Mussel Surveys in Streams That Drain National Alliance of Forest Owner Properties

Final Report

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Executive Summary

The Louisiana Department of Wildlife and Fisheries (LDWF), in coordination with the United States Fish and Wildlife Service (USFWS), National Alliance of Forest Owners (NAFO), and National Council for Air and Stream Improvement (NCASI), conducted freshwater mussel surveys during the summer and fall of 2022 in the Calcasieu and Sabine River watersheds. A total of 50 sites were surveyed that resulted in 6,456 mussel observations that represent 24 species. Observations included 21 specimens of *Pleurobema riddellii* (Louisiana Pigtoe) and 553 specimens of six other Species of Greatest Conservation Need (SGCN): *Fusconaia askewi* (Texas Pigtoe, 148), *Glebula rotundata* (Round Pearlshell, 178), *Lampsilis satura* (Sandbank Pocketbook, 64), *Obovaria arkansasensis* (Southern Hickorynut, 147), *Truncilla donaciformis* (Fawnsfoot, 2), and *Strophitus undulatus* (Creeper, 11). Catch per unit of effort (CPUE) ranged from 0.5 to 138.25 mussels per hour on Whisky Chitto (Site11) and Ten Mile (Site 24) respectively. Bundick Creek had the highest diversity (H'= 2.28), the highest average number of *P. riddellii* per site (1.67), and the highest number of *P. riddellii* (11) of all streams sampled. This study is the most comprehensive freshwater mussel survey of the Calcasieu River and Sabine River tributaries to date, and includes diverse stream habitats with mussel communities that reflect the diversity of habitat types. It also highlights the need for a more frequent mussel sampling regime across the Calcasieu and Sabine River basins to better understand the mussel communities and address the lack of data and age of existing data across the region.

Introduction

The Louisiana Pigtoe (*Pleurobema riddellii*) historically occurred as far west as the San Jacinto and Trinity Rivers in Texas and reached east into the Red River drainage in Louisiana (Howells et al. 1996, 1997). Recent DNA evidence supports a possible expansion of the range of this species east to the Pearl River basin (Johnson et al. 2023). Despite this possible expansion, this species has experienced widespread population declines across its range and has been determined to be 'rare and critically imperiled' in the Sabine River basin (Vidrine 1996; Randklev 2013, 2020, USFWS 2022) and 'rare' from multiple surveys of the Calcasieu River basin (Vidrine 1996, 1998; Ford 2018; Kinney et al. 2023; LDWF unpublished data). LDWF listed *P. riddellii* as a SGCN in 2005 in the Louisiana Comprehensive Wildlife Conservation Strategy (Lester et al. 2005) which was maintained in the most recent Louisiana Wildlife Action Plan (Holcomb et al. 2015) with a S1S2 ranking. On March 20, 2023, the USFWS proposed to list *P. riddellii* as threatened under the Endangered Species Act (ESA; 88 FR 16776).

Distributional data for *P. riddellii* from western Louisiana are fragmented and outdated from most locations. Vidrine (1993, 1996) conducted the most complete surveys in the range of *P. riddellii* but those data are now 30+ years old. More recent surveys on the Sabine River, as a requirement of the Federal Energy Regulatory Commission relicensing of the Toledo Bend Reservoir, suggest that *P. riddellii* has been extirpated from the main stem of the Sabine River below the reservoir (Randklev et al. 2011). Those surveys also indicate that the species persists isolated from main stem river due to hydrological changes in Anacoco Bayou, but in small numbers (Randklev 2013). Despite this low abundance in the Sabine River basin, two individuals genetically confirmed to be *P. riddellii* were detected in 2019 by LDWF biologists during routine tributary sampling in Tenmile Creek, Calcasieu River basin, Vernon Parish LA. In an effort to update occurrence data at historic sites within the Calcasieu River basin, surveys were conducted during the summer of 2022, resulting in 16 specimens distributed across four sample sites Kinney et al. (2023).

Historic Texas Heelsplitter *(Potamilus amphichaenus*) occurrences in Louisiana were confined to the Sabine River basin and the Trinity and Neches River basins in Texas (Randklev et al. 2020). In both the Louisiana Comprehensive Wildlife Conservation Strategy and the most recent Louisiana Wildlife Action Plan (Lester et al. 2005, Holcomb et al. 2015), it was considered to be extirpated from the state. However, one specimen was found in May of 2018 approximately 2.6 km above Highway 84 in Logansport (Chase Smith personal communication). A more recent survey effort (2019-2023) by Texas Parks and Wildlife Department (TPWD) found 45 individuals at a site near Hawkins, TX (TPWD unpublished data) which is situated approximately 130 km from the type locality near Logansport, LA. On March 20, 2023, the USFWS proposed listing *P. amphichaenus* as endangered under the Endangered Species Act (ESA; 88 FR 16776).

Project Objective

The primary objective of this study was to conduct freshwater mussel surveys in select streams of western Louisiana that fall within the historic ranges of *P. riddellii* and *P. amphichaenus*. For each sampling site we generated a species occurrence list and determined estimations of relative abundance, catch-per-unit-effort for all mussel species observed, and recorded water quality and observational habitat data. To achieve these objectives, funding was provided through a USFWS Wildlife Conservation Initiative grant, in partnership with NAFO. Accordingly, emphasis was placed on streams that either had historical occurrence records or were likely to harbor these two mussel species. Due to funding partners, these streams were required to traverse or drain properties enrolled as NAFO members. This research will provide data to the USFWS to inform future management actions and Species Status Assessments (SSA) for both mussel species.

Study Area

The Calcasieu River originates in the hills of west-central Louisiana, and flows 160 miles to the Gulf of Mexico through both the Lower West Gulf Coastal Plain and the Gulf Coast Prairies and Marshes ecoregions of Louisiana (Holcomb et al. 2015). The total drainage area is 3,910 square miles. The hydrological changes made to the main stem river include two low-head dams located at Kinder and Oakdale, LA. There are nine designated Natural and Scenic Streams found in this basin (Holcomb et al. 2015), and one impoundment, Bundick Lake, located on Bundick Creek.

The Sabine River originates just east of Dallas, TX in the High Plains and is primarily located in the South Central Plains and Western Gulf Coastal Plain ecoregions. It flows eastward towards Louisiana, then south, forming approximately 270 miles of Louisiana's western border with Texas, before emptying into Sabine Lake (Holcomb et al. 2015). The Nation's fifth largest impoundment, Toledo Bend Reservoir, extends 65 miles from Logansport, LA to the dam, which is located at the lower end of Sabine parish. Within Louisiana, this river basin drains 3,257 square miles, with Pearl Creek being the only stream designated as Natural and Scenic (Holcomb et al. 2015). For this survey effort, all sampling in the Sabine drainage occurred below the Toledo Bend Reservoir in tributaries of the Sabine River.

Our study area was confined to the portions of these two basins in which NAFO managed properties occurred streamside to facilitate access and maintain connectivity to managed forestlands.

Methods

LDWF was provided GIS landowner maps of all NAFO property located along select streams in the Calcasieu and Sabine River basins. These maps were used to remotely identify 108 potential sample sites with putative access to the river or creek via roads or trails. Attempts were made to visit each site prior to sampling in order to assess habitat suitability and sampling feasibility, which resulted in 50 sites deemed appropriate for survey. Fifty-eight sites (58) were eliminated due to access or suitability issues (i.e. gate lock incompatibility with provided key, use of ATVs required due to road or trail conditions, and unsuitable habitat).

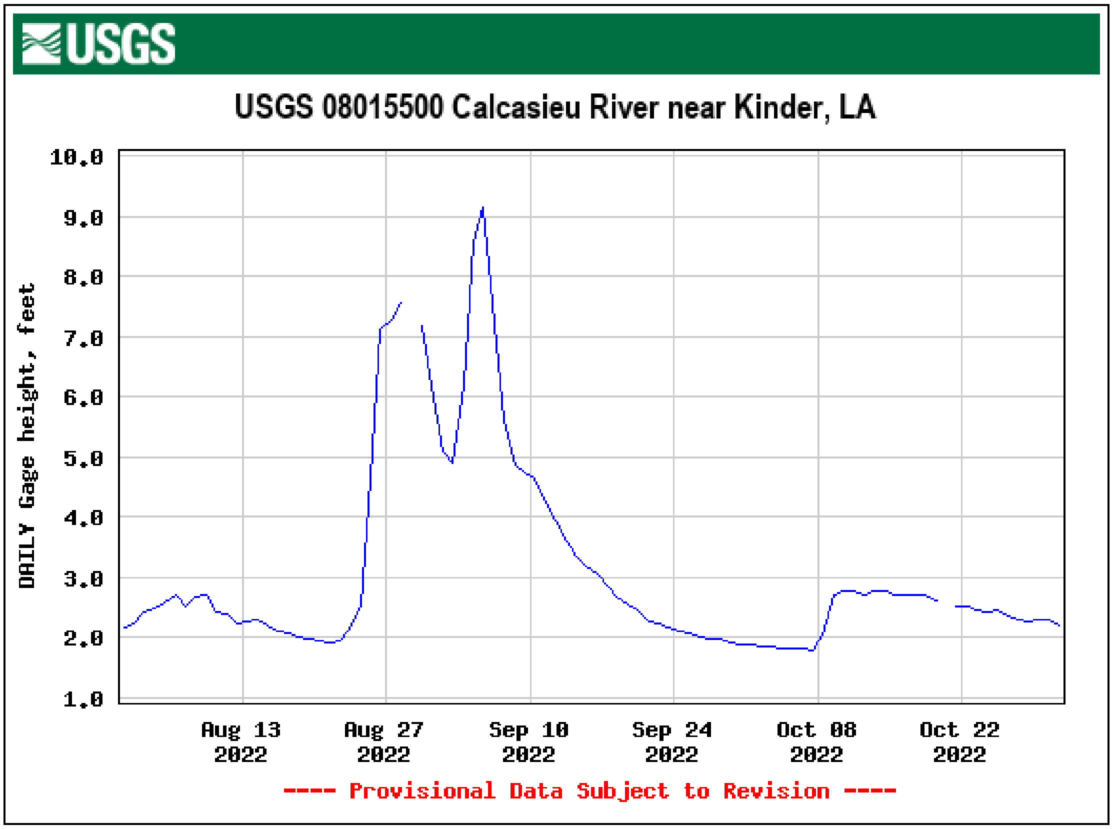
Mussel occurrence in any stream is limited to suitable habitat, which can be characterized by the preferences of the various species present within the system and the occurrence of stable substrate or suitable refugia. To ensure samples were taken in suitable habitat, we conducted pre-surveys both up- and downstream of each access point, examining mussel abundance and species richness, until a productive site was located. If such a site was not found after searching at least one hour, the location rendering the highest abundance was selected. At each sample site, a 150-m^2 search area was delineated with the perimeter length influenced by water depth and substrate. A semi-quantitative survey was performed in each plot using a timed search method following Randklev et al. (2017). Sample sites were surveyed tactilely and visually by a four member crew, four times repeatedly for 1 person-hour (p-h, 4 p-h total), except for four sites deemed unproductive during the pre-surveys. In order to conserve effort, sampling at these four sites was terminated after the second or third p-h when the prior sub-sample yielded no new species. Exceptions to established survey time methodology are detailed in Appendix C. Following the completion of each timed survey, all live mussels were identified to species and counted. The first p-h subset of mussels were measured and checked for gravidity for species when appropriate. All mussels were returned back to the water with the exception of specimens retained for genetic testing or vouchers. Data were used to produce a species occurrence list per site, estimations of relative abundance, diversity indexes, and catch-per-unit-effort (CPUE) for all mussel species observed, including our target species.

At each site, we recorded if the sampled habitat was bank, mid-channel, riffle, or backwater. Bank is described as the area from the water edge towards the middle of the stream and ending at the start of the main channel. Mid-channel is defined as the deeper area the stream with the most water flow and is geographically situated between the two bank areas. A riffle is defined as shallow area with faster flowing rough water. Backwater is defined as a section of water off of the main channel of a stream with little to no flow. Habitat data for substrate, water, and bank slope were also recorded at each site for use in describing the type of habitat being sampled.

Given *P. riddellii* can easily be confused with some individuals of *Cyclonaias pustulosa* (Pimpleback) and *Fusconaia flava* (Wabash Pigtoe), our identifications of all putative *P. riddellii* were verified genetically through DNA sequencing by malacologists at the University of Texas at Austin. The DNA results were sent to LDWF to use in reporting for the grant.

Results

Conditions during this study effort included below average rainfall and river levels for most of the summer and fall. With the exception of one rainfall event at the end of August, river and flow conditions were ideal for sampling (Figure 1).



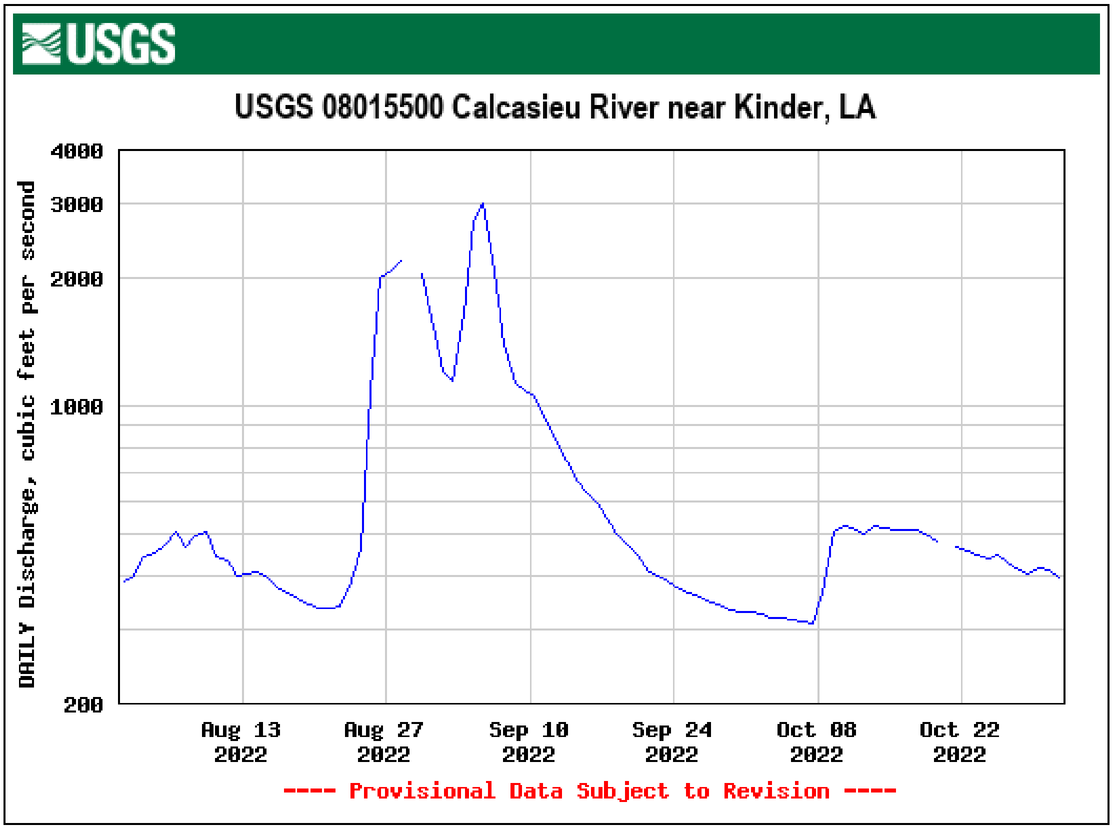


Figure 1. Daily Calcasieu River gauge height and discharge at Kinder, LA for August – October 2022.

LDWF surveyed 50 sample sites with a combined total effort of 193 person-hours of actual sampling conducted on 28 days from August through October 2022. Thirty-nine of these sites were located in the Calcasieu basin, and 11 were in the Sabine basin (Appendix A). Location of each site, the date sampled, and the habitat sampled can be found in Appendix A. The most common habitat sampled was defined as 'bank', followed by 'mid-channel', and the least sampled was 'backwater'.

Shannon-Wiener diversity values (H') ranged from 0.41-2.27 across all sample sites with a mean of 1.52. Variation in Gini-Simpson index values (GS) was 0.17-0.88 and averaged 0.71 (Appendix G).

A total of 6,456 mussels comprising 24 species was observed during this study (Appendix C), with *F. flava* (1,486 specimens found at 32 sample sites) being the most frequently encountered mussel species (Table 1). The most widely distributed species was *Lampsilis hydiana* (Louisiana Fatmucket) found at 49 sample sites.

At 40 of the 50 sites surveyed, at least one SGCN mussel was found, with the most productive sample sites located on Bundick Creek below Bundick Lake (Appendix C). SGCN numbers by site are mapped in Appendix E. The most common SGCN mussel observed was *Glebula rotundata* (Round Pearlshell; Table 1, Appendix C).

Table 1. Species occurrence data by sample site. Categories are defined as Abundant (>5 individuals/person-hour), Common (5-2 individuals/person-hour), Uncommon (2-0.3 individuals/person-hour), and Rare (<0.3 individuals/person-hour).

Species	No. of Sites	Total Live	Proportion (%)*	CPUE	Status
Fusconaia flava	32	1486	23.02	7.70	Abundant
Lampsilis hydiana	49	1190	18.43	6.17	Abundant
Cyclonaias pustulosa	31	833	12.90	4.32	Common
Leaunio lienosa	47	625	9.68	3.24	Common
Amblema plicata	20	504	7.81	2.61	Common
Lampsilis teres	36	425	6.58	2.20	Common
Toxolasma texasiense	39	357	5.53	1.85	Uncommon
Tritogonia verrucosa	22	290	4.49	1.50	Uncommon
Glebula rotundata +	4	178	2.76	0.92	Uncommon
Fusconaia askewi +	9	148	2.29	0.77	Uncommon
Obovaria arkansasensis +	22	147	2.28	0.76	Uncommon
Lampsilis satura +	14	66	1.02	0.34	Uncommon
Uniomerus declivis	8	45	0.70	0.23	Rare
Potamilus purpuratus	14	32	0.50	0.17	Rare
Pyganodon grandis	7	32	0.50	0.17	Rare
Plectomerus dombeyanus	3	23	0.36	0.12	Rare
Pleurobema riddellii +	9	21	0.33	0.11	Rare
Potamilus fragilis	6	14	0.22	0.07	Rare
Utterbackia imbecillis	5	13	0.20	0.07	Rare
Strophitus undulatus +	6	11	0.17	0.06	Rare
Obliquaria reflexa	4	10	0.15	0.05	Rare
Quadrula quadrula	2	2	0.03	0.01	Rare
Sagittunio subrostrata	2	2	0.03	0.01	Rare
Truncilla donaciformis+	1	2	0.03	0.01	Rare

* Relative abundance expressed as the proportion of specimens to total number of mussels observed

\+ SGCN species

This effort resulted in 21 live *P. riddellii* that were genetically verified from four streams, all in the Calcasieu River basin (Table 2, Appendix C). Sample sites are mapped in Appendix D with HUC 12 watersheds highlighted where *P. riddellii* were found. By waterbody, the largest number of individuals was observed in Bundick Creek (n=10), and sizes ranged from 32 to 68 mm (Table 2), the smallest of which was below the USFWS threshold of 35 mm and considered a juvenile. Despite finding one juvenile, we found no gravid specimens of this species (Table 2).

Table 2. Louisiana Pigtoe (*Pleurobema riddellii*) location, size, and gravidity data. All measurements are in mm.

Site Number	Gravid	Length	Height	Width
3	No	49.03	39.95	30.55
4	No	45.75	40.56	28.92
13	No	57.66	48.20	37.22
13	No	51.60	46.30	33.00
13	No	49.33	45.09	31.97

22	No	36.82	33.28	23.89
22	No	39.30	36.15	25.28
24	No	45.11	41.18	29.50
24	No	43.24	40.04	28.78
24	No	44.04	39.18	29.01
24	No	48.87	41.19	29.61
30	No	53.19	45.62	32.85
30	No	66.56	56.68	41.89
31	No	32.03	28.55	20.12
33	No	68.56	60.87	43.61
33	No	59.82	54.91	39.53
33	No	60.72	54.38	38.61
33	No	57.61	47.71	35.05
33	No	52.60	45.16	31.81
33	No	51.92	48.96	34.60
34	No	58.92	54.25	38.56

Calcasieu River Basin

Barnes Creek

We sampled Barnes Creek at three sites (Site 35-37) within a stream segment that extends from Hunt Road in Beauregard Parish to 4 km east of the Allen Parish line, and observed nine species (Appendix A and C). H' and GS values for this creek were 1.43 and 0.69, respectively (Appendix G), while CPUE and species-per-unit-effort (SPUE) averaged 36.25 and 1.67, respectively. *G. rotundata* was the only SGCN encountered and it was present at all three sites in high numbers (average 44.33 per site).

Beckwith Creek

Beckwith Creek was sampled at two sites (Site 38 and 39) within a 5.5 km stream segment that begins 100 m north of the Beauregard/Calcasieu Parish line. We observed nine species (Appendix C), with *S. undulatus* being the only SGCN encountered, and only at one site. H' and GS values were 1.65 and 0.77 (Appendix G), and CPUE and SPUE averaged 23.38 and 1.86.

Bundick Creek

Bundick Creek is the only Calcasieu tributary that possesses a reservoir. Two sites were sampled upstream of this lake (Site 27 and 28), in a 5.5 km stream segment that extends from Highway 112 and ends ca. 650 m south of Highway 26, and six were sampled downstream (Site 29-34), in-between the dam and the confluence with Whiskey Chitto Creek, where NAFO member properties were more abundant. When compared to the other creeks in this study, the upstream sites had the lowest CPUE and species richness averages, 8.00 and 4.0 respectively, the downstream sites had four SGCN (at least three at every site), the fourth highest CPUE average (40.92), and the highest averages for SPUE (3.17) and species richness (12.7). This stream segment also had the highest proportion of sites occupied by *P. riddellii* (4 of 6) and the highest average number per site (1.67).

Calcasieu River

We sampled nine sites on the Calcasieu River, of which eight were located between the two low-head dams (Site 1-8) mentioned above in a non-scenic stream segment, and one located approximately 23 km downstream (Site 9) from these structures, in a stream segment that is designated as a Natural and Scenic River. We observed 20 species (Appendix C), four of which were SGCN, with all but one site containing at least one of these species. The sites we sampled in this river had an average CPUE of 49.83, which was higher than any other stream in this project. In addition, the H' (2.26), GS (0.87) (Appendix G), and average SPUE (2.67; Appendix C) were second only to Bundick Creek.

Tenmile Creek

Six sites on NAFO managed tracts were sampled (Site 21-26) on Tenmile Creek in a 16 km stream segment originating 2 km south of the Allen Parish line and ending where it flows into Whiskey Chitto Creek. Nine species were observed (Appendix C), three SGCN (including *P. riddellii*), and CPUE and SPUE averages were 41.88 and 1.17. One location in particular (Site 24; Appendix C), had a CPUE of 138.25. This was considerably higher than the site with the second highest CPUE of 113.00, which was located on Whiskey Chitto Creek. Despite these favorable metrics, this creek had the lowest diversity index values (H', 0.86; GS, 0.43; Appendix G) of all streams, primarily due to a disproportionate abundance of *F. flava*.

Whiskey Chitto Creek

A 26 km segment beginning 2.5 km east of Highway 113 and ending 6.5 km north of Hwy 190, was sampled at 11 sites (Site 10-20). Thirteen species (average SPUE 1.73) were found with three of these being SGCN (Appendix C). H' and GS values for this creek were 1.78 and 0.73 (Appendix G). Three individual *P. riddellii* were observed at Site 13, which also had the second highest total CPUE (113.00) out of all 50 sites in the study; however, the CPUE estimates at the remaining Whiskey Chitto sites were relatively low resulting in Whiskey Chitto having the lowest average CPUE (17.70) of all the creeks we sampled (Appendix C).

<u>Sabine River Basin</u>

Bayou Anacoco

A 4.5 km stream segment of Bayou Anacoco was sampled at three sites (Site 40-42); two of which were located upstream of its confluence with Bayou Castor, and the third located downstream. We found 11 species (Appendix C), including one SGCN, in this stream segment, which placed third overall in this study with averages for CPUE (41.33), SPUE (2.25), and species richness (9.0). However, this creek also had the third lowest H' (1.37) and the second lowest GS value (0.60; Appendix G).

Bayou Castor

Bayou Castor was sampled in three sites (Site 43-45) in a 5.5 km stream segment beginning at Section Line Road and ending at Cooper Church Road. Nine species were observed (Appendix C), including two SGCN, and CPUE and SPUE averages were 22.75 and 2.00. Diversity values were midrange (H', 1.67; GS, 0.74) compared to the other creeks in this study (Appendix G).

Prairie Creek

A total of six species, including one SGCN, were observed between the two sites (Site 46 and 47) we sampled within a 9.5 km stream segment of Prairie Creek that began at Eubanks Road and ended at Highway 8. CPUE averaged 19.63 and the SPUE average was 1.25 (Appendix C). This creek was found to have the second lowest H' value at 1.23 and the third lowest GS value at 0.66 (Appendix G) when compared to the other streams in this study.

Bayou Toro

Three sites (48-50) were sampled within a 12 km stream segment of Bayou Toro, located between highways 473 and 392, which yielded eight species, one of which was an SGCN (Appendix C). Compared to the other creeks in this study, Bayou Toro had the lowest averages for SPUE (1.08) and species richness (4.0), and had a midrange average CPUE of 31.40. Diversity values were more favorable as the H' value (1.77) placed fourth and the GS value (0.81) placed third (Appendix G).

Discussion

Taxonomic changes and genetic analyses that have occurred in recent years explain ostensible discrepancies in our species composition comparisons of this study to Vidrine (1993, 1996) and Randklev et al. (2013). Lengths of the stream segments where our sample sites were located are described in Euclidean distance, and diversity indices for each segment are calculated by pooling the data from the sites sampled within, unless stated otherwise.

The status of mussel species listed in Table 1 was derived solely from the sampling results of this project, which was limited to two drainages and the habitat types sampled therein, and should not be used to infer commonness or rarity of a particular species throughout its distribution or within its preferred habitat. For example, four common and widespread mussel species (*Uniomerus declivis*, Tapered Pondhorn; *Pyganodon grandis*, Giant Floater; *Utterbackia imbecillis*, Paper Pondshell; and *Sagittunio subrostrata*, Pondmussel) are all listed as rare in Table 1, but are typically associated with habitat types that are not well represented in our samples. This is discussed in more detail below.

Calcasieu River Basin

All Calcasieu tributaries sampled during this project have been formally designated as a Natural and Scenic River by the State of Louisiana, which affords them certain protections under the Louisiana Scenic Rivers Act of 1988. The main stem of the Calcasieu River holds this designation as well, although only in specific segments.

Barnes Creek

This survey produced one species, *C. pustulosa* within Barnes Creek stream segment, which was not found in this creek during routine stream community samples collected by LDWF in 2018 (LDWF unpublished data). Of interest, we did not find two species that were reported in the 2018 samples, *U. imbecillis* and *Strophitus undulatus* (Creeper, an SGCN). Although *U. imbecillis* is considered to be a widespread and common species, it is reported to be uncommon in flowing streams (Vidrine 2019, Howells et al. 1996), possibly explaining why we didn't detect it in this stream and its apparent rarity throughout this entire study. *S. undulatus* was also rarely encountered during this study; however, given its appearance in 2018, it is likely that it would turn up with additional sampling in the area. The fact that we only found *C. pustulosa* to occur at the sample site located furthest downstream and its absence during the 2018 sampling are consistent with its preference for large creeks and rivers (Jones et al. 2019). The large representation of *G. rotundata* in our Barnes Creek samples is perplexing as we only encountered them at one other site during this project (Appendix C), which was located on the Calcasieu River, 4 km downstream of its confluence with Barnes Creek. *G. rotundata* are commonly associated with slow-flow bayous (Howells et al. 1996) and areas with clay, mud, or silty substrates (Jones et al. 2019). Barnes Creek appeared to have less flow and a higher silt and clay component in the substrate as compared to the other streams that we sampled with the exception of Beckwith Creek.

Beckwith Creek

We observed nine species, five of which were absent in the 2019 routine stream community sampling effort in Beckwith Creek, *Lampsilis teres* (Yellow Sandshell), *P. grandis*, *S. undulatus*, *Toxolasma texasiense* (Texas Lilliput), and *Tritogonia verrucosa* (Pistolgrip) (LDWF unpublished data). Of note, we did not detect *U. imbecillis* during this study, which was detected in 2019, likely for the reason mentioned in the Barnes Creek section. Freshwater mussel species richness tends to increase as one moves downstream (Atkinson et al. 2012, Daniel and Brown 2013, Ford et al. 2016). The 2019 effort was conducted approximately 29 km upstream of our segment, and when coupled with our increased sampling effort, likely explains the additional species encountered in this study. Beckwith Creek appeared similar to Barnes Creek in terms of substrate and gradient; however, no *G. rotundata* were observed.

Bundick Creek

Bundick Creek was sampled eight times from above Bundick Lake (lowest CPUE in this study) and below Bundick Lake (third highest CPUE and highest SPUE in this study) with widely varying results. As mentioned above, an increase in CPUE and species richness should be expected at the downstream sites, such a large disparity suggests that other factors may be at play. It is well documented that reservoirs such as Bundick Lake, and their associated dams often negatively affect freshwater mussel populations upstream (Watters 1996, Vaughn and Taylor 1999, Gillis et al. 2017).

Two sites on this creek in the Kisatchie National Forest, located approximately 11 km to the north and upstream of this project, were sampled by the LDWF in 2020 (LDWF unpublished data), with results similar to the upstream sites in this effort, in terms of both species and numbers. Vidrine (1996) surveyed two sites within our study area, one upstream of Bundick Lake, and one downstream. His upstream site had two species that we did not find at either of our upstream sites (*T. verrucosa* and *C. pustulosa*); however, we found three species that were not listed from his sample (*Leaunio lienosa*, Black Spectaclecase; *T. texasiense*; and *U. declivis*). With the exception of *L. lienosa*, only one individual was found for each of the species that were observed in only one of these two projects, suggesting that additional sampling by both parties may have reconciled these differences. We detected *L. lienosa* at both of our sites, and it was the second most abundant mussel observed, so we are unsure why this species was not present in Vidrine's sample. His downstream site yielded two species not detected at any of our lower Bundick sites (*Potamilis fragilis*, Fragile Papershell and *S. undulatus*, an SGCN); however, we observed ten additional species (*Amblema plicata*, Threeridge; *Obliquaria reflexa*, Threehorn Wartyback; *Plectomerus dombeyanus*, Bankclimber; *P. riddellii*, an SGCN; *Potamilis purpuratus*, Bleufer; *P. grandis*; *Quadrula quadrula*, Mapleleaf; *T. verrucosa*; *T. texasiense*; and *U. imbecillis*) not recorded by Vidrine. Most of the additional species that we found can likely be attributed to our higher number of sample sites. Although Vidrine observed only one individual of *P. fragilis* and *S. undulatus* at his sample site (sampled three times between 1975 and 1978), considering our more extensive survey effort, we would have expected to find them if they are still present in Bundick Creek.

In total, 19 species were observed in this creek (Appendix C), with five detected above the lake and 18 below. This stream also produced the highest H' (2.28) and GS (0.88) values (Appendix G) of all streams sampled during this study. Ironically, Bundick Creek was thought to be a low priority based on previous mussel sampling data upstream of Bundick Lake, however, our results indicate that the lower portion contains diverse mussel beds that support several SGCN species including *P. riddellii*.

Calcasieu River

Vidrine (1996) and Kinney et al. (2023) sampled three and seven sites, respectively, within our study area. There were three species reported from one or both of these efforts that were not detected in our study (*Tritogonia nobilis*, Gulf Mapleleaf; *Truncilla donaciformis*, Fawnsfoot, a SGCN; *Uniomerus tetralasmus*, Pondhorn), and three species we observed not reported in these earlier studies (*Q. quadrula*; *S. undulatus*, a SGCN; and *U. declivis*). *P. riddellii* was found to occur in this stream segment by all three projects. One finding that became apparent when comparing the results of these three projects, was that the SGCN *L. satura*, seems to be very rare from the Calcasieu River upstream of the low-head dam located near Kinder. Kinney et al. reported a total of 39 individuals distributed among six sample sites, and Vidrine also reported 39 individuals from one sample site (sampled 3 times), all located downstream of this structure, while only one individual was represented in our eight samples and none in the single sample Kinney et al. collected between the low-head dam near Oakdale and the one located near Kinder. Vidrine reported eight individuals from a single location within this stream segment that was sampled in 1973. Our study area did not extend beyond the low-head dam near Oakdale due to the lack of NAFO member properties; however, Kinney et al. sampled four sites in this stream segment and did not find any, while Vidrine sampled one of these sites in 1978 and found a single individual. *Q. quadrula* and *T. nobilis* prefer larger rivers (Jones et al. 2019), and are more abundant downstream of our study area (LDWF unpublished data). Only one individual of both species were found by Kinney et al., and none were reported by Vidrine, suggesting the size of the river in our project area as an explanation for their absence in our samples. It is not surprising that we did not find *T. donaciformis* in our Calcasieu River samples, as Vidrine found none, and Kinney et al. only found the shell of one dead individual. It appears to be uncommon throughout our entire project area. The two *Uniomerus* species that occur in Louisiana can be difficult to confidently differentiate between (Jones et al. 2019) and they both occupy similar habitats. Since we reported only *U. declivis* and Vidrine reported only *U. tetralasmus*, we suspect that we both may be reporting the same taxon. We only detected *S. undulatus* at two of our nine sample sites in this segment. Given that we observed two to three individuals at both sites, there may be some uncommon habitat characteristic that is preferred by *S. undulatus* and was present at these two sites, but not at any of the other sites in this study, or the sites sampled in the previous surveys.

Tenmile Creek

Four sites were sampled upstream of the stream segment in this study by either Vidrine (1996), Kinney et al. (2023), or LDWF (2019 unpublished data). The only difference in species composition between this study and the pooled data from these previous surveys was that *P. pupuratus* was observed at two sites in this study. This species prefers rivers and deep water streams (Howells et al. 1996), so it is likely that the previous surveys occurred too far upstream to be suitable. This study, as well as Kinney et al. (2023), observed *P. riddellii* individuals below 40 mm, suggesting recent recruitment (Table 2). This creek, which occurs almost entirely on industrial timber property, the vast majority of which is managed by NAFO members, appears to support large numbers of freshwater mussels, including a reproducing population of *P. riddellii*.

Whiskey Chitto Creek

Vidrine (1996) and LDWF (2019 unpublished data) each sampled two sites in Whiskey Chitto Creek approximately 30 km upstream of our study area. Vidrine reported two species, *U. tetralasmus* and *S. undulatus* (SGCN), which did not turn up in any of our surveys in this creek. He also surveyed one site approximately 1 km upstream of Site 13, but did not observe any *P. riddellii*. The five species he reported from this site were also observed during this study. Downstream of our study area, within the 6 km stretch before the confluence with the Calcasieu River, Kinney et al. (2023) surveyed three sites and Vidrine surveyed one. Kinney et al. reported two additional species (*O. reflexa* and *U. imbecillis*), which were not reflected in our data. Both *Uniomerus* species are typically found in mud or clay substrates and in smaller, often intermittent waters (Howells et al. 1996, Jones et al. 2019), so it is not surprising that we did not encounter them in our survey reach. It is surprising, however, that we did not find *S. undulatus*, if it is still present in this creek, given the number of sites that we sampled. *O. reflexa* prefers medium to large rivers (Harris and Gordon 1990), likely explaining why it only appears to occur downstream of our sample sites. As previously mentioned, *U. imbecillis* is uncommon in flowing streams.

Sabine River Basin

Three streams within the Sabine River basin were sampled, none of which are formally designated as a Natural and Scenic River. Despite *P. riddellii* having been observed in this drainage in Louisiana as recently as 2011 (Randklev et al. 2013), none were detected during this study.

Bayou Anacoco

Randklev et al. (2013) conducted one sample within this study's stream segment which resulted in a nearly identical suite of species to this study, the only differences being that we also found *P. grandis* and Randklev found *Toxolasma parvum* (Lilliput) in his sample. Both Randklev (2013) and Vidrine (1996) independently conducted samples downstream, and Vidrine sampled one site upstream of our stream segment. Combined, there were six species, including 3 SGCN, reported by these researchers that did not turn up where we sampled (*Obovaria arkansasensis*, Southern Hickorynut; *P. riddellii*, *S. subrostrata*, *S. undulatus*, *U. tetralasmus*, and *L. satura*). *T. parvum* typically occurs in lentic or slow moving waters in mud or silt (Howells et al. 1996, Jones et al. 2019), which is a habitat type that we did not sample in Bayou Anacoco. Interestingly, *P. grandis* prefers the same habitat type (Howells et al. 1996, Jones et al. 2019), and we did manage to pick a couple of those up in our samples. *O. arkansasensis* (n=31), *P. riddellii* (n=15), and *S. undulatus* (n=5), all SGCN, were well represented in the pooled results of the earlier surveys. Due to this presence at sites located outside of the stream segment that we sampled, it is concerning that they were completely absent in this study. As can be inferred its common name, Pondmussel, *S. subrostrata* typically inhabits lentic waters (Jones et al. 2019), and as mentioned previously, *U. tetralasmus* are typically found in mud or clay substrates in smaller, often intermittent waters. Both of these species were represented by a single individual in Vidrine's surveys and were not present in Randklev et al.'s results suggesting the habitat types preferred by these mussels may not be abundant in the areas that were sampled by us in Bayou Anacoco. We did observe *L. satura* to occur near our sites, but did not locate any while sampling.

Bayou Castor

We are unaware of any previous efforts by other researchers to survey freshwater mussels in this creek. This creek, which is tributary of Bayou Anacoco, had a midrange CPUE, SPUE, and diversity index (Appendix C and G), and included two SGCN species. A comparable sized creek in the same local area is Prairie Creek, which is a tributary of Anacoco Lake. The similarities stopped there, as Prairie had lower CPUE, SPUE, and the second and third lowest H' and GS values. This is may be another example of a hydrological barrier (Anacoco Lake Dam) blocking upstream movement of mussel host fish.

Prairie Creek

Ford (2018) surveyed two sites approximately 3.5 km upstream of our stream segment; however, he only found *Lampsilis hydiana* (Louisiana Fatmucket), which was one of the six species that we observed at our sites. Overall results from Prairie Creek were well below other creeks in the surrounding area, with the difference being its location above Anacoco Lake.

Bayou Toro

Vidrine (1996) and Randklev (2013) both independently sampled Bayou Toro near Highway 473, likely the same location sampled during this study. Combined, there were four species including one SGCN reported by these researchers that we did not observe (*O. arkansasensis*; *P. fragilis*; *T. parvum*; and *U. imbecillis*). Only one individual of each of these species was found by either Vidrine or Randklev, suggesting they were not present in high numbers when they collected their samples. It is possible that they were present and we failed to detect them, or that they no longer occur in this stream, or perhaps some combination of the two. Our sample included three individuals of *P. pupuratus*, which was not reported in their surveys.

This study represents the most comprehensive freshwater mussel survey in the Calcasieu River basin and tributaries of the lower Sabine River that has been conducted to date; however, our species accumulation curves did not reach an asymptote at 30% of our sample sites (n=15), suggesting that additional sampling in these areas may yield more species. Our results provide many new locations where SGCN mussels were previously not known to occur and updated some existing records. They also provide a baseline inventory from which future monitoring efforts can build upon. Distributional data gaps were filled for *P. riddellii* in-between the two low-head dams located on the Calcasieu River, and its occupied range was expanded to include Bundick Creek, both of which should be considered during the decision-making process of listing this mussel under the Endangered Species Act as currently proposed.

Although this study was not designed to model habitat conditions or changes in mussel populations, it was obvious where good habitat and natural hydrologic connections existed. Continued management of sedimentation and erosion, maintaining adequate water flow, and removing or reducing hydrologic alterations would benefit the mussel community in both basins. In particular, removal of the weirs on the Calcasieu River, located near Kinder and Oberlin, would eliminate the stretches of non-riverine habitat caused by these weirs and thus, the return of natural flows to this system. This would allow fish carrying glochidia (larval mussels developing on fish fins or gills) to move upstream without being impeded. An alternate strategy to removal would be to facilitate fish passage around or over the barriers using bypass channels or fish ladders. Bundick Creek and Prairie Creek are other examples of streams where hydrologic barriers are believed to be impeding mussel host fish movement upstream, and where mussel populations would benefit from the installation of such structures.

Based on our results, we conclude that some high conservation value mussel beds occur on or downstream of NAFO managed property.

Management Recommendations

This study showed that freshwater mussels are widespread in the study area with considerable variation in richness and diversity across space. The only potential factor limiting mussel populations that could be gleaned from this study was the occurrence of dams, both low-head and lake, and future management of mussels in these drainages should take this into account. Removal of these barriers or installing fish passage could revitalize mussel populations in areas found upstream. Survey efforts for these basins are not complete and additional sampling could result in findings of additional species or populations of mussels. The scenic streams and undeveloped areas are remote, which makes them more difficult to sample, but they also offer important refugia to freshwater mussels. Best Management Practices should be continued or improved by streamside landowners to perpetuate good water quality, reduce sedimentation, and maintain adequate flows. We suggest a more routine sampling schedule of every three years in order to monitor trends in mussel populations and keep occurrence data up to date. Long-term trend data would provide a better understanding of mussel populations over time, and result in more effective landscape scale management strategies for this important group of organisms. We also recommend the expansion of surveys, both into areas of the Calcasieu and Sabine drainages not captured by this project, and into other under-studied river basins as well.

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Appendix A. Sample locations with habitat and location data for sample sites in the Louisiana. All location data is in decimal degrees and uses datum WGS84.

Site #	Drainage	Date sampled	Habitat	Latitude	Longitude
1	Calcasieu	9/21/2022	Bank	N 30.803665	W -92.687295
2	Calcasieu	8/23/2022	Bank	N 30.721514	W -92.731964
3	Calcasieu	8/23/2022	Bank	N 30.719310	W -92.735145
4	Calcasieu	9/20/2022	Bank	N 30.704404	W -92.753956
5	Calcasieu	9/20/2022	Bank	N 30.688084	W -92.764248
6	Calcasieu	8/22/2022	Backwater/riffle	N 30.661253	W -92.806330
7	Calcasieu	8/22/2022	Bank	N 30.657821	W -92.806838
8	Calcasieu	9/21/2022	Bank	N 30.604176	W -92.845189
9	Calcasieu	10/24/2022	Backwater	N 30.401176	W -92.068011
10	Whisky Chitto	10/18/2022	Bank	N 30.784007	W -92.990077
11	Whisky Chitto	9/13/2022	Bank	N 30.738683	W -92.902533
12	Whisky Chitto	9/13/2022	Bank	N 30.708566	W -92.897269
13	Whisky Chitto	9/12/2022	Bank	N 30.690405	W -92.897803
14	Whisky Chitto	9/12/2022	Bank	N 30.676112	W -92.902346
15	Whisky Chitto	9/12/2022	Bank	N 30.652460	W -92.913204
16	Whisky Chitto	9/12/2022	Bank	N 30.644231	W -92.920319
17	Whisky Chitto	8/24/2022	Bank	N 30.604488	W -92.943253
18	Whisky Chitto	8/24/2022	Backwater	N 30.592378	W -92.936792
19	Whisky Chitto	9/15/2022	Bank	N 30.587432	W -92.939609
20	Whisky Chitto	9/15/2022	Bank	N 30.565089	W -92.923199
21	Tenmile	10/11/2022	Bank/mid-channel	N 30.855461	W -92.860848
22	Tenmile	10/18/2022	Bank/mid-channel	N 30.795916	W -92.879168
23	Tenmile	9/19/2022	Bank	N 30.784048	W -92.876495
24	Tenmile	9/19/2022	Bank	N 30.764981	W -92.875840
25	Tenmile	9/19/2022	Bank	N 30.732994	W -92.871825
26	Tenmile	9/13/2022	Bank/mid-channel	N 30.716014	W -92.889969
27	Bundick	10/26/2022	Bank/mid-channel	N 30.859543	W -93.217120
28	Bundick	9/28/2022	Bank/mid-channel	N 30.813244	W -93.229984
29	Bundick	9/22/2022	Bank	N 30.700592	W -93.050369
30	Bundick	9/27/2022	Bank	N 30.686005	W -93.045136
31	Bundick	9/22/2022	Bank	N 30.664183	W -93.022806
32	Bundick	9/27/2022	Bank	N 30.642419	W -93.003228
33	Bundick	9/28/2022	Bank/mid-channel	N 30.625916	W -92.975996
34	Bundick	9/15/2022	Bank	N 30.611774	W -92.952509
35	Barnes	10/06/2022	Bank/mid-channel	N 30.549708	W -93.161538
36	Barnes	10/26/2022	Bank/mid-channel	N 30.533008	W -93.160201
37	Barnes	10/06/2022	Bank/mid-channel	N 30.466967	W -93.092047
38	Beckwith	10/25/2022	Bank/mid-channel	N 30.403618	W -93.333643
39	Beckwith	10/25/2022	Bank	N 30.381397	W -93.330549
40	Anacoco	8/31/2022	Bank	N 31.019747	W -93.368225
41	Anacoco	8/31/2022	Bank	N 31.015650	W -93.365056
42	Anacoco	9/01/2022	Bank	N 30.984389	W -93.347603
43	Castor	10/11/2022	Bank	N 31.071036	W -93.305808
44	Castor	10/05/2022	Bank	N 31.064128	W -93.318031
45	Castor	10/05/2022	Bank/mid-channel	N 31.033089	W -93.337111
46	Prairie	10/10/2022	Bank/mid-channel	N 31.220691	W -93.261478
47	Prairie	10/10/2022	Bank/mid-channel	N 31.150948	W -93.311785
48	Toro	9/14/2022	Bank	N 31.307002	W -93.515493
49	Toro	9/14/2022	Bank	N 31.218016	W -93.549392
50	Toro	9/14/2022	Bank	N 31.206425	W -93.546353

Appendix B. Common and scientific names of mussel species found during this study.

Common Name	**Scientific Name**
Threeridge	*Amblema plicata*
Rock Pocketbook	*Arcidens confragosus*
Wartyback	*Cyclonaias nodulata*
Pimpleback	*Cyclonaias pustulosa*
Texas Pigtoe*	*Fusconaia askewi**
Wabash Pigtoe	*Fusconaia flava*
Round Pearlshell*	*Glebula rotundata**
Louisiana Fatmucket	*Lampsilis hydiana*
Sandbank Pocketbook*	*Lampsilis satura**
Yellow Sandshell	*Lampsilis teres*
Spectacle Case	*Leaunio lienosa*
Washboard	*Megalonaias nervosa*
Threehorn Wartyback	*Obliquaria reflexa*
Southern Hickorynut*	*Obovaria arkansasensis**
Bankclimber	*Plectomerus dombeyanus*
Louisiana Pigtoe*	*Pleurobema riddellii**
Fragile Papershell	*Potamilus fragilis*
Bleufer	*Potamilus purpuratus*
Giant Floater	*Pyganodon grandis*
Mapleleaf	*Quadrula quadrula*
Pondmussel	*Sagittunio subrostrata*
Creeper*	*Strophitus undulatus**
Lilliput	*Toxolasma parvum*
Texas Lilliput	*Toxolasma texasiense*
Pistolgrip	*Tritogonia verrucosa*
Fawnsfoot*	*Truncilla donaciformis**
Deertoe	*Truncilla truncata*
Tapered Pondhorn	*Uniomerus declivis*
Paper Pondshell	*Utterbackia imbecillis*

* SGCN species

Appendix C. Mussel collection data from surveys.

Site number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Search area m^2	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Person hours	4	4	4	4	4	4	4	4	4	4	2	4	4	4	4	4	4	4
Number of species	11	11	12	14	8	10	8	8	14	7	1	6	11	6	6	7	6	9
CPUE	26.75	52.75	87.00	81.00	26.75	30.00	12.00	73.50	58.75	21.75	0.50	6.25	113.00	5.25	5.25	9.75	3.00	8.50
SPUE	2.75	2.75	3.00	3.50	2.00	2.50	2.00	2.00	3.50	1.75	0.50	1.50	2.75	1.50	1.50	1.75	1.50	2.25
Total mussels	107	211	348	324	107	120	48	294	235	87	1	25	452	21	21	39	12	34
Species																		
Amblema plicata	1	50	164	116	0	2	0	0	42	0	0	0	0	0	0	0	0	1
Arcidens confragosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyclonaias nodulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyclonaias pustulosa	5	28	35	45	9	14	3	14	62	4	0	0	24	0	0	6	0	9
*Fusconaia askewi**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fusconaia flava	10	9	55	88	8	11	4	15	1	51	0	2	312	4	1	3	4	1
*Glebula rotundata**	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0
Lampsilis hydiana	25	27	25	32	32	18	11	115	15	20	1	9	16	6	5	9	3	1
*Lampsilis satura**	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	4	1	1
Lampsilis teres	4	9	19	3	13	13	2	50	12	0	0	3	2	1	1	0	0	3
Leaunio lienosa	25	22	15	10	25	34	22	74	0	3	0	8	4	6	10	5	1	2
Megalonaias nervosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Obliquaria reflexa	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
*Obovaria arkansasensis**	6	4	1	2	1	3	0	1	10	2	0	1	38	3	1	8	0	0
Plectomerus dombeyanus	0	0	0	4	0	0	0	0	18	0	0	0	0	0	0	0	0	0
*Pleurobema riddellii**	0	0	1	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Potamilus fragilis	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Potamilus purpuratus	1	0	0	0	0	0	1	0	8	0	0	0	1	0	0	0	0	0
Pyganodon grandis	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	8
Quadrula quadrula	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Sagittunio subrostrata	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
*Strophitus undulatus**	0	0	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Toxolasma parvum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toxolasma texasiense	15	49	9	3	11	22	4	22	6	4	0	2	2	0	3	4	2	8
Tritogonia nobilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tritogonia verrucosa	14	5	20	17	8	0	0	3	0	3	0	0	49	1	0	0	1	0
*Truncilla donaciformis**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Truncilla truncata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Uniomerus declivis	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utterbackia imbecillis	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

*SGCN species listed in the 2015 Louisiana Wildlife Action Plan.

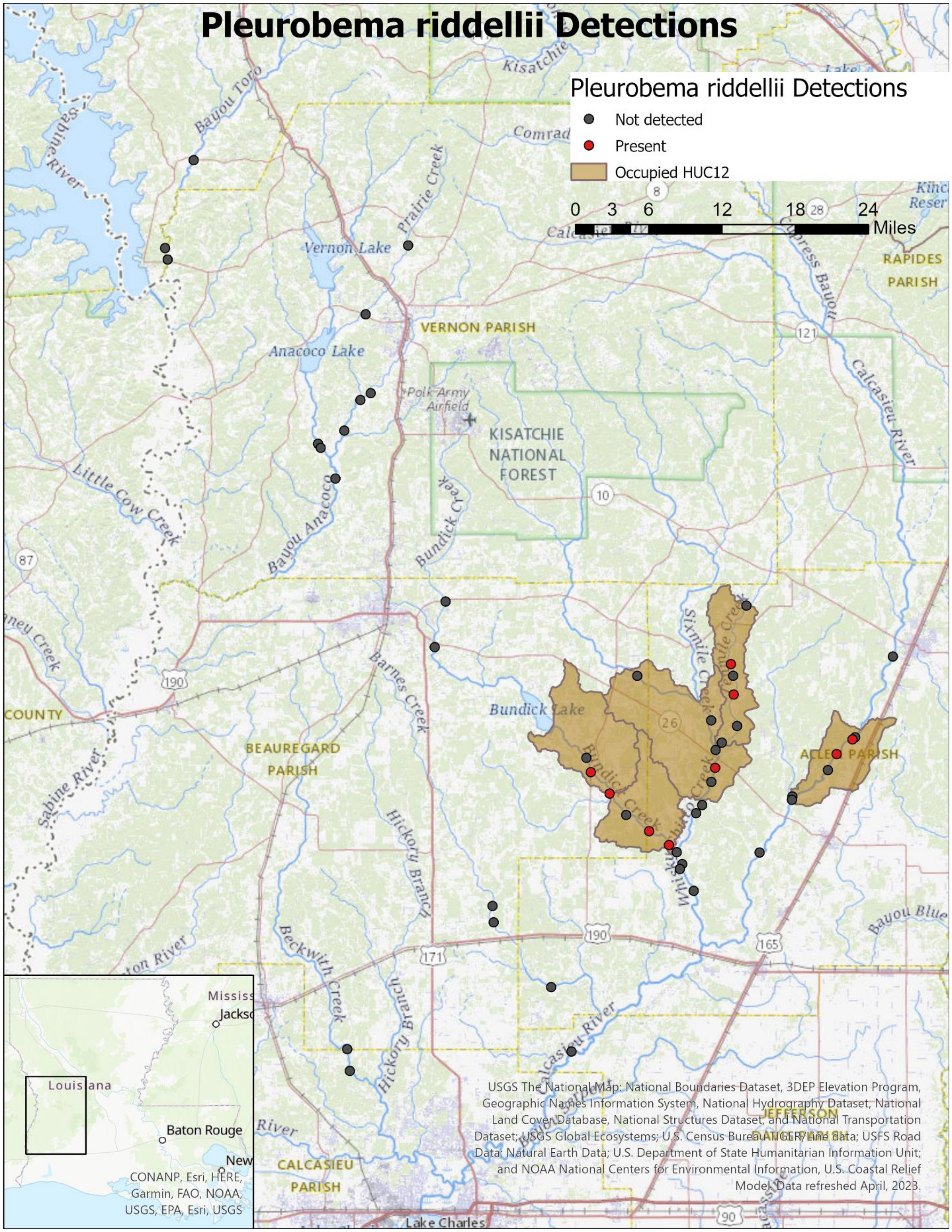
Site number	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Search area m^2	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Person hours	4	4	4	4	4	4	4	4	2	3	4	4	4	4	4	4	4
Number of species	9	7	5	6	5	8	4	1	5	3	14	12	13	10	15	12	6
CPUE	16.25	5.25	45.50	31.00	29.50	138.25	6.50	0.50	13.00	3.00	44.50	44.50	25.75	18.75	38.00	60.75	38.25
SPUE	2.25	1.75	1.25	1.50	1.25	1.75	1.00	0.25	2.50	1.00	3.50	3.00	3.25	2.50	3.75	3.00	1.50
Total mussels	65	21	182	124	118	553	26	2	26	9	178	231	103	75	152	243	153
Species																	
Amblema plicata	3	2	0	0	0	0	0	0	0	0	17	9	11	3	36	30	0
Arcidens confragosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyclonaias nodulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyclonaias pustulosa	35	5	0	1	0	0	0	0	0	0	59	23	8	6	18	81	0
*Fusconaia askewi**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fusconaia flava	1	0	71	73	76	502	14	0	1	4	5	42	11	11	43	51	0
*Glebula rotundata**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Lampsilis hydiana	1	1	71	38	16	33	6	2	14	3	25	43	25	12	3	5	92
*Lampsilis satura**	5	8	0	0	0	0	0	0	0	0	3	8	9	6	2	16	0
Lampsilis teres	6	1	0	0	0	0	0	0	0	0	37	44	14	9	6	7	7
Leaunio lienosa	8	3	35	8	17	9	5	0	9	2	13	20	9	14	2	4	15
Megalonaias nervosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Obliquaria reflexa	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	3	0
*Obovaria arkansasensis**	5	0	0	0	0	1	0	0	0	0	3	6	4	12	17	18	0
Plectomerus dombeyanus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
*Pleurobema riddellii**	0	0	0	2	0	4	0	0	0	0	0	2	1	0	6	1	0
Potamilus fragilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potamilus purpuratus	0	1	0	0	1	1	0	0	0	0	0	2	3	1	4	4	0
Pyganodon grandis	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Quadrula quadrula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Sagittunio subrostrata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*Strophitus undulatus**	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toxolasma parvum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toxolasma texasiense	0	0	3	2	8	3	1	0	1	0	1	1	4	0	0	0	18
Tritogonia nobilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tritogonia verrucosa	1	0	0	0	0	0	0	0	0	0	10	31	2	0	10	23	0
*Truncilla donaciformis**	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Truncilla truncata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Uniomerus declivis	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	11
Utterbackia imbecillis	0	0	0	0	0	0	0	0	0	0	1	0	2	1	2	0	0

*SGCN species listed in the 2015 Louisiana Wildlife Action Plan.

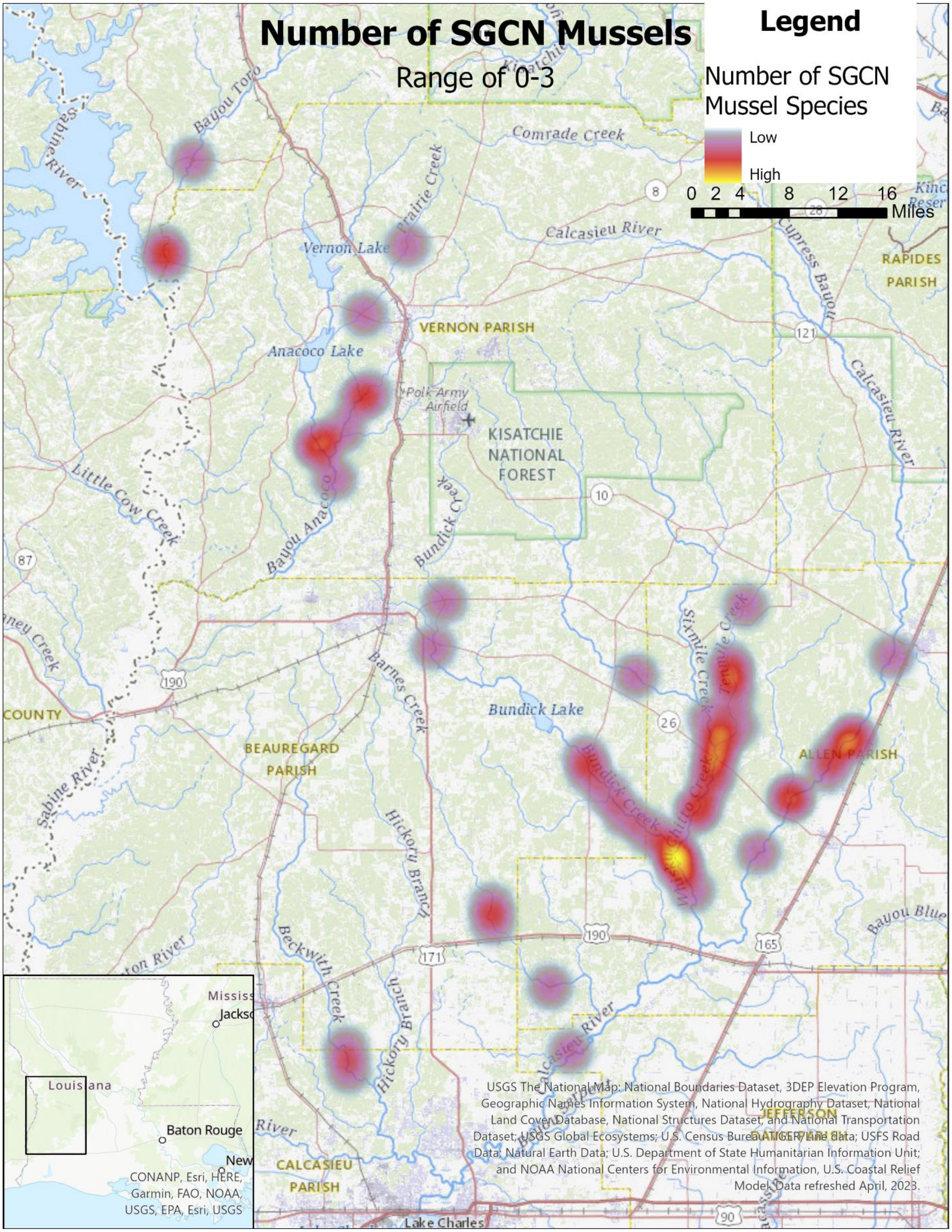
Site number	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**Total**
Search area m^2	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	
Person hours	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	
Number of species	6	8	9	6	9	8	10	8	9	7	5	5	7	4	1	
CPUE	33.50	37.00	30.25	16.50	34.50	41.25	48.25	30.25	22.25	15.75	25.75	13.50	59.25	19.00	0.50	
SPUE	1.50	2.00	2.25	1.50	2.25	2.00	2.50	2.00	2.25	1.75	1.25	1.25	1.75	1.00	0.50	
Total mussels	134	148	121	66	138	165	193	121	89	63	103	54	237	76	1	6456
Species																
Amblema plicata	0	0	0	0	0	1	3	10	2	1	0	0	0	0	0	504
Arcidens confragosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyclonaias nodulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyclonaias pustulosa	0	2	0	0	42	119	139	2	11	2	1	0	21	0	0	833
*Fusconaia askewi**	0	0	0	0	30	19	14	11	2	1	10	1	60	0	0	148
Fusconaia flava	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1486
*Glebula rotundata**	33	90	0	0	0	0	0	0	0	0	0	0	0	0	0	178
Lampsilis hydiana	75	27	26	9	15	8	5	47	42	26	45	29	53	23	0	1190
*Lampsilis satura**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	64
Lampsilis teres	4	10	18	18	30	7	16	7	2	1	0	1	17	28	0	425
Leaunio lienosa	11	1	2	3	9	4	9	37	13	18	30	20	6	22	1	625
Megalonaias nervosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Obliquaria reflexa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
*Obovaria arkansasensis**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	147
Plectomerus dombeyanus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23
*Pleurobema riddellii**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
Potamilus fragilis	0	0	0	0	4	3	4	0	0	0	0	0	0	0	0	13
Potamilus purpuratus	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	32
Pyganodon grandis	0	2	6	4	2	0	0	0	0	0	0	0	0	0	0	32
Quadrula quadrula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Sagittunio subrostrata	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
*Strophitus undulatus**	0	0	1	0	0	0	0	2	1	0	0	0	0	0	0	11
Toxolasma parvum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toxolasma texasiense	10	15	52	16	4	0	1	5	9	14	17	3	0	3	0	357
Tritogonia nobilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tritogonia verrucosa	0	0	1	0	2	4	1	0	7	0	0	0	77	0	0	290
*Truncilla donaciformis**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Truncilla truncata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Uniomerus declivis	1	0	13	16	0	0	0	0	0	0	0	0	0	0	0	45
Utterbackia imbecillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4

*SGCN species listed in the 2015 Louisiana Wildlife Action Plan.

Appendix D. Map of sample sites in Louisiana with confirmed *P. riddellii* locations.



Appendix E. Map of SGCN mussel species per sample site.



Appendix F. Habitat and water quality data by sample site.

	Structure and Substrate %							Water Attributes*			Bank Slope		
Site #	Wood	Clay/silt	Sand	Gravel	Cobble	Bedrock	Detritus	Max Depth (m)	Current	Turbidity	% vertical	% moderate	% gradual
1	0 – 25 %	50	30				20	1	SL/NC	turbid	100		
2	0 – 25 %	45	45				10	2.3	SL/NC	clear		25	75
3	0 – 25 %	50	50					1	MO	clear		100	
4	0 – 25 %	65	35					1.5	MO	clear		100	
5	26 – 50 %	25	70	5				1	MO	clear		100	
6	0 – 25 %	50	40				10	1.2	SL/MO	clear		100	
7	0 – 25 %	50	25	25				1.5	SL/NC	clear		100	
8	26 – 50 %	85	15					1.7	SL/NC	clear		100	
9	0 – 25 %	94	3				3	1	SL/NC	clear		50	50
10	0 – 25 %	30	65	5				1	MO	clear		100	
11	0 – 25 %	25	75					0.7	MO	clear		100	
12	0 – 25 %	25	75					1.2	MO	clear		100	
13	26 – 50 %	80	20					1	MO	clear			100
14	26 – 50 %	50	40				10	2.1	MO	clear	100		
15	51 – 75 %	100						1.8	SW	turbid	100		
16	0 – 25 %	33	66					1	MO	clear		100	
17	0 – 25 %	50	50					1.5	SW	clear		100	
18	0 – 25 %	100						1.8	SL/NC	clear			100
19	26 – 50 %	25	75					1.2	MO	clear			100
20	0 – 25 %	10	90					0.7	MO	clear			100
21	26 – 50 %	50	25				25	1.3	SL/NC	clear	33	66	
22	26 – 50 %	80	20					1.3	MO	clear		66	33
23	0 – 25 %	40	60					0.9	MO	clear		100	
24	26 – 50 %	35	65					1.2	MO	clear	100		
25	26 – 50 %	10	80				10	1	MO	clear			100
26	0 – 25 %	66		33				1	MO	clear		50	50
27	0 – 25 %	50	50					1	SL/NC	clear	50	50	
28	0 – 25 %	25	75					1	SL/NC	clear	100		
29	0 – 25 %	60	35	5				1.5	MO	clear	50	50	
30	26 – 50 %	5	90	5				1.3	MO	clear		100	

* Abbreviations for water attributes: SL=Sluggish, NC=No Current, MO=Moderate, SW=Swift

Site #	Woody Debris	Substrate %						Water Attributes*			Bank Slope		
		Clay/silt	Sand	Gravel	Cobble	Bedrock	Detritus	Max Depth (m)	Current	Turbidity	% vertical	% moderate	% gradual
31	0 – 25 %	40	50				10	1.5	SL/NC	clear		100	
32	0 – 25 %		100					1	MO	clear	50	50	
33	0 – 25 %	5	25	70				1	SW	clear		100	
34	0 – 25 %	25	70		5			1.2	MO	clear			100
35	26 – 50 %	50	50					1.4	SL/NC	turbid		100	
36	26 – 50 %	40	60					1	SL/NC	clear		100	
37	0 – 25 %	85	10				5	1.4	SL/NC	clear		100	
38	26 – 50 %	100						1.3	SL/NC	clear			100
39	26 – 50 %	70					30	1.3	SL/NC	clear		100	
40	0 – 25 %	15	85					1.2	SL/NC	clear	33	33	33
41	0 – 25 %	65	25	10				0.3	SL/NC	clear		100	
42	26 – 50 %	25	75					1.2	MO	turbid		66	33
43	0 – 25 %	25	75					2	SL/NC	turbid		100	
44	0 – 25 %	10	85				5	0.5	SL/NC	clear	30		70
45	0 – 25 %	10	90					1.3	SL/NC	clear	50	50	
46	0 – 25 %	5	85				10	0.7	SL/NC	clear	50		50
47	0 – 25 %	10	90					1.3	SL/NC	clear	50		50
48	26 – 50 %	15	75			10		0.9	MO	clear	100		
49	0 – 25 %	50	40			10		1.8	MO	turbid	100		
50	0 – 25 %	10	90					0.7	SL/NC	turbid			100

* Abbreviations for water attributes: SL=Sluggish, NC=No Current, MO=Moderate, SW=Swift

Appendix G. Diversity indexes by sample site.

Site #	CPUE	SPUE	Shannon-Wiener Index	Gini-Simpson Index
1	26.75	2.75	2.00	0.85
2	52.75	2.75	2.02	0.84
3	87.00	3.00	1.71	0.73
4	81.00	3.50	1.73	0.77
5	26.75	2.00	1.83	0.82
6	30.00	2.50	1.93	0.84
7	12.00	2.00	1.58	0.73
8	73.50	2.00	1.57	0.75
9	58.75	3.50	2.12	0.85
10	21.75	1.75	1.25	0.60
11	0.50	0.50	*	*
12	6.25	1.50	1.52	0.77
13	113.00	2.75	1.13	0.50
14	5.25	1.50	1.60	0.81
15	5.25	1.50	1.41	0.72
16	9.75	1.75	1.88	0.86
17	3.00	1.50	1.63	0.85
18	8.50	2.25	1.83	0.83
19	16.25	2.25	1.54	0.68
20	5.25	1.75	1.65	0.80
21	45.50	1.25	1.17	0.66
22	31.00	1.50	1.02	0.56
23	29.50	1.25	1.06	0.55
24	138.25	1.75	0.41	0.17
25	6.50	1.00	1.11	0.64
26	0.50	0.25	*	*
27	13.00	2.50	1.08	0.61
28	3.00	1.00	1.06	0.72
29	44.50	3.50	1.95	0.81
30	57.75	3.00	2.09	0.86
31	25.75	3.25	2.27	0.88
32	18.75	2.50	2.08	0.87
33	38.25	3.75	2.08	0.84
34	60.75	3.00	1.94	0.81
35	38.25	1.50	1.29	0.61
36	33.50	1.50	1.21	0.62
37	37.00	2.00	1.21	0.59
38	30.25	2.25	1.58	0.74
39	16.50	1.50	1.62	0.80
40	34.50	2.25	1.77	0.80
41	41.25	2.00	1.05	0.46
42	48.25	2.50	1.10	0.47
43	30.25	2.00	1.59	0.74
44	22.25	2.25	1.63	0.73
45	15.75	1.75	1.36	0.70
46	25.75	1.25	1.29	0.69
47	13.50	1.25	1.01	0.58
48	59.25	1.75	1.60	0.77
49	19.00	1.00	1.22	0.70
50	0.50	0.50	*	*

*Diversity indexes not calculated due to low number of species.