

FINAL PERFORMANCE REPORT



Federal Aid Grant No. F14AF01355 (T-79-1)

**Assessment of Distribution, Status and Habitat Needs of Rare Mussel
Species in the Little River Watershed in Oklahoma**

Oklahoma Department of Wildlife Conservation

October 1, 2014 through September 30, 2016

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State: Oklahoma

Grant Number: F14F01225 (T-79)

Grant Program: State Wildlife Grant

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Grant Period: October 1, 2014 – September 30, 2016

Report Period: October 1, 2014 – September 30, 2016

Project Leader: Caryn C. Vaughn, Oklahoma Biological Survey and Department of Biology, University of Oklahoma. **Project Participants:** Kathryn Murphy and Patrick Olson, MS students.

Executive Summary:

There are 15 mussel species identified as Oklahoma Species of Greatest Conservation Need that are known from the Little River watershed, including the federally listed species *Arcidens (Arkansia) wheeleri*, *Quadrula cylindrica* and *Quadrula fragosa*. The objectives of this study are to: 1) Conduct quantitative surveys in the Little River Oklahoma, from below Pine Creek Lake to the state line, to ascertain the distribution, status and habitat needs of *Pleurobema rubrum*, *Lampsilis hydiana*, *Ptychobranthus occidentalis* and *Obovaria arkansasensis*, and 2) Collect genetic samples for species verification of *Pleurobema rubrum* and *Lampsilis siliquoidea/hydiana* from the lower Little River. Collect genetic samples of *Lampsilis siliquoidea/hydiana* from known, accessible populations in the upper Little River, Mountain Fork River and Glover River for species verification. We conducted surveys for mussels during low flow water conditions in the summers of 2015 and 2016 by canoeing stretches of the Little River between Pine Creek reservoir and the state line and looked for signs of mussel beds by conducting visual searches in shallow water and looking for spent shells in the water and on shore. We sampled a total of 16,363 mussels at 42 sites in the Little River, encountering 29 species. Mussels are abundant in the river, with an average abundance of 243 (\pm 30) mussels encountered / hour and a mean density in large mussel beds of 52 (\pm 5) individuals / square meter. The mussel fauna is dominated by the species *Amblema plicata* (threeridge), *Quadrula pustulosa* (pimpleback), and *Actinonaias ligamentina* (mucket). *Pleurobema rubrum* is extremely rare in the Little River. We only found three individuals in two years of sampling, all of which occurred within large mussel beds on the USFWS Little River National Wildlife Refuge. We only found 7 individuals of possible *Lampsilis hydiana* at one site above Pine Creek Reservoir, F15VAU01. Genetic tests at Iowa State University identified these individuals as *Lampsilis powellii*, the Arkansas fatmucket, a federally threatened species. Overall, the Little River supports a healthy and diverse mussel fauna. Populations of mussels located on the USFWS Little River National Wildlife Refuge are particularly abundant and diverse, and include three federally listed species (*Arcidens wheeleri*, *Quadrula cylindrica*, and *Quadrula fragosa*). The populations of *Obovaria arkansasensis* and *Ptychobranthus occidentalis* appear to be stable. *Pleurobema rubrum* is extremely rare in the river, similarly to what was found almost 20 years

ago. What has previously been thought to be *Lampsilis hydiana* may actually be *Lampsilis powelii*, a federally threatened species.

I. BACKGROUND AND NEED:

The Little River is a major tributary of the Red River. It drains 10,720 km² in southeastern Oklahoma and southwestern Arkansas. The Upper Little River above Pine Creek Reservoir is a high gradient upland stream as are its major tributaries the Glover and Mountain Fork Rivers. Below Pine Creek Reservoir the river is lower gradient as it flows through Gulf Coastal Plain (Matthews et al. 2005).

Mussel populations in the Little River have been impacted by the construction and operation of Pine Creek and Broken Bow reservoirs (Vaughn and Taylor 1999, Galbraith et al. 2008, Galbraith and Vaughn 2011). Freshwater mussels have been extirpated in the Mountain Fork River below Broken Bow Reservoir due to hypolimnetic, cold-water releases, and have decreased in abundance in the Little River below the inflow from the Mountain Fork because of these releases (Vaughn and Taylor 1999, Galbraith and Vaughn 2011). Mussel populations now face a new threat, proposed water diversions to both the Dallas and Oklahoma City metropolitan areas. These actions may further impact Little River mussel populations by (1) altering stream hydrology and the subsequent creation of new mussel habitat and (2) in particular by creating stressful low flow conditions during times of drought when water demand will be highest (Galbraith et al. 2010, Allen et al. 2013). Thus, it is imperative that we determine the distribution and status of mussel species of concern so that we can take appropriate actions to protect them.

There are 15 mussel species identified as Oklahoma Species of Greatest Conservation Need that are known from the Little River watershed (Vaughn and Taylor 1999, Vaughn 2005, Galbraith et al. 2008). These include the federally listed species *Arcidens (Arkansia) wheeleri*, *Quadrula cylindrica* and *Quadrula fragosa* (Galbraith et al. 2008). However, the river also harbors several species that are believed to be declining but for which we do not have enough information to determine their true status. These species include the Ohio or Pyramid Pigtoe (*Pleurobema rubrum*), Louisiana fatmucket (*Lampsilis hydiana*), Ouachita kidneyshell (*Ptychobranthus occidentalis*) and Southern Hickorynut (*Obovaria arkansasensis*). *Pleurobema rubrum* occurs sporadically in low to moderate gradient medium sized to large rivers in the Mississippi drainage. In surveys conducted by Vaughn and her students in the Little River in the early to mid 1990s, *Pleurobema rubrum* were found at seven sites below Pine Creek Reservoir. No *P. rubrum* were found in limited surveys conducted in the Little River in 2004 (Galbraith et al. 2005). This species does not occur in the higher-gradient habitats of the upper Little River, Mountain Fork River or Glover River (Vaughn and Taylor 1999, Vaughn 2003, Spooner and Vaughn 2007). *Ptychobranthus occidentalis* is a fairly common species in the upper portions of the Little, Mountain Fork and Glover rivers. Carla Atkinson, a PhD student in the Vaughn lab, conducted mussel surveys at multiple sites in the upper Little and Mountain Fork rivers in 2010 and 2012 (Atkinson et al. 2012, 2014). She also measured habitat and land use characteristics. *Ptychobranthus* occurred at most sites. Vaughn and her students canoed the lower 40 km of the Glover River in 1996 and surveyed mussels at 22 sites (Vaughn 2003). Mussels in the Glover River mainly occur in small pockets of sand and gravel on the downstream side of large boulders. *Ptychobranthus* occurred at 13 of the surveyed sites (Vaughn 2003). *Lampsilis*

hydiana is difficult to distinguish morphologically from *Lampsilis siliquoidea* in the Little River watershed. *Lampsilis siliquoidea* is abundant in upper reaches of the Little, Mountain Fork and Glover rivers, and occurs less frequently in the lower Little River (Vaughn 2003, Spooner and Vaughn 2007, Atkinson et al. 2012). *Obovaria jacksoniana* and *Villosa arkansasensis* are now considered to be morphological variations of the same species, *Obovaria arkansasensis* (Inoue et al. 2013). This species is fairly abundant in upper reaches of the Little, Mountain Fork and Glover rivers and occurs sporadically in the lower Little River (Vaughn and Taylor 1999, Vaughn 2003, Spooner and Vaughn 2007, Atkinson et al. 2012).

II. OBJECTIVES

Objective 1: Conduct quantitative surveys in the Little River Oklahoma, from below Pine Creek Lake to the state line, to ascertain the distribution, status and habitat needs of *Pleurobema rubrum*, *Lampsilis hydiana*, *Ptychobranhus occidentalis* and *Obovaria arkansasensis*.

Objective 2: Collect genetic samples for species verification of *Pleurobema rubrum* and *Lampsilis siliquoidea/hydiana* from the lower Little River. Collect genetic samples of *Lampsilis siliquoidea/hydiana* from known, accessible populations in the upper Little River, Mountain Fork River and Glover River for species verification.

III. METHODS

We conducted surveys for mussels during low flow water conditions in the summers of 2015 and 2016. We canoed stretches of the Little River between Pine Creek reservoir and the state line and looked for signs of mussel beds by conducting visual searches in shallow water and looking for spent shells in the water and on shore. When we encountered mussels, we conducted timed searches via snorkel surveys or SCUBA in deeper areas (> 0.75 m) to estimate CPUE or mussels encountered/hour spent searching. For large mussel beds, we also sampled mussels with 0.25 m² quadrats (n = 20) following protocols established by Vaughn et al. (1997) and Strayer and Smith (2003), to estimate density as number of mussels / square meter. We recorded the universal transverse mercator (UTM) coordinates for each site using a global positioning system (GPS). We also sampled a site on the upper Little River above Pine Creek reservoir, and took genetic samples from a site on the Glover River. For large mussel beds, we measured a suite of habitat variables including physico-chemical characteristics, sediment particle sizes, canopy cover, and discharge.

We took non-lethal mantle clippings for genetic analyses of *Pleurobema rubrum* and *Lampsilis siliquoidea/hydiana* (Henley et al. 2006). We also collected samples from *Obovaria arkansasensis* and *Ptychobranhus occidentalis*. Genetic analyses were conducted by Dr. Kevin J. Roe at Iowa State University, who specializes in freshwater mussel phylogenetics and population genetics (<http://www.public.iastate.edu/~kjroe/researchpage.html>).

IV. RESULTS

We sampled a total of 16,363 mussels at 42 sites in the Little River (Figs. 1–3, Table 1), encountering 29 species (Table 2). Mussels are abundant in the river, with an average abundance

of 243 (± 30) mussels encountered / hour and a mean density in large mussel beds of 52 (± 5) individuals / square meter (Figs. 4 and 5). The mussel fauna is dominated by the species *Amblema plicata* (three-ridge), *Quadrula pustulosa* (pimpleback), and *Actinonaias ligamentina* (mucket) (Figs. 6 and 7).

Pleurobema rubrum is extremely rare in the Little River. We only found three individuals in two years of sampling (Table 1), all of which occurred within large mussel beds on the USFWS Little River National Wildlife Refuge (Fig. 3). The individual sampled in 2015 at site F15VAULY was genetically verified as both *P. sintoxia* and *P. rubrum* (Table 3). Tissue samples from individuals encountered at F16VAU08 in 2016 were verified as *P. rubrum* (Table 3). While *Pleurobema sintoxia* and *P. rubrum* in the Little River are very similar in appearance and difficult to distinguish based on shell morphology, our genetic data indicate that *P. rubrum* does occur in the river, but at very low abundance.

We only found 7 individuals of possible *Lampsilis hydiana* at one site above Pine Creek Reservoir, F15VAU01. Genetic tests at Iowa State University identified these individuals as *Lampsilis powelii*, the Arkansas fatmucket, a federally threatened species. Previously, *L. powelii* has only been known from the Ouachita River drainage in Arkansas. However, given the proximity of the Little River and Ouachita River drainages, it is likely that this species could occur in the upper Little River and its high gradient tributaries, the Mountain Fork River and Glover River. Further sampling and genetic testing are needed to resolve this issue.

Obovaria arkansasensis is common in the Little River. It occurred at 21 sites, with an average density of 5.16 individuals / square meter in large mussel beds. Genetic tests for *O. arkansasensis* identify it as *Obovaria jacksoniana* / *Villosa arkansasensis* (Table 2), but *O. jacksoniana* and *V. arkansasensis* were recently found to be the same species, now called *O. arkansasensis* (Inoue et al. 2013). Thus, we are confident in the identity of this species.

Ptychobranthus occidentalis occurred at 10 sites with an average density of 4 individuals / square meter in large mussel beds. While this species is only moderately abundant in the Little River below Pine Creek Reservoir, it is common in the upper, higher gradient portion of the river, as well as in the Glover River and Mountain Fork River (Atkinson et al. 2012, 2014, Vaughn, 2003).

Although not required as a part of this project, we also recorded the distribution and abundance of all federally listed species that we encountered. We found *Arcidens (Arkansia) wheeleri* at two sites, F15VAU07 and F16VAU12 (Table 1). Both of these sites were large mussel beds on the USFWS Little River National Wildlife Refuge (Fig. 3). *Arcidens wheeleri* remains extremely rare in the Little River (Vaughn and Pyron 1995, Galbraith et al. 2008). We found *Quadrula fragosa* at 10 sites (Table 1), although it was never very abundant. We found *Quadrula cylindrica* at 22 sites and this species had an average density of 4 individuals / square meter in large mussel beds.

Habitat variables measured in large mussel beds are reported in Table 4. These results are consistent with our previous analyses of mussel habitat preferences in the Little River. Mussel

beds tend to occur in areas that experience low shear stresses under high flows, but that remain flowing during drought periods (Vaughn and Taylor 1999, Allen and Vaughn 2010).

Overall, the Little River supports a healthy and diverse mussel fauna. Populations of mussels located on the USFWS Little River National Wildlife Refuge are particularly abundant and diverse, and include three federally listed species (*Arcidens wheeleri*, *Quadrula cylindrica*, and *Quadrula fragosa*). The populations of *Obovaria arkansasensis* and *Ptychobranchus occidentalis* appear to be stable. *Pleurobema rubrum* is extremely rare in the river, similarly to what we found almost 20 years ago (Vaughn and Taylor 1999). What has previously been thought to be *Lampsilis hydiana* may actually be *Lampsilis powelii*, a federally threatened species.

V. RECOMMENDATIONS

(1) Further sampling and genetic testing is need to determine if *Lampsilis hydiana* in the Little River watershed (upper Little River, Mountain Fork River, and Glover River) is actually *Lampsilis powelii*, the Arkansas fatmucket.

(2) The USFWS Little River Wildlife Refuge harbors the most abundant and diverse mussel fauna in the state, including two federally endangered species (*Arcidens wheeleri* and *Quadrula fragosa*), and a large population of federally threatened *Quadrula cylindrica* (including designated critical habitat for this species). This refuge should be maintained and protected.

VI. SIGNIFICANT DEVIATIONS

There have been no significant deviations.


VII. EQUIPMENT


No equipment exceeding \$5,000 in cost was purchased for this project.

VIII. PREPARED BY: Caryn C. Vaughn, Kathryn Murphy and Patrick Olson, University of Oklahoma

DATE: February 7, 2017

APPROVED BY:


 Fisheries Division Administration
 Oklahoma Department of Wildlife Conservation


 Andrea Crews, Federal Aid Coordinator
 Oklahoma Department of Wildlife Conservation

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Table 2. List of mussel species found in the Little River in 2015 – 2016. Species abbreviations used in Figures 6 and 7 are given in parentheses.

Actinonaias ligamentina (AL)
Amblema plicata (AP)
Arcidens wheeleri
Ellipsaria lineolata (EL)
Fusconaia flava (FF)
Lampsilis cardium (LC)
Lampsilis powelii
Lampsilis satura
Lampsilis siliquoidia/hydiana
Lampsilis teres (LT)
Lasmigona costata
Leptodea fragilis (LF)
Megalonaias nervosa (MN)
Obliquaria reflexa (OR)
Obovaria arkansasensis (OA)
Plectomerus dombeyanus (PD)
Pleurobema rubrum
Pleurobema sintoxia (PS)
Potamilus purpuratus (PP)
Ptychobranhus occidentalis (PO)
Pyganodon grandis (PG)
Quadrula cylindrica (QC)
Quadrula fragosa
Quadrula pustulosa (QP)
Quadrula quadrula (QQ)
Quadrula verrucosa (QV)
Strophitus undulates (SU)
Truncilla donaciformis (TD)
Truncilla truncata (TT)
Villosa sp.

F16VAU13	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU17	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU19	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU24	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU24	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU24	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU24	<i>P. occidentalis</i>	<i>P.occidentalis</i>	99
F16VAU25	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU27	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU27_2	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU28_1	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU29_1	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU29_2	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU29_3	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU30_1	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU30_2	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU30_3	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU30_5	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU30_6	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU30_7	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU30_8	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU30_10	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU30_11	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU30_12	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU30_13	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU32_1	<i>O. arkansasensis</i>	<i>O. arkansasensis/O. jacksoniana</i>	99
F16VAU34_1	<i>P. occidentalis</i>	<i>P.occidentalis</i>	99

Table # &	Habitat/variables recorded	pH	DO' (mg/L)	Conductivity' (µs/cm)	H ₂ O Temp'' (°C)	Mean Discharge (m ³ /sec)	(S.E.)'	Mean sediment particle size (mm)	(S.E.)'	Sediment particle size range (mm)'	Mean canopy (%)'	(S.E.)'
F15VAU01	30 June 2015	6.74	6.8	29	30.5	0.298	0.026	105.49	9.51	1.88/0.0	64.83	8.09
F16VAU24	3 Aug 2016	7.4	6.39	126.7	31.2	0.153	0.031	38.63	3.06	0.288/20	78.75	1.85
F16VAU09	17 July 2016	7.3	5.06	197.7	30.5	0.050	0.005	37.27	2.92	0.188/39	78.81	6.25
F16VAU08	13 July 2016	7.4	4.77	208.4	29.6	0.054	0.001	33.04	2.31	0.288/18	86.40	1.04
F16VAU07	11 July 2016	6.98	*	266.6	30.3	0.070	0.004	32.03	3.33	0.288/02	87.95	1.73
F16VAU06	10 July 2016	6.83	*	260.1	31.0	0.201	0.050	25.77	2.27	0.188/09	89.38	2.66
F15VAU04	13 Aug 2015	7.4	7.09	259	31.3	0.098	0.006	18.14	1.50	0.288/8	87.05	1.31
F15VAU1Y	11 Aug 2015	7.63	6.14	234	32.1	0.276	0.123	31.73	2.09	0.288/2	88.25	0.47
F15VAU07	17 Aug 2015	7.8	6.3	292	28.9	0.070	0.004	21.11	1.89	0.288/35	87.95	1.73
F15VAU08	13 Sep 2015	7.8	7.47	377	27.4	0.054	0.001	33.04	2.31	0.288/18	86.40	1.04
F16VAU03	24 June 2016	6.5	*	208.7	30.9	0.357	0.055	48.24	4.47	0.188/46	53.25	8.07
F16VAU04	26 June 2016	6.75	*	224.3	33.1	0.098	0.006	18.14	1.50	0.288/8	78.75	2.94

*DO meter not working

Figure 1. Locations of sites sampled in the upper Little River above Pine Creek Reservoir.



Figure 2. Locations of sites sampled on the Little River.

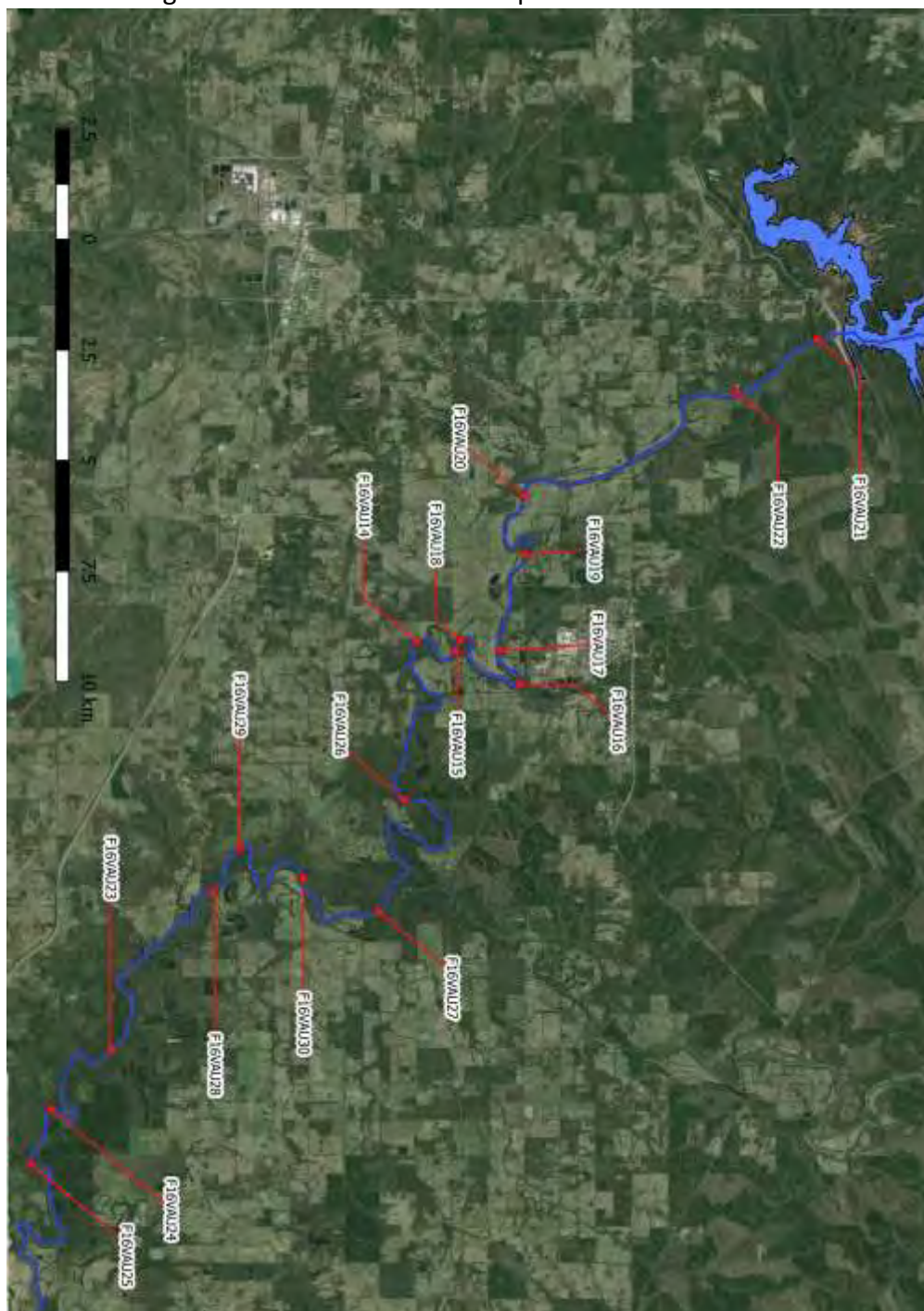


Figure 3. Locations of sites sampled on the lower Little River.

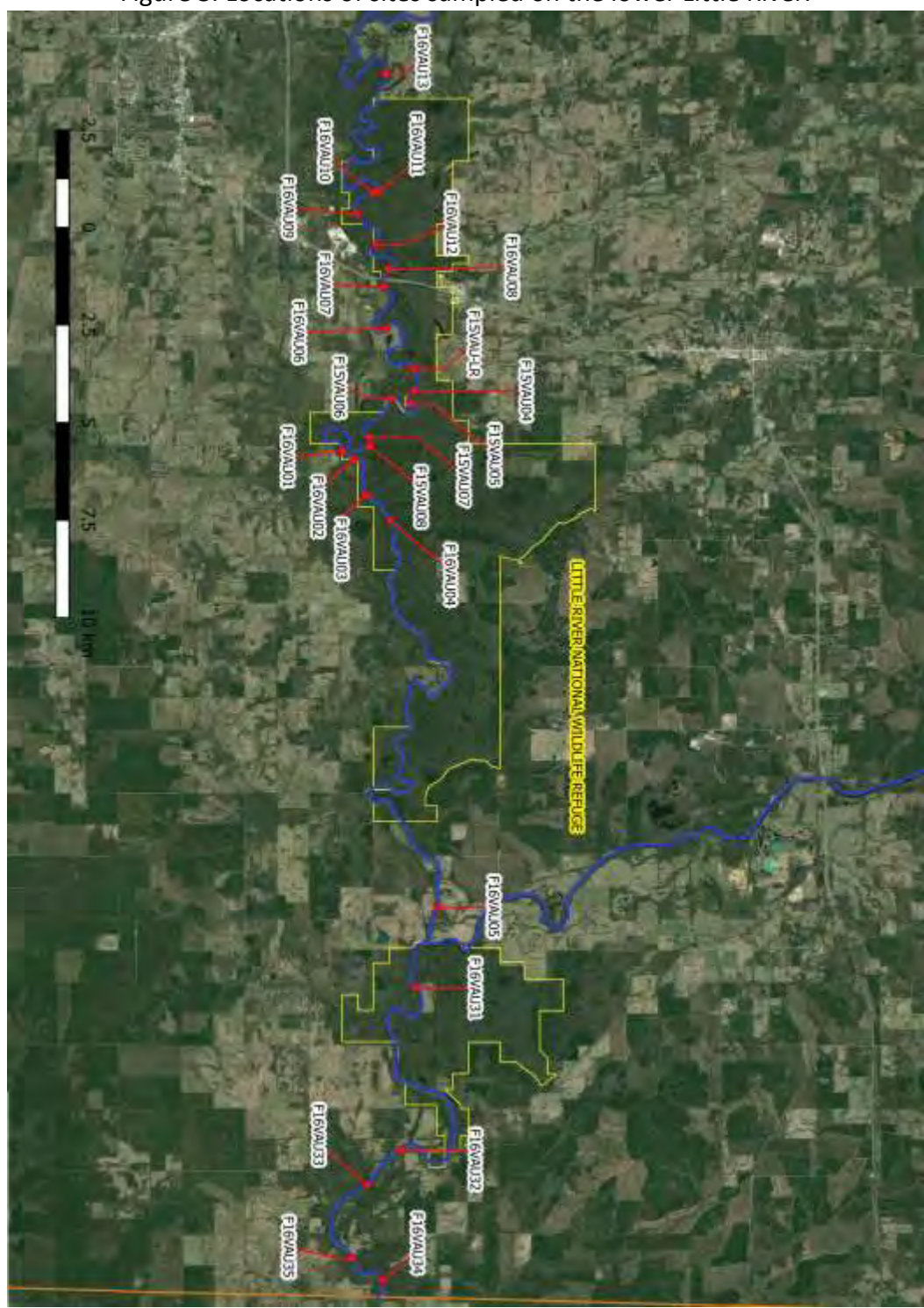


Figure 4. Abundance of mussels at the 42 sites sampled with timed searches.

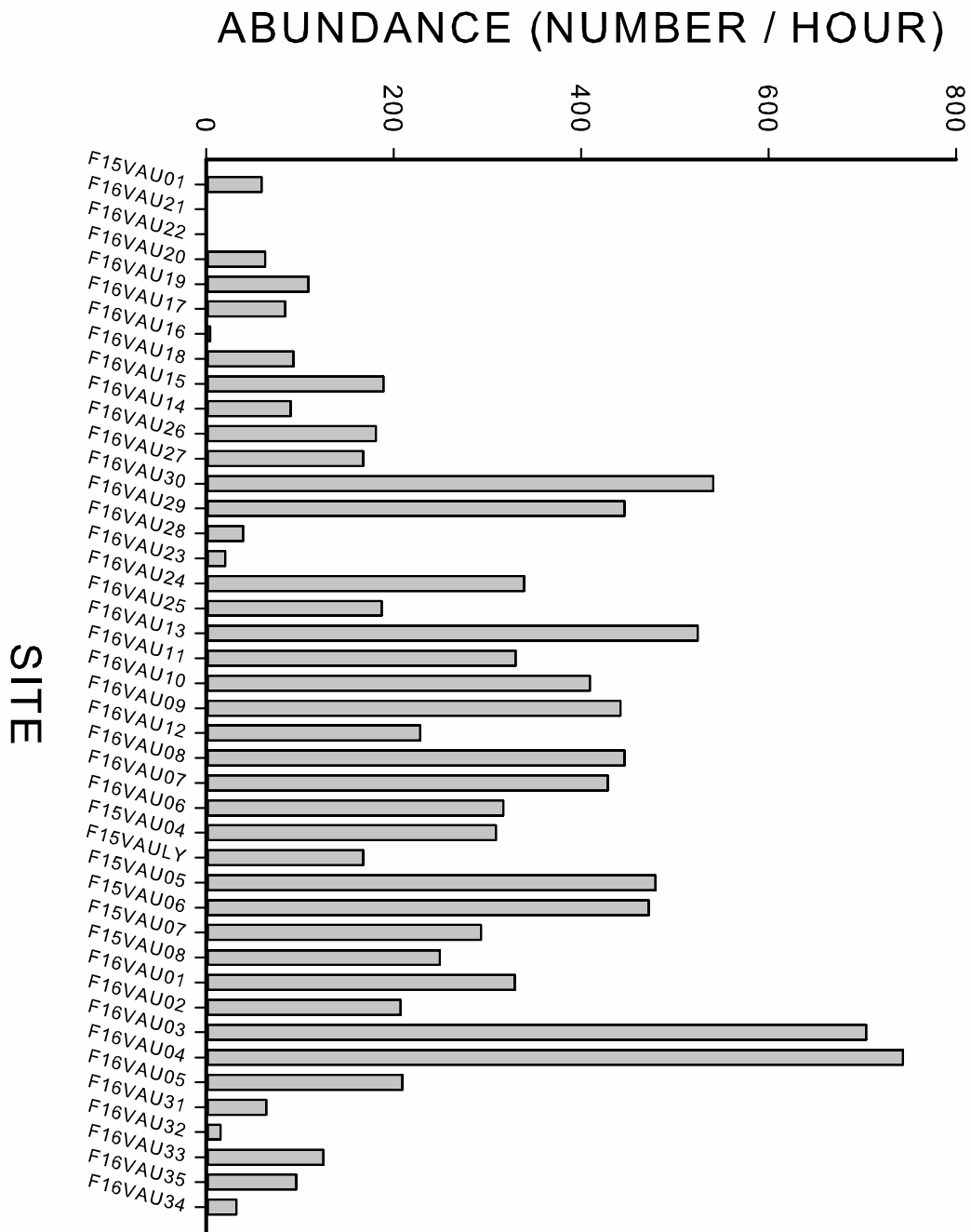


Figure 5. Densities of mussels in large mussel beds.

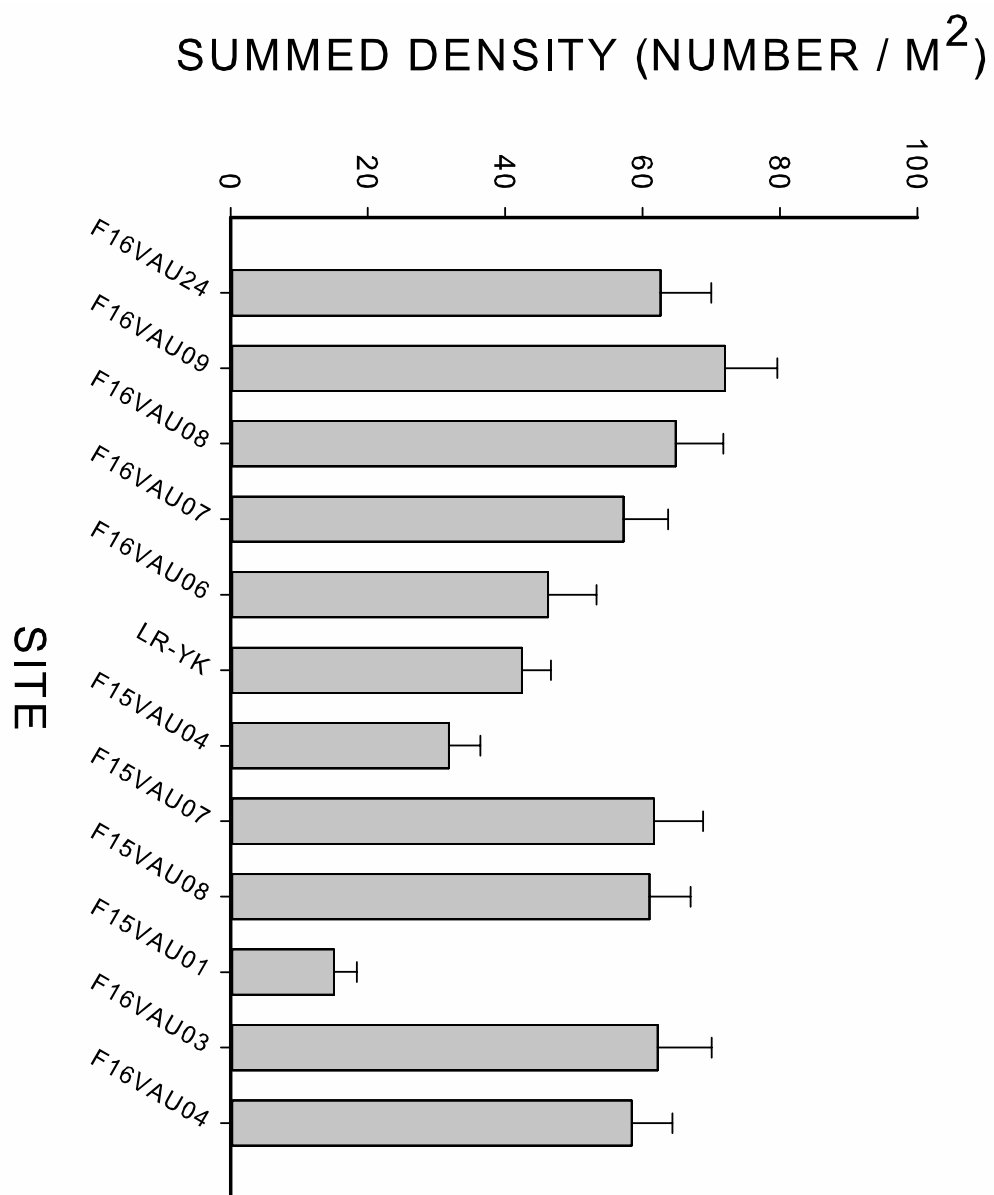


Figure 6. Relative abundance of mussel species in timed search samples. Only species with relative abundances greater than 0.1% are shown. Species abbreviations are defined in Table 2.

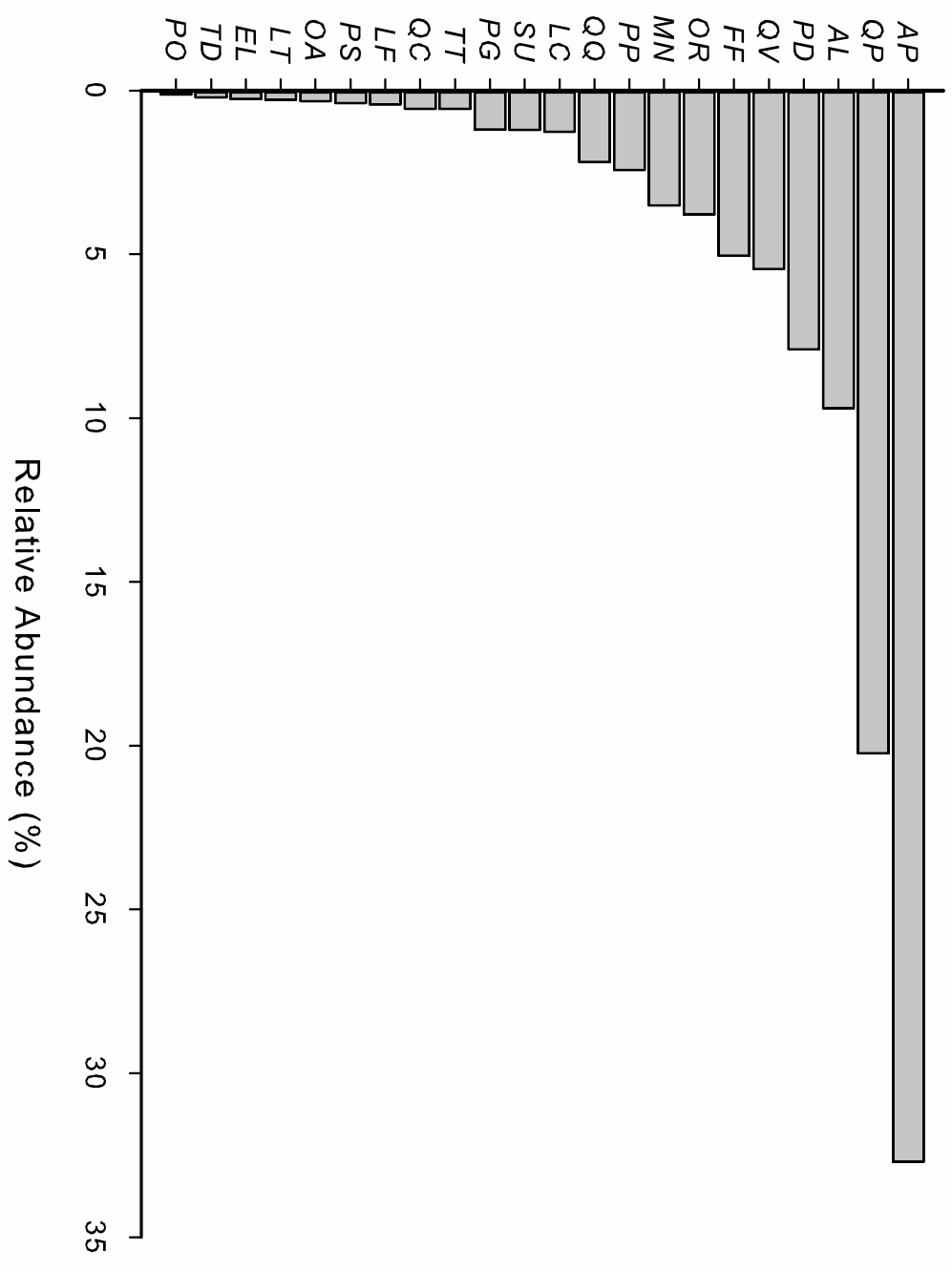


Figure 7. Mean densities of common species in large mussel beds. Species abbreviations are given in Table 2.

