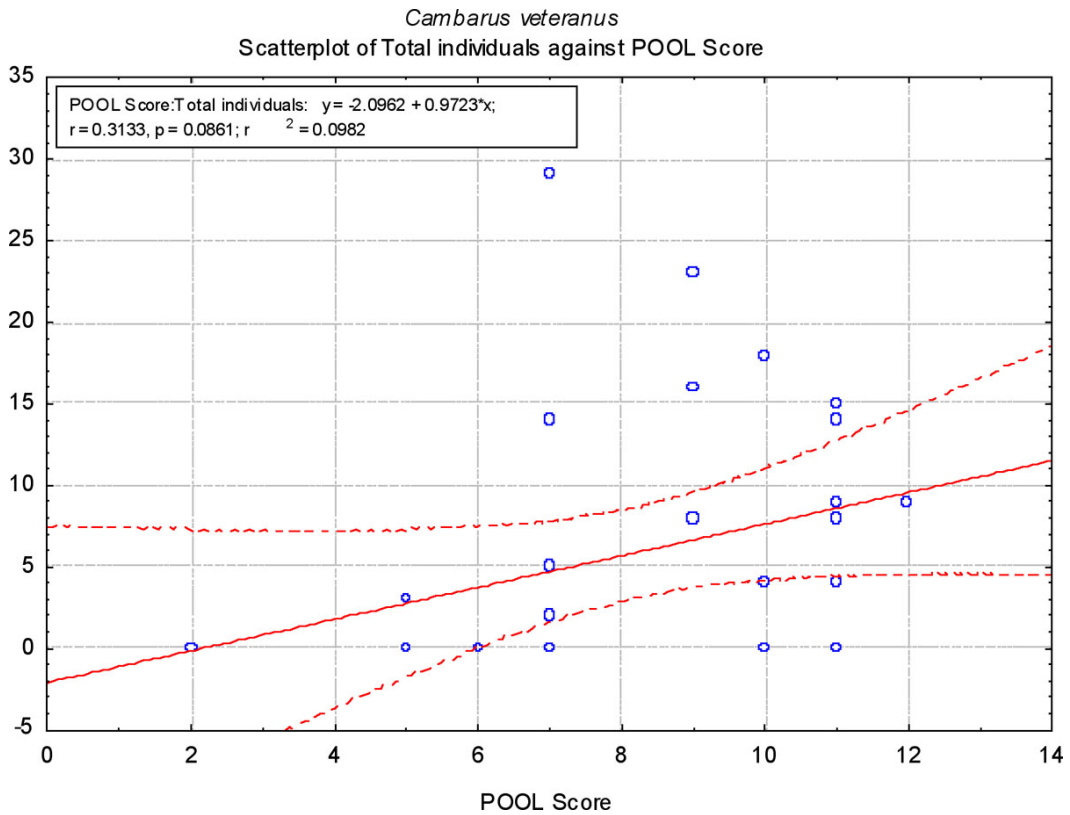


Figure A-14. Regression plot of Pool score values against total individuals of *Cambarus veteranus* collected at all sites sampled.

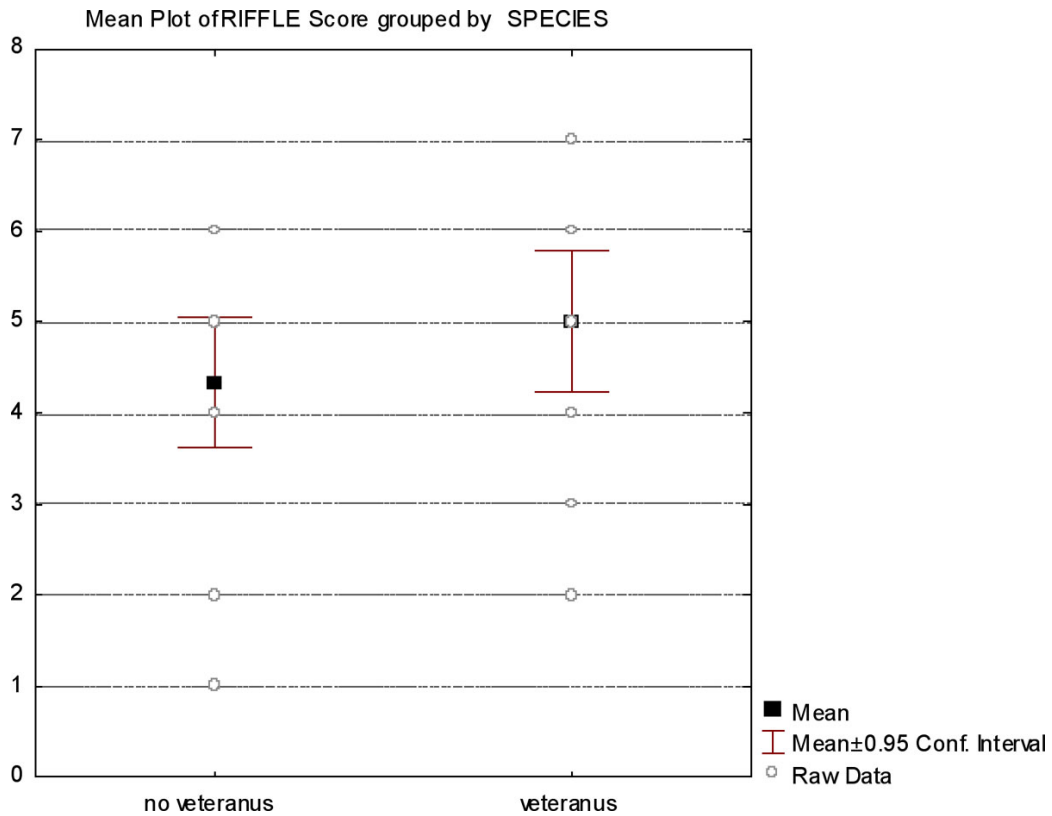


Figure A-15. Box & Whisker plot of Riffle score values for sites where *Cambarus veteranus* was and was not found.

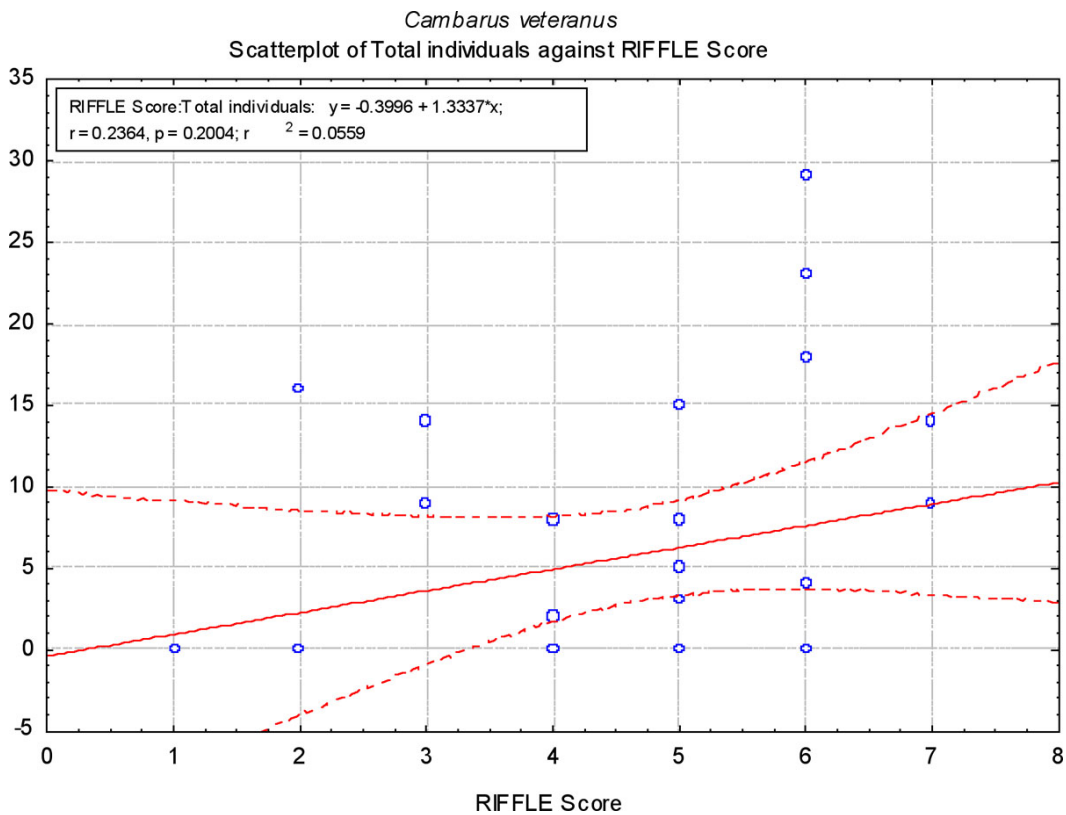


Figure A-16. Regression plot of Riffle score values against total individuals of *Cambarus veteranus* collected at all sites sampled.

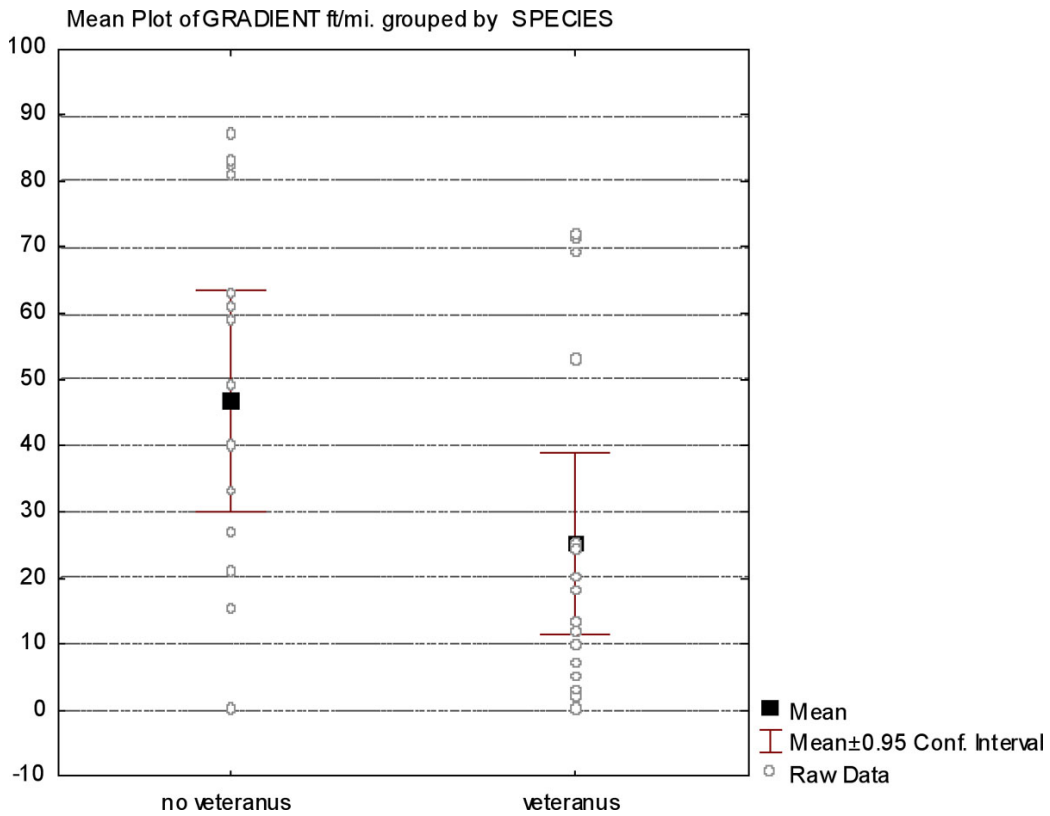


Figure A-17. Box & Whisker plot of gradient values for sites where *Cambarus veteranus* was and was not found.

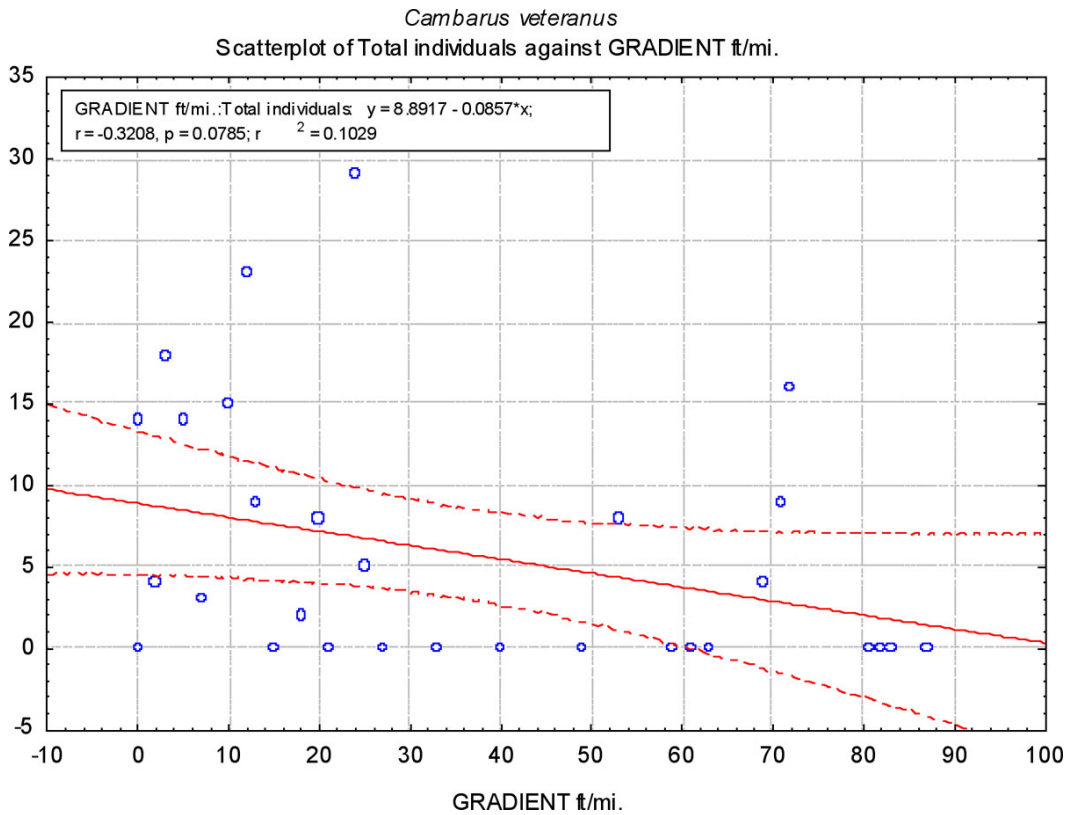


Figure A-18. Regression plot of Gradient values against total individuals of *Cambarus veteranus* collected at all sites sampled.

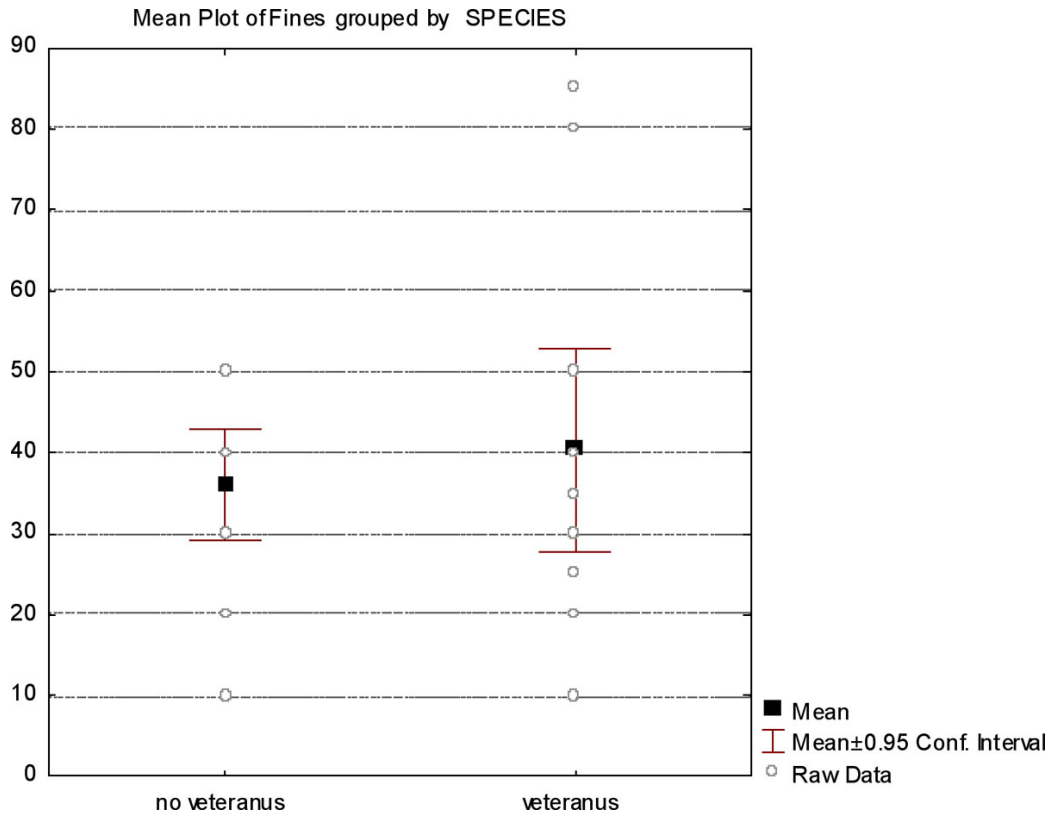


Figure A-19. Box & Whisker plot of % fines values for sites where *Cambarus veteranus* was and was not found.

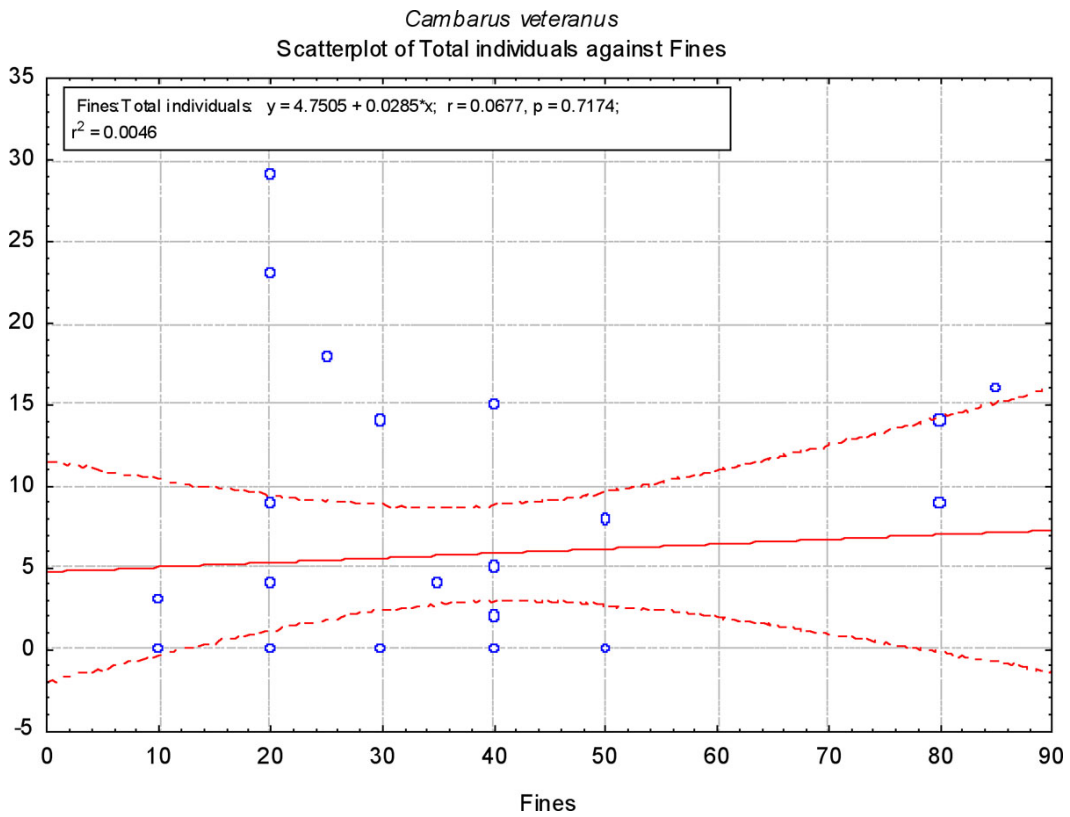


Figure A-20. Regression plot of % Fines against total individuals of *Cambarus veteranus* collected at all sites sampled.

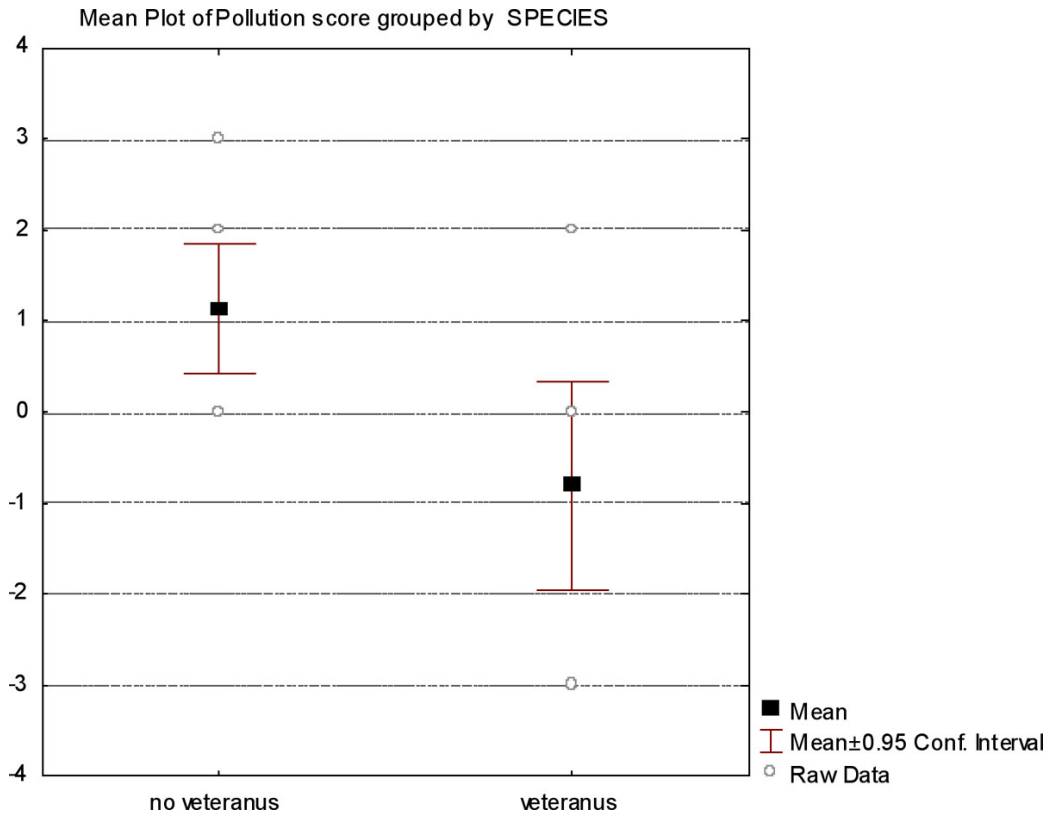


Figure A-21. Box & Whisker plot of pollution score values for sites where *Cambarus veteranus* was and was not found.

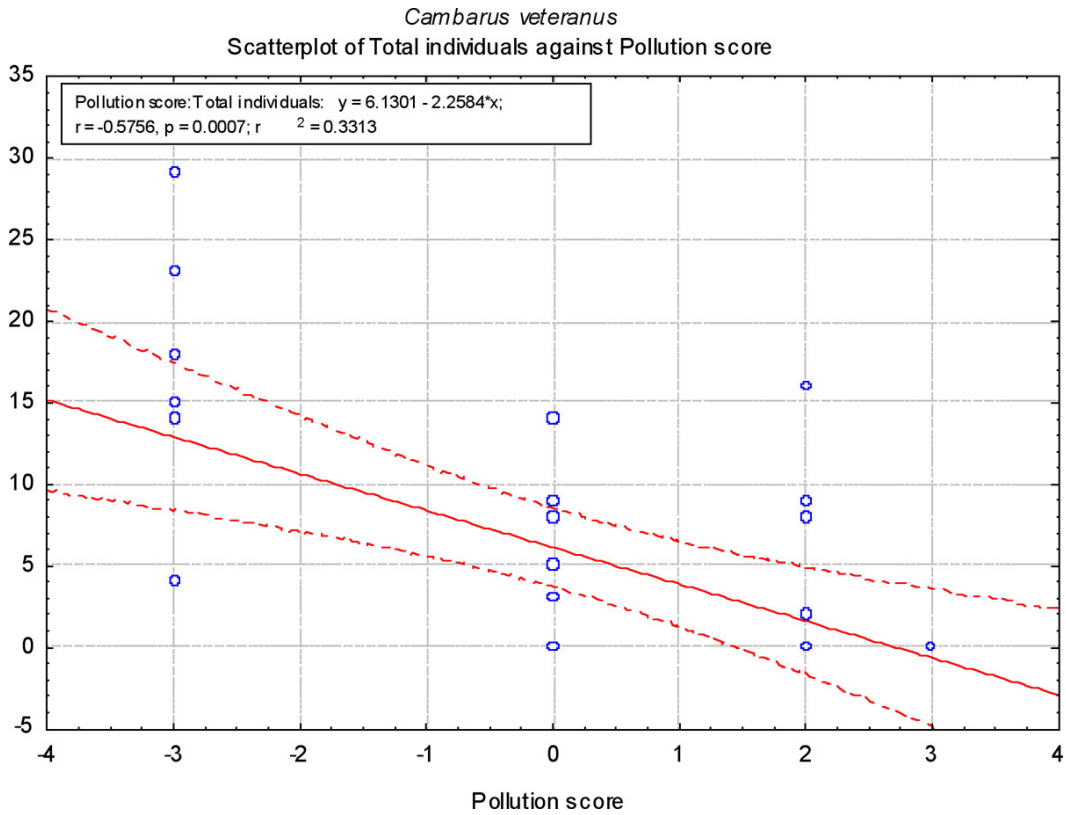


Figure A-22. Regression plot of Pollution score values against total individuals of *Cambarus veteranus* collected at all sites sampled.

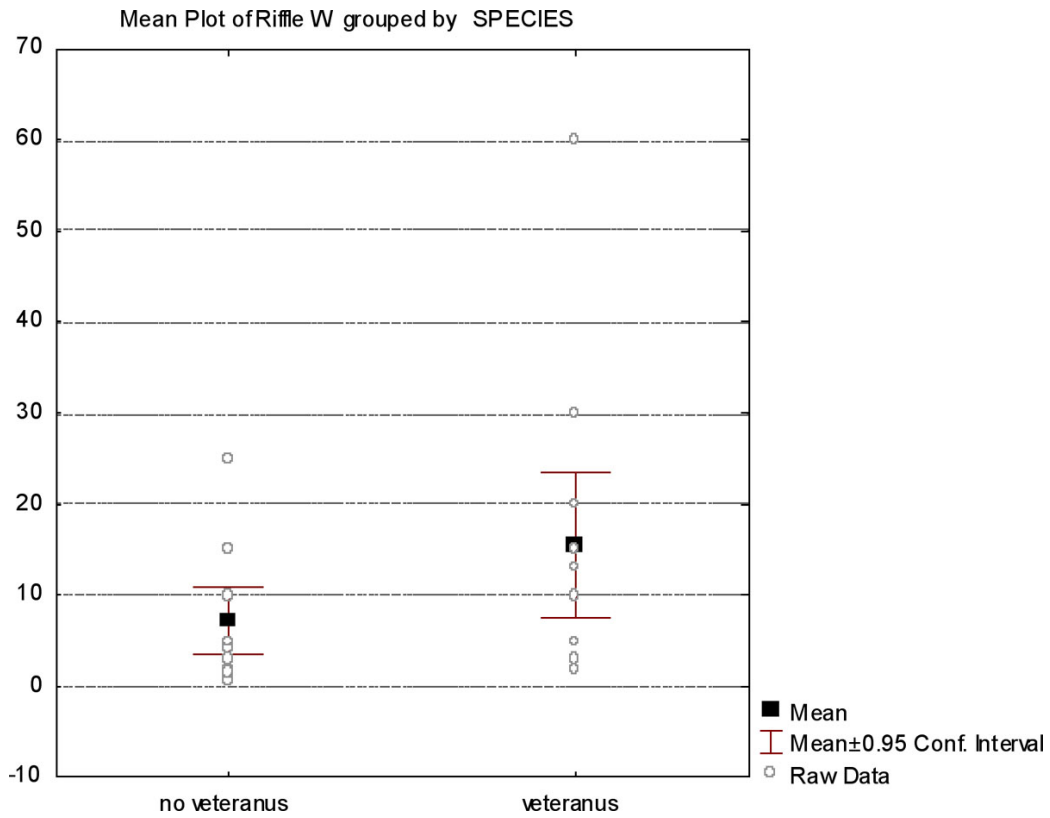


Figure A-23. Box & Whisker plot of riffle width values for sites where *Cambarus veteranus* was and was not found.

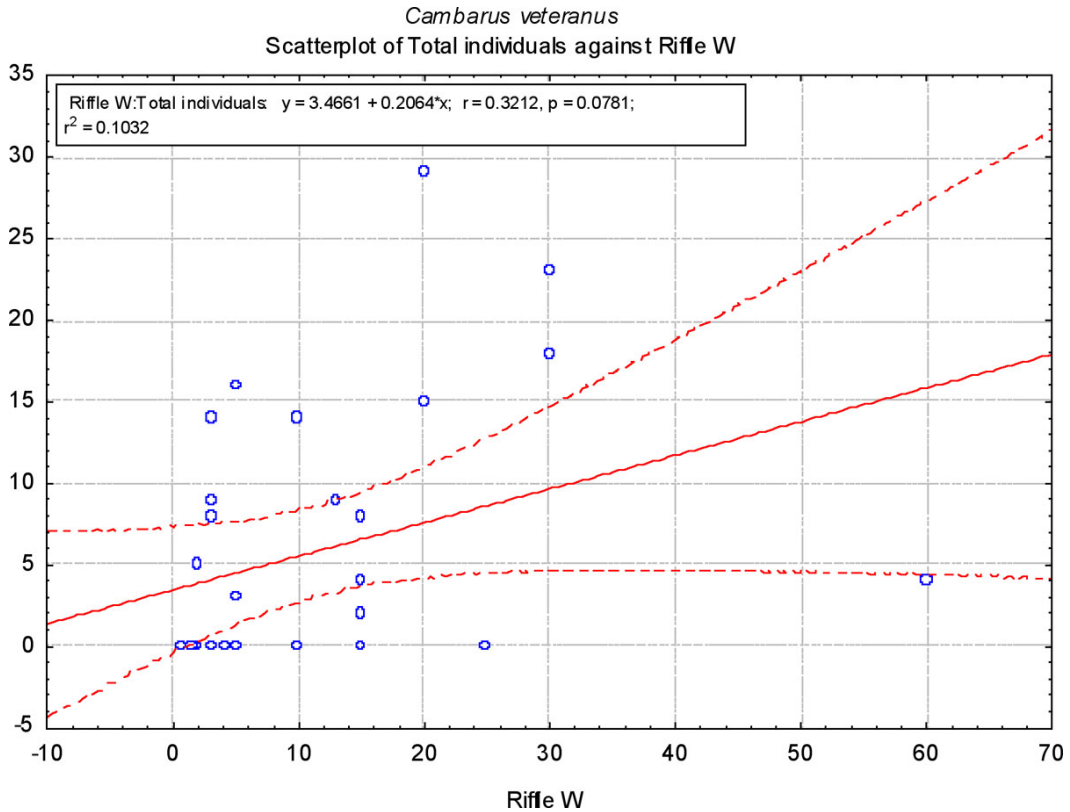


Figure A-24. Regression plot of Riffle width values against total individuals of *Cambarus veteranus* collected at all sites sampled.

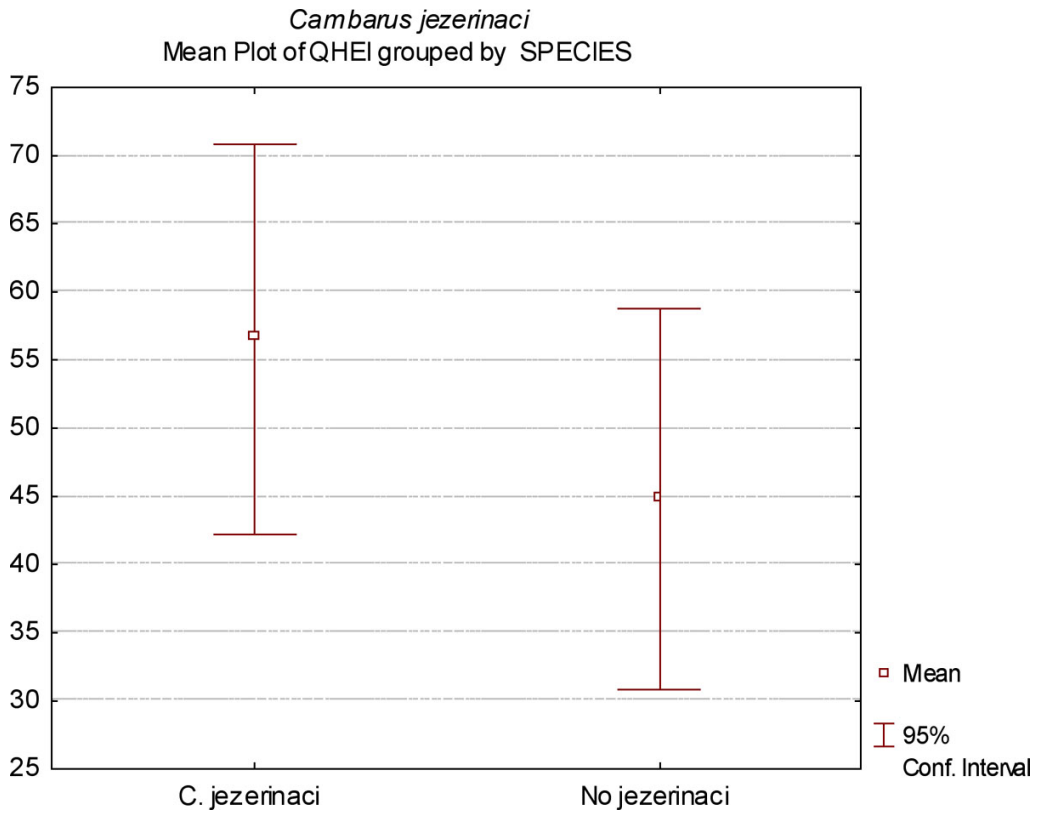


Figure A-25. Box & Whisker plot of QHEI values for sites where *Cambarus jezerinaci* was and was not found.

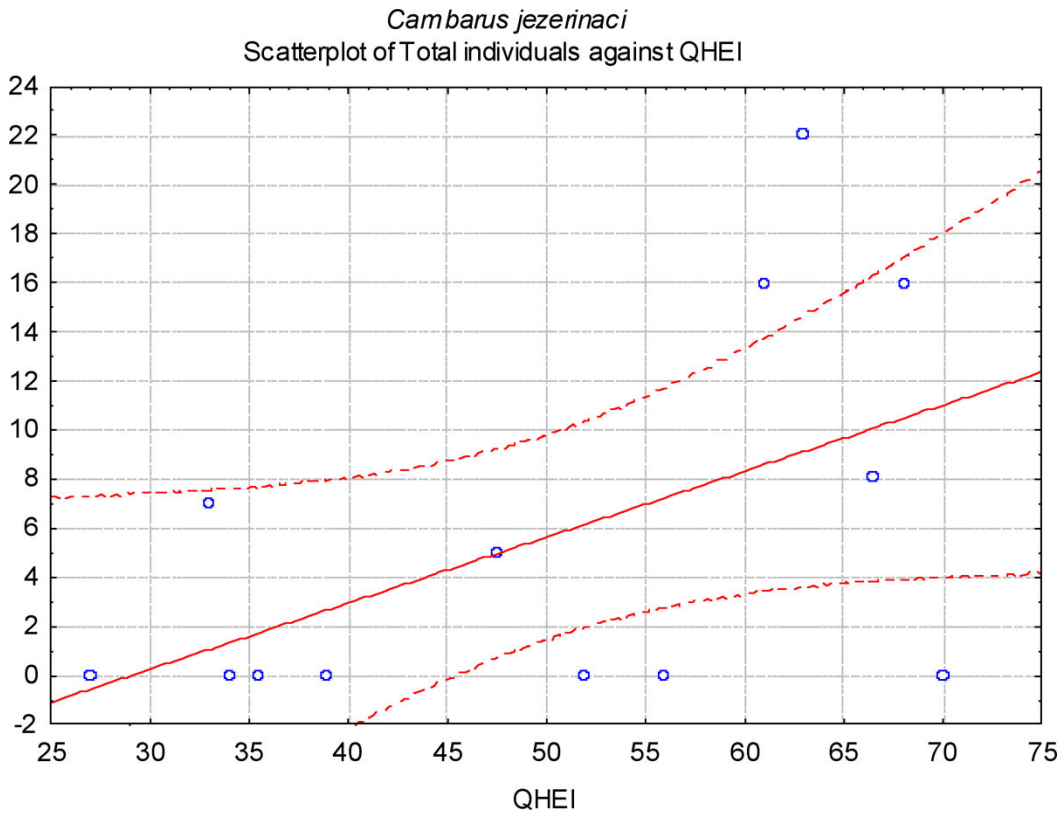


Figure A-26. Regression plot of QHEI values against total individuals of *Cambarus jezerinaci* collected at all sites sampled.

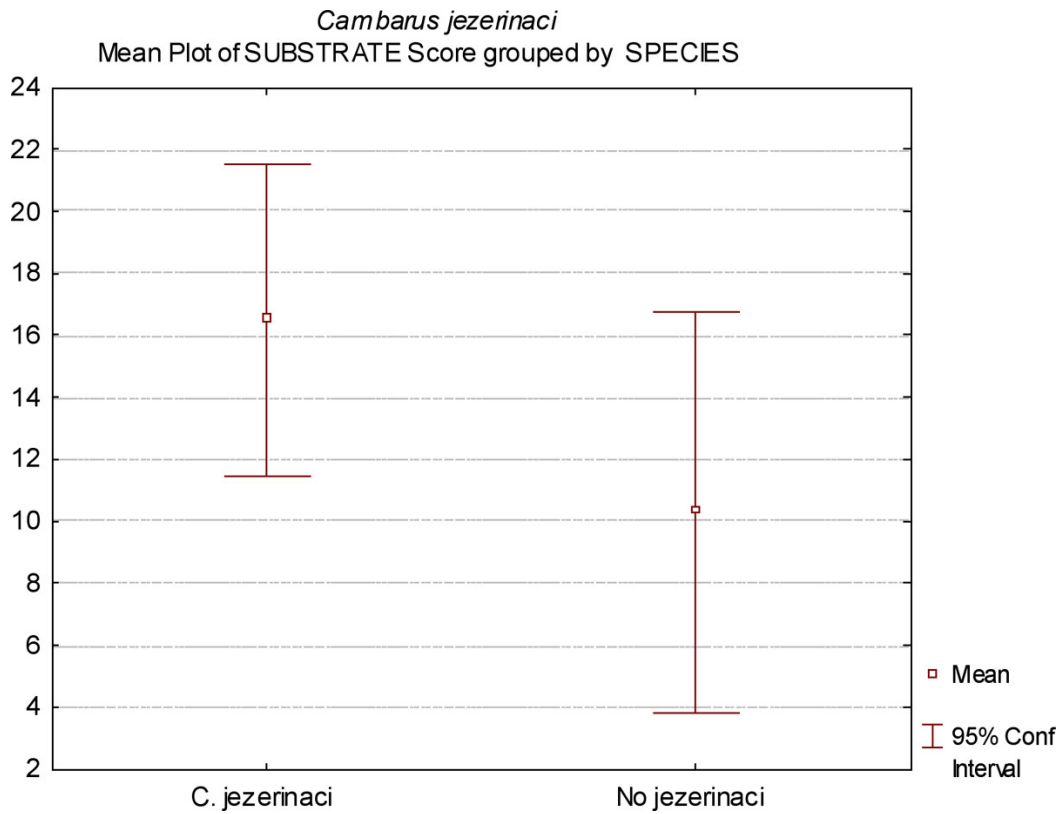


Figure A-27. Box & Whisker plot of Substrate score values for sites where *Cambarus jezerinaci* was and was not found.

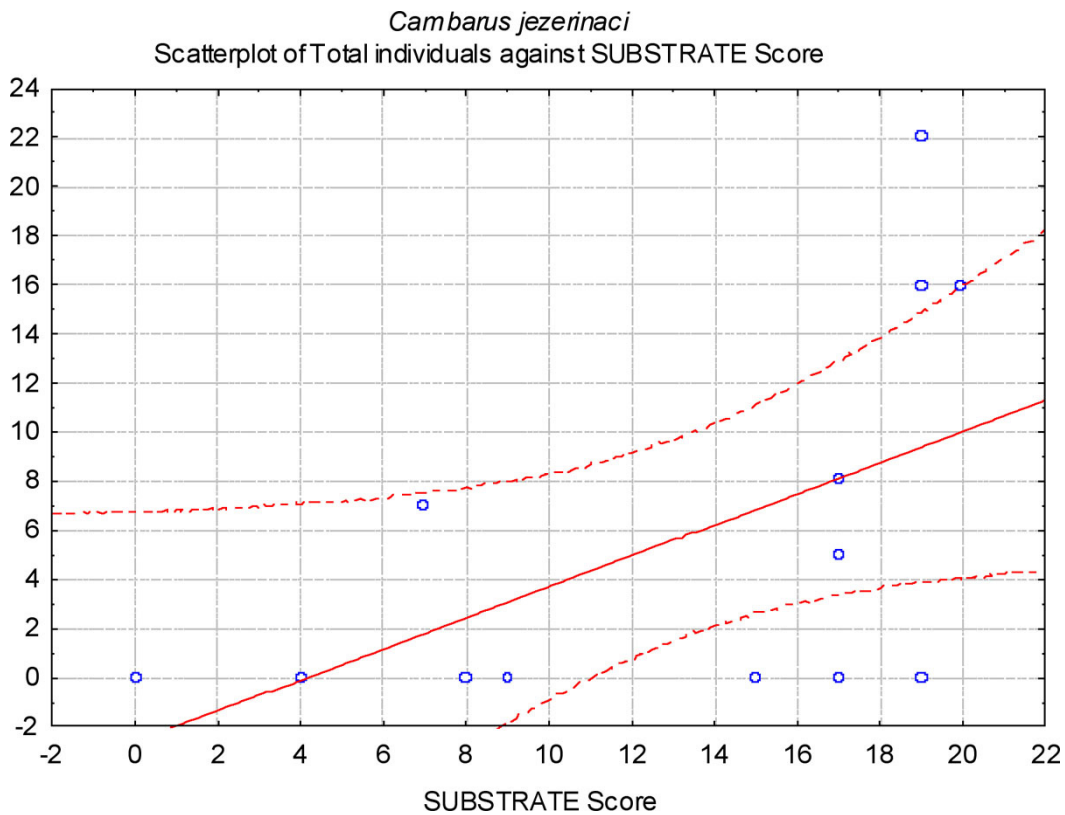


Figure A-28. Regression plot of Substrate score values against total individuals of *Cambarus jezerinaci* collected at all sites sampled.



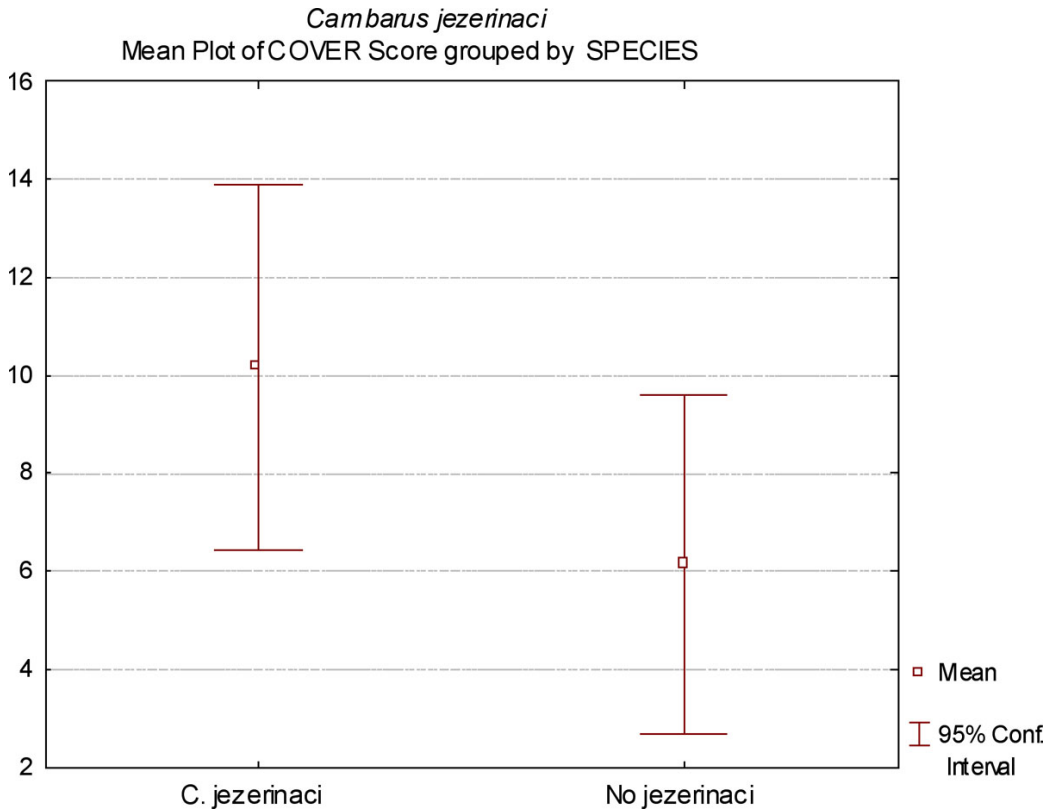


Figure A-29. Box & Whisker plot of Cover score values for sites where *Cambarus jezerinaci* was and was not found.

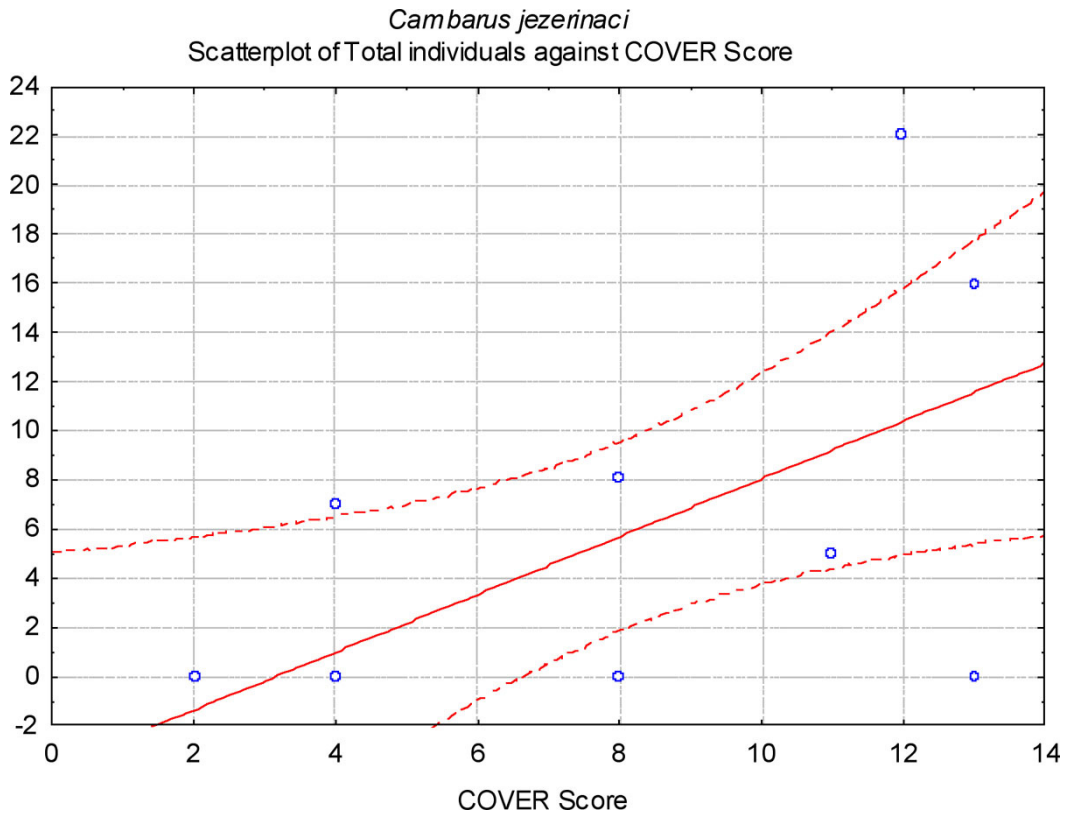


Figure A-30. Regression plot of Cover score values against total individuals of *Cambarus jezerinaci* collected at all sites sampled.

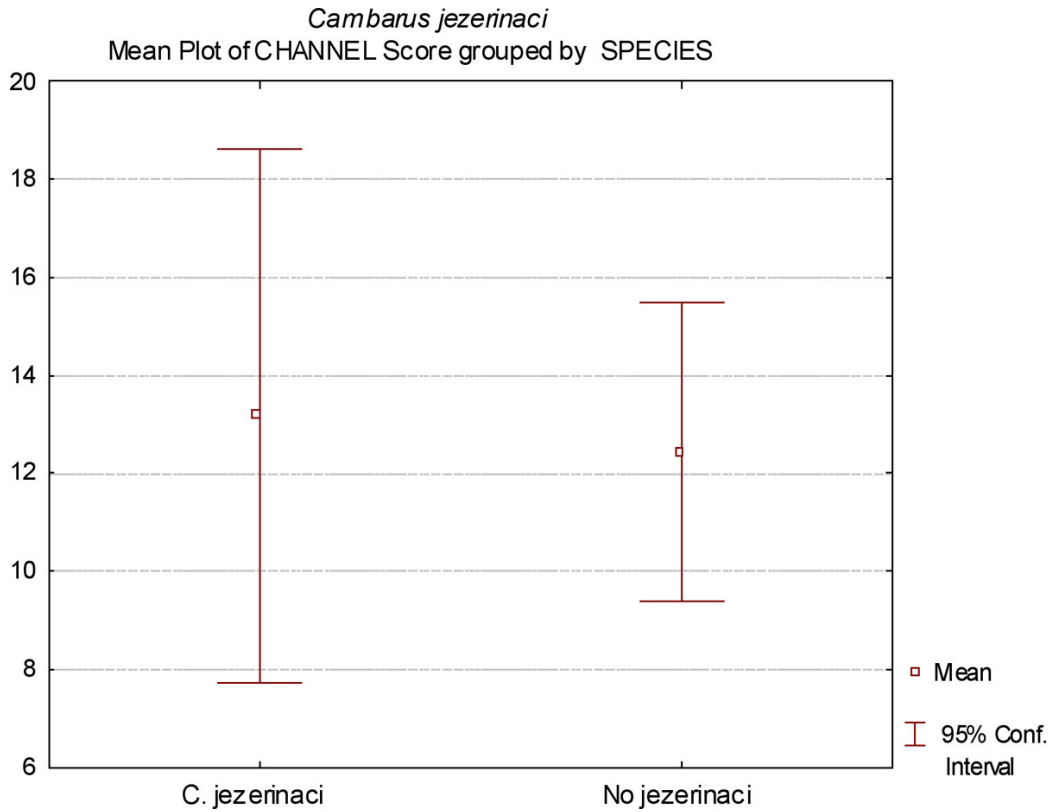


Figure A-31. Box & Whisker plot of Channel score values for sites where *Cambarus jezerinaci* was and was not found.

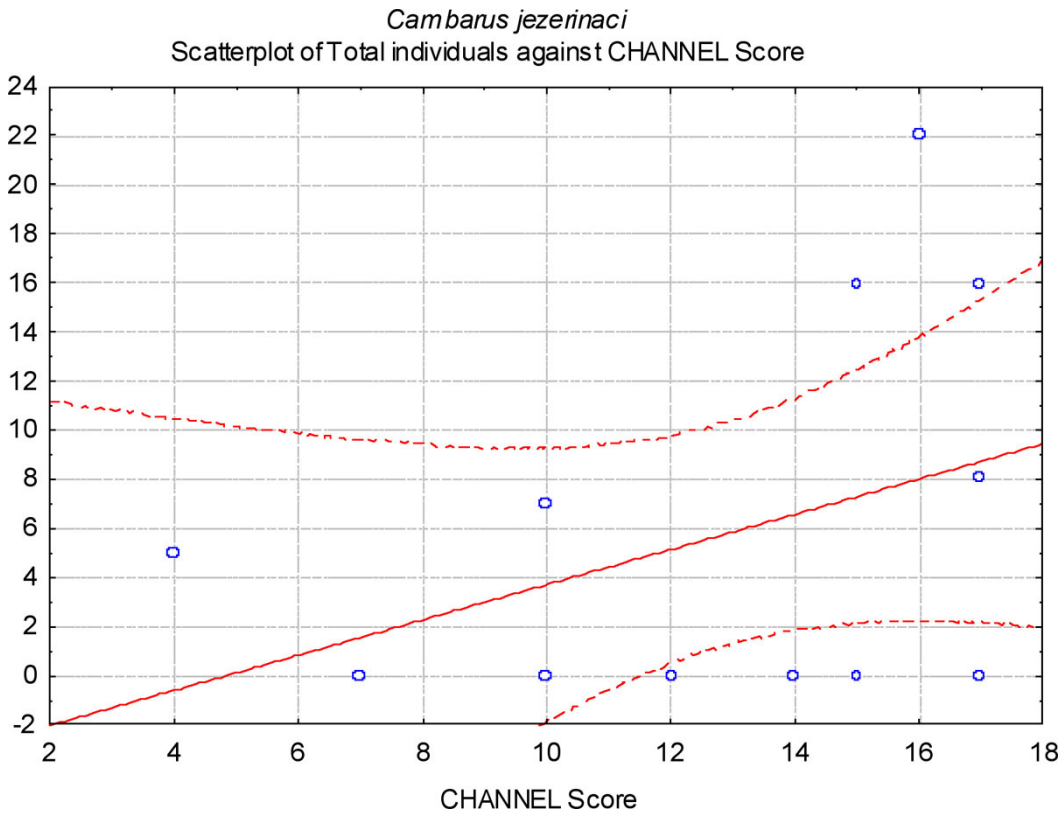


Figure A-32. Regression plot of Channel score values against total individuals of *Cambarus jezerinaci* collected at all sites sampled.

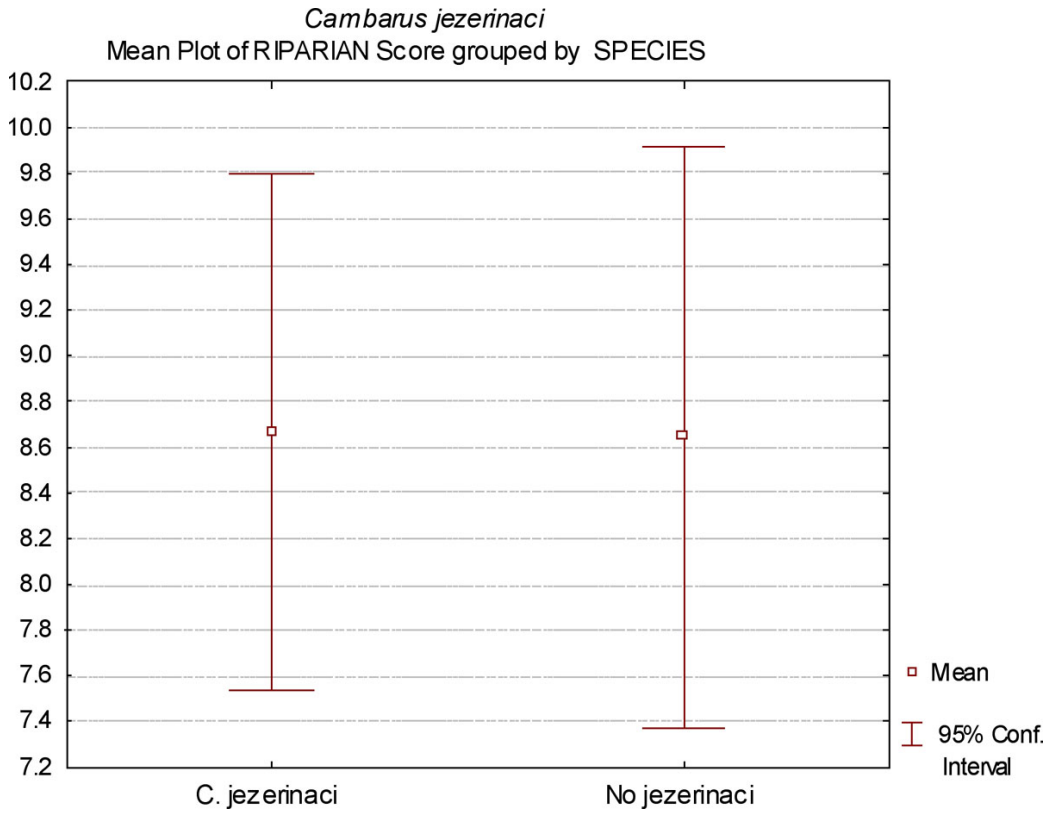


Figure A-33. Box & Whisker plot of Riparian score values for sites where *Cambarus jezerinaci* was and was not found.

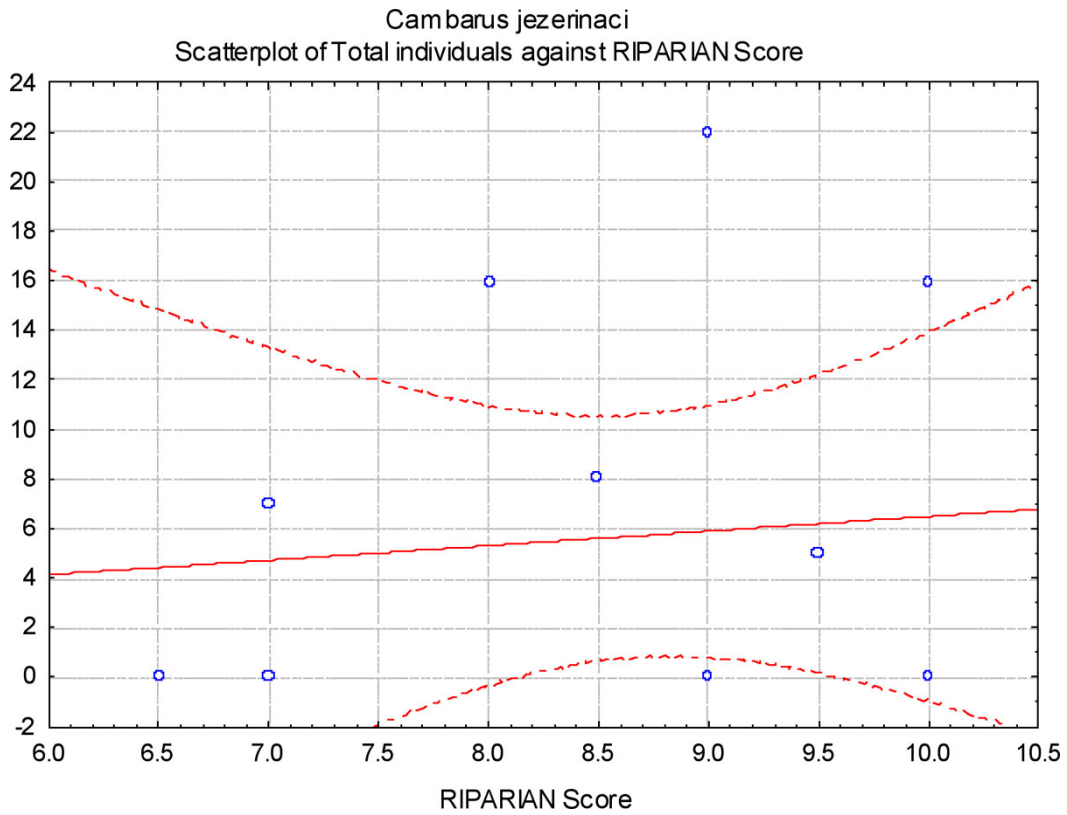


Figure A-34. Regression plot of Riparian score values against total individuals of *Cambarus jezerinaci* collected at all sites sampled.

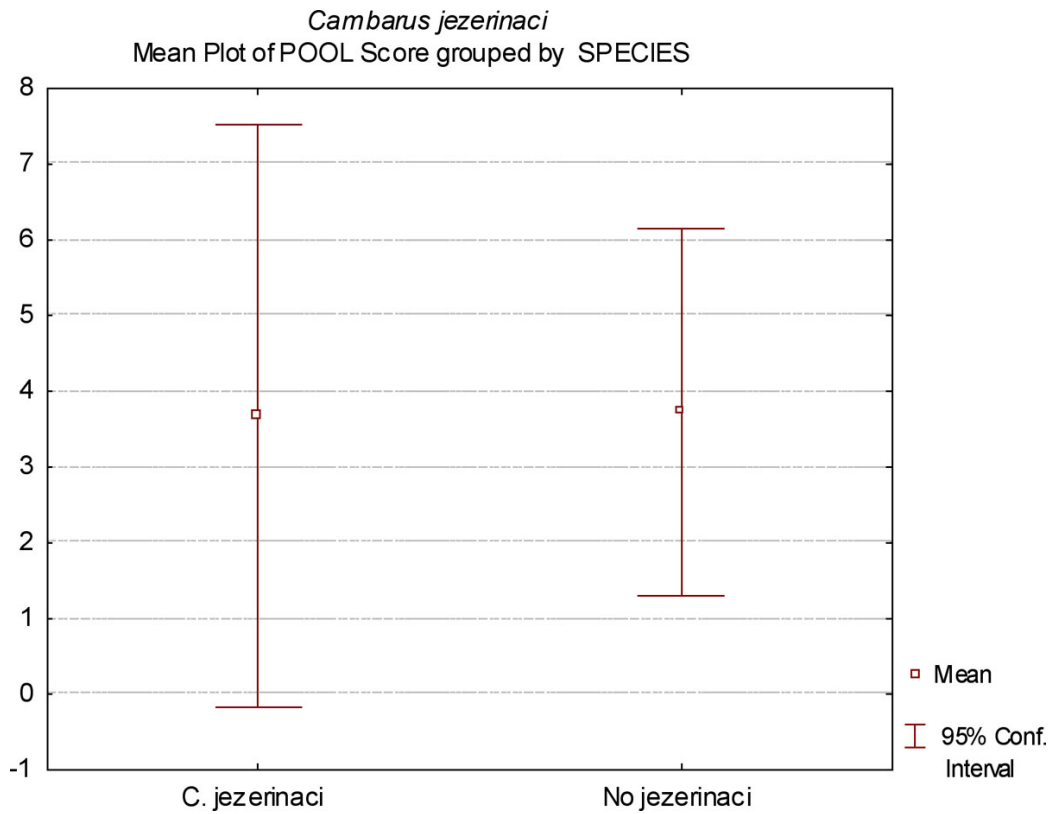


Figure A-35. Box & Whisker plot of Pool score values for sites where *Cambarus jezerinaci* was and was not found.

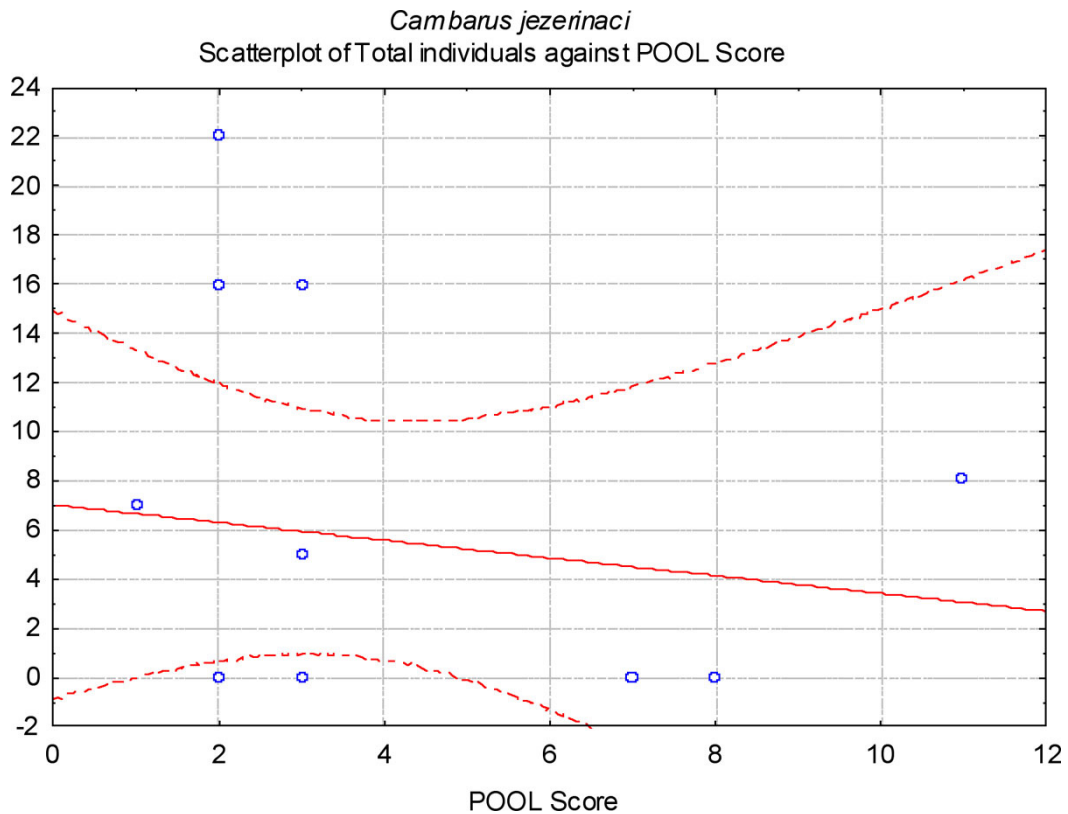


Figure A-36. Regression plot of Pool score values against total individuals of *Cambarus jezerinaci* collected at all sites sampled.

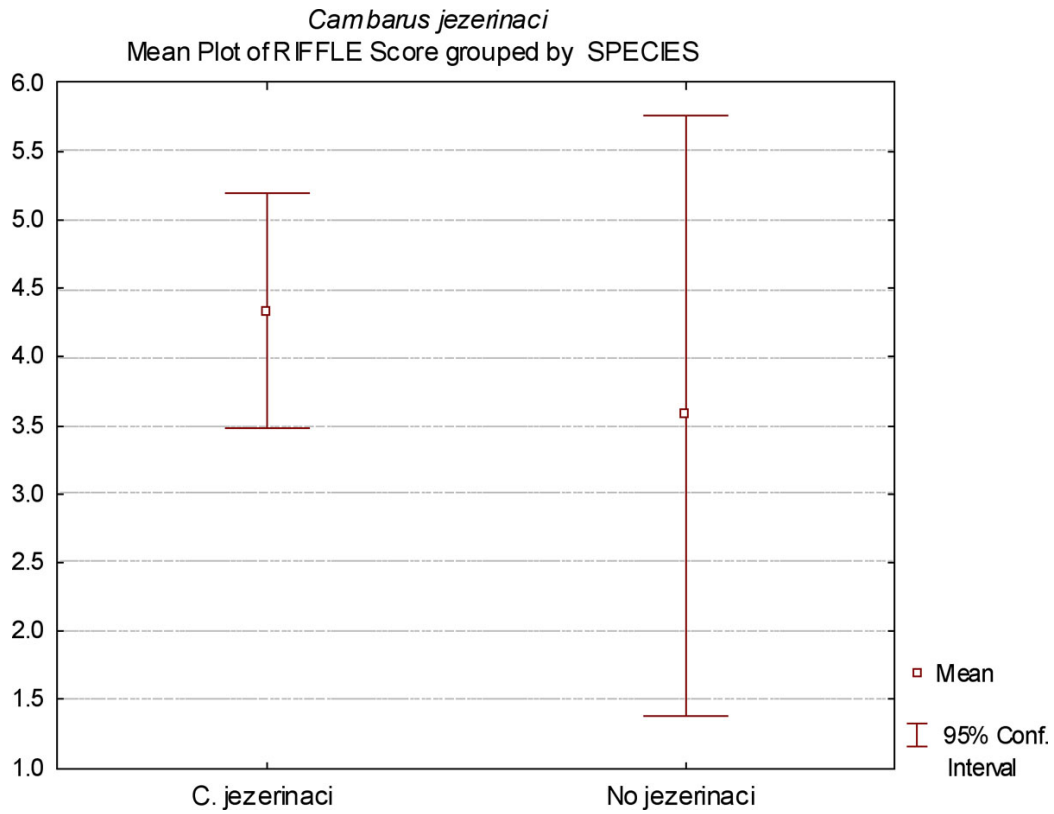


Figure A-37. Box & Whisker plot of Riffle score values for sites where *Cambarus jezerinaci* was and was not found.

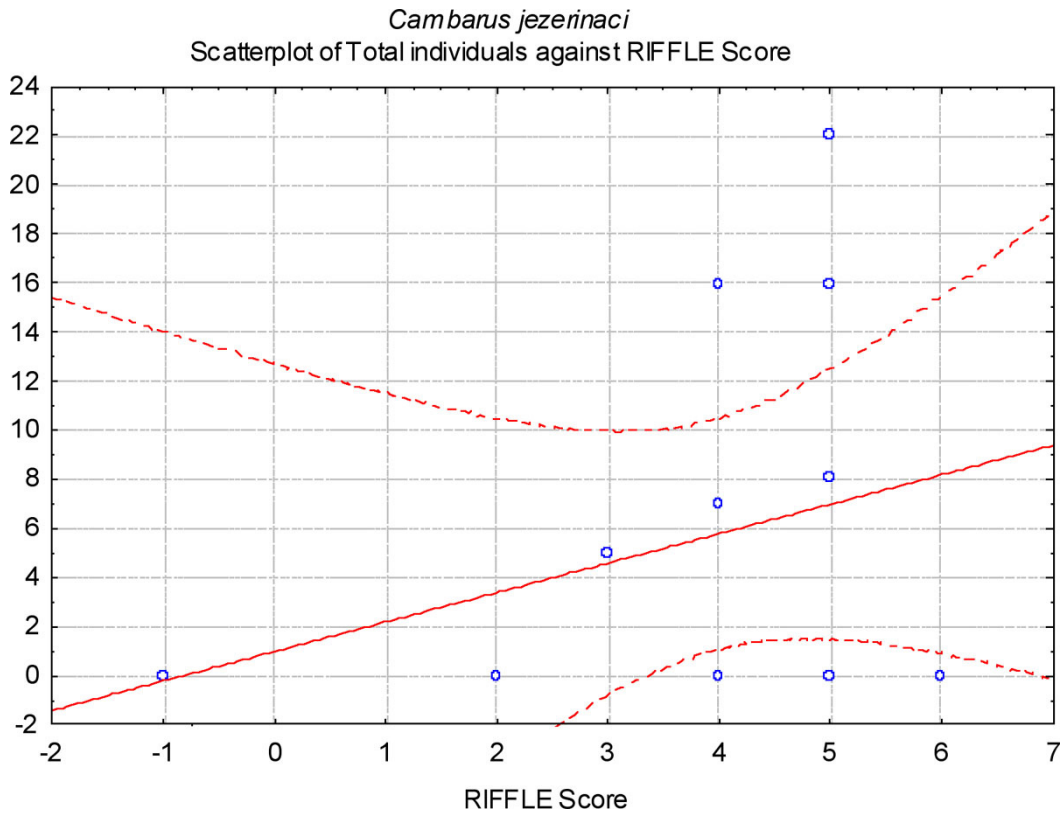


Figure A-38. Regression plot of Riffle score values against total individuals of *Cambarus jezerinaci* collected at all sites sampled.

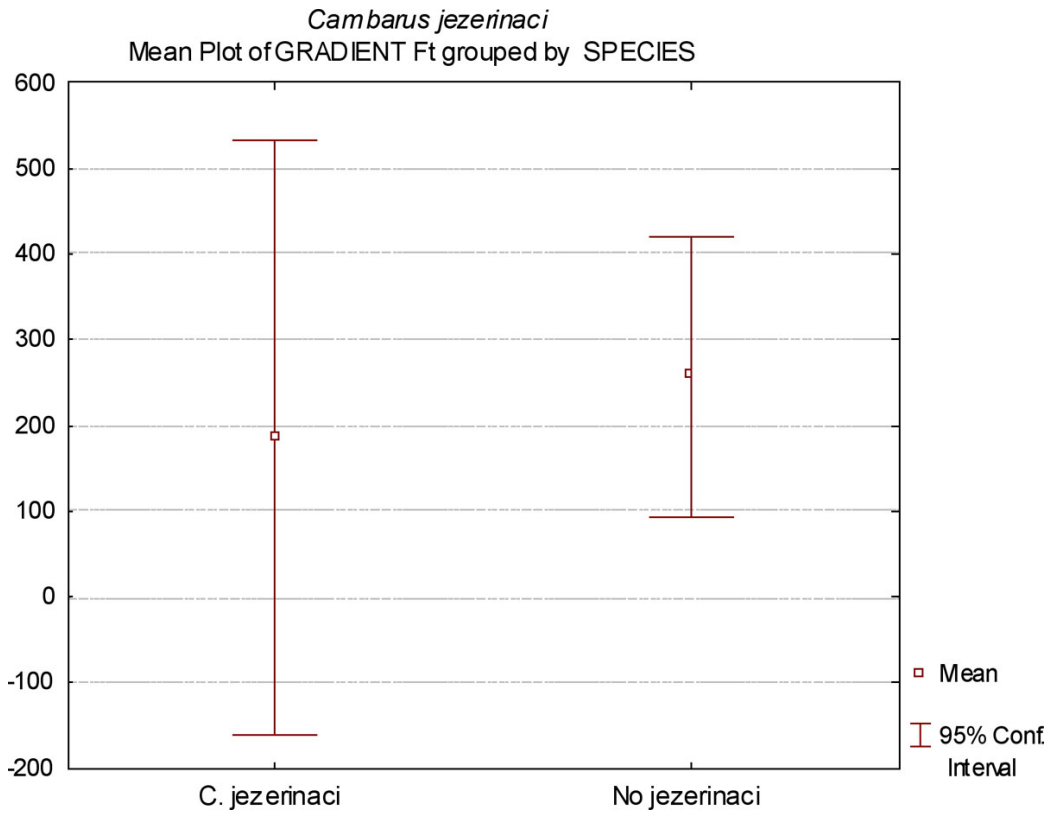


Figure A-39. Box & Whisker plot of Gradient values for sites where *Cambarus jezerinaci* was and was not found.

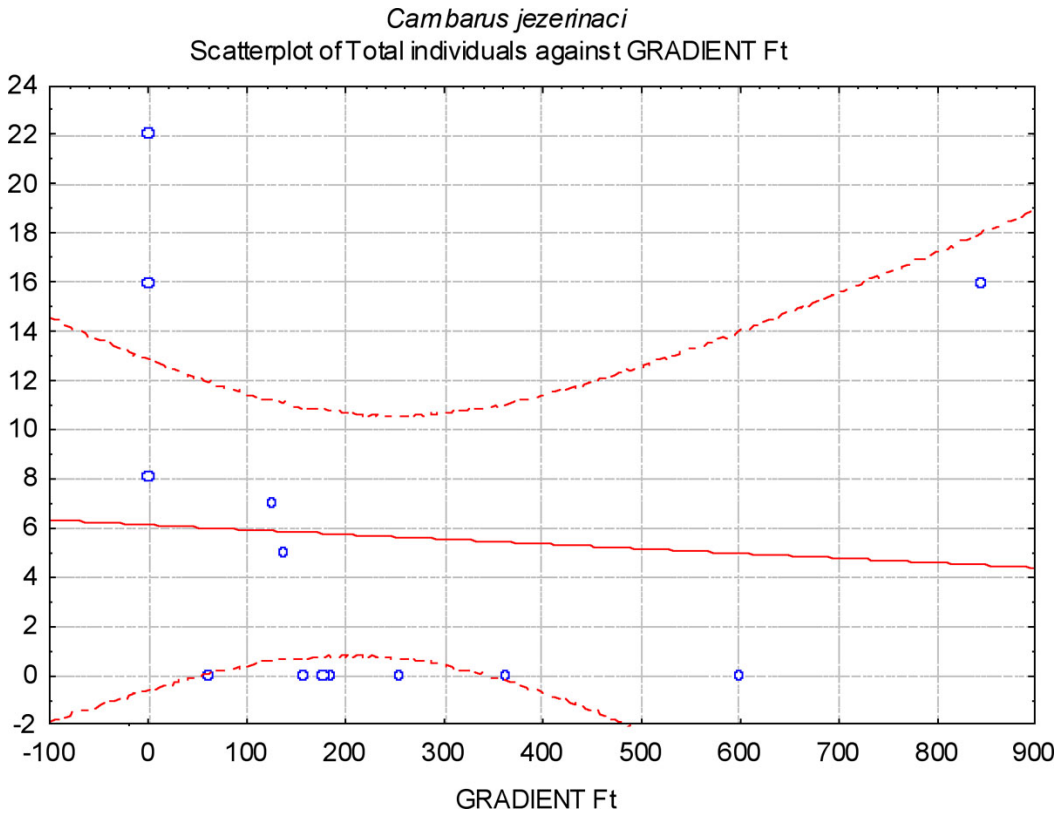


Figure A-40. Regression plot of Gradient values against total individuals of *Cambarus jezerinaci* collected at all sites sampled.

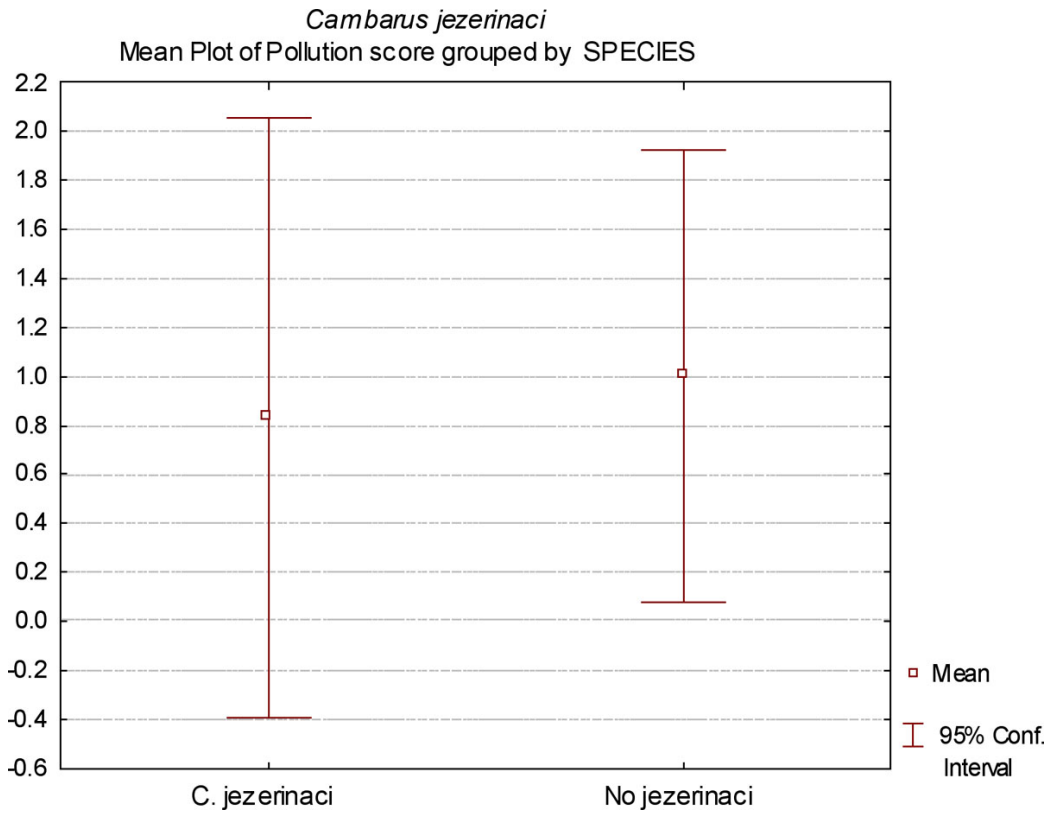


Figure A-41. Box & Whisker plot of Pollution score values for sites where *Cambarus jezerinaci* was and was not found.

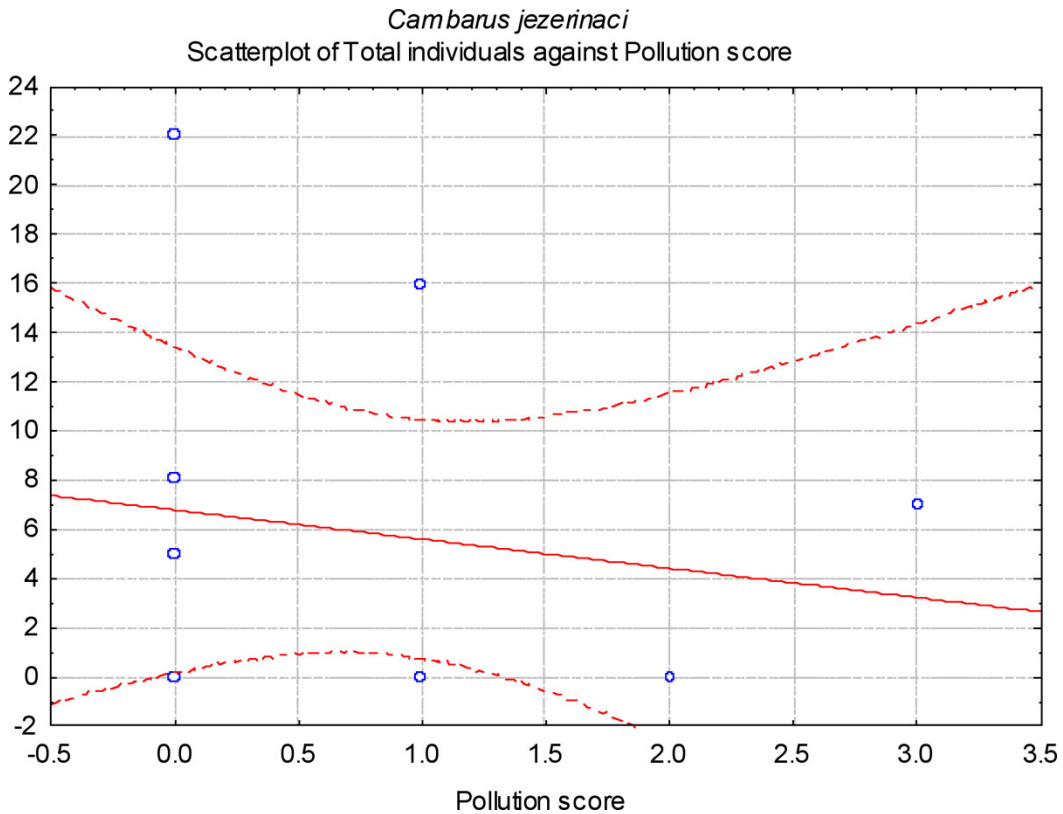


Figure A-42. Regression plot of Pollution score values against total individuals of *Cambarus jezerinaci* collected at all sites sampled.

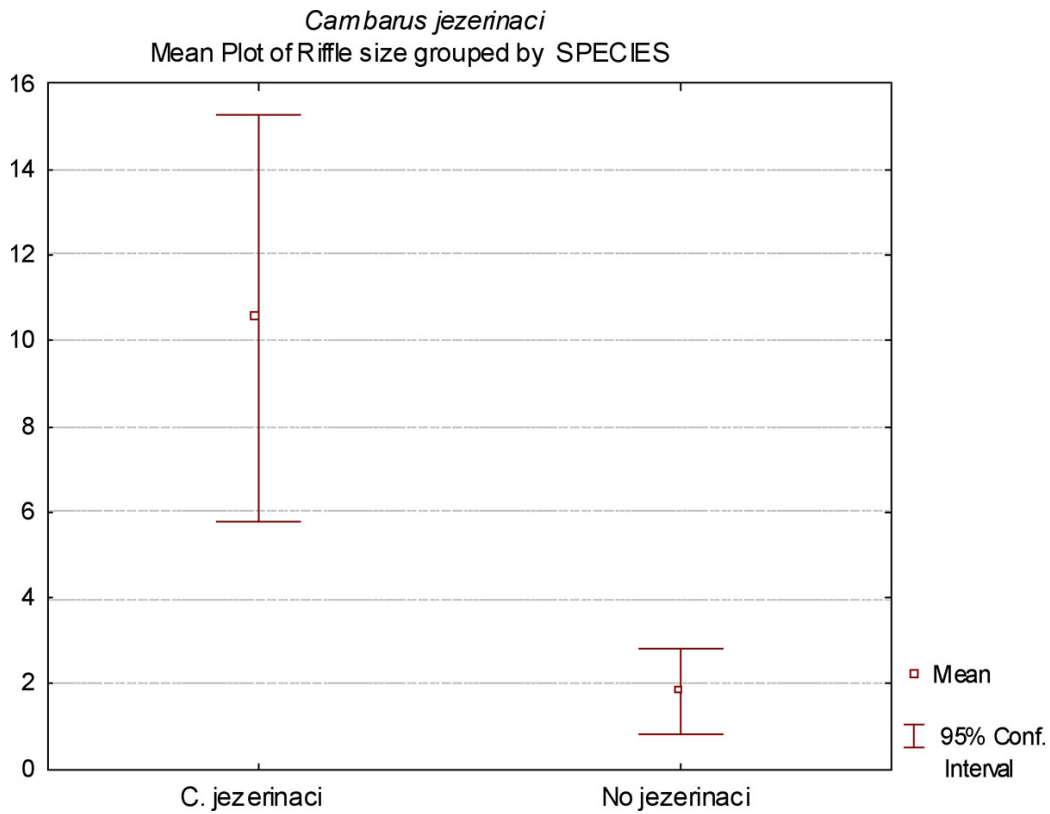


Figure A-43. Box & Whisker plot of Riffle width values for sites where *Cambarus jezerinaci* was and was not found.

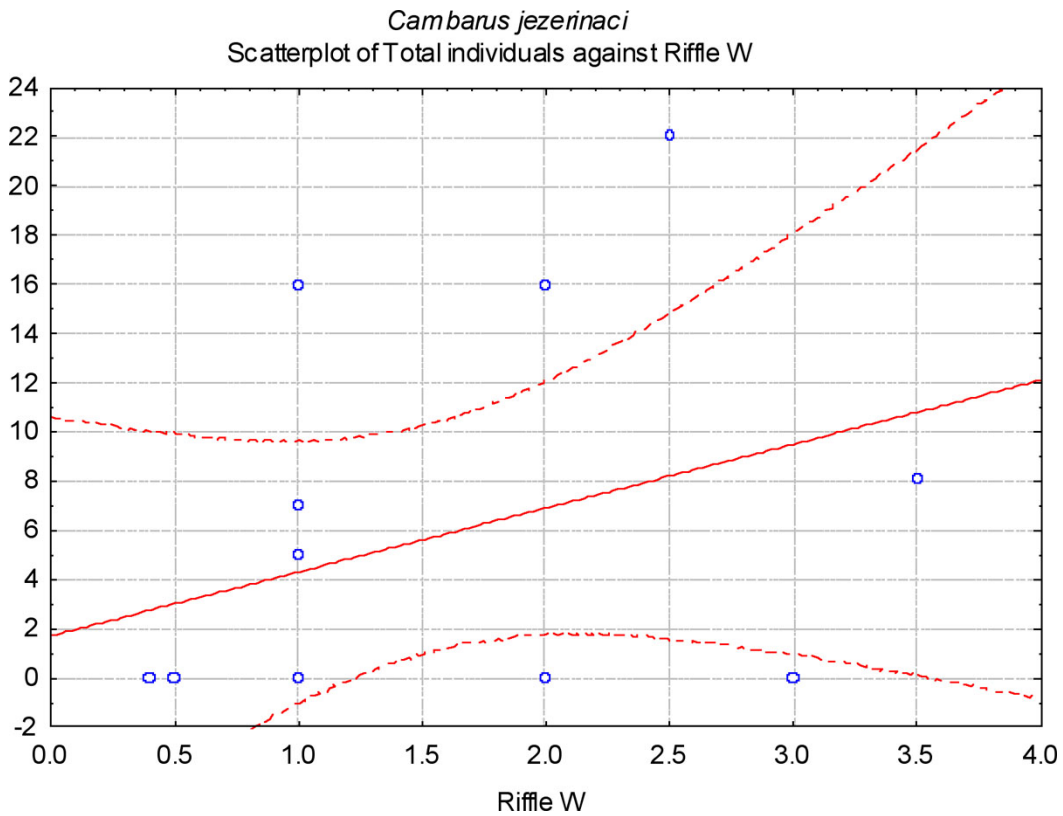


Figure A-44. Regression plot of Riffle width values against total individuals of *Cambarus jezerinaci* collected at all sites sampled.



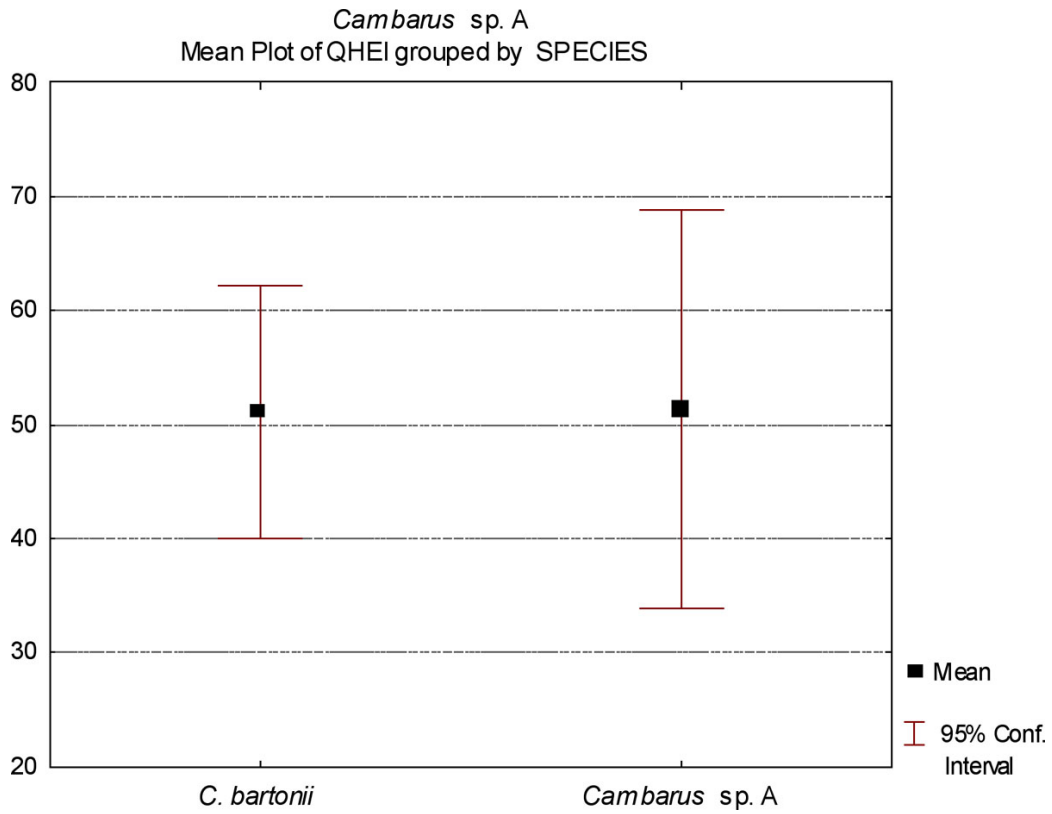


Figure A-45. Box & Whisker plot of QHEI values for sites where *Cambarus bartonii* and *Cambarus* sp. A were found.

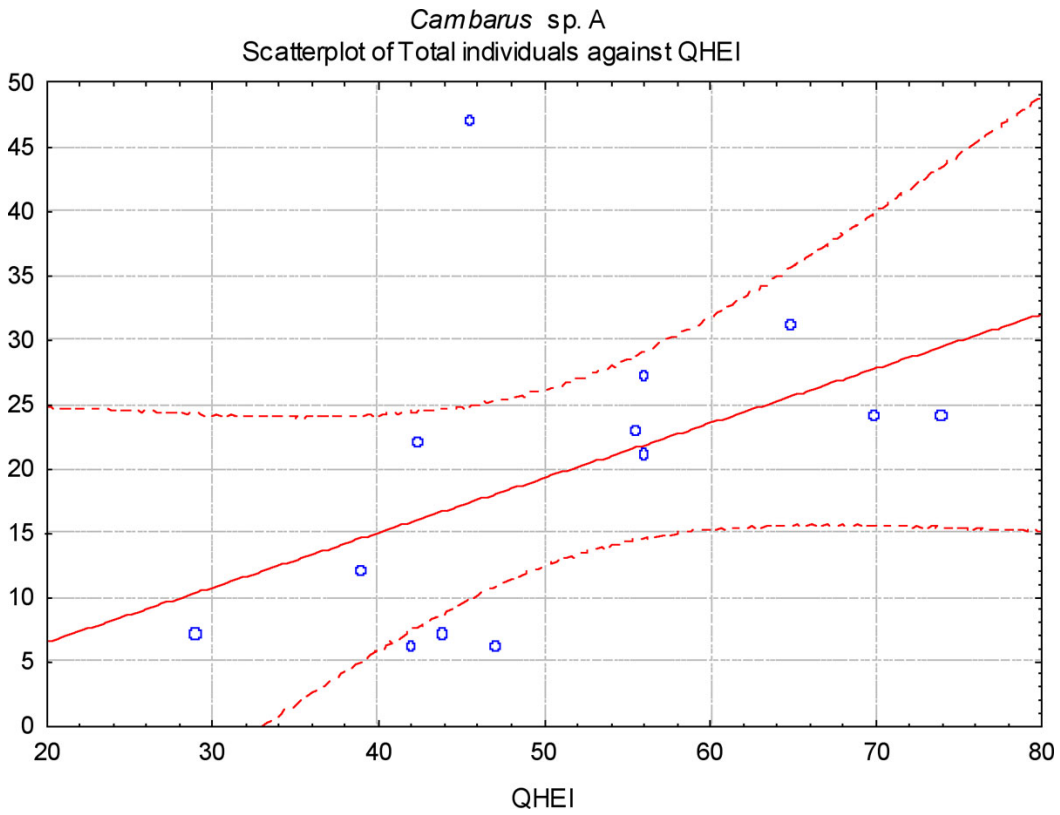


Figure A-46. Regression plot of QHEI values against total individuals of *Cambarus* sp. A collected at all sites sampled.

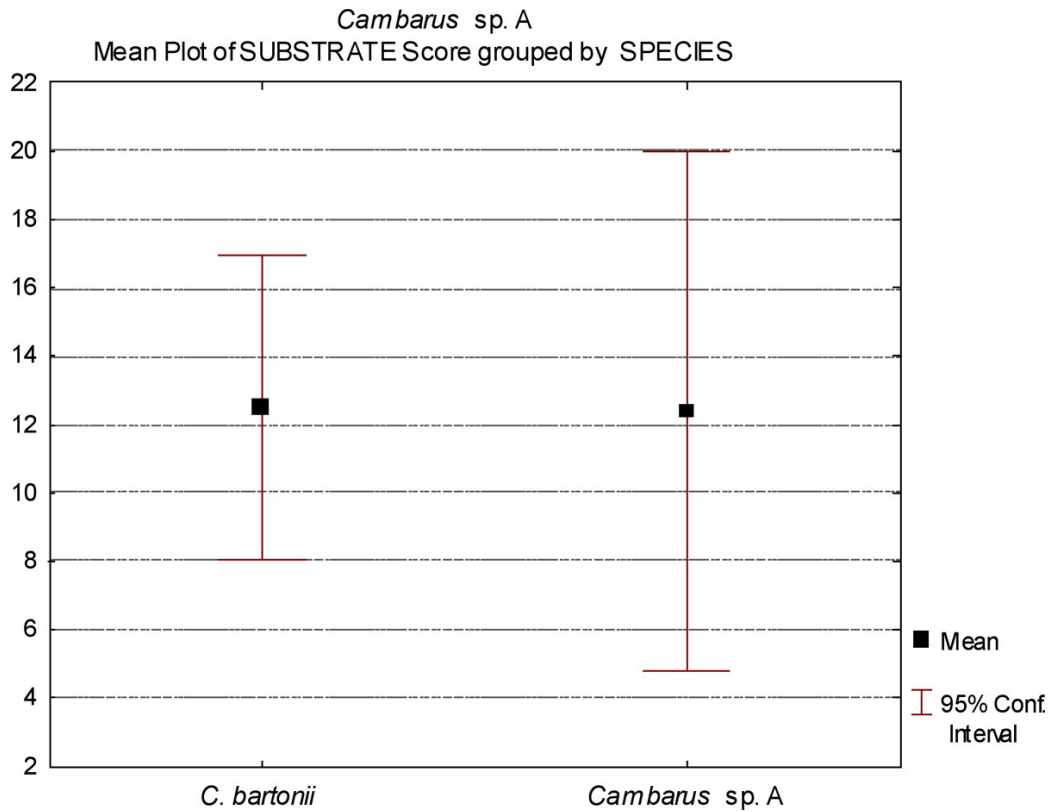


Figure A-47. Box & Whisker plot of Substrate score values for sites where *Cambarus bartonii* and *Cambarus sp. A* were found.

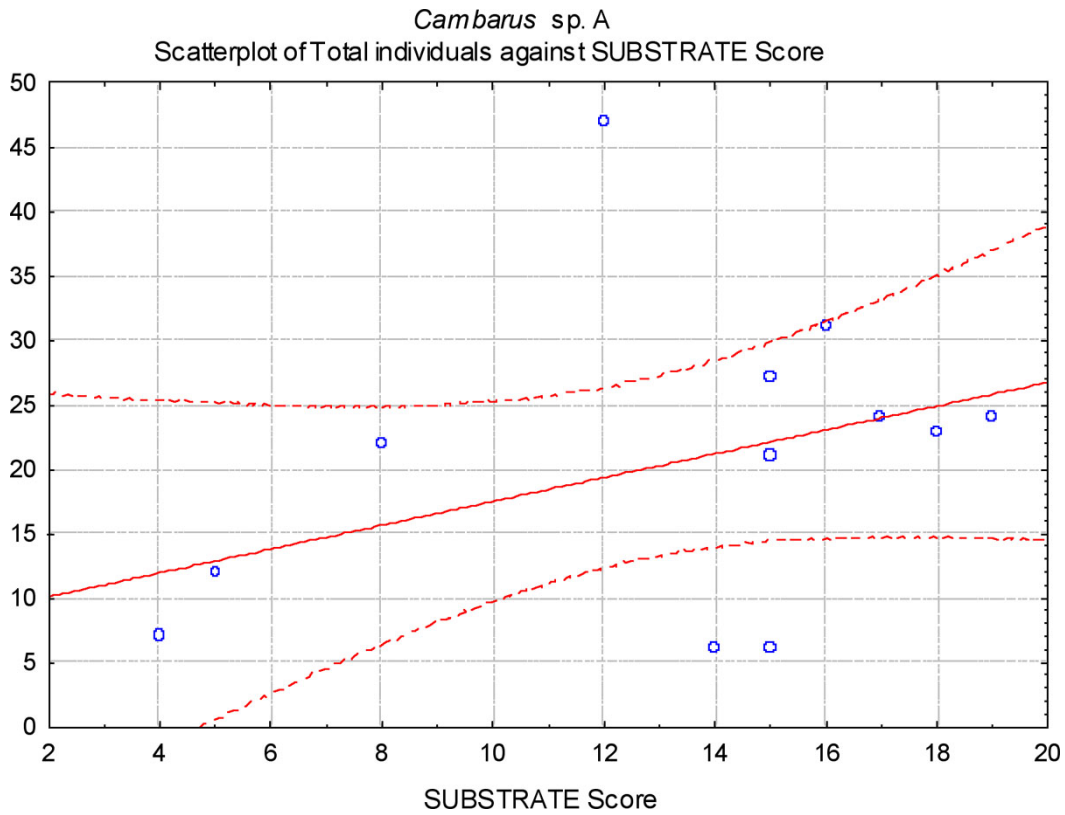


Figure A-48. Regression plot of Substrate score values against total individuals of *Cambarus sp. A* collected at all sites sampled.

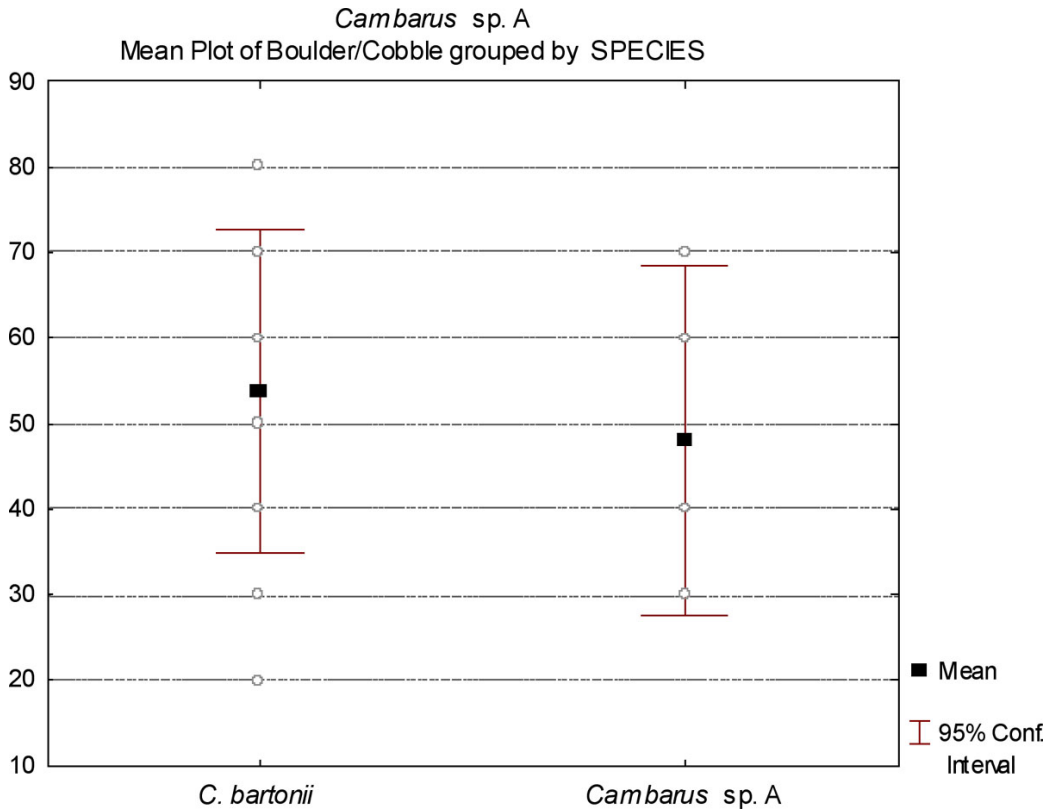


Figure A-49. Box & Whisker plot of % Boulder/Cobble values for sites where *Cambarus bartonii* and *Cambarus* sp. A were found.

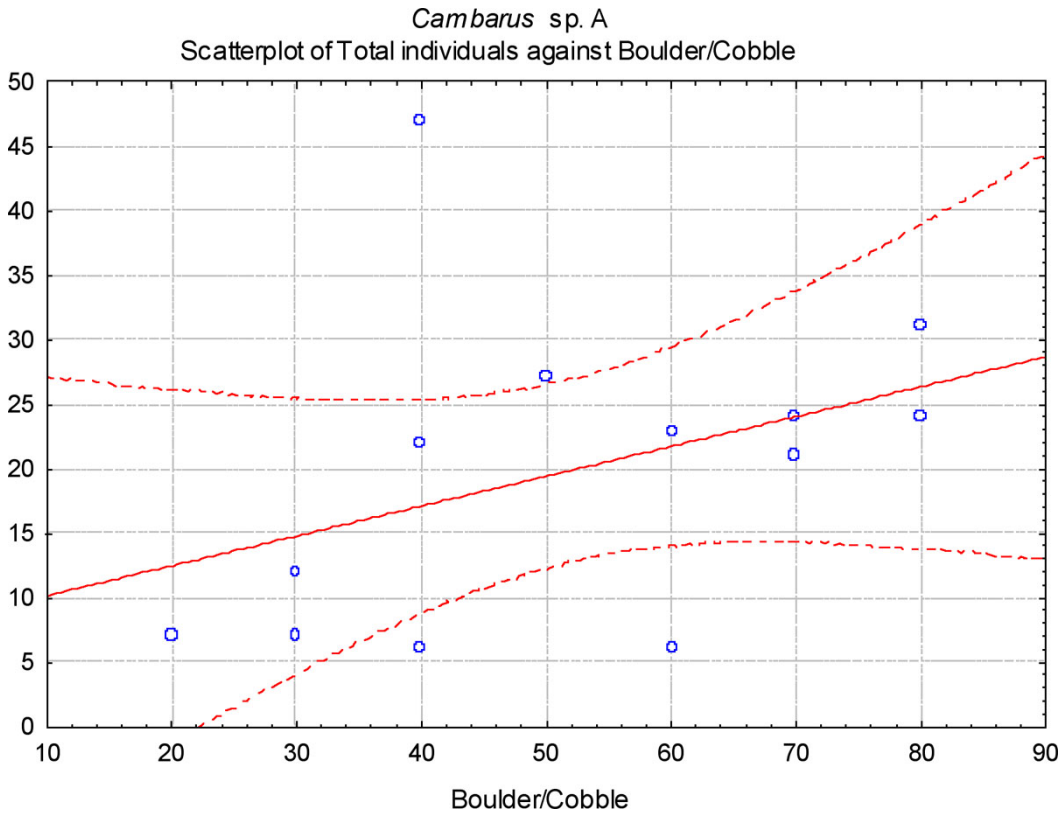


Figure A-50. Regression plot of % Boulder/Cobble values against total individuals of *Cambarus* sp. A collected at all sites sampled.

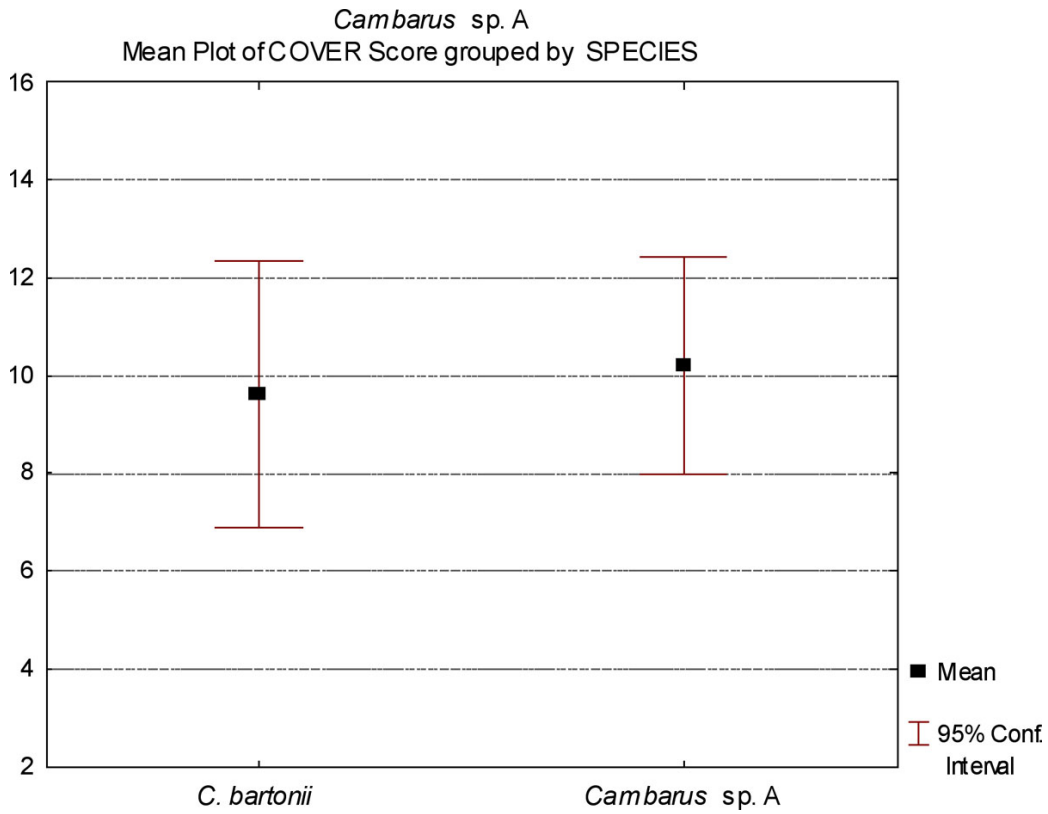


Figure A-51. Box & Whisker plot of Cover score values for sites where *Cambarus bartonii* and *Cambarus* sp. A were found.

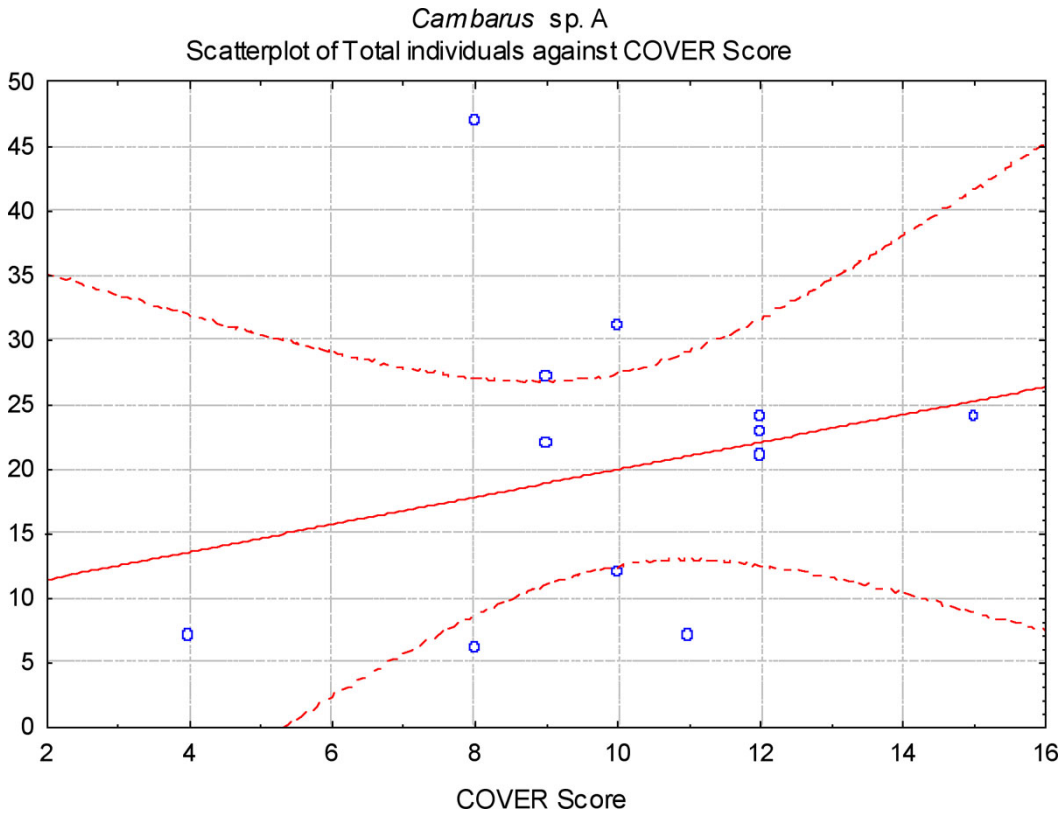


Figure A-52. Regression plot of Cover score values against total individuals of *Cambarus* sp. A collected at all sites sampled.

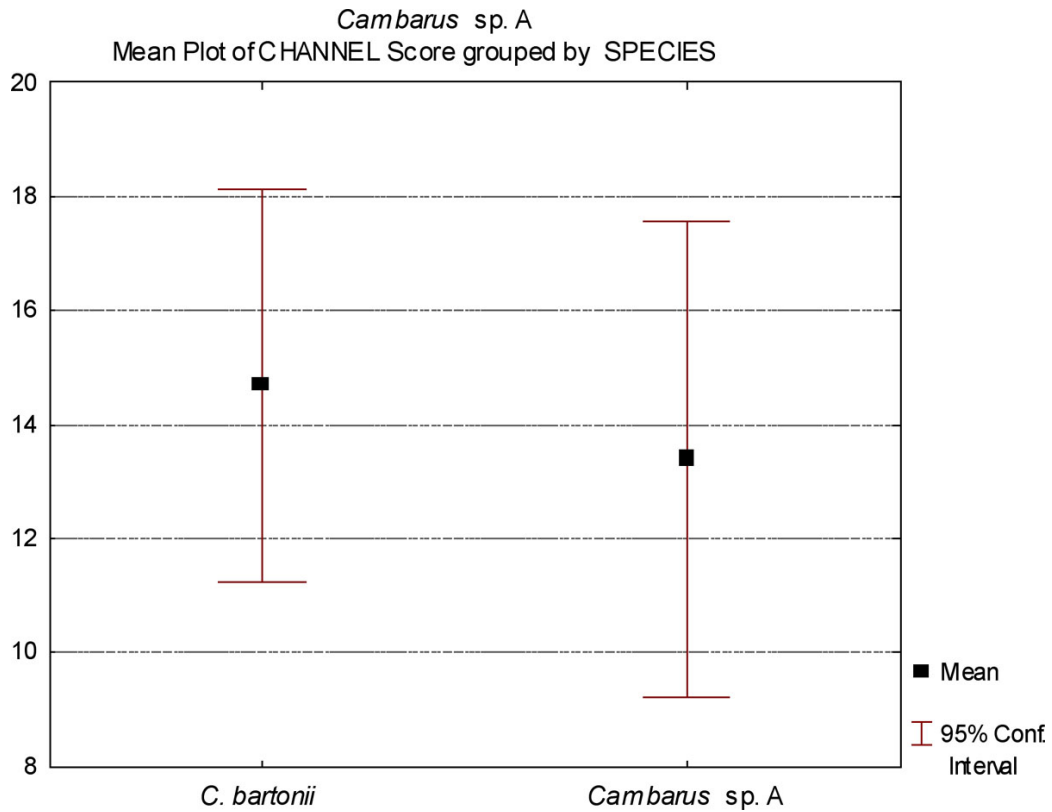


Figure A-53. Box & Whisker plot of Channel score values for sites where *Cambarus bartonii* and *Cambarus* sp. A were found.

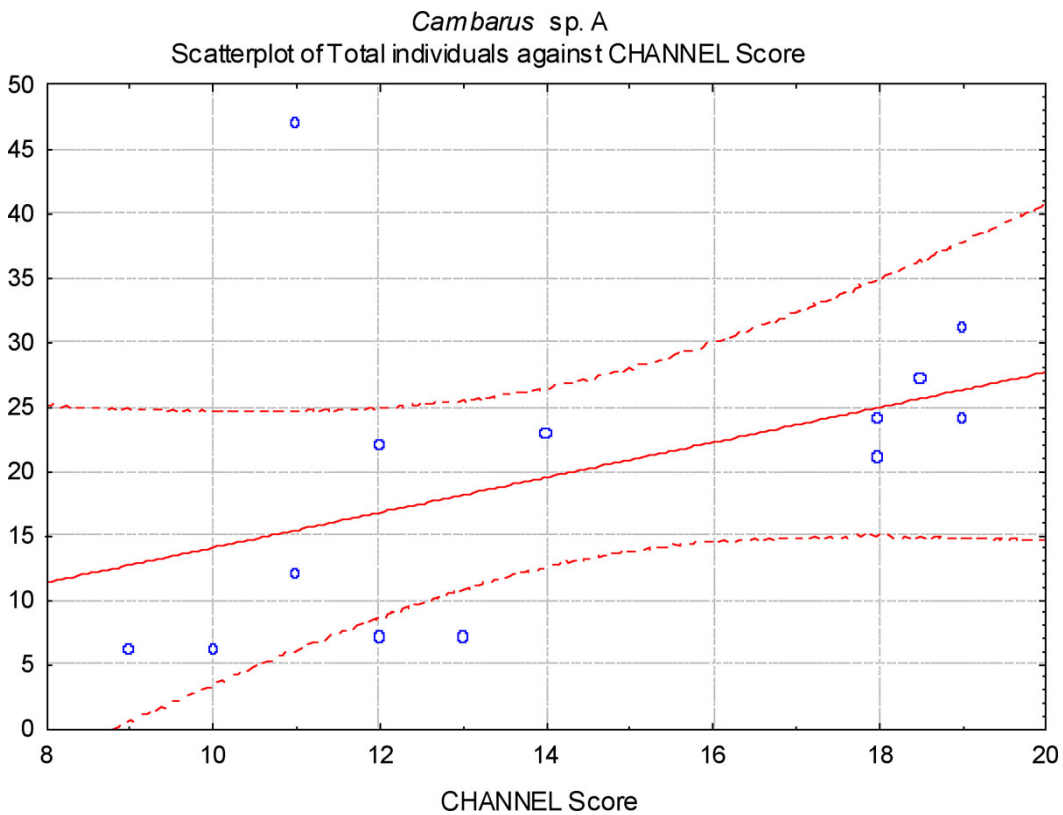


Figure A-54. Regression plot of Channel score values against total individuals of *Cambarus* sp. A collected at all sites sampled.

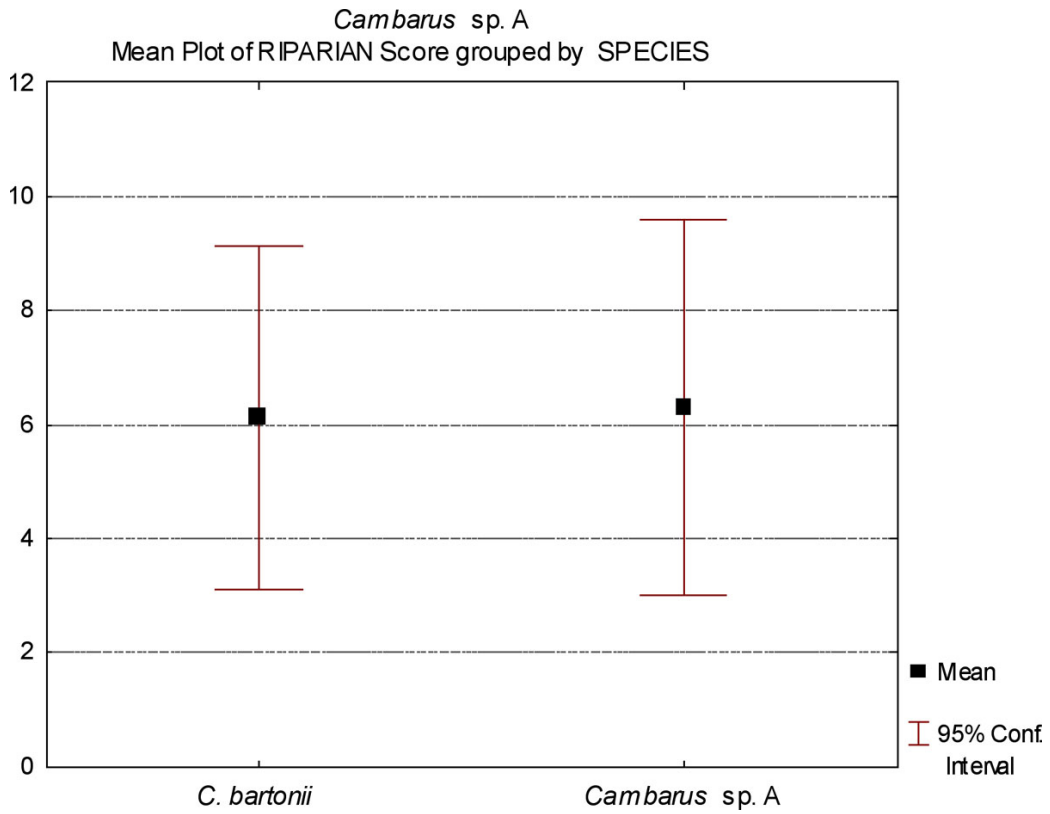


Figure A-55. Box & Whisker plot of Riparian score values for sites where *Cambarus bartonii* and *Cambarus* sp. A were found.

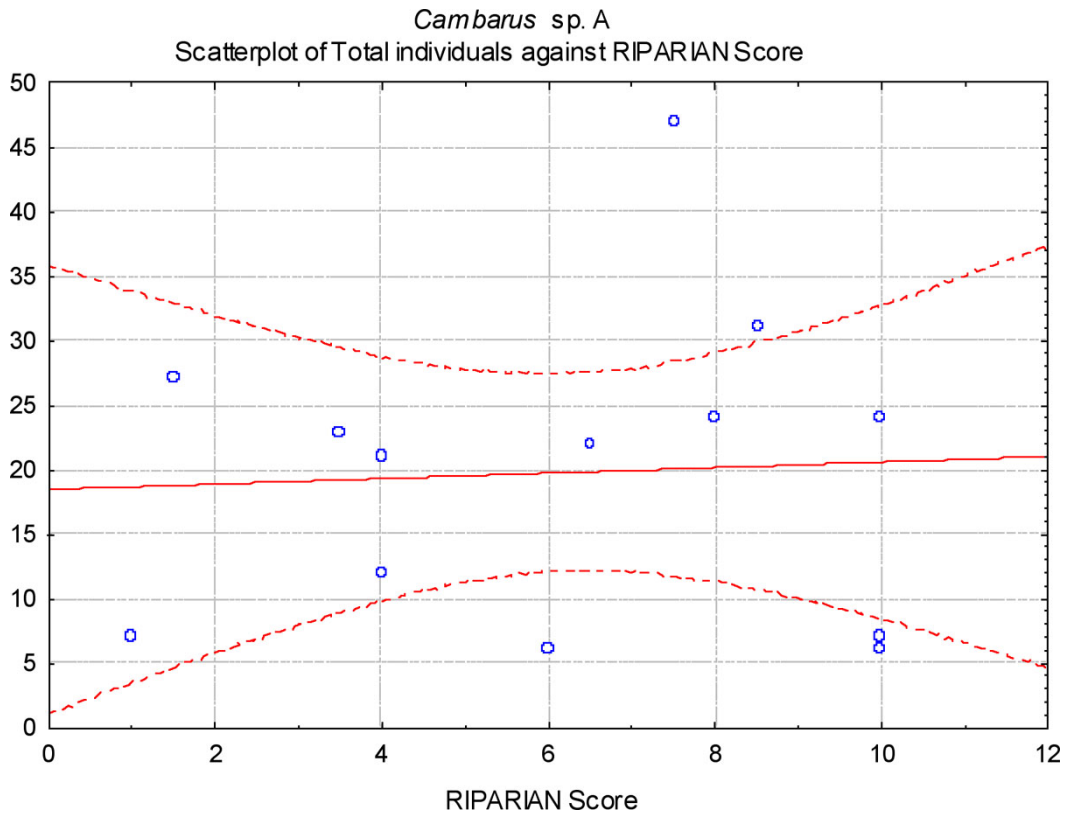


Figure A-56. Regression plot of Riparian score values against total individuals of *Cambarus* sp. A collected at all sites sampled.

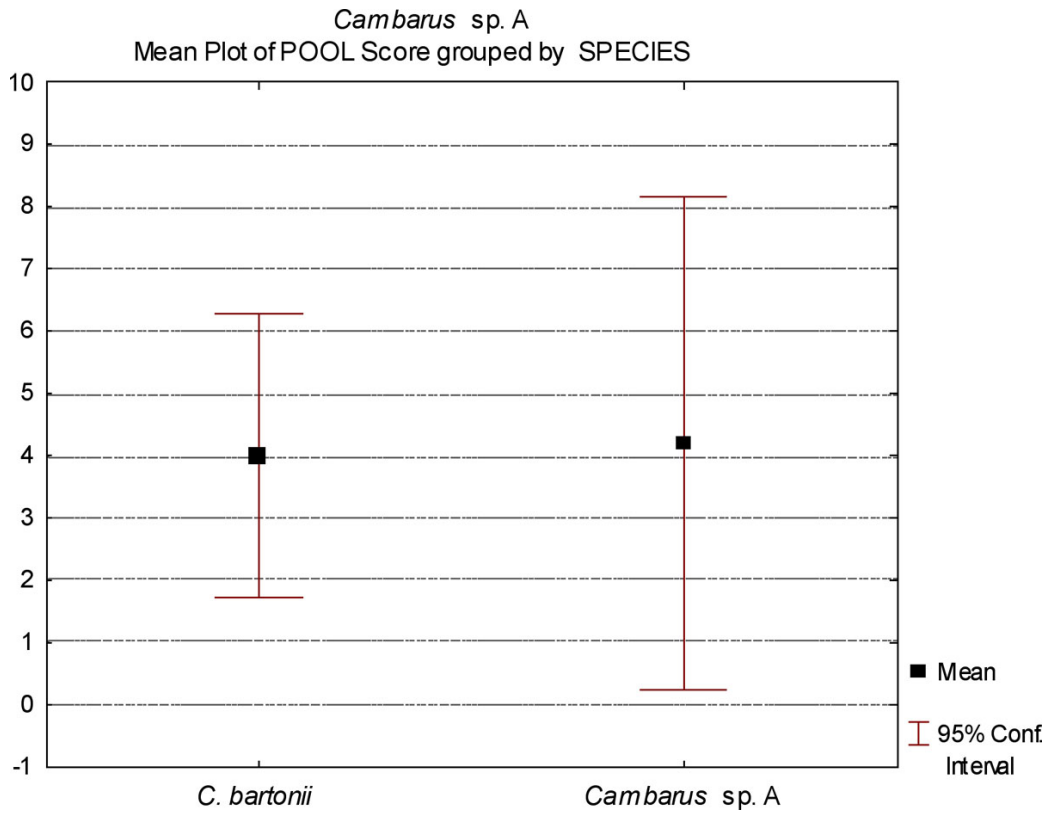


Figure A-57. Box & Whisker plot of Pool score values for sites where *Cambarus bartonii* and *Cambarus* sp. A were found.

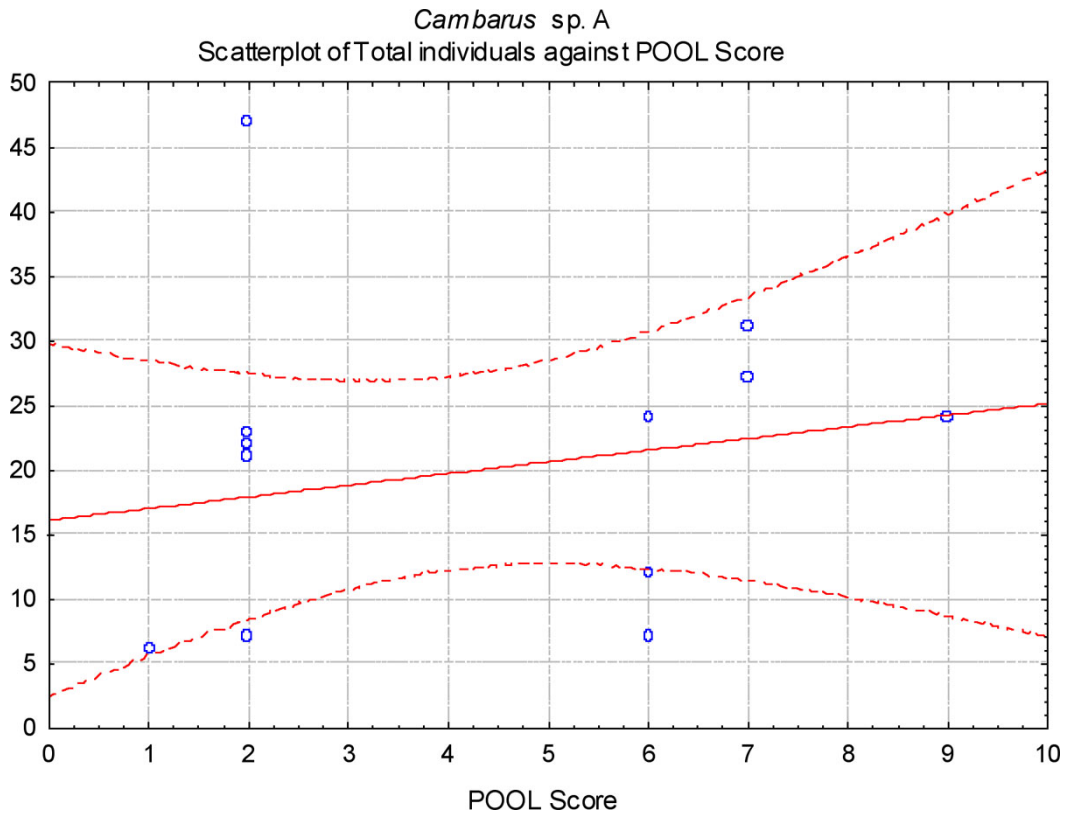


Figure A-58. Regression plot of Pool score values against total individuals of *Cambarus* sp. A collected at all sites sampled.

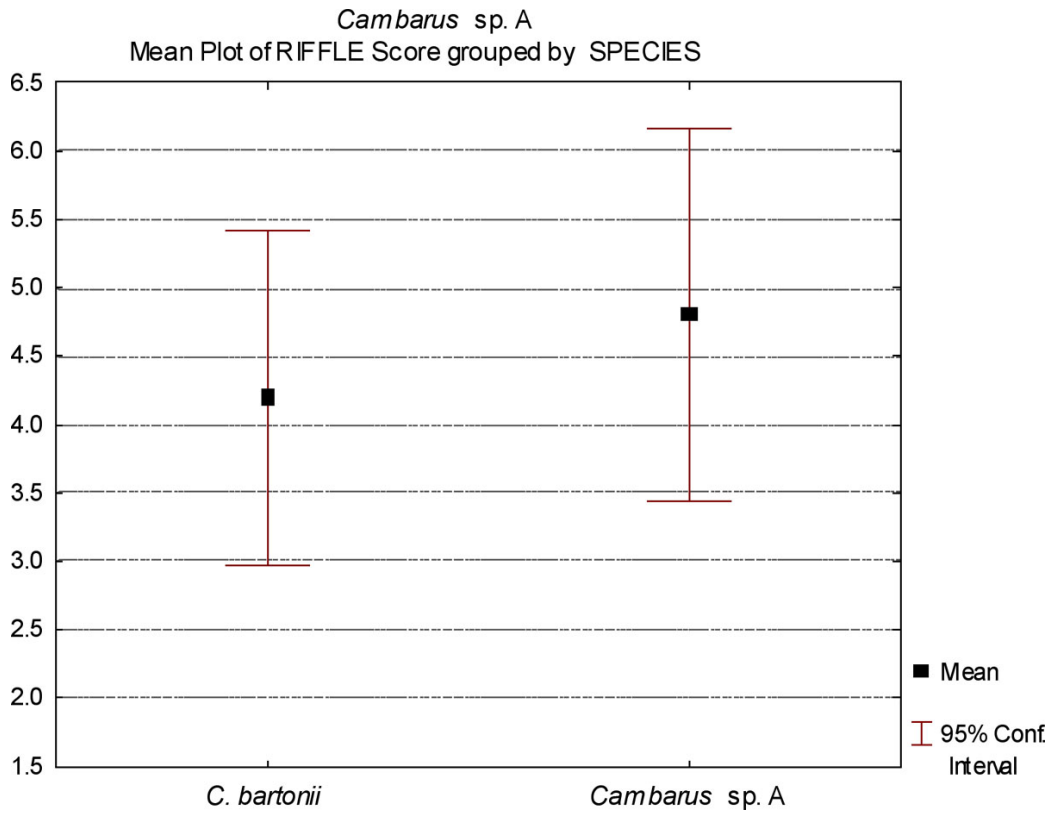


Figure A-59. Box & Whisker plot of Riffle score values for sites where *Cambarus bartonii* and *Cambarus* sp. A were found.

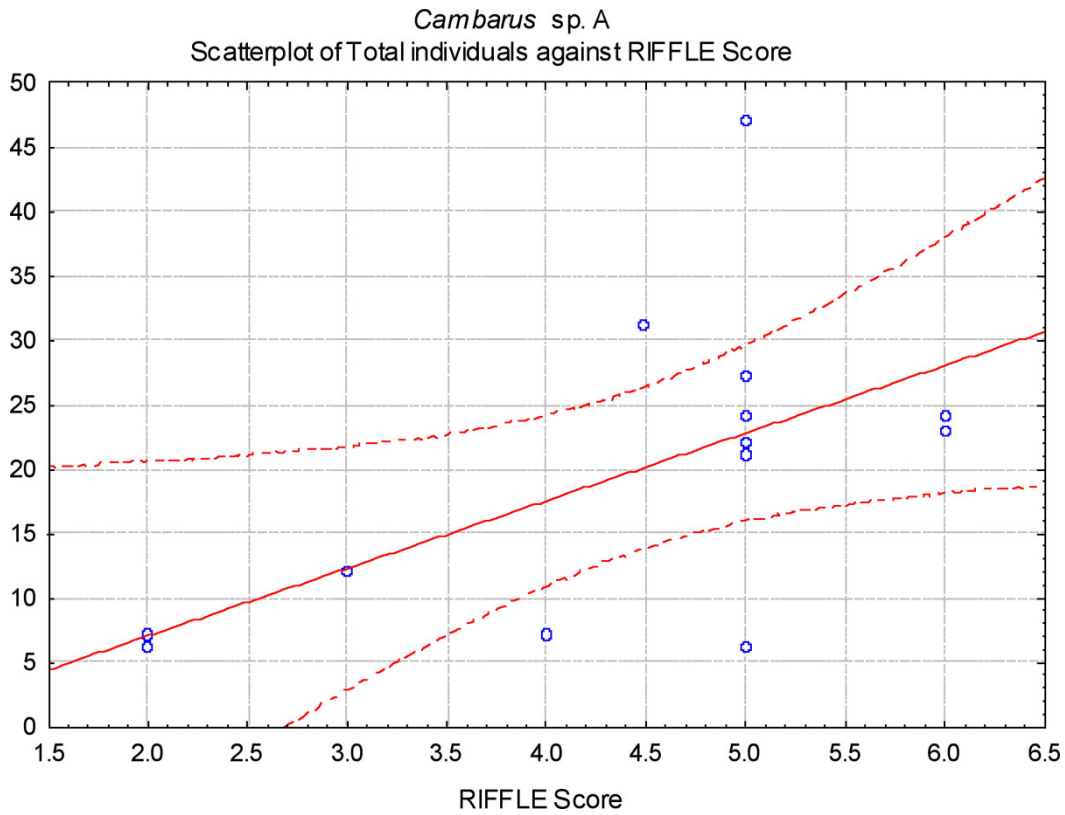


Figure A-60. Regression plot of Riffle score values against total individuals of *Cambarus* sp. A collected at all sites sampled.



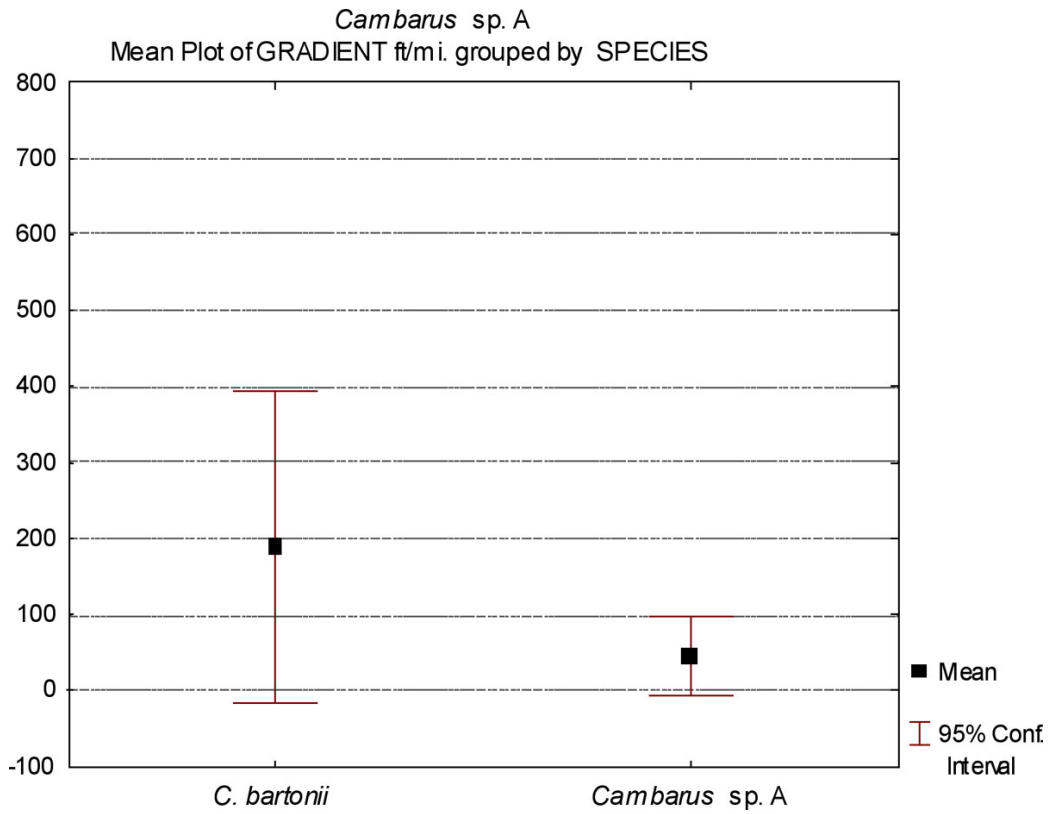


Figure A-61. Box & Whisker plot of Gradient values for sites where *Cambarus bartonii* and *Cambarus sp. A* were found.

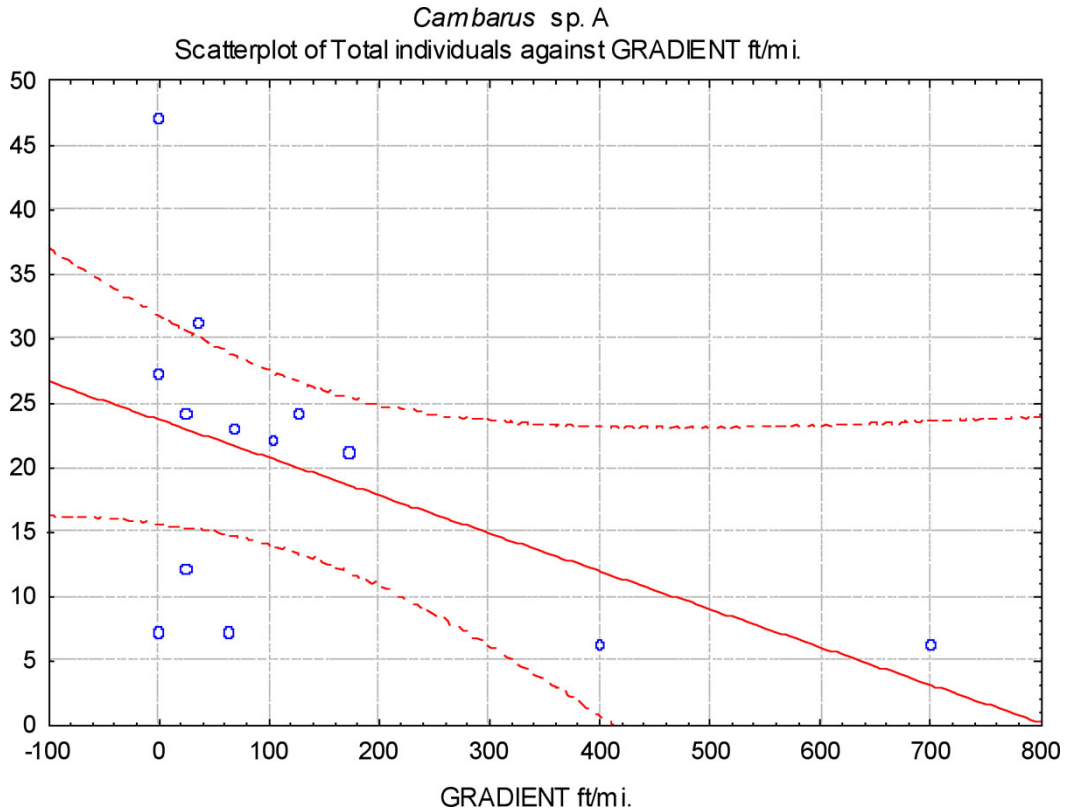


Figure A-62. Regression plot of Gradient values against total individuals of *Cambarus sp. A* collected at all sites sampled.

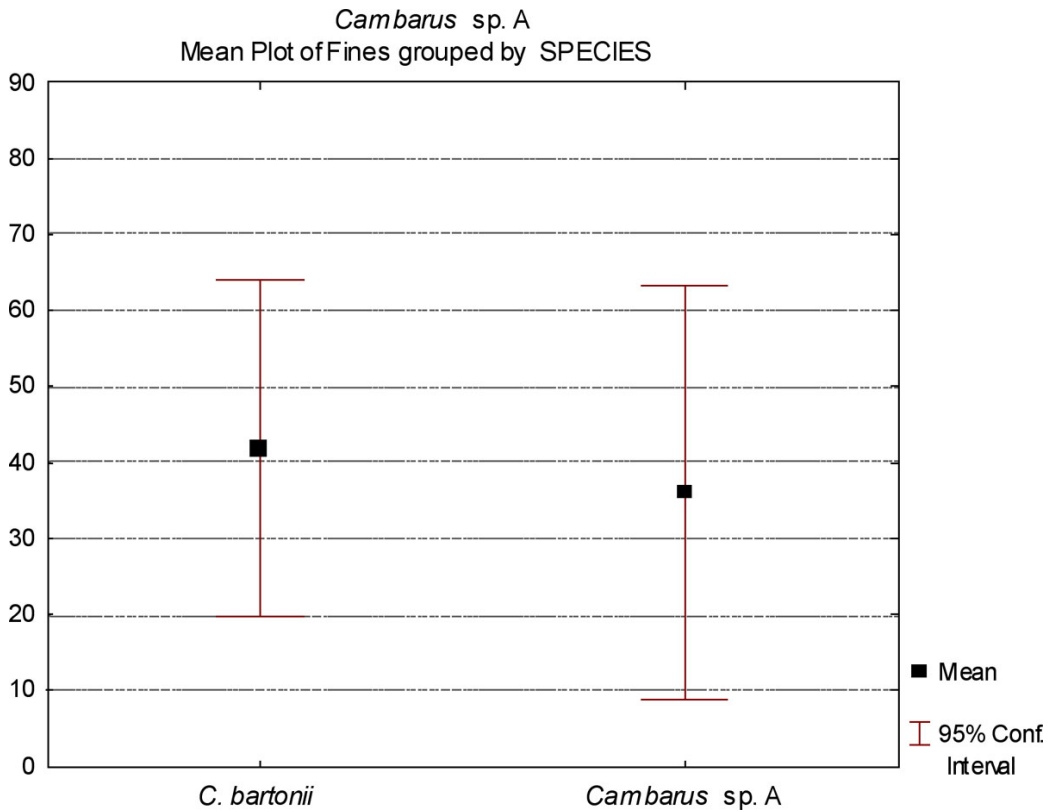


Figure A-63. Box & Whisker plot of % Fines values for sites where *Cambarus bartonii* and *Cambarus sp. A* were found.

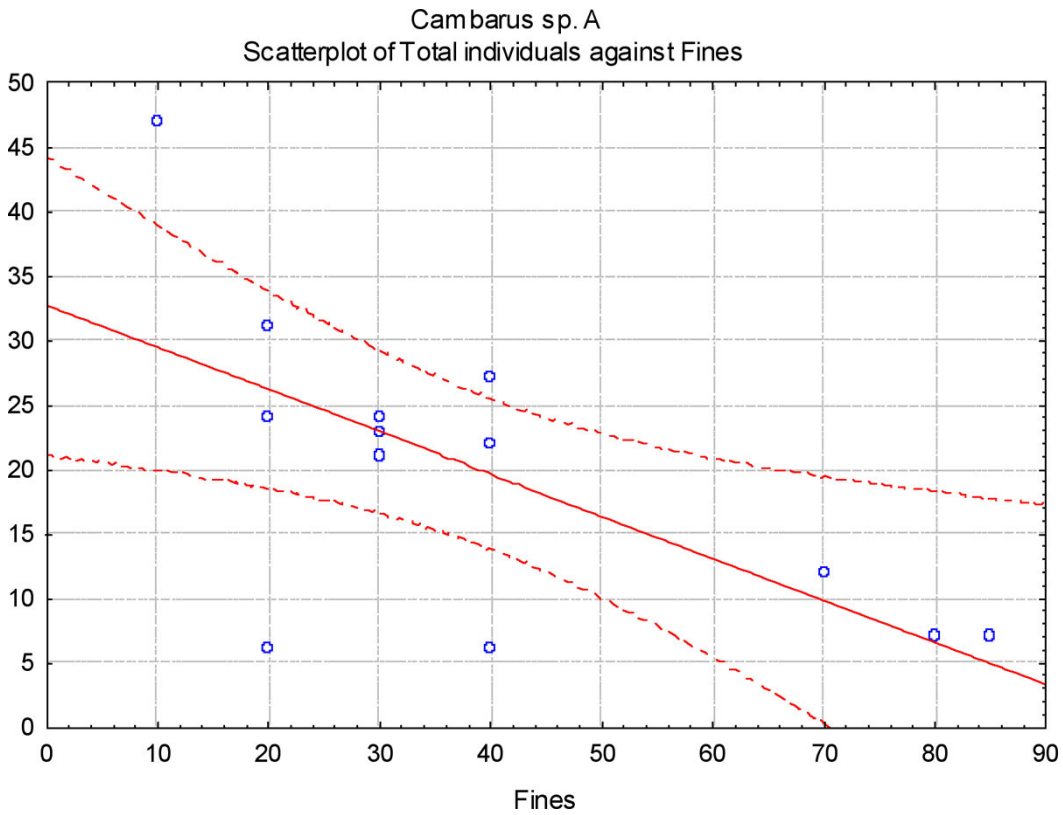


Figure A-64. Regression plot of % Fines values against total individuals of *Cambarus sp. A* collected at all sites sampled.

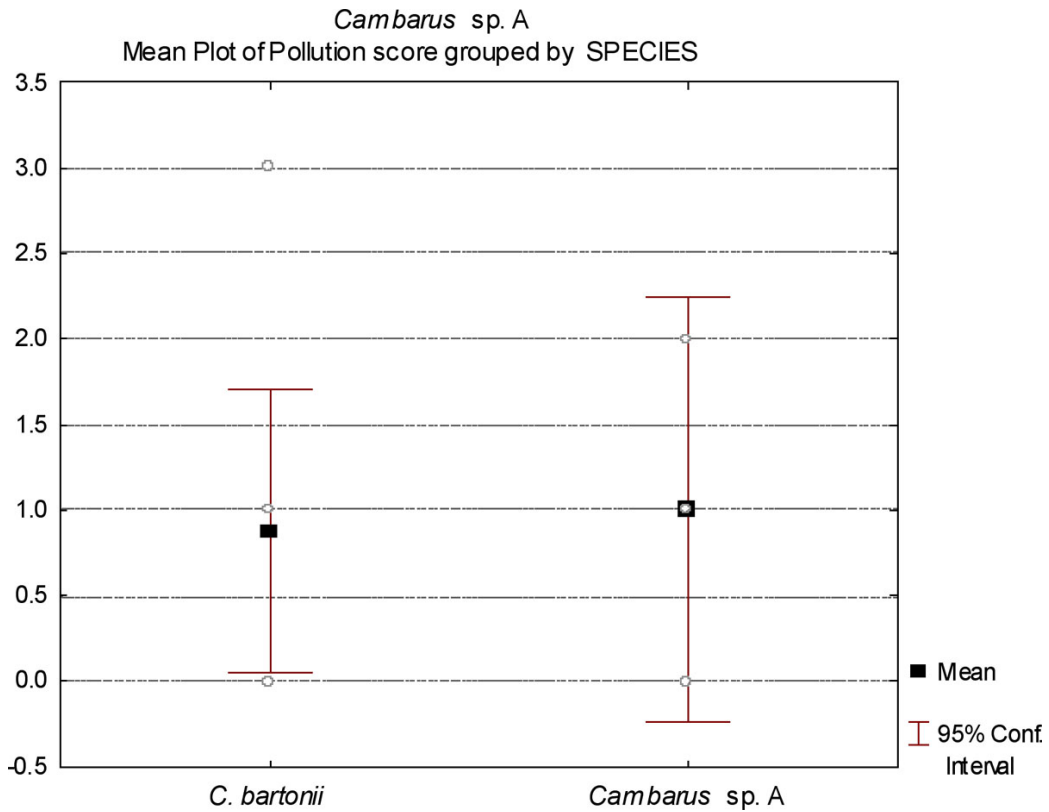


Figure A-65. Box & Whisker plot of Pollution score values for sites where *Cambarus bartonii* and *Cambarus* sp. A were found.

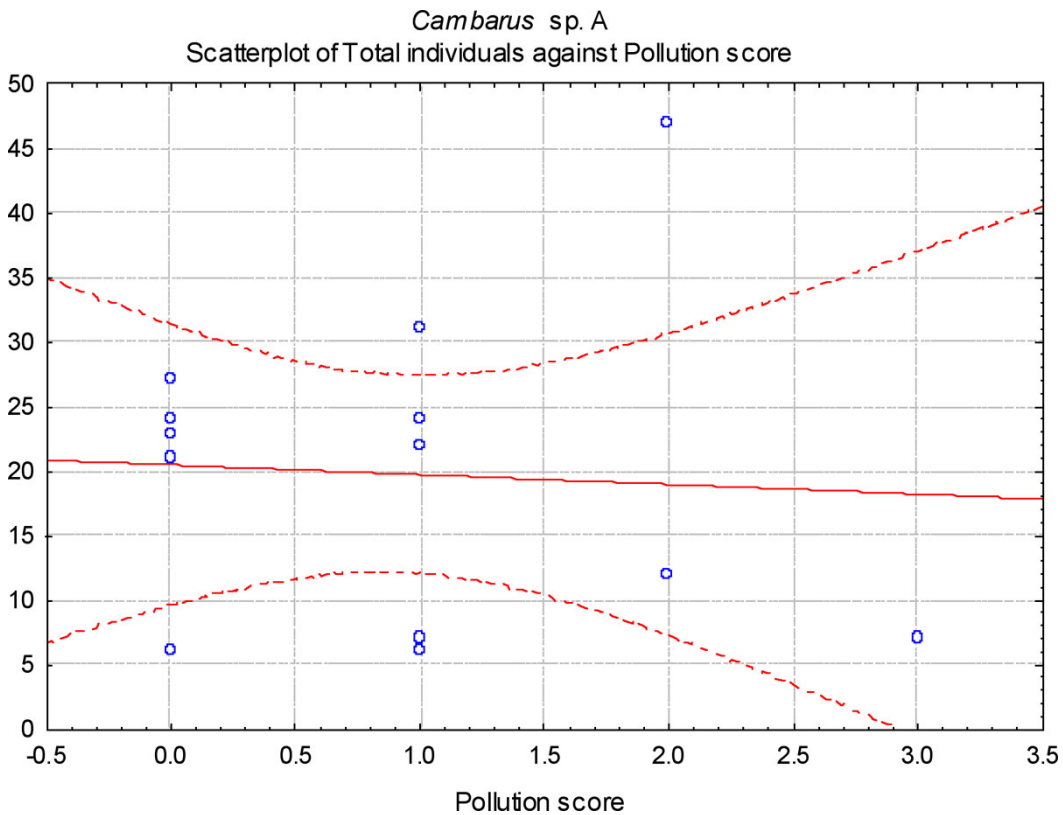


Figure A-66. Regression plot of Pollution score values against total individuals of *Cambarus* sp. A collected at all sites sampled.

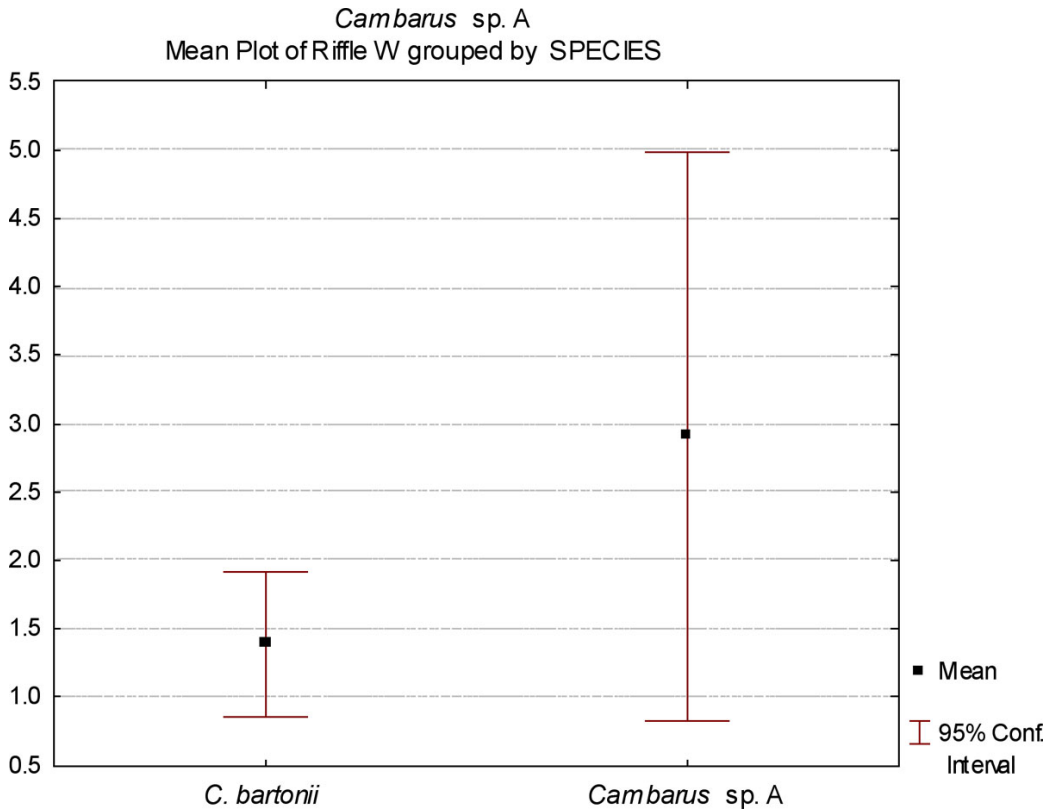


Figure A-67. Box & Whisker plot of Riffle width values for sites where *Cambarus bartonii* and *Cambarus sp. A* were found.

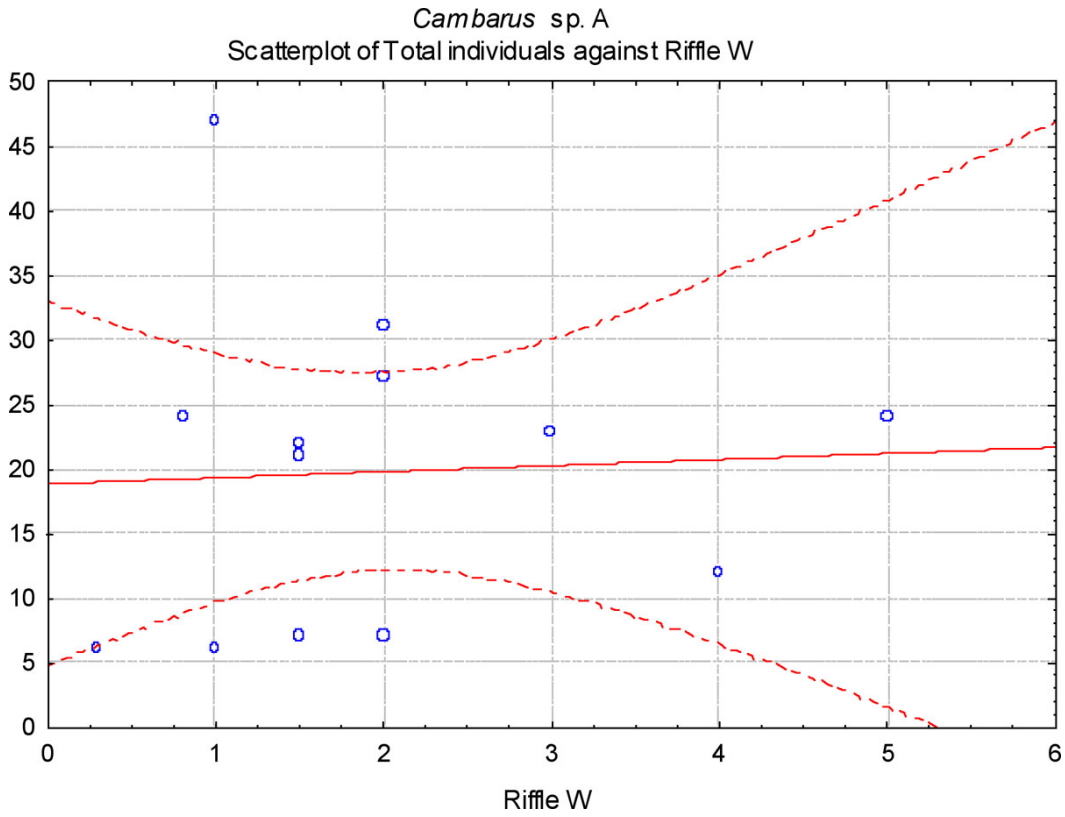


Figure A-68. Regression plot of Riffle width values against total individuals of *Cambarus sp. A* collected at all sites sampled.

## **Appendix B**

Habitat Correlation tables

Appendix B. Table B-1. Correlation analysis of *Cambarus veteranus* numbers and 12 habitat measures. Red font numbers are variables that were found to be significant at  $p < 0.050$ .

Variable	Correlations (C veteranus_QH EI) Marked correlations are significant at $p < .05000$ N=31 (Casewise deletion of missing data)								
	Means	Std. Dev.	QHEI	Subst rate Score	Boulder/Cobble	Fines	Cover Score	Channel Score	Riparian Score
QHEI	56.9597	12.1165	1.00000	0.60523	0.58590	-0.50195	0.82584	0.67249	0.52635
SUBSTRATE Score	12.3871	5.0443	0.60523	1.00000	0.79286	-0.48520	0.48245	-0.05015	-0.09881
Boulder/Cobble	55.645	20.6051	0.58590	0.79286	1.00000	-0.78094	0.55488	0.13914	-0.04613
Fines	38.2258	18.7771	-0.50195	-0.48520	-0.78094	1.00000	-0.40253	-0.26937	-0.14231
COVER Score	9.6452	3.5921	0.82584	0.48245	0.55488	-0.40253	1.00000	0.50582	0.27874
CHANNEL Score	14.3226	3.9360	0.67249	-0.05015	0.13914	-0.26937	0.50582	1.00000	0.63843
RIPARIAN Score	7.7661	2.2032	0.52635	-0.09881	-0.04613	-0.14231	0.27874	0.63843	1.00000
POOL Score	8.1613	2.5442	0.54303	0.06770	0.01067	-0.01125	0.36391	0.35079	0.27456
RIFLE Score	4.6774	1.3997	0.64929	0.57064	0.45243	-0.56152	0.32122	0.24943	0.32873
GRADIENT ft/mi.	35.6355	29.5612	-0.48186	0.02166	-0.02026	0.08983	-0.51030	-0.48669	-0.55421
Pollution score	0.1290	2.0123	-0.70008	-0.49109	-0.46030	0.46499	-0.61599	-0.48519	-0.36326
Riffle W	11.4935	12.2851	0.62355	0.25549	0.35812	-0.26745	0.61571	0.44219	0.36833
H2O Vegetation	0.0968	0.5975	0.11797	0.13093	0.18429	-0.19217	0.18738	-0.12711	0.13172
Total individuals	5.8387	7.8956	0.47537	0.31129	0.03242	0.06770	0.47156	0.20016	0.26316

Variable	Correlations (C veteranus_QH EI) Marked correlations are significant at $p < .05000$ N=31 (Casewise deletion of missing data)						
	Pool Score	Rifle Score	Gradient ft/mi.	Pollution score	Rifle Width	Aquatic Veg.	Total individuals
QHEI	0.54303	0.64929	-0.48186	-0.70008	0.62355	0.11797	0.47537
SUBSTRATE Score	0.06770	0.57064	0.02166	-0.49109	0.25549	0.13093	0.31129
Boulder/Cobble	0.01067	0.45243	-0.02026	-0.46030	0.35812	0.18429	0.03242
Fines	-0.01125	-0.56152	0.08983	0.46499	-0.26745	-0.19217	0.06770
COVER Score	0.36391	0.32122	-0.51030	-0.61599	0.61571	0.18738	0.47156
CHANNEL Score	0.35079	0.24943	-0.48669	-0.48519	0.44219	-0.12711	0.20016
RIPARIAN Score	0.27456	0.32873	-0.55421	-0.36326	0.36833	0.13172	0.26316
POOL Score	1.00000	0.28655	-0.25470	-0.20603	0.42651	0.01132	0.31330
RIFLE Score	0.28655	1.00000	-0.23576	-0.39893	0.29840	0.19801	0.23643
GRADIENT ft/mi.	-0.25470	-0.23576	1.00000	0.30604	-0.17479	-0.09456	-0.32077
Pollution score	-0.20603	-0.39893	0.30604	1.00000	-0.47728	0.04472	-0.57559
Riffle W	0.42651	0.29840	-0.17479	-0.47728	1.00000	0.06594	0.32120
H2O Vegetation	0.01132	0.19801	-0.09456	0.04472	0.06594	1.00000	-0.03898
Total individuals	0.31330	0.23643	-0.32077	-0.57559	0.32120	-0.03898	1.00000

Appendix B. Table B-2. Correlation analysis of *Cambarus jezerinaci* numbers and 12 habitat measures. Red font numbers are variables that were found to be significant at  $p < 0.050$ .

Variable	Correlations (jezerinaci QHEI) Marked correlations are significant at $p < .05000$ N=15 (Case wise deletion of missing data)								
	Means	Std. Dev	QHEI	SUBS TRATE Score	% Bouldr/Cobble	% Fines	COVER Score	CHANN E L Score	RIPARIA N Score
QHEI	53.800	13.396	1.00000	0.90568	0.84431	-0.61574	0.88651	0.73700	0.57357
SUBS TRATE Score	14.800	5.375	0.90568	1.00000	0.88628	-0.52814	0.93437	0.50497	0.64034
% Bouldr/Cobble	59.333	30.111	0.84431	0.88628	1.00000	-0.63120	0.87574	0.52577	0.54233
% Fines	29.667	25.944	-0.61574	-0.52814	-0.63120	1.00000	-0.54930	-0.38558	-0.59087
COVER Score	9.000	3.684	0.88651	0.93437	0.87574	-0.54930	1.00000	0.47697	0.57280
CHANNE L Score	13.000	4.106	0.73700	0.50497	0.52577	-0.38558	0.47697	1.00000	0.34440
RIPARIA N Score	8.533	1.642	0.57357	0.64034	0.54233	-0.59087	0.57280	0.34440	1.00000
POOL Score	4.067	3.411	0.22147	-0.05376	-0.08993	-0.04008	-0.02273	0.09179	-0.38303
RIF FLE Score	4.400	0.986	0.54748	0.38025	0.58726	-0.70672	0.35410	0.42363	0.38846
GRADIEN T	335.267	315.254	0.61653	0.60220	0.63473	-0.52848	0.66670	0.51774	0.60702
Pollution score	0.933	1.100	-0.51731	-0.63080	-0.30341	0.08678	-0.47601	-0.28474	-0.59209
Rifle W	1.967	1.246	0.40933	0.16960	0.20880	-0.24344	0.24121	0.29322	-0.29624
Total individuals	6.267	8.216	0.48890	0.51895	0.53494	-0.35478	0.56877	0.44046	0.25614

Variable	Correlations (jezerinaci QHEI) Marked correlations are significant at $p < .05000$ N=15 (Casewise deletion of missing data)					
	POOL Score	RIF FLE Score	Gradient	Pollution score	Rifle Width	Total individuals
QHEI	0.22147	0.54748	0.61653	-0.51731	0.40933	0.48890
SUBS TRATE Score	-0.05376	0.38025	0.60220	-0.63080	0.16960	0.51895
% Bou ldr/Cobble	-0.08993	0.58726	0.63473	-0.30341	0.20880	0.53494
% Fines	-0.04008	-0.70672	-0.52848	0.08678	-0.24344	-0.35478
COVER Score	-0.02273	0.35410	0.66670	-0.47601	0.24121	0.56877
CHANNE L Score	0.09179	0.42363	0.51774	-0.28474	0.29322	0.44046
RIPARIA N Score	-0.38303	0.38846	0.60702	-0.59209	-0.29624	0.25614
POOL Score	1.00000	0.18269	-0.27657	0.13454	0.79879	-0.22495
RIF FLE Score	0.18269	1.00000	0.39342	-0.10543	0.24430	0.20642
GRADIEN T	-0.27657	0.39342	1.00000	-0.32154	0.12632	0.59018
Pollution score	0.13454	-0.10543	-0.32154	1.00000	0.12858	-0.11647
Rifle W	0.79879	0.24430	0.12632	0.12858	1.00000	-0.01303
Total individuals	-0.22495	0.20642	0.59018	-0.11647	-0.01303	1.00000

Appendix B. Table B-3. Correlation analysis of *Cambarus* sp. A numbers and 12 habitat measures. Red font numbers are variables that were found to be significant at  $p < 0.050$ .

Variable	Correlations (Cambarus sp. A_QHEI in Imported QHEI) Marked correlations are significant at $p < .05000$ N=12 (Casewise deletion of missing data)							
	Means	Std. Dev.	QHEI	Subst rate Score	Boulder/Cobble	Fines	COVER Score	CHANNE L Score
QHEI	50.0417	12.8831	1.000000	0.807065	0.804870	-0.602234	0.808818	0.792944
SUBSTRATE Score	12.1667	5.5076	0.807065	1.000000	0.879020	-0.809350	0.516477	0.509284
Boulder/Cobble	49.1667	18.8092	0.804870	0.879020	1.000000	-0.653330	0.630603	0.650129
Fines	41.2500	24.3203	-0.602234	-0.809350	-0.653330	1.000000	-0.380676	-0.202884
COVER Score	9.8333	2.8231	0.808818	0.516477	0.630603	-0.380676	1.000000	0.622185
CHANNE L Score	13.7917	3.6273	0.792944	0.509284	0.650129	-0.202884	0.622185	1.000000
RIPARIAN Score	6.0000	3.2193	0.358931	0.161511	0.052547	-0.330923	0.360108	-0.107046
POOL Score	3.8333	2.7579	0.409592	0.091771	0.207378	0.193140	0.147900	0.609622
RIF FLE Score	4.4167	1.3790	0.720464	0.588529	0.470252	-0.694628	0.673335	0.500571
GRADIEN T ft/mi.	141.00	209.059	-0.126103	0.258262	0.218936	-0.215545	-0.120609	-0.415694
Pollution score	0.9167	0.9962	-0.644287	-0.742847	-0.634754	0.454958	-0.554911	-0.495823
Aquatic Moss	0.8333	0.3892	0.581617	0.650213	0.475975	-0.696223	0.468798	0.295107
Cambarus sp. A #	10.6667	15.3050	0.086986	0.121509	-0.035790	-0.410313	-0.001403	-0.121724

Variable	Correlations (Cambarus sp. A_QHEI in Imported QHEI) Marked correlations are significant at $p < .05000$ N=12 (Casewise deletion of missing data)						
	RIPARIAN Score	POOL Score	RIF FLE Score	GRADIEN T	Pollution score	Aquatic Moss	Cambarus sp. A #
QHEI	0.358931	0.409592	0.720464	-0.126103	-0.644287	0.581617	0.086986
SUBSTRATE Score	0.161511	0.091771	0.588529	0.258262	-0.742847	0.650213	0.121509
Boulder/Cobble	0.052547	0.207378	0.470252	0.218936	-0.634754	0.475975	-0.035790
Fines	-0.330923	0.193140	-0.694628	-0.215545	0.454958	-0.696223	-0.410313
COVER Score	0.360108	0.147900	0.673335	-0.120609	-0.554911	0.468798	-0.001403
CHANNE L Score	-0.107046	0.609622	0.500571	-0.415694	-0.495823	0.295107	-0.121724
RIPARIAN Score	1.000000	-0.189428	0.296940	0.228484	-0.155907	0.507833	0.177129
POOL Score	-0.189428	1.000000	-0.003984	-0.538614	0.093751	-0.366962	-0.040203
RIF FLE Score	0.296940	-0.003984	1.000000	-0.325439	-0.435667	0.649241	0.317319
GRADIEN T ft/mi.	0.228484	-0.538614	-0.325439	1.000000	-0.350951	0.287108	-0.375838
Pollution score	-0.155907	0.093751	-0.435667	-0.350951	1.000000	-0.742391	0.135149
Aquatic Moss	0.507833	-0.366962	0.649241	0.287108	-0.742391	1.000000	0.142424
Cambarus sp. A #	0.177129	-0.040203	0.317319	-0.375838	0.135149	0.142424	1.000000



## **Appendix C**

Material collected and used in this study

Appendix Table C. Material collected and used in this study arranged by species.

CATNO	GENUS	SPECIES	MALE1	MALE2	FEMALE	OVIG	JUVS	EGGS	INSTARS	Total	FIELDNO	STATE	COUNTY
6374	Cambarus	acuminatus	0	0	0	0	1f	0	0	1	RFT-06-098	Virginia	Amherst
6844	Cambarus	acuminatus	1	0	0	1	0	0	17	2	RFT-07-086	Virginia	Patrick
6377	Cambarus	acuminatus	1	0	2	0	0	0	0	3	RFT-06-099	Virginia	Amherst
6846	Cambarus	acuminatus	0	0	1	0	2m	0	0	3	RFT-07-087	Virginia	Carroll
6843	Cambarus	acuminatus	0	2	3	1	1m,1f	152	0	8	RFT-07-085	Virginia	Carroll
6952	Cambarus	acuminatus	1	4	5	0	0	0	0	10	RFT-07-084A	Virginia	Carroll
6837	Cambarus	acuminatus	1	2	2	0	4m,4f	0	0	13	RFT-07-084	Virginia	Carroll
6836	Cambarus	acuminatus	3	2	11	2	11m,12f	189	105	41	RFT-07-083	Virginia	Carroll
6359	Cambarus	angularis	0	1	1	0	0	0	0	2	RFT-06-089	Tennessee	Claiborne
6944	Cambarus	angularis	0	0	0	1	0	194	0	1	RFT-08-028	Virginia	Lee
7064	Cambarus	angularis	1	0	0	0	0	0	0	1	RFT-09-006	Virginia	Lee
6382	Cambarus	angularis	2	0	0	0	0	0	0	2	RFT-06-104	Virginia	Russell
6934	Cambarus	angularis	0	0	0	3	0	61,85,143	0	3	RFT-08-027	Virginia	Lee
6938	Cambarus	angularis	0	0	1	0	1m,1f	0	0	3	RFT-08-029	Virginia	Lee
6858	Cambarus	angularis	0	1	0	0	1m,2f	0	0	4	RFT-07-091	Virginia	Lee
6804	Cambarus	angularis	0	1	1	0	1m,1	0	0	4	RFT-07-022A	Virginia	Lee
7025	Cambarus	angularis	0	1	1	0	1m,1f	0	0	4	RFT-08-046	Virginia	Wise
6355	Cambarus	angularis	0	2	1	0	1m,2f	0	0	6	RFT-06-086	Virginia	Wise
6802	Cambarus	angularis	0	1	1	0	2m,2f	0	0	6	RFT-07-022	Virginia	Lee
6808	Cambarus	angularis	2	3	0	2	1m	134,36	0	8	RFT-07-023	Virginia	Lee
7034	Cambarus	angularis	3	0	2	0	3f	0	0	8	RFT-08-065	Virginia	Wise
6914	Cambarus	angularis	8	0	2	0	1f	0	0	11	RFT-07-153	Virginia	Lee
6862	Cambarus	angularis	0	0	0	0	3m,7f 0,3?	0	0	13	RFT-07-092	Virginia	Lee
6356	Cambarus	angularis	1	3	6	0	2m,2f	0	0	14	RFT-06-087	Virginia	Lee
7001	Cambarus	angularis	0	1	1	0	0	0	0	16	RFT-08-047	Virginia	Wise
6354	Cambarus	angularis	1	7	5	0	2f	0	0	18	RFT-06-085	Virginia	Wise
6801	Cambarus	angularis	4	10	8	0	1	0	0	23	RFT-07-021	Virginia	Lee
6357	Cambarus	angularis	0	8	12	0	13m, 13f	0	0	46	RFT-06-088	Virginia	Lee
7050	Cambarus	bartonii	5	0	3	0	0	0	0	8	JWF-2008-58	North Carolina	Clay
6985	Cambarus	bartonii	3	1	1	0	4f	0	0	13	RFT-08-005	Tennessee	Polk
6834	Cambarus	bartonii	0	0	0	0	2m	0	0	2	RFT-07-083	Virginia	Carroll
6379	Cambarus	bartonii	1	1	1	0	0	0	0	3	RFT-06-100	Virginia	Franklin
6853	Cambarus	bartonii	1	0	3	0	2m	0	0	6	RFT-07-089	Virginia	Grayson

Appendix Table C. Material collected and used in this study arranged by species.

LOCALITY	LAT	LONG	COLLECTOR	COLLECTION DATE
South Fork Buffalo Creek at confluence with North Fork at VA Rt. 635/North Fork Buffalo River Road	37.68139	-79.22222	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, M. Stine	20-Oct-06
Squirrel Creek of Dan River adjacent VA SSR 631	36.61707	-80.45588	R.F. Thoma, Michael Puckett	30-Jul-07
Buffalo River adjacent US Rt. 600 downstream of Dodd Store at baptist church	37.66722	-79.21078	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, M. Stine	20-Oct-06
Pine Creek of Big Reed Island Creek at culvert on VA SSR 631	36.66439	-80.50373	R.F. Thoma, Michael Puckett	30-Jul-07
Little Pauls Creek of Stewarts Creek upstream of VA SSR 905 (and nearby seep to north)	36.62693	-80.69814	R.F. Thoma, Michael Puckett	30-Jul-07
Stewarts Creek of Ararat River at entrance to Stewarts Creek Wildlife Management Area at end of SSR 795	36.59522	-80.78069	R.F. Thoma, J. Fetzner	2-Oct-07
Stewarts Creek of Ararat River at entrance to Stewarts Creek Wildlife Management Area (end of VA SSR 795)	36.59522	-80.78069	R.F. Thoma, Michael Puckett	30-Jul-07
Stewarts Creek of Ararat River at VA SSR 696 at Lambsburg	36.58093	-80.76476	R.F. Thoma, Michael Puckett	30-Jul-07
Powell River upstream of US Rt. 25E & adjacent TN Rt. 32 (River Road)	36.54723	-83.63192	R.F. Thoma, Michael Puckett	18-Aug-06
White Branch of Poor Valley Creek at intersection of VA SSR 775 & 673, north of Ross Hill	36.68413	-83.36461	R.F. Thoma	4-Jun-08
White Branch of Martin Creek at intersection of VA SR 797 & 673 (ATV parking area)	36.68311	-83.36447	R.F. Thoma	1-Apr-09
Grassy Creek of Copper Creek adjacent VA Rt. 611 just upstream of county line	36.77583	-82.35444	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, C. Luchaup, W. Stocker	22-Oct-06
Cane Creek adjacent VA SSR 645, north of Ben Hur	36.73819	-83.09703	R.F. Thoma	3-Jun-08
Hardy Creek at farm field bridge adjacent VA SSR 660, SSW of Hagan	36.68311	-83.26583	R.F. Thoma	4-Jun-08
Cane Creek adjacent VA SSR 621 at Baptist Church	36.76725	-83.03974	R.F. Thoma, Michael Puckett	1-Aug-07
White Branch - Martin Creek - Powell River upstream VA Rt. 673 at ATV parking area, N of Rose Hill	36.68391	-83.36414	R.F. Thoma, Michael Puckett	25-Jul-07
Pigeon Creek of Powell River at railroad tressel adjacent VA SR 68, 1.32 mi. SW of Appalachia	36.89240	-82.79780	R.F. Thoma and V.M. Thoma	16-Jul-08
trib to Powell River issuing from Big Spring at Tate Spring Road (VA Rt. 612)	36.85830	-82.72940	R.F. Thoma, Michael Puckett	18-Aug-06
White Branch - Martin Creek - Powell River upstream VA Rt. 673 at ATV parking area, N of Rose Hill	36.68391	-83.36414	R.F. Thoma	25-May-07
Dry Creek - Wellan Creek - Powell River, upstream Fox Branch at VA Rt. 752	36.73267	-82.90466	R.F. Thoma	25-May-07
South Fork Powell River at Big Stone Gap Water Treatment Plant in Cracker Neck	36.84736	-82.71137	R.F. Thoma	16-Oct-08
Old Cane Creek adjacent VA SSR 645 (downstream VA SSR 621), 0.9 mi. NW of Ben Hur	36.73792	-83.09702	R.F. Thoma, J. Fetzner	4-Oct-07
Shafer Creek adjacent VA SSR 644, downstream Ben Hur, upstream Collier Mill	36.71918	-83.05218	R.F. Thoma, Michael Puckett	1-Aug-07
Wade Spring of Mud Creek of Powell River at dead end of VA Rt. 728 below US Rt. 58	36.79553	-82.84582	R.F. Thoma, Michael Puckett	18-Aug-06
Looney Creek adjacent VA SR 160, 1.35 mi. WNW of Inman	36.91685	-82.83629	R.F. Thoma and V.M. Thoma	16-Jul-08
Callaghan Creek at overpass in Appalachia, VA Rt. 78	36.90675	-82.78228	R.F. Thoma, Michael Puckett	18-Aug-06
Poor Valley Creek of Powell River adjacent VA Rt. 62, 1.37 mi. NE of Dryden	36.79692	-82.93469	R.F. Thoma	25-May-07
Cheek Branch Spring of Powell River below Tanbark Mountain at VA Rt. 783	36.67451	-83.06750	R.F. Thoma, Michael Puckett	18-Aug-06
Shooting Creek of Hiwassee River at Old Highway 64E bridge, 22.6 mi. ESE of Murphy	35.04031	-83.63869	R.F. Thoma, J.W. Fetzner	28-Oct-08
Halfway Branch of Conasauga River just north of Georgia Stateline and adjacent Peavine Sheeds Road	35.00651	-84.66553	R.F. Thoma and D.I. Withers	30-Apr-08
Stewarts Creek of Ararat River at VA SSR 696 at Lambsburg	36.58093	-80.76476	R.F. Thoma, Michael Puckett	30-Jul-07
Maggadee Creek of Blackwater River at VA Rt. 852 and VA Rt. 613 intersection	37.14028	-79.98694	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, M. Stine	20-Oct-06
Little Peach Bottom Creek adjacent VA SSR 684 (1.68 mi. NW of Independence)	36.63445	-81.17785	R.F. Thoma, Michael Puckett, Brian Watson	31-Jul-07

Appendix Table C. Material collected and used in this study arranged by species.

CATNO	GENUS	SPECIES	MALE1	MALE2	FEMALE	OVIG	JUVS	EGGS	INSTARS	Total	FIELDNO	STATE	COUNTY
6983	Cambarus	bartonii	0	0	4	2	0	80,44	0	6	RFT-08-048	Virginia	Grayson
6845	Cambarus	bartonii	0	3	2	0	1m,1f	0	0	7	RFT-07-086	Virginia	Patrick
6847	Cambarus	bartonii	0	0	3	0	2m,2f	0	0	7	RFT-07-087	Virginia	Carroll
6924	Cambarus	bartonii	1	0	2	1	1m,2f	110	0	7	RFT-08-034	Virginia	Grayson
6987	Cambarus	bartonii	1	0	4	0	1f,1m	0	0	7	RFT-08-049	Virginia	Grayson
6838	Cambarus	bartonii	2	3	0	1	3f	8	19	9	RFT-07-084	Virginia	Carroll
6842	Cambarus	bartonii	1	2	2	1	1m,2f	0	27	9	RFT-07-085	Virginia	Carroll
6839	Cambarus	bartonii	2	2	6	0	1m,1f	0	0	12	RFT-07-084A	Virginia	Carroll
6909	Cambarus	bartonii	2	4	7	1	3m,7f	0	27	21	RFT-07-151	Virginia	Grayson
6906	Cambarus	bartonii	9	1	8	0	4m,2f	0	0	24	RFT-07-149	Virginia	Carroll
6921	Cambarus	bartonii	0	3	10	0	1m	0	0	27	RFT-08-035	Virginia	Grayson
6821	Cambarus	bartonii	0	17	11	0	3f	0	0	31	RFT-07-026	Virginia	Carroll
6373	Cambarus	bartonii	0	0	1	0	0	0	0	1	RFT-06-098	Virginia	Amherst
6375	Cambarus	bartonii	2	1	2	0	0	0	0	5	RFT-06-099	Virginia	Amherst
6484	Cambarus	bartonii c.f.	5	2	3	0	0	0	0	10	RFT-79-19	North Carolina	Ashe
6338	Cambarus	buntingi	0	4	0	0	0	0	0	4	RFT-05-028	Tennessee	Campbell
6326	Cambarus	buntingi	1	0	0	0	0	0	0	1	RFT-05-011	Tennessee	Campbell
6329	Cambarus	buntingi	0	0	0	0	1f	0	0	1	RFT-05-022	Tennessee	Fentress
6371	Cambarus	buntingi	0	0	3	0	1m,3f	0	0	7	RFT-06-095	Tennessee	Claiborne
6380	Cambarus	carinirostris	3	3	12	0	1m,3f	0	0	22	RFT-06-101	Virginia	Tazewell
6935	Cambarus	carinirostris	1	0	0	0	0	0	0	1	RFT-08-036	West Virginia	Greenbrier
6988	Cambarus	carolinas	1	0	0	0	0	0	0	1	JFW-08-043	Virginia	Wise
6340	Cambarus	cavatus	1	4	5	0	0	0	0	10	RFT-05-029	Kentucky	Whitley
6369	Cambarus	cavatus	0	1	1	0	0	0	0	2	RFT-06-094	Tennessee	Claiborne
6367	Cambarus	cavatus	0	1	2	0	0	0	0	3	RFT-06-093	Tennessee	Claiborne
6358	Cambarus	cavatus	0	4	0	0	1m,1f	0	0	6	RFT-06-088	Virginia	Lee
7037	Cambarus	cavatus	1	0	9	0	0	0	0	10	RFT-08-065	Virginia	Wise
6322	Cambarus	cavatus	0	0	1	0	0	0	0	1	RFT-05-008	Virginia	Lee
6928	Cambarus	cavatus	0	2	0	0	1m	0	0	3	RFT-08-021	West Virginia	Mason
6006	Cambarus	chasmodactylus	1	1	3	0	0	0	0	5	RFT-05-059	North Carolina	Ashe
6010	Cambarus	chasmodactylus	0	0	5	0	3m,1f	0	0	9	RFT-05-058	North Carolina	Ashe
7066	Cambarus	chasmodactylus	1	0	0	0	0	0	0	1	SJC 16 98	Virginia	Grayson
7069	Cambarus	chasmodactylus	1	0	0	0	0	0	0	1	SJC 17 98	Virginia	Grayson

Appendix Table C. Material collected and used in this study arranged by species.

LOCALITY	LAT	LONG	COLLECTOR	COLLECTION DATE
Briar Run Creek and adjacent wetland (old pond with seeps) at Peace Haven Road off of Brian Run Road, 3.78 mi. W of Volney	36.62697	-81.45508	R.F. Thoma, V.M. Thoma	17-Jul-08
Squirrel Creek of Dan River adjacent VA SSR 631	36.61707	-80.45588	R.F. Thoma, Michael Puckett	30-Jul-07
Pine Creek of Big Reed Island Creek at culvert on VA SSR 631	36.66439	-80.50373	R.F. Thoma, Michael Puckett	30-Jul-07
unnamed trib. New River at Little River Road bridge	36.59034	-81.07039	R.F. Thoma, Brian T. Watson	5-Jun-08
Little Fox Creek tributary of new river at Grubbs Chapel Baptist church on Vassar 601	36.64819	-81.29942	R.F. Thoma and V.M. Thoma	17-Jul-08
Stewarts Creek of Ararat River at entrance to Stewarts Creek Wildlife Management Area (end of VA SSR 795)	36.59522	-80.78069	R.F. Thoma, Michael Puckett	30-Jul-07
Little Pauls Creek of Stewarts Creek upstream of VA SSR 905 (and nearby seep to north)	36.62693	-80.69814	R.F. Thoma, Michael Puckett	30-Jul-07
Stewarts Creek of Ararat River at entrance to Stewarts Creek Wildlife Management Area (end of VA SSR 795)	36.59522	-80.78069	R.F. Thoma, J. Fetzner	2-Oct-07
Peach Bottom Creek adjacent VA SSR 669, 5.48 mi. NW of Independence	36.68594	-81.21058	R.F. Thoma, J. Fetzner	3-Oct-07
Elkhorn Creek of Crooked Creek at Elkhorn Road bridge, 5.33 mi. E of Galax	36.66050	-80.82819	R.F. Thoma, J. Fetzner	2-Oct-07
unnamed trib. New River adjacent Crab Orchard Road (VA SSR 628) at upstream end of pasture	36.57905	-81.06620	R.F. Thoma, Brian T. Watson	5-Jun-08
Crooked Creek and trib. upstream intersection of VA Rt. 939 & 620	36.63802	-80.80657	R.F. Thoma	26-May-07
South Fork Buffalo Creek at confluence with North Fork at VA Rt. 635/North Fork Buffalo River Road	37.68139	-79.22222	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, M. Stine	20-Oct-06
Buffalo River adjacent US Rt. 600 downstream of Dodd Store at baptist church	37.66722	-79.21078	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, M. Stine	20-Oct-06
Meadow Fork of Cranberry Creek at bridge on NC Rt. 18 just north of Blue Ridge Parkway [1.6 mi. SE of Laurel Springs, 17.2 mi. N of Wilkes boro]	36.39220	-81.24640	R.F. Thoma, R.F. Jezerinac, Ed Franks, Carol Messmer	29-Aug-79
unnamed trib to Big Branch of Stinking Creek at Stinking Creek Road crossing	36.42995	-84.27419	R.F. Thoma, Emily Imhoff	11-Jun-05
No Business Branch of Clear Fork at US Rt. 25W and TN Rt. 9 crossing	36.55162	-84.06752	R.F. Thoma, Chris Lukhaup, Jim & Hillary Fetzner	10-Apr-05
Rocky Branch at confluence with Hurricane Creek of East Fork Obey River	36.19530	-85.06830	R.F. Thoma, Emily Imhoff	10-Jun-05
Hurricane Creek upstream Valley Creek Road, just above confluence with Valley Creek	36.55072	-83.86170	R.F. Thoma, Michael Puckett	20-Aug-06
Clear Fork of Wolf Creek adjacent VA Rt. 61 at Shawver Mill and church	37.15472	-81.35361	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, C. Luchaup, W. Stocker	21-Oct-06
roadside ditch to Meadow River adjacent Co. Rd. 27, 0.4 mi. S of Dawson adjacent Meadow River Wildlife Management Area	37.85077	-80.71276	R.F. Thoma	6-Jun-08
Birchfield creek tributary Cranes Nest River adjacent to Vassar 634	37.06781	-82.51214	R.F. Thoma and V.M. Thoma	15-Jul-08
Limestone Branch of Poplar Creek adjacent Limestone Road at southwest edge of Little Round Mountain	36.66888	-83.92586	R.F. Thoma, Emily Imhoff	12-Jun-05
unnamed trib. of Bennetts Fork further upstream from RFT-06-093	36.55584	-83.82115	R.F. Thoma, Michael Puckett	20-Aug-06
unnamed trib. of Bennetts Fork	36.56525	-83.81214	R.F. Thoma, Michael Puckett	20-Aug-06
Cheek Branch Spring of Powell River below Tanbark Mountain at VA Rt. 783	36.67451	-83.06750	R.F. Thoma, Michael Puckett	18-Aug-06
South Fork Powell River at Big Stone Gap Water Treatment Plant in Cracker Neck	36.84736	-82.71137	R.F. Thoma	16-Oct-08
unnamed trib of Dry Branch (C. jezerinaci type locality?) at SSR 688	36.65444	-83.49278	R.F. Thoma, Chris Lukhaup, Guenter Schuster, Jim & Hillary Fetzner	9-Apr-05
ditch to Lower Ninemile Creek at Chief Corn Stalk Wildlife Management Area campground	38.74234	-82.04272	R.F. Thoma	2-Jun-08
South Fork New River at US Rt. 221	36.47468	-81.33714	R.F. Thoma, Jim Grow	15-Sep-05
Old Field Creek adjacent US Rt. 221 and Ira Jordan Rd., 2.04 mi. SSE of Baldwin, 1.04 mi. N of Fleetwood	36.32124	-81.51778	R.F. Thoma, Jim Grow	15-Sep-05
upper Chestnut Creek at VA SSR 790 & 613	36.58164	-80.89113	SJC, MJP	21-Apr-98
Chestnut Creek, site S4	0.00000	0.00000	SJC, MJP	21-Apr-98

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CATNO	GENUS	SPECIES	MALE1	MALE2	FEMALE	OVIG	JUVS	EGGS	INSTARS	Total	FIELDNO	STATE	COUNTY
6385	Cambarus	chasmodactylus	1	0	1	0	0	0	0	2	RFT-06-106	Virginia	Grayson
7072	Cambarus	chasmodactylus	1	2	0	0	0	0	0	3	141	Virginia	Grayson
7062	Cambarus	chasmodactylus	0	2	1	0	1m,2f	0	0	6	RFT-09-008	Virginia	Grayson
6812	Cambarus	chasmodactylus	1	0	1	0	3m,2f	0	0	7	RFT-07-025	Virginia	Grayson
6816	Cambarus	chasmodactylus	0	0	0	0	2f	0	0	9	RFT-07-025a	Virginia	Grayson
6820	Cambarus	chasmodactylus	0	0	1	0	1m,1	0	0	10	RFT-07-025b	Virginia	Grayson
6823	Cambarus	chasmodactylus	1	10	3	0	10m, 15f	0	0	39	RFT-07-026	Virginia	Carroll
3190	Cambarus	chasmodactylus	0	0	1	0	0	0	0	1	J-84-69	Virginia	Grayson
7024	Cambarus	crinipes	2	0	4	0	8m,11 f	0	0	25	RFT-08-054	Tennessee	Morgan
6365	Cambarus	deweesae	0	4	8	0	3m,1f	0	0	16	RFT-06-092	Tennessee	Anderson
7012	Cambarus	distans	1	0	3	0	4m,2f	0	0	10	RFT-08-052	Kentucky	McCreary
6339	Cambarus	distans	0	2	6	0	3f	0	0	11	RFT-05-029	Kentucky	Whitley
6332	Cambarus	distans	0	6	4	0	0	0	0	10	RFT-05-024	Tennessee	Campbell
6335	Cambarus	distans	1	1	4	0	0	0	0	6	RFT-05-027	Tennessee	Campbell
6911	Cambarus	dubius	0	0	2	0	0	0	0	2	RFT-07-152	North Carolina	Ashe
6009	Cambarus	dubius	0	0	3	0	1m,1f	0	0	5	RFT-05-058	North Carolina	Ashe
6364	Cambarus	dubius	1	0	5	0	1m,1f	0	0	8	RFT-06-091	Tennessee	Campbell
6334	Cambarus	dubius	0	1	0	0	0	0	0	1	RFT-05-025	Tennessee	Campbell
6886	Cambarus	dubius	0	0	1	0	0	0	0	1	RFT-07-139	Virginia	Buchanan
6852	Cambarus	dubius	0	0	1	0	1m	0	0	2	RFT-07-088	Virginia	Grayson
6981	Cambarus	dubius	0	1	0	0	0	0	0	2	RFT-08-048	Virginia	Grayson
7036	Cambarus	dubius	0	0	2	0	0	0	0	2	RFT-08-065	Virginia	Wise
7056	Cambarus	dubius	1	0	1	0	0	0	0	2	RFT-08-043	Virginia	Wise
6855	Cambarus	dubius	0	1	1	0	1m	0	0	3	RFT-07-090	Virginia	Lee
6841	Cambarus	dubius	0	0	2	0	1m	0	0	3	RFT-07-085	Virginia	Carroll
6872	Cambarus	dubius	0	0	1	0	1m,1f	0	0	3	RFT-07-096	Virginia	Tazewell
6940	Cambarus	dubius	1	0	1	1	0	5	20	3	RFT-08-030	Virginia	Lee
6864	Cambarus	dubius	0	1	1	0	2m	0	0	4	RFT-07-093	Virginia	Wise
6861	Cambarus	dubius	1	1	2	0	1	0	0	5	RFT-07-092	Virginia	Lee
6848	Cambarus	dubius	0	0	5	0	0	0	0	5	RFT-07-088A	Virginia	Grayson
6866	Cambarus	dubius	2	2	3	0	0	0	0	7	RFT-07-093A	Virginia	Wise
6351	Cambarus	dubius	1	1	0	0	1f	0	0	11	RFT-06-084	Virginia	Lee
6959	Cambarus	dubius	1	0	5	0	5f	0	0	11	RFT-08-064	Virginia	Wise

Appendix Table C. Material collected and used in this study arranged by species.

LOCALITY	LAT	LONG	COLLECTOR	COLLECTION DATE
Chestnut Creek upstream confluence with East Fork adjacent VA Rt. 790	36.58028	-80.89167	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, C. Luchaup, W. Stocker	22-Oct-06
upper Chestnut Creek at VA SSR 790 & 613	38.58164	-80.89113	E. Wilhelm, J. Jones	31-Mar-00
East Fork Chestnut Creek upstream VA SR 613, 6.1 mi. SE of Galax	36.58150	-80.89056	R.F. Thoma	2-Apr-09
East Fork Chestnut Creek - New River, upstream VA Rt. 613 east of intersection with VA Rt. 790	36.58069	-80.89048	R.F. Thoma	26-May-07
East Fork Chestnut Creek - New River, upstream VA Rt. 613 east of intersection with VA Rt. 790	36.58069	-80.89048	R.F. Thoma, Michael Pucket, Brian Watson	31-Jul-07
East Fork Chestnut Creek - New River, upstream VA Rt. 613 east of intersection with VA Rt. 790	36.58069	-80.89048	R.F. Thoma, J. Fetzner	2-Oct-07
Crooked Creek and trib. upstream intersection of VA Rt. 939 & 620	36.63802	-80.80657	R.F. Thoma	26-May-07
Trib -> Big Wilson Cr: St Rte 16, (4.1 mi NW of Mouth of Wilson; 15.8 mi SE of Marion)			R. F. Jezerinac, G. W. Stocker, +	8-Nov-84
White Oak Creek at Mill Creek Road (first bridge above Cambarus crinipes type locality) at White Oak Chappel, east edge of Sunbright	36.24293	-84.65900	R.F. Thoma, J.W. Fetzner	24-Sep-08
Key Spring of Brushy Fork at NW edge of Oak Ridge, dirtb trail off of Key Spring Road	36.03308	-84.26347	R.F. Thoma, Michael Puckett	19-Aug-06
unnamed tributary of Cumberland River upstream & adjacent KY St. Rt. 90, at Cumberland Falls State Park	36.83674	-84.34553	R.F. Thoma, J.W. Fetzner	23-Sep-08
Limestone Branch of Poplar Creek adjacent Limestone Road at southwest edge of Little Round Mountain	36.66888	-83.92586	R.F. Thoma, Emily Imhoff	12-Jun-05
Cave Spring of Cove Creek at end of gravel drive off of MacDerman Road	36.30536	-84.18381	R.F. Thoma, Emily Imhoff	11-Jun-05
unnamed trib of Titus Creek at unnamed road next to Royal Blue Wildlife Mngt. Area	36.41662	-84.28741	R.F. Thoma, Emily Imhoff	11-Jun-05
Old Fields Creek adjacent (between) NC Rt. 221 & Ira Jacobs Road, 1.16 mi. NNW of Fleetwood	36.32248	-81.51798	R.F. Thoma, J. Fetzner	3-Oct-07
Old Field Creek adjacent US Rt. 221 and Ira Jordan Rd., 2.04 mi. SSE of Baldwin, 1.04 mi. N of Fleetwood	36.32124	-81.51778	R.F. Thoma, Jim Grow	15-Sep-05
unnamed trib of Big Creek at outfall of drainage pipe	36.40063	-84.09266	R.F. Thoma, Michael Puckett	19-Aug-06
unnamed trib Davids Creek of Round Rock Creek of Beech Fork of New River at Stoney Branch Road	36.29281	-84.25632	R.F. Thoma, Emily Imhoff	11-Jun-05
hillside seep & seep at road cut at roadside pull out on US Rt. 460	37.34986	-82.18650	R.F. Thoma, John A. Thoma	25-Sep-07
unnamed trib. Of Little River adjacent VA SSR 622	36.57866	-81.00235	R.F. Thoma, Michael Pucket, Brian Watson	31-Jul-07
Briar Run Creek and adjacent wetland (old pond with seeps) at Peace Haven Road off of Brian Run Road, 3.78 mi. W of Volney	36.62697	-81.45508	R.F. Thoma, V.M. Thoma	17-Jul-08
South Fork Powell River at Big Stone Gap Water Treatment Plant in Cracker Neck	36.84736	-82.71137	R.F. Thoma	16-Oct-08
Birchfield Creek of Cranes Nest River adjacent VA SSR 634, 7.9 mi. WSW of McClure	37.06781	-82.51214	R.F. Thoma and V.M. Thoma	15-Jul-08
Rocklick Branch and seep adjacent VA SSR 742, 2.36 mi. NE of Stone Creek	36.79485	-83.02117	R.F. Thoma, Michael Pucket	31-Jul-07
Little Pauls Creek of Stewarts Creek upstream of VA SSR 905 (and nearby seep to north)	36.62693	-80.69814	R.F. Thoma, Michael Puckett	30-Jul-07
Mud Fork of Bluestone River upstream VA SSR 643	37.25692	-81.35845	R.F. Thoma, Michael Pucket	2-Aug-07
hay field adjacent Hardy Creek adjacent VA SSR 660, SSW of Hagan	36.68386	-83.26685	R.F. Thoma	4-Jun-08
South Fork Powell River upstream Cracker Neck at bridge on VA SSR 616 (Cracked Neck Road)	36.83606	-82.70552	R.F. Thoma, Michael Pucket	1-Aug-07
Shafer Creek adjacent VA SSR 644, downstream Ben Hur, upstream Collier Mill	36.71918	-83.05218	R.F. Thoma, Michael Pucket	1-Aug-07
unnamed trib. Of Little River adjacent VA SSR 622	36.57866	-81.00235	R.F. Thoma, J. Fetzner	3-Oct-07
South Fork Powell River upstream Cracker Neck at bridge on VA SSR 616 (Cracked Neck Road)	36.83606	-82.70552	R.F. Thoma, J. Fetzner	4-Oct-07
Wells Branch of Powell River near Keokee Lake upstream VA Rt. 623 in woods	36.85802	-82.87101	R.F. Thoma, Michael Puckett	17-Aug-06
South Fork Powell River upstream Forest Road 621 crossing, 3.8 mi. SSW of Norton	36.87977	-82.64122	R.F. Thoma	16-Oct-08

Appendix Table C. Material collected and used in this study arranged by species.

CATNO	GENUS	SPECIES	MALE1	MALE2	FEMALE	OVIG	JUVS	EGGS	INSTARS	Total	FIELDNO	STATE	COUNTY
6960	Cambarus	dubius	0	1	5	00	0		0	7	RFT-08-036	West Virginia	Greenbrier
7019	Cambarus	howardi	1	4	3	01f	0		0	9	CES-08-41	Georgia	Hall
7018	Cambarus	howardi	2	2	5	02m,1f	0		0	12	RFT-08-060	Georgia	Cobb
6991	Cambarus	howardi	6	1	5	03m	0		0	12	RFT-08-068	North Carolina	Spartinburg
7020	Cambarus	howardi	7	5	7	03f	0		0	22	RFT-08-066	North Carolina	Catawba
6992	Cambarus	howardi	5	1	3	02m,5f	0		0	9	RFT-08-067	South Carolina	Cherokee
6325	Cambarus	jezerinaci	0	3	2	00	0		0	5	RFT-05-010	Kentucky	Bell
6319	Cambarus	jezerinaci	1	1	3	01m	0		0	6	RFT2005-006	Kentucky	Letcher
6323	Cambarus	jezerinaci	0	1	0	11m,1f	44		0	4	RFT-05-009	Kentucky	Bell
6362	Cambarus	jezerinaci	0	0	0	01m	0		0	1	RFT-06-090	Tennessee	Campbell
6366	Cambarus	jezerinaci	0	0	0	01f	0		0	1	RFT-06-093	Tennessee	Claiborne
6336	Cambarus	jezerinaci	0	0	0	01m	0		0	1	RFT-05-028	Tennessee	Campbell
6370	Cambarus	jezerinaci	0	0	3	00	0		0	3	RFT-06-095	Tennessee	Claiborne
6368	Cambarus	jezerinaci	0	0	8	00	0		0	8	RFT-06-094	Tennessee	Claiborne
5920	Cambarus	jezerinaci	0	2	0	20	0		0	4	RFT-86-4:21a	Tennessee	Clairborn
3607	Cambarus	jezerinaci	0	4	8	00	0		0	12	RFT-8-13a	Tennessee	Clairborne
3611	Cambarus	jezerinaci	0	1	4	10	0		0	6	J-84-3	Tennessee	Clairborne
3613	Cambarus	jezerinaci	3	0	3	65	0		0	17	RFT-86-2a	Tennessee	Clairborne
3665	Cambarus	jezerinaci	1	5	8	01	0		0	15	RFT-78-37	Tennessee	Clairborne
6320	Cambarus	jezerinaci	1	1	7	03m	0		0	12	RFT-05-007	Tennessee	Claiborne
6800	Cambarus	jezerinaci	1	1	1	20	30,49		0	5	RFT-07-021	Virginia	Lee
6856	Cambarus	jezerinaci	0	0	1	02m,3f	0		0	7	RFT-07-090A	Virginia	Lee
6860	Cambarus	jezerinaci	0	1	4	02f	0		0	7	RFT-07-091	Virginia	Lee
6937	Cambarus	jezerinaci	0	4	2	00	0		0	8	RFT-08-029	Virginia	Lee
6807	Cambarus	jezerinaci	1	1	1	00	0		0	15	RFT-07-022B	Virginia	Lee
6803	Cambarus	jezerinaci	0	0	0	01f	0		0	16	RFT-07-022	Virginia	Lee
6932	Cambarus	jezerinaci	1	1	0	61m,2f	55,32,48,3 8,30,41		0	16	RFT-08-027	Virginia	Lee
6912	Cambarus	jezerinaci	2	1	2	01m	0		0	18	RFT-07-153	Virginia	Lee
6956	Cambarus	jezerinaci	0	1	0	34m,1f	0		0	20	RFT-07-022	Virginia	Lee
6945	Cambarus	jezerinaci	1	0	0	22m	32,49		0	22	RFT-08-028	Virginia	Lee
6806	Cambarus	jezerinaci	0	1	0	02m,1f	0		0	35	RFT-07-022A	Virginia	Lee
3608	Cambarus	jezerinaci	0	0	0	10	0		0	1	RFT-86-1c	Virginia	Lee
3609	Cambarus	jezerinaci	1	1	7	10	0		0	10	RFT-86-1a	Virginia	Lee



Appendix Table C. Material collected and used in this study arranged by species.

LOCALITY	LAT	LONG	COLLECTOR	COLLECTION DATE
roadside ditch tributary of Meadow Creek adjacent Co. Rd. 27, 0.4 mi. S of Dawson and adjacent Meadow River Wildlife Management Area	37.85077	-80.71276	R.F. Thoma	6-Jun-08
Balus Creek downstream Old Flowery Branch Road, 2.83 mi. W of Chicopee, east of Lake Sidney Lanier	34.24766	-83.89068	Chris E. Skelton	27-Sep-08
Sope Creek at Cambarus howardi type locality upstream Paper Mill Road, 6.66 mi. SE of Elizabeth	33.94251	-84.43836	R.F. Thoma, J.W. Fetzner	27-Sep-08
Lawsons Fork at NC Rt. 108 bridge, 2.7 mi. E of Glendale (Pacolet River basin)	34.94327	-81.78873	R.F. Thoma, J.W. Fetzner	23-Oct-08
McLin Creek of Lyle Creek at Bethany Church Road bridge, 1.2 mi. S of Claremont	35.69769	-81.14575	R.F. Thoma, J.W. Fetzner	22-Oct-08
Cherokee Creek of Broad River at park at old mill dam adjacent Mill Ginn Road, 6.2 mi. NW Gaffney	35.13654	-81.73159	R.F. Thoma, J.W. Fetzner	23-Oct-08
Ingram Branch of Greasy Creek at Ingrum and bridge on KY Rt. 92	36.73006	-83.79775	R.F. Thoma, Chris Lukhaup, Guenter Schuster, Jim & Hillary Fetzner, Brian	10-Apr-05
unnamed trib to Cumberland River at Bad Branch State Nature Preserve at SSR 932 culvert	37.06726	-82.77182	R.F. Thoma, Chris Lukhaup, Guenter Schuster	9-Apr-05
unnamed trib of Clear Creek at SSR 382, east end of Pine Mountain State Park	36.74288	-83.70293	R.F. Thoma, Chris Lukhaup, Guenter Schuster, Jim & Hillary Fetzner, Brian	10-Apr-05
unnamed trib of Dry Branch at Doakes Creek Road	36.45584	-83.94943	R.F. Thoma, Michael Puckett	19-Aug-06
unnamed trib. of Bennetts Fork	36.56525	-83.81214	R.F. Thoma, Michael Puckett	20-Aug-06
unnamed trib to Big Branch of Stinking Creek at Stinking Creek Road crossing	36.42995	-84.27419	R.F. Thoma, Emily Imhoff	11-Jun-05
Hurricane Creek upstream Valley Creek Road, just above confluence with Valley Creek	36.55072	-83.86170	R.F. Thoma, Michael Puckett	20-Aug-06
unnamed trib. of Bennetts Fork further upstream from RFT-06-093	36.55584	-83.82115	R.F. Thoma, Michael Puckett	20-Aug-06
seep off of Giles Lane 6.7 mi. NE of Tazewell, 11.8 mi. ESE of Middlesboro (unnamed trib. of Powell River)	36.53810	-83.51020	R.F. Thoma, Ed T. Rankin, Zachary B. Thoma	21-Apr-86
Mill Hollow just below Cave Spring, 0.9 mi N of Cave Spring Church, 4.5 mi NNE of Tazewell	36.50972	-83.55583	Roger Thoma, Zachary Thoma	13-Aug-84
Mill Hollow, 3.8 mi ENE of Bacchus, 10.3 mi SE of Middleboro	36.52139	-83.55833	Raymond F. Jezerinac, G. Whitney Stocker	1-Mar-84
Mill Hollow, 4.9 mi N of Tazewell, 2.8 mi NE of Bacchus	36.52889	-83.56139	Roger Thoma, Ed Rankin, Zach Thoma	21-Apr-86
unnamed trib in Mill Hollow, 0.75 mi N of Cave Spring, 4.3 mi N of Tazewell	36.51611	-83.55444	Roger Thoma	18-Aug-78
Gap Creek at road to WWTP in Cumberland Gap	36.59867	-83.66936	R.F. Thoma, Chris Lukhaup, Guenter Schuster	9-Apr-05
Poor Valley Creek of Powell River adjacent VA Rt. 62, 1.37 mi. NE of Dryden	36.79692	-82.93469	R.F. Thoma	25-May-07
Rocklick Branch and seep adjacent VA SSR 742, 2.36 mi. NE of Stone Creek	36.79485	-83.02117	R.F. Thoma, Michael Pucket	1-Aug-07
Cane Creek adjacent VA SSR 621 at Baptist Church	36.76725	-83.03974	R.F. Thoma, Michael Pucket	1-Aug-07
Hardy Creek at farm field bridge adjacent VA SSR 660, SSW of Hagan	36.68311	-83.26583	R.F. Thoma	4-Jun-08
White Branch - Martin Creek - Powell River upstream VA Rt. 673 at ATV parking area, N of Rose Hill	36.68391	-83.36414	R.F. Thoma, J. Fetzner	4-Oct-07
White Branch - Martin Creek - Powell River upstream VA Rt. 673 at ATV parking area, N of Rose Hill	36.68391	-83.36414	R.F. Thoma	25-May-07
Cane Creek adjacent VA SSR 645, north of Ben Hur	36.73819	-83.09703	R.F. Thoma	3-Jun-08
Old Cane Creek adjacent VA SSR 645 (downstream VA SSR 621), 0.9 mi. NW of Ben Hur	36.73792	-83.09702	R.F. Thoma, J. Fetzner	4-Oct-07
White Branch of Martin Creek at VA Rt. 673 bridge, N of Rose Hill	36.68391	-83.36414	R.F. Thoma	25-May-07
White Branch of Poor Valley Creek at intersection of VA SSR 775 & 673, north of Ross Hill	36.68413	-83.36461	R.F. Thoma	4-Jun-08
White Branch - Martin Creek - Powell River upstream VA Rt. 673 at ATV parking area, N of Rose Hill	36.68391	-83.36414	R.F. Thoma, Michael Puckett	25-Jul-07
Hardy Creek alongside US Rt 58, just downstream of Smiley, 5.0 mi E of Rose Hill	36.68833	-83.28556	Roger Thoma, Ed Rankin, Zach Thoma	20-Apr-86
large spring tributary to Hardy Creek, 1.0 mi S of US Rt 58, 3.7 mi WNW of Caney Hollow, 1.1 mi SE of Smiley	36.68472	-83.27028	Roger Thoma, Ed Rankin, Zach Thoma	20-Apr-86

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CATNO	GENUS	SPECIES	MALE1	MALE2	FEMALE	OVIG	JUVS	EGGS	INSTARS	Total	FIELDNO	STATE	COUNTY
3610	Cambarus	jezerinaci	1	2	0	64	0	0	0	13	RFT-86-1d	Virginia	Lee
3612	Cambarus	jezerinaci	2	0	1	62	0	0	0	11	RFT-86-1b	Virginia	Lee
3614	Cambarus	jezerinaci	1	0	0	00	0	0	0	1	RFT-86-1d	Virginia	Lee
3615	Cambarus	jezerinaci	0	0	0	10	0	0	0	1	RFT-86-1d	Virginia	Lee
3616	Cambarus	jezerinaci	0	1	0	00	0	0	0	1	RFT-86-1d	Virginia	Lee
6321	Cambarus	jezerinaci	0	5	1	15m,1f	110	0	0	13	RFT-05-008	Virginia	Lee
6363	Cambarus	longirostris	0	0	0	02m,5f	0	0	0	7	RFT-06-090	Tennessee	Campbell
6939	Cambarus	longirostris	0	0	0	10	0	0	59	1	RFT-08-029	Virginia	Lee
6381	Cambarus	longirostris	2	1	1	00	0	0	0	4	RFT-06-103	Virginia	Scott
6383	Cambarus	longirostris	4	0	4	01m,1f	0	0	0	10	RFT-06-104	Virginia	Russell
6840	Cambarus	longulus	0	0	1	00	0	0	0	1	RFT-07-084A	Virginia	Carroll
6378	Cambarus	longulus	4	0	2	00	0	0	0	6	RFT-06-100	Virginia	Franklin
6835	Cambarus	longulus	0	3	4	04m,3f	0	0	0	14	RFT-07-083	Virginia	Carroll
6372	Cambarus	longulus	3	7	9	00	0	0	0	19	RFT-06-098	Virginia	Amherst
6376	Cambarus	longulus	3	0	2	00	0	0	0	5	RFT-06-099	Virginia	Amherst
7016	Cambarus	obeyensis	5	0	2	09m,2f	0	0	0	18	RFT-08-056	Tennessee	Morgan
7023	Cambarus	obeyensis	3	1	10	04f	0	0	0	18	RFT-08-055	Tennessee	Morgan
7015	Cambarus	parvoculus	0	0	0	01f	0	0	0	1	RFT-08-052	Kentucky	McCreary
7038	Cambarus	parvoculus	0	0	1	01f	0	0	0	2	JWF-2008-17	Tennessee	Cumberland
6337	Cambarus	parvoculus	1	2	2	03m	0	0	0	8	RFT-05-028	Tennessee	Campbell
6327	Cambarus	parvoculus	2	1	1	00	0	0	0	4	RFT-05-011	Tennessee	Campbell
6328	Cambarus	parvoculus	1	2	1	00	0	0	0	4	RFT-05-022	Tennessee	Fentress
6330	Cambarus	parvoculus	0	5	3	00	0	0	0	8	RFT-05-023	Tennessee	Fentress
6333	Cambarus	parvoculus	1	2	1	00	0	0	0	4	RFT-05-025	Tennessee	Campbell
6868	Cambarus	parvoculus	1	0	2	00	0	0	0	3	RFT-07-093A	Virginia	Wise
6865	Cambarus	parvoculus	2	0	2	01f	0	0	0	5	RFT-07-093	Virginia	Wise
6903	Cambarus	parvoculus	4	0	1	02m,3f	0	0	0	10	RFT-07-148	Virginia	Wise
7059	Cambarus	robustus	0	0	1	00	0	0	0	1	RFT-09-009	North Carolina	Alleghany
6907	Cambarus	robustus	0	0	4	01m	0	0	0	5	RFT-07-150	North Carolina	Surry
6011	Cambarus	robustus	4	3	8	00	0	0	0	15	RFT-05-058	North Carolina	Ashe
6859	Cambarus	robustus	0	0	0	00	0	0	0	1	RFT-07-091	Virginia	Lee
6910	Cambarus	robustus	0	0	1	00	0	0	0	1	RFT-07-151	Virginia	Grayson
6819	Cambarus	robustus	1	0	0	00	0	0	0	1	RFT-07-025b	Virginia	Grayson

Appendix Table C. Material collected and used in this study arranged by species.

LOCALITY	LAT	LONG	COLLECTOR	COLLECTION DATE
unnamed trib. Of Dry Branch, 0.2 mi E of Chadwell Gap Trail, 1.4 mi N of Caylor	36.65444	-83.49861	Roger Thoma, Ed Rankin, Zach Thoma	20-Apr-86
unnamed hillside trib. Of Hardy Creek at culvert on St Rt 790 at intersection with St Rt 658, 3.2 mi E of Caney Hollow	36.67750	-83.25778	Roger Thoma, Ed Rankin, Zach Thoma	20-Apr-86
unnamed trib. Of Dry Branch, 0.2 mi E of Chadwell Gap Trail, 1.4 mi N of Caylor	36.65444	-83.49861	Roger Thoma, Ed Rankin, Zach Thoma	20-Apr-86
unnamed trib. Of Dry Branch, 0.2 mi E of Chadwell Gap Trail, 1.4 mi N of Caylor	36.65444	-83.49861	Roger Thoma, Ed Rankin, Zach Thoma	20-Apr-86
unnamed trib. Of Dry Branch, 0.2 mi E of Chadwell Gap Trail, 1.4 mi N of Caylor	36.65444	-83.49861	Roger Thoma, Ed Rankin, Zach Thoma	20-Apr-86
unnamed trib of Dry Branch (C. jezerinaci type locality?) at SSR 688	36.65444	-83.49278	R.F. Thoma, Chris Lukhaup, Guenter Schuster, Jim & Hillary Fetzner	9-Apr-05
unnamed trib of Dry Branch at Doakes Creek Road	36.45584	-83.94943	R.F. Thoma, Michael Puckett	19-Aug-06
Hardy Creek at farm field bridge adjacent VA SSR 660, SSW of Hagan	36.68311	-83.26583	R.F. Thoma	4-Jun-08
Copper Creek of Clinch River at VA Rt. 612 & VA Rt. 611 intersections	36.75278	-82.37917	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, C. Luchaup, W. Stocker	22-Oct-06
Grassy Creek of Copper Creek adjacent VA Rt. 611 just upstream of county line	36.77583	-82.35444	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, C. Luchaup, W. Stocker	22-Oct-06
Stewarts Creek of Ararat River at entrance to Stewarts Creek Wildlife Management Area (end of VA SSR 795)	36.59522	-80.78069	R.F. Thoma, J. Fetzner	2-Oct-07
Maggadee Creek of Blackwater River at VA Rt. 852 and VA Rt. 613 intersection	37.14028	-79.98694	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, M. Stine	20-Oct-06
Stewarts Creek of Ararat River at VA SSR 696 at Lambsburg	36.58093	-80.76476	R.F. Thoma, Michael Puckett	30-Jul-07
South Fork Buffalo Creek at confluence with North Fork at VA Rt. 635/North Fork Buffalo River Road	37.68139	-79.22222	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, M. Stine	20-Oct-06
Buffalo River adjacent US Rt. 600 downstream of Dodd Store at baptist church	37.66722	-79.21078	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, M. Stine	20-Oct-06
Cane Branch of Emory River at church & cemetery on Scitcheon Roar, 3.81 mi. NNW of Wartburg	36.15638	-84.62163	R.F. Thoma, J.W. Fetzner	24-Sep-08
Rock Creek (of Emory River) adjacent US Rt 27 in Pilot Mountain, 3.10 mi. S of Sunbright	36.19908	-84.66007	R.F. Thoma, J.W. Fetzner	24-Sep-08
unnamed tributary of Cumberland River upstream & adjacent KY St. Rt. 90, at Cumberland Falls State Park	36.83674	-84.34553	R.F. Thoma, J.W. Fetzner	23-Sep-08
Bean Creek at bridge on Claysville Road, 2.03 mi. NW of Pamona	35.97514	-85.14172	R.F. Thoma, J.W. Fetzner	26-Sep-08
unnamed trib to Big Branch of Stinking Creek at Stinking Creek Road crossing	36.42995	-84.27419	R.F. Thoma, Emily Imhoff	11-Jun-05
No Business Branch of Clear Fork at US Rt. 25W and TN Rt. 9 crossing	36.55162	-84.06752	R.F. Thoma, Chris Lukhaup, Jim & Hillary Fetzner	10-Apr-05
Rocky Branch at confluence with Hurricane Creek of East Fork Obey River	36.19530	-85.06830	R.F. Thoma, Emily Imhoff	10-Jun-05
Big Branch of Clear Creek of Obed River adjacent Rock Quarry Road	36.17685	-85.01018	R.F. Thoma, Emily Imhoff	10-Jun-05
unnamed trib Davids Creek of Round Rock Creek of Beech Fork of New River at Stoney Branch Road	36.29281	-84.25632	R.F. Thoma, Emily Imhoff	11-Jun-05
South Fork Powell River upstream Cracker Neck at bridge on VA SSR 616 (Cracked Neck Road)	36.83606	-82.70552	R.F. Thoma, J. Fetzner	4-Oct-07
South Fork Powell River upstream Cracker Neck at bridge on VA SSR 616 (Cracked Neck Road)	36.83606	-82.70552	R.F. Thoma, Michael Pucket	1-Aug-07
South Fork Powell River 2,222 ft. upstream of water treatment plant at end of Cracker Neck Rd.	36.82964	-82.70242	R.F. Thoma, John A. Thoma	28-Sep-07
Wolf Branch at confluence with Gladly Run of S. Fk. New River downstream NC SR 1113 bridge, 3.93 mi. SE of Sparta	36.46635	-81.06946	R.F. Thoma	2-Apr-09
Gully Creek of Fisher River at noth end of field at end of NC SSR 1420, 1.76 mi NW of Lowgap	36.54075	-80.89300	R.F. Thoma, J. Fetzner	2-Oct-07
Old Field Creek adjacent US Rt. 221 and Ira Jordan Rd., 2.04 mi. SSE of Baldwin, 1.04 mi. N of Fleetwood	36.32124	-81.51778	R.F. Thoma, Jim Grow	15-Sep-05
Cane Creek adjacent VA SSR 621 at Baptist Church	36.76725	-83.03974	R.F. Thoma, Michael Pucket	1-Aug-07
Peach Bottom Creek adjacent VA SSR 669, 5.48 mi. NW of Independence	36.68594	-81.21058	R.F. Thoma, J. Fetzner	3-Oct-07
East Fork Chestnut Creek - New River, upstream VA Rt. 613 east of intersection with VA Rt. 790	36.58069	-80.89048	R.F. Thoma, J. Fetzner	2-Oct-07

Appendix Table C. Material collected and used in this study arranged by species.

CATNO	GENUS	SPECIES	MALE1	MALE2	FEMALE	OVIG	JUVS	EGGS	INSTARS	Total	FIELDNO	STATE	COUNTY
6871	Cambarus	robustus	0	0	1	0	0	0	0	1	RFT-07-095	Virginia	Tazewell
6887	Cambarus	robustus	0	0	1	0	0	0	0	1	RFT-07-139	Virginia	Buchanan
6933	Cambarus	robustus	0	0	0	0	1f	0	0	1	RFT-08-027	Virginia	Lee
7052	Cambarus	robustus	0	0	1	0	0	0	0	1	RFT-08-058.0	Virginia	Buchanan
7067	Cambarus	robustus	1	0	0	0	0	0	0	1	SJC 16 98	Virginia	Grayson
6384	Cambarus	robustus	1	0	1	0	0	0	0	2	RFT-06-106	Virginia	Grayson
6793	Cambarus	robustus	0	0	2	0	0	0	0	2	RFT-07-019	Virginia	Dickenson
6999	Cambarus	robustus	0	0	1	0	1f	0	0	2	RFT-08-042	Virginia	Dickenson
6352	Cambarus	robustus	0	4	3	0	1m,2f	0	0	3	RFT-06-084	Virginia	Lee
6913	Cambarus	robustus	0	0	2	0	1f	0	0	3	RFT-07-153	Virginia	Lee
6854	Cambarus	robustus	0	0	2	1	1f	2	122	4	RFT-07-089	Virginia	Grayson
6922	Cambarus	robustus	1	2	0	1	1f	146	0	4	RFT-08-034	Virginia	Grayson
6813	Cambarus	robustus	2	1	0	0	1m	0	0	4	RFT-07-025	Virginia	Grayson
6815	Cambarus	robustus	1	0	0	0	0	0	0	4	RFT-07-025a	Virginia	Grayson
6894	Cambarus	robustus	1	0	3	0	0	0	0	4	RFT-07-143	Virginia	Dickenson
6920	Cambarus	robustus	0	4	0	0	1f	0	0	5	RFT-08-035	Virginia	Grayson
6810	Cambarus	robustus	1	0	0	0	1m,3f	0	0	5	RFT-07-024	Virginia	Grayson
7073	Cambarus	robustus	0	1	3	0	1f	0	0	5	141	Virginia	Grayson
6851	Cambarus	robustus	0	2	2	0	1m,1f	0	0	6	RFT-07-088	Virginia	Grayson
6904	Cambarus	robustus	3	2	1	0	1m,1f	0	0	8	RFT-07-148	Virginia	Wise
6982	Cambarus	robustus	0	1	2	1	4f	194	0	8	RFT-08-048	Virginia	Grayson
6343	Cambarus	robustus	0	2	5	0	2f	0	0	9	RFT-06-080	Virginia	Buchannon
7063	Cambarus	robustus	0	0	2	0	4m,4f	0	0	10	RFT-09-006	Virginia	Lee
6863	Cambarus	robustus	0	2	5	0	4f	0	0	11	RFT-07-093	Virginia	Wise
6905	Cambarus	robustus	4	1	6	0	1m	0	0	12	RFT-07-149	Virginia	Carroll
6822	Cambarus	robustus	2	3	2	0	2m,3f	0	0	12	RFT-07-026	Virginia	Carroll
6347	Cambarus	robustus	2	7	4	0	0	0	0	13	RFT-06-082	Virginia	Dickenson
6857	Cambarus	robustus	0	3	1	0	5m,1 0f	0	0	19	RFT-07-090A	Virginia	Lee
6867	Cambarus	robustus	0	2	2	0	6m,1 2f	0	0	22	RFT-07-093A	Virginia	Wise
6881	Cambarus	sciotensis	0	0	0	0	1f	0	0	1	RFT-07-135	Virginia	Buchanan
6891	Cambarus	sciotensis	0	0	0	0	1m	0	0	1	RFT-07-141	Virginia	Dickenson
7065	Cambarus	sciotensis	1	0	0	0	0	0	0	1	VDGIF 001-2001	Virginia	Buchanan
6789	Cambarus	sciotensis	1	1	0	0	0	0	0	2	RFT-07-017	Virginia	Buchanan

Appendix Table C. Material collected and used in this study arranged by species.

LOCALITY	LAT	LONG	COLLECTOR	COLLECTION DATE
Bluestone River adjacent VA SSR 720 at west edge of Bluefield	37.23476	-81.29373	R.F. Thoma, Michael Pucket	2-Aug-07
hillside seep & seep at road cut at roadside pull out on US Rt. 460	37.34986	-82.18650	R.F. Thoma, John A. Thoma	25-Sep-07
Cane Creek adjacent VA SSR 645, north of Ben Hur	36.73819	-83.09703	R.F. Thoma	3-Jun-08
Dismal Creek of Levisa Fork adjacent VA SSR 638, 5.54 mi. ENE of Vansant	37.25793	-82.00524	R.F. Thoma	15-Oct-08
upper Chestnut Creek at VA SSR 790 & 613	36.58164	-80.89113	SJC, MJP	21-Apr-98
Chestnut Creek upstream confluence with East Fork adjacent VA Rt. 790	36.58028	-80.89167	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, C. Luchaup, W. Stocker	22-Oct-06
McClure River at baseball field at noth end of McClure upstream VA Rt. 63 and Caney Creek confluence	37.10638	-82.37852	R.F. Thoma	24-May-07
Lick Creek of Russell Fork at intersection of VA SSR 670 & VA SSR 661, at Counts	37.12755	-82.30865	R.F. Thoma and V.M. Thoma	15-Jul-08
Wells Branch of Powell River near Keokee Lake upstream VA Rt. 623 in woods	36.85802	-82.87101	R.F. Thoma, Michael Pucket	17-Aug-06
Old Cane Creek adjacent VA SSR 645 (downstream VA SSR 621), 0.9 mi. NW of Ben Hur	36.73792	-83.09702	R.F. Thoma, J. Fetzner	4-Oct-07
Little Peach Bottom Creek adjacent VA SSR 684 (1.68 mi. NW of Independence)	36.63445	-81.17785	R.F. Thoma, Michael Pucket, Brian Watson	31-Jul-07
unnamed trib. New River at Little River Road bridge	36.59034	-81.07039	R.F. Thoma, Brian T. Watson	5-Jun-08
East Fork Chestnut Creek - New River, upstream VA Rt. 613 east of intersection with VA Rt. 790	36.58069	-80.89048	R.F. Thoma	26-May-07
East Fork Chestnut Creek - New River, upstream VA Rt. 613 east of intersection with VA Rt. 790	36.58069	-80.89048	R.F. Thoma, Michael Pucket, Brian Watson	31-Jul-07
McClure River at intersection of Va Rt. 63 & VA SSR 656, downstream Roaring Fork	37.02840	-82.30096	R.F. Thoma, John A. Thoma	26-Sep-07
unnamed trib. New River adjacent Crab Orchard Road (VA SSR 628) at upstream end of pasture	36.57905	-81.06620	R.F. Thoma, Brian T. Watson	5-Jun-08
Meadow Creek - New River, at VA Rt. 621, near intersection with VA Rt. 622	36.62592	-80.96298	R.F. Thoma	25-May-07
upper Chestnut Creek at VA SSR 790 & 613	38.58164	-80.89113	E. Wilhelm, J. Jones	31-Mar-00
unnamed trib. Of Little River adjacent VA SSR 622	36.57866	-81.00235	R.F. Thoma, Michael Pucket, Brian Watson	31-Jul-07
South Fork Powell River 2,222 ft. upstream of water treatment plant at end of Cracker Neck Rd.	36.82964	-82.70242	R.F. Thoma, John A. Thoma	28-Sep-07
Briar Run Creek and adjacent wetland (old pond with seeps) at Peace Haven Road off of Brian Run Road, 3.78 mi. W of Volney	36.62697	-81.45508	R.F. Thoma, V.M. Thoma	17-Jul-08
Russell Fork at park in Council adjacent VA Rt. 80	37.07882	-82.07037	R.F. Thoma, Michael Pucket	17-Aug-06
White Branch of Martin Creek at intersection of VA SR 797 & 673 (ATV parking area)	36.68311	-83.36447	R.F. Thoma	1-Apr-09
South Fork Powell River upstream Cracker Neck at bridge on VA SSR 616 (Cracked Neck Road)	36.83606	-82.70552	R.F. Thoma, Michael Pucket	1-Aug-07
Elkhorn Creek of Crooked Creek at Elkhorn Road bridge, 5.33 mi. E of Galax	36.66050	-80.82819	R.F. Thoma, J. Fetzner	2-Oct-07
Crooked Creek and trib. upstream intersection of VA Rt. 939 & 620	36.63802	-80.80657	R.F. Thoma	26-May-07
unnamed trib of Russell Fork at intersection of Laural Branch Road & Russell Fork River Road (VA Rt. 605)	37.17194	-82.23607	R.F. Thoma, Michael Pucket	17-Aug-06
Rocklick Branch and seep adjacent VA SSR 742, 2.36 mi. NE of Stone Creek	36.79485	-83.02117	R.F. Thoma, Michael Pucket	1-Aug-07
South Fork Powell River upstream Cracker Neck at bridge on VA SSR 616 (Cracked Neck Road)	36.83606	-82.70552	R.F. Thoma, J. Fetzner	4-Oct-07
Slate Creek adjacent VA Rt. 83 at upstream (northeast) edge of Grundy	37.27874	-82.09352	R.F. Thoma, John A. Thoma	25-Sep-07
Fryingpan Creek adjacent VA Rt. 80 just downstream of Rock Lick confluence (Colley)	37.15825	-82.24979	R.F. Thoma, John A. Thoma	26-Sep-07
Dismal River Site #2, SRT 613	37.23270	-81.80420	MJP, GCP	30-Oct-01
Levisa Fork at Concol Energy parking lot at north edge of Oakwood, adjacent US Rt. 460	37.20699	-82.00004	R.F. Thoma	24-May-07

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CATNO	GENUS	SPECIES	MALE1	MALE2	FEMALE	OVIG	JUVS	EGGS	INSTARS	Total	FIELDNO	STATE	COUNTY
6877	Cambarus	sciotensis	0	0	0	0	1m,1f	0	0	2	RFT-07-134	Virginia	Buchanan
6882	Cambarus	sciotensis	1	1	0	0	0	0	0	2	RFT-07-136	Virginia	Buchanan
7011	Cambarus	sciotensis	0	1	0	0	1m	0	0	2	RFT-08-040	Virginia	Buchanan
7058	Cambarus	sciotensis	0	0	1	0	01f	0	0	2	RFT-09-013	Virginia	Buchanan
6941	Cambarus	sciotensis	1	1	0	0	0	0	0	4	RFT-08-024	Virginia	Buchanan
6995	Cambarus	sciotensis	0	2	2	0	0	0	0	4	RFT-08-038	Virginia	Buchanan
7005	Cambarus	sciotensis	0	1	2	0	04f	0	0	7	RFT-08-037	Virginia	Buchanan
6828	Cambarus	sciotensis	0	1	1	0	03m,3f	0	0	8	RFT-07-080	Virginia	Buchanan
6870	Cambarus	sciotensis	0	1	1	0	05m,1f	0	0	8	RFT-07-095	Virginia	Tazewell
6892	Cambarus	sciotensis	2	2	0	0	04f	0	0	8	RFT-07-142	Virginia	Dickenson
6925	Cambarus	sciotensis	0	5	6	0	01m,5f	0	0	17	RFT-08-023	Virginia	Tazewell
6869	Cambarus	sciotensis	1	8	3	0	12m,5f	0	58	20	RFT-07-094	Virginia	Tazewell
6824	Cambarus	sciotensis	0	4	1	0	09m,7f	0	0	21	RFT-07-078	Virginia	Tazewell
6825	Cambarus	sciotensis	0	4	4	0	09m,5f	0	0	22	RFT-07-079	Virginia	Buchanan
6929	Cambarus	sciotensis	3	0	12	0	07m,6f	0	0	27	RFT-08-022	Virginia	Tazewell
6874	Cambarus	sciotensis	1	10	5	0	18m,7f	82	0	32	RFT-07-096	Virginia	Tazewell
6875	Cambarus	sciotensis	4	2	6	0	09m,3f	0	0	22	RFT-07-132	West Virginia	Mercer
7021	Cambarus	sp. Nova	4	1	3	0	01m	0	0	9	RFT-08-053	Tennessee	Fentress
7035	Cambarus	sp. nova	1	0	3	0	03m,2f	0	0	9	RFT-08-065	Virginia	Wise
6805	Cambarus	sp?	0	0	1	0	0	0	0	1	RFT-07-022A	Virginia	Lee
7014	Cambarus	sphenoides	0	0	1	0	0	0	0	1	RFT-08-052	Kentucky	McCreary
7017	Cambarus	sphenoides	0	0	1	0	01f	0	0	2	RFT-08-056	Tennessee	Morgan
7039	Cambarus	sphenoides	1	0	3	0	07m,7f	0	0	18	JWF-2008-17	Tennessee	Cumberland
6331	Cambarus	sphenoides	1	0	1	0	01f	0	0	3	RFT-05-023	Tennessee	Fentress
6324	Cambarus	thomai	0	1	0	0	0	0	0	1	RFT-05-009	Kentucky	Bell
6936	Cambarus	thomai	0	0	2	0	0	0	0	2	RFT-08-036	West Virginia	Greenbrier
6927	Cambarus	thomai	2	1	3	0	0	0	0	6	RFT-08-021	West Virginia	Mason
7022	Cambarus	unestami	2	3	5	0	0	0	0	10	RFT-08-059	Georgia	Dade
6908	Cambarus	upenus	6	1	3	0	0	0	0	10	RFT-07-150	North Carolina	Surry
6012	Cambarus	upenus	3	2	12	0	0	0	0	17	RFT-05-058	North Carolina	Ashe
7060	Cambarus	upenus	7	0	9	0	04m,1f	0	0	21	RFT-09-009	North Carolina	Alleghany
6946	Cambarus	upenus	4	1	14	0	04f	0	0	23	RFT-07-152	North Carolina	Ashe
7070	Cambarus	upenus	1	0	0	0	0	0	0	1	SJC 17 98	Virginia	Grayson

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LOCALITY	LAT	LONG	COLLECTOR	COLLECTION DATE
Dismal Creek at handicapped fishing access site, adjacent VA SSR 638	37.25183	-82.00568	R.F. Thoma, John A. Thoma	25-Sep-07
Slate Creek adjacent VA Rt. 83 upstream Hobbs Branch confluence, downstream Stacy	37.30728	-82.02457	R.F. Thoma, John A. Thoma	25-Sep-07
Big Prater Creek of Levisa Fork at railroad tressls adjacent VA SR 83 at Vasant	37.23166	-82.10002	R.F. Thoma and V.M. Thoma	14-Jul-08
Prater Creek of Levisa Fork at New Hope Christiarn Church adjacent VA Rt 83	37.30051	-82.02962	R.F. Thoma	3-Apr-09
Dismal Creek at intersection of VA SSR 690 & 638	37.24556	-81.88144	R.F. Thoma	3-Jun-08
Bull Creek of Levisa Fork just upstream mouth, adjacent VA SSR 609, NE of Maxie	37.31252	-82.16622	R.F. Thoma and V.M. Thoma	14-Jul-08
Knox Creek of Tug Fork at VA SSR 697 bridge, N of Kelsa	37.45147	-82.05975	R.F. Thoma and V.M. Thoma	14-Jul-08
Dismal Creek at VA SSR 690 & 638	37.24636	-81.88173	R.F. Thoma, Michael Puckett	24-Jul-07
Bluestone River adjacent VA SSR 720 at west edge of Bluefield	37.23476	-81.29373	R.F. Thoma, Michael Pucket	2-Aug-07
Fryingpan Creek adjacent VA SSR 625 at Fryingpan Independent Freewill Baptist Church	37.12434	-82.23788	R.F. Thoma, John A. Thoma	26-Sep-07
Beech Fork adjacent VA SSR 624 just inside VA State border	37.20310	-81.63685	R.F. Thoma	2-Jun-08
Bluestone River adjacent US Rt. 460/19, 1.01 mi. SW of St Clair	37.22570	-81.32952	R.F. Thoma, Michael Pucket	2-Aug-07
Bluestone River at intersection of US Rt 460/19 & VA SSR 656	37.20968	-81.37501	R.F. Thoma, Michael Puckett	23-Jul-07
Dismal Creek at VA SSR 636 & 638	37.22918	-81.81081	R.F. Thoma, Michael Puckett	24-Jul-07
Dry Fork just downstream of Mill Branch and adjacent VA SSR 637 at coal mine conveyer belt crossing	37.20160	-81.62045	R.F. Thoma	2-Jun-08
Mud Fork of Bluestone River upstream VA SSR 643	37.25692	-81.35845	R.F. Thoma, Michael Pucket	2-Aug-07
Crane Creek adjacent CO Rd. 11, upstream Godfrey and downstream McComas	37.37639	-81.27762	R.F. Thoma, John A. Thoma	24-Sep-07
Mill Creek downstream Campbell Branch and Stockton Road bridge, 5.25 mi. ESE of Allardt	36.39274	-84.79127	R.F. Thoma, J.W. Fetzner	24-Sep-08
South Fork Powell River at Big Stone Gap Water Treatment Plant in Cracker Neck	36.84736	-82.71137	R.F. Thoma	16-Oct-08
White Branch - Martin Creek - Powell River upstream VA Rt. 673 at ATV parking area, N of Rose Hill	36.68391	-83.36414	R.F. Thoma, Michael Puckett	25-Jul-07
unnamed tributary of Cumberland River upstream & adjacent KY St. Rt. 90, at Cumberland Falls State Park	36.83674	-84.34553	R.F. Thoma, J.W. Fetzner	23-Sep-08
Cane Branch of Emory River at church & cemetary on Scitcheon Roar, 3.81 mi. NNW of Wartburg	36.15638	-84.62163	R.F. Thoma, J.W. Fetzner	24-Sep-08
Bean Creek at bridge on Claysville Road, 2.03 mi. NW of Pamona	35.97514	-85.14172	R.F. Thoma, J.W. Fetzner	26-Sep-08
Big Branch of Clear Creek of Obed River adjacent Rock Quarry Road	36.17685	-85.01018	R.F. Thoma, Emily Imhoff	10-Jun-05
unnamed trib of Clear Creek at SSR 382, east end of Pine Mountain State Park roadside ditch to Meadow River adjacent Co. Rd. 27, 0.4 mi. S of Dawson adjacent Meadow River Wildlife Management Area	36.74288	-83.70293	R.F. Thoma, Chris Lukhaup, Guenter Schuster, Jim & Hillary Fetzner, Brian	10-Apr-05
ditch to Lower Ninemile Creek at Chief Corn Stalk Wildlife Management Area campground	37.85077	-80.71276	R.F. Thoma	6-Jun-08
Daniel Creek (of Lookout Creek) at Cambarus unistami type locality, upstream GA Rt. 136 bridge and Cloudland Canyon State Park, 4.54 mi. NNE of Rising Fawn	34.81613	-85.49109	R.F. Thoma, J.W. Fetzner	26-Sep-08
Gully Creek of Fisher River at noth end of field at end of NC SSR 1420, 1.76 mi NW of Lowgap	36.54075	-80.89300	R.F. Thoma, J. Fetzner	2-Oct-07
Old Field Creek adjacent US Rt. 221 and Ira Jordan Rd., 2.04 mi. SSE of Baldwin, 1.04 mi. N of Fleetwood	36.32124	-81.51778	R.F. Thoma, Jim Grow	15-Sep-05
Wolf Branch at confluence with Gladly Run of S. Fk. New River downstream NC SR 1113 bridge, 3.93 mi. SE of Sparta	36.46635	-81.06946	R.F. Thoma	2-Apr-09
Old Fields Creek adjacent Ira Jones Rd. and NC Rt 221	36.32248	-81.51798	R.F. Thoma, J. Fetzner	3-Oct-07
Chestnut Creek, site S4	36.64163	-80.92056	SJC, MJP	21-Apr-98

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CATNO	GENUS	SPECIES	MALE1	MALE2	FEMALE	OVIG	JUVS	EGGS	INSTARS	Total	FIELDNO	STATE	COUNTY
7068	Cambarus	upenus	2	0	0	0	0	0	0	2	SJC 16 98	Virginia	Grayson
6486	Cambarus	upenus	7	0	2	0	0	0	0	9		Virginia	Grayson
6809	Cambarus	upenus	0	8	4	0	0	0	0	12	RFT-07-024	Virginia	Grayson
7074	Cambarus	upenus	7	3	8	0	0	0	0	18	141	Virginia	Grayson
6386	Cambarus	upenus	3	2	14	0	0	0	0	19	RFT-06-106	Virginia	Grayson
6818	Cambarus	upenus	2	2	3	0	0	0	0	22	RFT-07-025b	Virginia	Grayson
6850	Cambarus	upenus	0	4	7	0	6m,5f	0	0	22	RFT-07-088	Virginia	Grayson
6811	Cambarus	upenus	2	2	2	0	2m,3f	0	0	24	RFT-07-025	Virginia	Grayson
6849	Cambarus	upenus	0	2	5	0	4f	0	0	31	RFT-07-088A	Virginia	Grayson
6817	Cambarus	upenus	0	0	1	0	1m	0	0	43	RFT-07-025a	Virginia	Grayson
6931	Cambarus	upenus	1	0	0	1	2f	80	0	47	RFT-08-033	Virginia	Grayson
6898	Cambarus	veteranus	1	0	1	0	0	0	0	2	RFT-07-145	Virginia	Wise
6830	Cambarus	veteranus	1	0	2	0	0	0	0	3	RFT-07-081	Virginia	Buchanan
6832	Cambarus	veteranus	1	1	0	1	1m	142	0	4	RFT-07-082	Virginia	Buchanan
6879	Cambarus	veteranus	0	1	1	0	1m	0	0	4	RFT-07-134	Virginia	Buchanan
6209	Cambarus	veteranus	0	2	2	0	1m	0	0	5	J-90-32	Virginia	Dickenson
6989	Cambarus	veteranus	2	0	1	0	2f	0	0	5	RFT-08-061	Virginia	Dickenson
7000	Cambarus	veteranus	0	0	0	0	2m	0	0	5	RFT-08-042	Virginia	Dickenson
6342	Cambarus	veteranus	0	0	1	0	2m,3	0	0	6	RFT-06-080	Virginia	Buchannon
6897	Cambarus	veteranus	0	1	3	0	0	0	0	8	RFT-07-144	Virginia	Dickenson
7002	Cambarus	veteranus	0	0	2	0	1m,2f	0	0	8	RFT-08-041	Virginia	Dickenson
6827	Cambarus	veteranus	1	0	2	0	5m,1f	0	0	9	RFT-07-080	Virginia	Buchanan
6902	Cambarus	veteranus	2	1	1	0	3m,1f	0	0	9	RFT-07-147	Virginia	Dickenson
7054	Cambarus	veteranus	2	2	6	0	1f	0	0	11	RFT-08-062	Virginia	Dickenson
6345	Cambarus	veteranus	2	3	6	0	1m,1f	0	0	13	RFT-06-081	Virginia	Buchannon/Dickenson
6888	Cambarus	veteranus	1	1	1	0	2m	0	0	14	RFT-07-140	Virginia	Dickenson
6942	Cambarus	veteranus	1	0	1	0	1f	0	0	14	RFT-08-024	Virginia	Buchanan
6901	Cambarus	veteranus	1	4	7	0	2m,1f	0	0	15	RFT-07-146	Virginia	Dickenson
6958	Cambarus	veteranus	3	0	11	0	1f	0	0	15	RFT-08-063	Virginia	Dickenson
6795	Cambarus	veteranus	1	1	4	0	3m	0	0	16	RFT-07-019	Virginia	Dickenson
6791	Cambarus	veteranus	1	1	1	0	0	0	0	18	RFT-07-018	Virginia	Dickenson
6349	Cambarus	veteranus	4	0	11	1	1m,2f	90	0	19	RFT-06-083	Virginia	Dickenson
7051	Cambarus	veteranus	1	1	1	0	0	0	0	21	RFT-08-058.0	Virginia	Buchanan



Appendix Table C. Material collected and used in this study arranged by species.

LOCALITY	LAT	LONG	COLLECTOR	COLLECTION DATE
upper Chestnut Creek at VA SSR 790 & 613	36.58164	-80.89113	SJC, MJP	21-Apr-98
unnamed trib of Chestnut Creek at second bridge on Blue Ridge Parkway after intersection with VA Rt. 89 [6.5 mi. S of Galax, 3.7 mi. NW of Low Gap]	36.57020	-80.90570	R.F. Thoma, R.F. Jezerinac, Ed Franks, Carol Messmer	28-Aug-79
Meadow Creek - New River, at VA Rt. 621, near intersection with VA Rt. 622	36.62592	-80.96298	R.F. Thoma	25-May-07
upper Chestnut Creek at VA SSR 790 & 613	38.58164	-80.89113	E. Wilhelm, J. Jones	31-Mar-00
Chestnut Creek upstream confluence with East Fork adjacent VA Rt. 790	36.58028	-80.89167	R.F. Thoma, Jim & Hillary Fetzner, Brian Watson, C. Lucaup, W. Stocker	22-Oct-06
East Fork Chestnut Creek - New River, upstream VA Rt. 613 east of intersection with VA Rt. 790	36.58069	-80.89048	R.F. Thoma, J. Fetzner	2-Oct-07
unnamed trib. Of Little River adjacent VA SSR 622	36.57866	-81.00235	R.F. Thoma, Michael Pucket, Brian Watson	31-Jul-07
East Fork Chestnut Creek - New River, upstream VA Rt. 613 east of intersection with VA Rt. 790	36.58069	-80.89048	R.F. Thoma	26-May-07
unnamed trib. Of Little River adjacent VA SSR 622	36.57866	-81.00235	R.F. Thoma, J. Fetzner	3-Oct-07
East Fork Chestnut Creek - New River, upstream VA Rt. 613 east of intersection with VA Rt. 790	36.58069	-80.89048	R.F. Thoma, Michael Pucket, Brian Watson	31-Jul-07
unnamed trib. of Little River adjacent Beaver Creek Road	36.57937	-81.00330	R.F. Thoma, Brian T. Watson	5-Jun-08
Pound River downstream VA SSR 666	37.15677	-82.56956	R.F. Thoma, John A. Thoma	27-Sep-07
Dismal Creek at VA SSR 638 below Rowe Mtn.	37.26125	-81.00391	R.F. Thoma, Michael Puckett	24-Jul-07
Russel Fork adjacent VA SSR 612 downstream of intersection with VA SSR 611 at Bartlick	37.24772	-82.32525	R.F. Thoma, Michael Puckett	24-Jul-07
Dismal Creek at handicapped fishing access site, adjacent VA SSR 638	37.25183	-82.00568	R.F. Thoma, John A. Thoma	25-Sep-07
McClure River of Russell Fork of Big Sandy River at intersections of Co. Rd. 647 & VA Rt. 63 (0.1 mi. S of McClure; 6.1 mi. SE of Clintwood) [Jenkins N.T.]	37.08887	-82.37256	R.F. Jezeronac, G.W. Stocker	21-Jul-90
Russel Fork tributary of Levisa Fork adjacent to VA SSR 605	37.16888	-82.25013	R.F. Thoma	15-Oct-08
Lick Creek of Russell Fork at intersection of VA SSR 670 & VA SSR 661, at Counts	37.12755	-82.30865	R.F. Thoma and V.M. Thoma	15-Jul-08
Russell Fork at park in Council adjacent VA Rt. 80	37.07882	-82.07037	R.F. Thoma, Michael Puckett	17-Aug-06
McClure River at VA Rt. 83/63 & VA SSR 780, behind Rescue Squade building	37.15940	-82.37398	R.F. Thoma, John A. Thoma	26-Sep-07
Prater Creek of Russell Fork at Haysi Community Library upstream VA SR 83 at Haysi	37.20938	-82.28704	R.F. Thoma and V.M. Thoma	16-Jul-08
Dismal Creek at VA SSR 690 & 638	37.24636	-81.88173	R.F. Thoma, Michael Puckett	24-Jul-07
Cranes Nest River at VA SSR 637 bridge, 1.0 mi. east of Darwin	37.09874	-82.47329	R.F. Thoma, John A. Thoma	27-Sep-07
McClure River of Russell Fork downstream VA SR 738 bridge, 1.45 mi. NE of Clinchco	37.17683	-82.34172	R.F. Thoma	15-Oct-08
Russell Fork adjacent VA Rt. 605 at county line	37.11954	-82.17185	R.F. Thoma, Michael Puckett	17-Aug-06
Lick Creek at ford upstream 90 degree bend in stream on VA SSR 670	37.16638	-82.27159	R.F. Thoma, John A. Thoma	26-Sep-07
Dismal Creek at intersection of VA SSR 690 & 638	37.24556	-81.88144	R.F. Thoma	3-Jun-08
Cranes Nest River upstream VA Rt. 83 bridge adjacent VA SSR 649	37.13405	-82.42723	R.F. Thoma, John A. Thoma	27-Sep-07
Cranes Nest River downstream VA Rt. 83 bridge, 2.0 mi. SE Clintwood	37.13618	-82.42578	R.F. Thoma	15-Oct-08
McClure River at baseball field at noth end of McClure upstream VA Rt. 63 and Caney Creek confluence	37.10638	-82.37852	R.F. Thoma	24-May-07
Russell Fork of Big Sandy River at intersection of VA Rt. 810 & 605	37.17056	-82.24851	R.F. Thoma	24-May-07
Russell Fork downstream bridge and pipeline at Martha Gap (VA Rt. 80 & VA Rt. 722?)	37.19298	-82.28797	R.F. Thoma, Michael Puckett	17-Aug-06
Dismal Creek of Levisa Fork adjacent VA SSR 638, 5.54 mi. ENE of Vasant	37.25793	-82.00524	R.F. Thoma	15-Oct-08

Appendix Table C. Material collected and used in this study arranged by species.

CATNO	GENUS	SPECIES	MALE1	MALE2	FEMALE	OVIG	JUVS	EGGS	INSTARS	Total	FIELDNO	STATE	COUNTY
6796	Cambarus	veteranus	2	0	2	0	2m,2f	0	0	23	RFT-07-020	Virginia	Dickenson
7007	Cambarus	veteranus	1	1	1	0	0	0	0	29	RFT-08-043	Virginia	Wise
6798	Cambarus	veteranus	0	1	2	0	7m,3f	0	3	40	RFT-07-020A	Virginia	Dickenson
7013	Orconectes	crstavarius	0	0	0	0	1f	0	0	1	RFT-08-052	Kentucky	McCreary
6007	Orconectes	crstavarius	9	6	14	0	0	0	0	29	RFT-05-059	North Carolina	Ashe
6008	Orconectes	crstavarius	0	1	1	0	0	0	0	2	RFT-05-058	North Carolina	Ashe
6814	Orconectes	crstavarius	0	1	0	0	0	0	0	1	RFT-07-025	Virginia	Grayson
7010	Orconectes	crstavarius	0	0	1	0	0	0	0	1	RFT-08-040	Virginia	Buchanan
7061	Orconectes	crstavarius	0	0	0	1	0	113	0	1	RFT-09-011	Virginia	Buchanan
7071	Orconectes	crstavarius	1	0	0	0	0	0	0	1	SJC 17 98	Virginia	Grayson
6348	Orconectes	crstavarius	1	0	1	0	0	0	0	2	RFT-06-082	Virginia	Dickenson
6890	Orconectes	crstavarius	2	0	0	0	0	0	0	2	RFT-07-141	Virginia	Dickenson
6895	Orconectes	crstavarius	1	1	0	0	0	0	0	2	RFT-07-143	Virginia	Dickenson
7055	Orconectes	crstavarius	1	0	1	0	0	0	0	2	RFT-08-062	Virginia	Dickenson
6790	Orconectes	crstavarius	0	2	1	0	0	0	0	3	RFT-07-017	Virginia	Buchanan
6885	Orconectes	crstavarius	1	1	1	0	0	0	0	3	RFT-07-138	Virginia	Buchanan
6957	Orconectes	crstavarius	1	0	2	0	0	0	0	3	RFT-08-063	Virginia	Dickenson
7053	Orconectes	crstavarius	3	0	0	0	0	0	0	3	RFT-08-058.0	Virginia	Buchanan
6896	Orconectes	crstavarius	2	0	2	0	0	0	0	4	RFT-07-144	Virginia	Dickenson
6346	Orconectes	crstavarius	0	0	3	0	2f	0	0	5	RFT-06-081	Virginia	Buchannon/Dickenson
6792	Orconectes	crstavarius	0	3	2	0	0	0	0	5	RFT-07-018	Virginia	Dickenson
6797	Orconectes	crstavarius	0	4	1	0	0	0	0	5	RFT-07-020	Virginia	Dickenson
6893	Orconectes	crstavarius	3	0	2	0	0	0	0	5	RFT-07-142	Virginia	Dickenson
6873	Orconectes	crstavarius	1	0	3	0	1m,1f	0	0	6	RFT-07-096	Virginia	Tazewell
6996	Orconectes	crstavarius	1	3	1	0	1m	0	0	6	RFT-08-038	Virginia	Buchanan
6900	Orconectes	crstavarius	0	0	2	0	4m,2f	0	0	8	RFT-07-146	Virginia	Dickenson
6794	Orconectes	crstavarius	0	8	1	0	0	0	0	9	RFT-07-019	Virginia	Dickenson
6831	Orconectes	crstavarius	1	2	2	0	2m,2f	0	0	9	RFT-07-081	Virginia	Buchanan
6926	Orconectes	crstavarius	0	6	3	0	0	0	0	9	RFT-08-023	Virginia	Tazewell
6353	Orconectes	crstavarius	5	0	8	0	5f	0	0	10	RFT-06-085	Virginia	Wise
6884	Orconectes	crstavarius	8	0	2	0	0	0	0	10	RFT-07-137	Virginia	Buchanan
6889	Orconectes	crstavarius	7	0	2	0	1m	0	0	10	RFT-07-140	Virginia	Dickenson
7057	Orconectes	crstavarius	4	3	2	1	0	100	0	10	RFT-09-013	Virginia	Buchanan

Appendix Table C. Material collected and used in this study arranged by species.

LOCALITY	LAT	LONG	COLLECTOR	COLLECTION DATE
Pound River adjacent VA Rt. 754, first pullout north of fenced horse track and stands area (Isom)	37.19172	-82.45783	R.F. Thoma	24-May-07
Birchfield Creek of Cranes Nest River adjacent VA SSR 634, 7.9 mi. WSW of McClure	37.06781	-82.51214	R.F. Thoma and V.M. Thoma	15-Jul-08
Pound River adjacent VA Rt. 754, first pullout north of fenced horse track and stands area (downstream Isom)	37.19172	-82.45783	R.F. Thoma, John A. Thoma	27-Sep-07
unnamed tributary of Cumberland River upstream & adjacent KY St. Rt. 90, at Cumberland Falls State Park	36.83674	-84.34553	R.F. Thoma, J.W. Fetzner	23-Sep-08
South Fork New River at US Rt. 221	36.47468	-81.33714	R.F. Thoma, Jim Grow	15-Sep-05
Old Field Creek adjacent US Rt. 221 and Ira Jordan Rd., 2.04 mi. SSE of Baldwin, 1.04 mi. N of Fleetwood	36.32124	-81.51778	R.F. Thoma, Jim Grow	15-Sep-05
East Fork Chestnut Creek - New River, upstream VA Rt. 613 east of intersection with VA Rt. 790	36.58069	-80.89048	R.F. Thoma	26-May-07
Big Prater Creek of Levisa Fork at railroad tressls adjacent VA SR 83 at Vasant	37.23166	-82.10002	R.F. Thoma and V.M. Thoma	14-Jul-08
Levisa Fork downstream of Dismal Creek confluence adjacent US Rt 460	37.23574	-82.05343	R.F. Thoma	2-Apr-09
Chestnut Creek, site S4	0.00000	0.00000	SJC, MJP	21-Apr-98
unnamed trib of Russell Fork at intersection of Laural Branch Road & Russell Fork River Road (VA Rt. 605)	37.17194	-82.23607	R.F. Thoma, Michael Puckett	17-Aug-06
Fryingpan Creek adjacent VA Rt. 80 just downstream of Rock Lick confluence (Colley)	37.15825	-82.24979	R.F. Thoma, John A. Thoma	26-Sep-07
McClure River at intersection of Va Rt. 63 & VA SSR 656, downstream Roaring Fork	37.02840	-82.30096	R.F. Thoma, John A. Thoma	26-Sep-07
McClure River of Russell Fork downstream VA SR 738 bridge, 1.45 mi. NE of Clinchco	37.17683	-82.34172	R.F. Thoma	15-Oct-08
Levisa Fork at Concol Energy parking lot at north edge of Oakwood, adjacent US Rt. 460	37.20699	-82.00004	R.F. Thoma	24-May-07
Levisa Fork adjacent UC Rt. 460 and downstream Home Creek confluence (at pull out near seep)	37.34987	-82.18613	R.F. Thoma, John A. Thoma	25-Sep-07
Cranes Nest River downstream VA Rt. 83 bridge, 2.0 mi. SE Clintwood	37.13618	-82.42578	R.F. Thoma	15-Oct-08
Dismal Creek of Levisa Fork adjacent VA SSR 638, 5.54 mi. ENE of Vasant	37.25793	-82.00524	R.F. Thoma	15-Oct-08
McClure River at VA Rt. 83/63 & VA SSR 780, behind Rescue Squade building	37.15940	-82.37398	R.F. Thoma, John A. Thoma	26-Sep-07
Russell Fork adjacent VA Rt. 605 at county line	37.11954	-82.17185	R.F. Thoma, Michael Puckett	17-Aug-06
Russell Fork of Big Sandy River at intersection of VA Rt. 810 & 605	37.17056	-82.24851	R.F. Thoma	24-May-07
Pound River adjacent VA Rt. 754, first pullout north of fenced horse track and stands area (downstream Isom)	37.19172	-82.45783	R.F. Thoma	24-May-07
Fryingpan Creek adjacent VA SSR 625 at Fryingpan Independent Freewill Baptist Church	37.12434	-82.23788	R.F. Thoma, John A. Thoma	26-Sep-07
Mud Fork of Bluestone River upstream VA SSR 643	37.25692	-81.35845	R.F. Thoma, Michael Pucket	2-Aug-07
Bull Creek of Levisa Fork just upstream mouth, adjacent VA SSR 609, NE of Maxie	37.31252	-82.16622	R.F. Thoma and V.M. Thoma	14-Jul-08
Cranes Nest River upstream VA Rt. 83 bridge adjacent VA SSR 649	37.13405	-82.42723	R.F. Thoma, John A. Thoma	27-Sep-07
McClure River at baseball field at noth end of McClure upstream VA Rt. 63 and Caney Creek confluence	37.10638	-82.37852	R.F. Thoma	24-May-07
Dismal Creek at VA SSR 638 below Rowe Mtn.	37.26125	-81.00391	R.F. Thoma, Michael Puckett	24-Jul-07
Beech Fork adjacent VA SSR 624 just inside VA State border	37.20310	-81.63685	R.F. Thoma	2-Jun-08
Callahhan Creek at overpass in Appalachia, VA Rt. 78	36.90675	-82.78228	R.F. Thoma, Michael Puckett	18-Aug-06
Home Creek at intersection of VA SSR 650 (Home Creek Rd.) & VA SSR 700	37.34510	-82.17484	R.F. Thoma, John A. Thoma	25-Sep-07
Lick Creek at ford upstream 90 degree bend in stream on VA SSR 670	37.16638	-82.27159	R.F. Thoma, John A. Thoma	26-Sep-07
Prater Creek of Levisa Fork at New Hope Christiarn Church adjacent VA Rt 83	37.30051	-82.02962	R.F. Thoma	3-Apr-09

Appendix Table C. Material collected and used in this study arranged by species.

CATNO	GENUS	SPECIES	MALE1	MALE2	FEMALE	OVIG	JUVS	EGGS	INSTARS	Total	FIELDNO	STATE	COUNTY
6833	Orconectes	crisnavarius	0	4	6	0	2f	0	0	12	RFT-07-082	Virginia	Buchanan
6880	Orconectes	crisnavarius	8	0	1	0	3f	0	0	12	RFT-07-135	Virginia	Buchanan
6943	Orconectes	crisnavarius	0	1	1	0	0	0	0	12	RFT-08-024	Virginia	Buchanan
6923	Orconectes	crisnavarius	0	7	5	0	2f	0	0	14	RFT-08-034	Virginia	Grayson
6799	Orconectes	crisnavarius	8	0	7	0	0	0	0	15	RFT-07-020A	Virginia	Dickenson
7003	Orconectes	crisnavarius	1	8	5	0	1m	0	0	15	RFT-08-041	Virginia	Dickenson
6350	Orconectes	crisnavarius	2	1	4	0	1m,3f	0	0	18	RFT-06-083	Virginia	Dickenson
6883	Orconectes	crisnavarius	15	1	2	0	0	0	0	18	RFT-07-136	Virginia	Buchanan
6878	Orconectes	crisnavarius	2	0	2	0	1f	0	0	20	RFT-07-134	Virginia	Buchanan
7004	Orconectes	crisnavarius	0	2	4	0	6m,8f	0	0	20	RFT-08-037	Virginia	Buchanan
6930	Orconectes	crisnavarius	0	14	7	0	0	0	0	21	RFT-08-022	Virginia	Tazewell
6947	Orconectes	crisnavarius	8	0	7	0	5m,2f	0	0	22	RFT-07-147	Virginia	Dickenson
6829	Orconectes	crisnavarius	3	5	8	0	4m,4f	0	0	24	RFT-07-080	Virginia	Buchanan
6876	Orconectes	crisnavarius	14	0	4	0	4m,4f	0	0	26	RFT-07-133	Virginia	Buchanan
6997	Orconectes	crisnavarius	0	12	15	0	0	0	0	27	RFT-08-044	Virginia	Wise
6998	Orconectes	crisnavarius	1	13	11	0	1m,2f	0	0	28	RFT-08-042	Virginia	Dickenson
7006	Orconectes	crisnavarius	2	2	2	0	1m,1f	0	0	31	RFT-08-043	Virginia	Wise
6953	Orconectes	crisnavarius	0	26	14	0	0	0	0	40	RFT-07-024	Virginia	Grayson
6826	Orconectes	crisnavarius	3	3	7	0	12m,22f	0	0	47	RFT-07-079	Virginia	Buchanan
6899	Orconectes	crisnavarius	22	2	33	0	3m,1f	0	0	61	RFT-07-145	Virginia	Wise
6341	Orconectes	crisnavarius	12	0	8	0	3m,4f	0	0	27	RFT-06-080	Virginia	Buchannon
6361	Orconectes	erichsonianus	0	1	0	0	0	0	0	1	RFT-06-089	Tennessee	Claiborne
6360	Orconectes	forceps	0	1	5	0	0	0	0	6	RFT-06-089	Tennessee	Claiborne
6984	Procambarus	acutus	0	8	5	0	0	0	0	13	RFT-08-008	Tennessee	Polk

Appendix Table C. Material collected and used in this study arranged by species.

LOCALITY	LAT	LONG	COLLECTOR	COLLECTION DATE
Russel Fork adjacent VA SSR 612 downstream of intersection with VA SSR 611 at Bartlick	37.24772	-82.32525	R.F. Thoma, Michael Puckett	24-Jul-07
Slate Creek adjacent VA Rt. 83 at upstream (northeast) edge of Grundy	37.27874	-82.09352	R.F. Thoma, John A. Thoma	25-Sep-07
Dismal Creek at intersection of VA SSR 690 & 638	37.24556	-81.88144	R.F. Thoma	3-Jun-08
unnamed trib. New River at Little River Road bridge	36.59034	-81.07039	R.F. Thoma, Brian T. Watson	5-Jun-08
Pound River adjacent VA Rt. 754, first pullout north of fenced horse track and stands area (downstream Isom)	37.19172	-82.45783	R.F. Thoma, John A. Thoma	27-Sep-07
Prater Creek of Russell Fork at Haysi Community Library upstream VA SR 83 at Haysi	37.20938	-82.28704	R.F. Thoma and V.M. Thoma	16-Jul-08
Russell Fork downstream bridge and pipeline at Martha Gap (VA Rt. 80 & VA Rt. 722?)	37.19298	-82.28797	R.F. Thoma, Michael Puckett	17-Aug-06
Slate Creek adjacent VA Rt. 83 upstream Hobbs Branch confluence, downstream Stacy	37.30728	-82.02457	R.F. Thoma, John A. Thoma	25-Sep-07
Dismal Creek at handicapped fishing access site, adjacent VA SSR 638	37.25183	-82.00568	R.F. Thoma, John A. Thoma	25-Sep-07
Knox Creek of Tug Fork at VA SSR 697 bridge, N of Kelsa	37.45147	-82.05975	R.F. Thoma and V.M. Thoma	14-Jul-08
Dry Fork just downstream of Mill Branch and adjacent VA SSR 637 at coal mine conveyer belt crossing	37.20160	-81.62045	R.F. Thoma	2-Jun-08
Cranes Nest Creek at VA SSR 637 bridge east of Darwin	37.09874	-82.47329	R.F. Thoma, J.A. Thoma	27-Sep-07
Dismal Creek at VA SSR 690 & 638	37.24636	-81.88173	R.F. Thoma, Michael Puckett	24-Jul-07
Levisa Fork at intersection of US Rt. 460 & VA SSR 618 (Old Kentucky Trunk)	37.17349	-81.94106	R.F. Thoma, John A. Thoma	25-Sep-07
South Fork Pound River at Calvary Baptist Church of Pound, SW of Pound adjacent VA SSR 671	37.09201	-82.63525	R.F. Thoma and V.M. Thoma	15-Jul-08
Lick Creek of Russell Fork at intersection of VA SSR 670 & VA SSR 661, at Counts	37.12755	-82.30865	R.F. Thoma and V.M. Thoma	15-Jul-08
Birchfield Creek of Cranes Nest River adjacent VA SSR 634, 7.9 mi. WSW of McClure	37.06781	-82.51214	R.F. Thoma and V.M. Thoma	15-Jul-08
Meadow Creek of New River at VA Rt. 621 bridge near junction with VA Rt. 622, 3.25 mi. SW of Galax	36.62592	-80.96298	R.F. Thoma	25-May-07
Dismal Creek at VA SSR 636 & 638	37.22918	-81.81081	R.F. Thoma, Michael Puckett	24-Jul-07
Pound River downstream VA SSR 666	37.15677	-82.56956	R.F. Thoma, John A. Thoma	27-Sep-07
Russell Fork at park in Council adjacent VA Rt. 80	37.07882	-82.07037	R.F. Thoma, Michael Puckett	17-Aug-06
Powell River upstream of US Rt. 25E & adjacent TN Rt. 32 (River Road)	36.54723	-83.63192	R.F. Thoma, Michael Puckett	18-Aug-06
Powell River upstream of US Rt. 25E & adjacent TN Rt. 32 (River Road)	36.54723	-83.63192	R.F. Thoma, Michael Puckett	18-Aug-06
ditch to Cookson Creek of Ocoee River adjacent Cookson Creek Road, 3.65 mi. E of Old Fort	35.06964	-84.66991	R.F. Thoma and D.I. Withers	30-Apr-08

## Appendix D

Data collection sheets used in the field  
during this study



Qualitative Habitat Evaluation Index Field Sheet QHEI Score:

River Code: \_\_\_\_\_ RM: \_\_\_\_\_ Stream \_\_\_\_\_  
 Date \_\_\_\_\_ Location \_\_\_\_\_  
 Scorers Initials: \_\_\_\_\_ Comments \_\_\_\_\_

**1] SUBSTRATE (Check ONLY Two Substrate TYPE BOXES; Estimate % present);**

TYPE	POOL RIFFLE	POOL RIFFLE	SUBSTRATE ORIGIN	SUBSTRATE QUALITY
<input type="checkbox"/> <input type="checkbox"/> BLDR/SLBS[10] _____	<input type="checkbox"/> <input type="checkbox"/> GRAVEL [7] _____	_____	Check ONE (OR 2 & AVERAGE)	Check ONE (OR 2 & AVERAGE)
<input type="checkbox"/> <input type="checkbox"/> BOULDER [9] _____	<input type="checkbox"/> <input type="checkbox"/> SAND [6] _____	_____	<input type="checkbox"/> - LIMESTONE [1] SILT:	<input type="checkbox"/> - SILT HEAVY [-2]
<input type="checkbox"/> <input type="checkbox"/> COBBLE [8] _____	<input type="checkbox"/> <input type="checkbox"/> BEDROCK [5] _____	_____	<input type="checkbox"/> - TILLS [1]	<input type="checkbox"/> - SILT MODERATE [-1] Substrate
<input type="checkbox"/> <input type="checkbox"/> HARDPAN [4] _____	<input type="checkbox"/> <input type="checkbox"/> DETRITUS [3] _____	_____	<input type="checkbox"/> - WETLANDS [0]	<input type="checkbox"/> - SILT NORMAL [0]
<input type="checkbox"/> <input type="checkbox"/> MUCK [2] _____	<input type="checkbox"/> <input type="checkbox"/> ARTIFICIAL [0] _____	_____	<input type="checkbox"/> - HARDPAN [0]	<input type="checkbox"/> - SILT FREE [1] <input type="text"/>
<input type="checkbox"/> <input type="checkbox"/> SILT [2] _____	_____	_____	<input type="checkbox"/> - SANDSTONE [0] EMBEDDED	<input type="checkbox"/> - EXTENSIVE [-2] Max 20
NOTE: (Ignore sludge originating from point-sources; score on natural substrates)			<input type="checkbox"/> - RIP/RAP [0] NESS:	<input type="checkbox"/> - MODERATE [-1]
NUMBER OF SUBSTRATE TYPES: <input type="checkbox"/> -5 or More [2]			<input type="checkbox"/> - LACUSTRINE [0]	<input type="checkbox"/> - NORMAL [0]
COMMENTS _____			<input type="checkbox"/> - SHALE [-1]	<input type="checkbox"/> - NONE [1]
			<input type="checkbox"/> - COALFINES [-2]	

**2] INSTREAM COVER (see back for instructions for additional cover scoring method) AMOUNT: (Check ONLY One or check 2 and AVERAGE)**

TYPE: (Check All That Apply)	AMOUNT: (Check ONLY One or check 2 and AVERAGE)
<input type="checkbox"/> UNDERCUT BANKS [1]	<input type="checkbox"/> POOLS > 70 cm [2]
<input type="checkbox"/> OVERHANGING VEGETATION [1]	<input type="checkbox"/> OXBOWS, BACKWATERS [1]
<input type="checkbox"/> SHALLOWS (IN SLOW WATER) [1]	<input type="checkbox"/> ROOTWADS [1]
<input type="checkbox"/> ROOTMATS [1]	<input type="checkbox"/> AQUATIC MACROPHYTES [1]
COMMENTS: _____	<input type="checkbox"/> LOGS OR WOODY DEBRIS [1]
	<input type="checkbox"/> SPARSE 5-25% [3]
	<input type="checkbox"/> NEARLY ABSENT < 5% [1]

**3] CHANNEL MORPHOLOGY: (Check ONLY One PER Category OR check 2 and AVERAGE)**

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY	MODIFICATIONS/OTHER
<input type="checkbox"/> HIGH [4]	<input type="checkbox"/> EXCELLENT [7]	<input type="checkbox"/> NONE [6]	<input type="checkbox"/> HIGH [3]	<input type="checkbox"/> SNAGGING <input type="checkbox"/> IMPOUND.
<input type="checkbox"/> MODERATE [3]	<input type="checkbox"/> GOOD [5]	<input type="checkbox"/> RECOVERED [4]	<input type="checkbox"/> MODERATE [2]	<input type="checkbox"/> RELOCATION <input type="checkbox"/> ISLANDS
<input type="checkbox"/> LOW [2]	<input type="checkbox"/> FAIR [3]	<input type="checkbox"/> RECOVERING [3]	<input type="checkbox"/> LOW [1]	<input type="checkbox"/> CANOPY REMOVAL <input type="checkbox"/> LEVEED
<input type="checkbox"/> NONE [1]	<input type="checkbox"/> POOR [1]	<input type="checkbox"/> RECENT OR NO RECOVERY [1]		<input type="checkbox"/> DREDGING <input type="checkbox"/> BANK SHAPING
				<input type="checkbox"/> ONE SIDE CHANNEL MODIFICATIONS

**4] RIPARIAN ZONE AND BANK EROSION (check ONE box per bank or check 2 and AVERAGE per bank) ★ River Right Looking Downstream ★**

RIPARIAN WIDTH		FLOOD PLAIN QUALITY (PAST 100 Meter RIPARIAN)		BANK EROSION	
L R (Per Bank)	L R (Most Predominant Per Bank)	L R	L R	L R (Per Bank)	Riparian
<input type="checkbox"/> WIDE > 50m [4]	<input type="checkbox"/> FOREST, SWAMP [3]	<input type="checkbox"/> CONSERVATION TILLAGE [1]	<input type="checkbox"/> NONE/LITTLE [3]	<input type="checkbox"/> NONE/LITTLE [3]	<input type="text"/>
<input type="checkbox"/> MODERATE 10-50m [3]	<input type="checkbox"/> SHRUB OR OLD FIELD [2]	<input type="checkbox"/> URBAN OR INDUSTRIAL [0]	<input type="checkbox"/> MODERATE [2]	<input type="checkbox"/> MODERATE [2]	
<input type="checkbox"/> NARROW 5-10m [2]	<input type="checkbox"/> RESIDENTIAL, PARK, NEW FIELD [1]	<input type="checkbox"/> OPEN PASTURE, ROW CROP [0]	<input type="checkbox"/> MODERATE [2]	<input type="checkbox"/> HEAVY/SEVERE [1]	
<input type="checkbox"/> VERY NARROW < 5m [1]	<input type="checkbox"/> FENCED PASTURE [1]	<input type="checkbox"/> MINING/CONSTRUCTION [0]	<input type="checkbox"/> MODERATE [2]	<input type="checkbox"/> HEAVY/SEVERE [1]	
<input type="checkbox"/> NONE [0]			<input type="checkbox"/> MODERATE [2]	<input type="checkbox"/> HEAVY/SEVERE [1]	

**5.] POOL/GLIDE AND RIFFLE/RUN QUALITY**

MAX. DEPTH (Check 1 ONLY!)	MORPHOLOGY (Check 1 or 2 & AVERAGE)	CURRENT VELOCITY (POOLS & RIFFLES!) (Check All That Apply)	Pool/Current
<input type="checkbox"/> > 1m [6]	<input type="checkbox"/> POOL WIDTH > RIFFLE WIDTH [2]	<input type="checkbox"/> EDDIES [1] <input type="checkbox"/> TORRENTIAL [-1]	<input type="text"/>
<input type="checkbox"/> 0.7-1m [4]	<input type="checkbox"/> POOL WIDTH = RIFFLE WIDTH [1]	<input type="checkbox"/> FAST [1] <input type="checkbox"/> INTERSTITIAL [-1]	
<input type="checkbox"/> 0.4-0.7m [2]	<input type="checkbox"/> POOL WIDTH < RIFFLE W. [0]	<input type="checkbox"/> MODERATE [1] <input type="checkbox"/> INTERMITTENT [-2]	
<input type="checkbox"/> 0.2-0.4m [1]		<input type="checkbox"/> SLOW [1]	
<input type="checkbox"/> < 0.2m [POOL=0]	COMMENTS: _____		

**CHECK ONE OR CHECK 2 AND AVERAGE**

RIFFLE DEPTH	RUN DEPTH	RIFFLE/RUN SUBSTRATE	RIFFLE/RUN EMBEDDEDNESS	Riffle/Run
<input type="checkbox"/> Best Areas > 10 cm [2]	<input type="checkbox"/> MAX > 50 [2]	<input type="checkbox"/> STABLE (e.g., Cobble, Boulder) [2]	<input type="checkbox"/> NONE [2]	<input type="text"/>
<input type="checkbox"/> Best Areas 5-10 cm [1]	<input type="checkbox"/> MAX < 50 [1]	<input type="checkbox"/> MOD. STABLE (e.g., Large Gravel) [1]	<input type="checkbox"/> LOW [1]	
<input type="checkbox"/> Best Areas < 5 cm [RIFFLE=0]		<input type="checkbox"/> UNSTABLE (Fine Gravel, Sand) [0]	<input type="checkbox"/> MODERATE [0]	Gradient
COMMENTS: _____		<input type="checkbox"/> NO RIFFLE [Metric=0]	<input type="checkbox"/> EXTENSIVE [-1]	<input type="text"/>

**6] GRADIENT (ft/mi): \_\_\_\_\_ DRAINAGE AREA (sq.mi.): \_\_\_\_\_**

% POOL: <input type="text"/>	% GLIDE: <input type="text"/>
% RIFFLE: <input type="text"/>	% RUN: <input type="text"/>

\*Best areas must be large enough to support a population of riffle-obligate fish species.

Is Sampling Reach Representative of the Stream (Y/N) \_\_\_ If Not, Explain: \_\_\_\_\_

Subjective Rating (1-10) <input type="text"/>		Aesthetic Rating (1-10) <input type="text"/>		First Sampling Pass _____		Gear: _____		Distance: _____		Water Clarity: _____		Water Stage: _____		Canopy % Open _____	
Average Width _____		Average Depth _____		Maximum Depth _____		Av. Bankfull Width _____		Bankfull Mean Depth _____		W/D Ratio _____		Bankfull Max Depth _____		Floodprone Area Width _____	
Entrench. Ratio _____		Stream Measurements: _____		_____		_____		_____		_____		_____		_____	

**Stream Drawing:**

- Major Suspected Sources of Impacts (Check All That Apply):
- None
  - Industrial
  - WWTP
  - Ag
  - Livestock
  - Silviculture
  - Construction
  - Urban Runoff
  - CSOs
  - Suburban Impacts
  - Mining
  - Channelization
  - Riparian Removal
  - Landfills
  - Natural
  - Dams
  - Other Flow Alteration

Instructions for Scoring the Alternate Cover Metric: Each Cover Type Should Receive a Score of Between 0 and 3, Where:  
 0 - Cover type absent; 1 - Cover type present in very small amounts or if more common of marginal quality; 2 - Cover type present in moderate amounts, but not of highest quality or in small amounts of highest quality; 3 - Cover type of highest quality in moderate or greater amounts. Examples of highest quality cover include very large boulders in deep or fast water, large diameter logs that are stable, well developed rootwads in deep/fast water, or deep, well-defined, functional pools.



Ohio State University Museum of Crustacea  
Stream Inventory field data sheet

**Stream drawing**  
**Collection site**

Collection #: \_\_\_\_\_  
Ohio State University Museum of Crustacea  
Stream Inventory field data sheet

Stream Name: \_\_\_\_\_  
Tributary of: \_\_\_\_\_  
State: \_\_\_\_\_; County: \_\_\_\_\_; Twp.: \_\_\_\_\_  
Geographic marker: \_\_\_\_\_  
\_\_\_\_\_ miles (N S E W NE NW SE SW) \_\_\_\_\_ (Town/Village)  
Road/bridge: \_\_\_\_\_  
Latitude: \_\_\_\_\_ N : S; Longitude: \_\_\_\_\_ E : W  
Water condition: \_\_\_\_\_  
Flood crest: \_\_\_\_\_ Flow stability: Intermittent Interstitial Normal High Flood  
Pollution: \_\_\_\_\_  
Riffle: W \_\_\_\_\_ L \_\_\_\_\_ D \_\_\_\_\_  
Pools: W \_\_\_\_\_ L \_\_\_\_\_ D \_\_\_\_\_  
Gradient:  High  Moderate  Low  
Valley type:  Youthful  Middle aged  Mature  Old age  
%Substrate: \_\_\_\_\_ boulder \_\_\_\_\_ cobble \_\_\_\_\_ gravel \_\_\_\_\_ sand \_\_\_\_\_ silt \_\_\_\_\_ hardpan \_\_\_\_\_ muck \_\_\_\_\_ bedrock  
Shore vegetation: \_\_\_\_\_  
Aquatic Vegetation: \_\_\_\_\_ Woody debris \_\_\_\_\_  
Flood plain vegetation: \_\_\_\_\_  
Bank shape: \_\_\_\_\_  
Bank composition: \_\_\_\_\_  
Sample period: \_\_\_\_\_ Rocks flipped: \_\_\_\_\_ Imbedded  Silt free   
Max Depth seined: \_\_\_\_\_ ) Seine hauls: \_\_\_\_\_ ) Area sampled: \_\_\_\_\_ W \_\_\_\_\_ L  
Collection methods: \_\_\_\_\_  
Collectors: \_\_\_\_\_  
Date: \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ ; Time: \_\_\_\_\_ : \_\_\_\_\_ AM: PM

Tissue samples (see back)

Species collected:	M1	/	M2	/	F	/	juv
1) _____ vouchers Observed (	/		/		/		)
2) _____ vouchers Observed (	/		/		/		)
3) _____ vouchers Observed (	/		/		/		)
4) _____ vouchers Observed (	/		/		/		)
5) _____ vouchers Observed (	/		/		/		)
6) _____ vouchers Observed (	/		/		/		)
7) _____ vouchers Observed (	/		/		/		)
8) _____ vouchers Observed (	/		/		/		)

**NOTES:**  
Tissue samples

