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ABSTRACT

Bayou Bartholomew in Arkansas and Louisiana is one of the largest free-flowing unchannelized rivers in the United States. A 2004 survey of the unionoid mussel fauna of Bayou Bartholomew in Arkansas yielded 35 native species across 50 sites. The washboard (*Megalonaias nervosa*) was the most common mussel encountered. Relict valves of black sandshell (*Ligumia recta*) and the federally endangered pink mucket (*Lampsilis abrupta*) were also found during the survey. Species richness, Pielou's evenness, and Shannon's diversity all increased from upstream to downstream. These data provide baseline information about the aquatic diversity of Bayou Bartholomew and can serve as possible benchmarks for restoring freshwater ecosystems in other Southeastern rivers and streams.

INTRODUCTION

The southeastern United States harbors one of the most diverse freshwater mussel assemblages in the world (Williams et al., 1993; Neves et al., 1997). Of the roughly 300 recognized species of unionoid bivalves (Turgeon et al., 1998), the number of taxa estimated to have occurred historically within Arkansas ranges between 68 and 75 (Harris and Gordon, 1990; Posey et al., 1996; Harris et al., 1997; NatureServe, 2007). Eight of these species are currently considered either federally endangered or threatened and two species are candidates for listing (USFWS, 2005). Modern assessments of unionoid populations serve three important purposes. First, distribution and status surveys provide baseline data for tracking population fluctuations and declines before extirpation (Hartfield and Rummel, 1985; Blalock and Sickel, 1996; Vaughn, 1997; Lydeard et al., 1999; Vaughn and Taylor, 1999). Second, these studies can reveal biotic and abiotic interactions that may be influencing mussel community structure (Roper and Hickey, 1995; Tyrrell and Hornbach, 1998; Strayer and Fetterman, 1999). Finally, given their dependence on fishes to serve as hosts for their larval stage (glochidia), healthy and diverse mussel populations suggest equally healthy and diverse ichthyofaunas.

Few river and stream channels in the United States with abundant mussel resources remain unaltered. Minimally impacted systems offer a glimpse of conditions prior to widespread impoundment, channelization, and other human influences. Bayou Bartholomew in Arkansas and Louisiana remains one of the few unmodified rivers in the United States harboring a diverse mussel fauna. Most research conducted on Bayou Bartholomew has focused on fishes (Black, 1940; Thomas, 1976; Hutchins, 1988; Pezold et al., 2002). The Louisiana portion of Bayou Bartholomew was sampled for mussels by George and Vidrine (1992) and Pezold et al., (2002). Their results suggested that Bayou Bartholomew harbors one of the most diverse mussel assemblages in Louisiana. Surveys of the Louisiana portion of the river (George and Vidrine, 1993) yielded forty native mussel species including the federally endangered pink mucket (*Lampsilis abrupta* Say, 1831). However, no intense mussel survey of the Arkansas portion of the river has been conducted. Our objectives were to assess the current status and distribution of unionoid species in the Arkansas portion of Bayou Bartholomew and to provide baseline data for monitoring these species in the future.

METHODS

Originating in loess hills west of Pine Bluff, Arkansas, Bayou Bartholomew flows 457 km through Jefferson, Lincoln, Drew, Desha, and Ashley counties in Arkansas and then into Morehouse Parish in Louisiana before its confluence with the Ouachita River near Sterlington, Louisiana. Currently, it is the only non-channelized river in southeast Arkansas and northeast Louisiana. The Bayou Bartholomew watershed occupies approximately 20 percent of the Ouachita River basin and drains over one million acres in southeast Arkansas and northeast Louisiana (Broom, 1973). Most of Bayou Bartholomew occurs within the Mississippi Alluvial Basin ecoregion that is characterized by fine textured and fertile alluvial soils well suited to agricultural development (Alley, 2005). The watershed is dominated by agriculture fields and pastureland. The riparian zone is dominated by bottomland hardwood species such as water tupelo (*Nyssa aquatica* L.), bald cypress (*Taxodium distichum* L. [Rich]), and maples (*Acer* spp.) and in most cases is less than 50 m wide. Erosion, sedimentation, input of agricultural, and urban nutrients, input of contaminants, and irrigation water withdrawals associated with agriculture have been the main stressors of the stream ecosystem for many years (Alley, 2005).

We surveyed the Arkansas portion of Bayou Bartholomew from 27 August to 15 October 2004. Fifty sites, evenly distributed along the Bayou, were chosen based on ease of vehicular access starting at the headwaters west of Pine Bluff, Arkansas and ending at the Arkansas-Louisiana state line (Figure 1 and Appendix). Using a timed protocol modified from Metcalfe-Smith et al., (2000), we conducted hour-long searches at each site and all mussels encountered were collected, identified to species, and returned to the streambed. Voucher specimens of some species were preserved in 95% ethanol and housed at Arkansas State University. Searches were conducted using "pollywogging" (tactile search using hands to rake through the substrate). Deeper sites were surveyed through free diving. Latitude and longitude coordinates were taken for each site using a handheld Magellan Gold Global Positioning Satellite unit. Live and dead specimens were included in the survey with no distinction being made between fresh dead and relict valves. While including all dead valves may bias survey results (e.g., no evidence when an individual died, empty valves being washed downstream, predators moving valves, etc.), their inclusion is consistent with quantitative survey guidelines elsewhere (e.g., Wisconsin Department of Natural Resources, 2005). The Asian clam (*Corbicula fluminea*) and specimens of native fingernail clams (Sphaeriidae) were collected at many sites but are not included in any calculations. All specimens were identified in the field based on shell features. Nomenclature follows Turgeon et al., (1998) and Cicerello and Schuster (2003) except for *Quadrula verrucosa* (Rafinesque, 1820). Molecular evidence (Serb et al., 2003; Campbell et al., 2005) published after Turgeon et al., (1998) places *Tritogonia verrucosa* in *Quadrula* and we have chosen to follow it accordingly. Complete records for each site are available from the authors.

For each site, we recorded species richness (S) and the number of live and dead mussels. We also recorded catch per unit effort (CPUE) which was calculated by dividing the total number of individual mussels encountered by the total number of hours spent surveying at each site. Additionally, Shannon's diversity (H') and Pielou's evenness (J) indices were calculated for each site using the Palaeontological Statistics (PAST) statistical package (Hammer et al., 2006). Since no distinction was made between fresh dead and relict valves, both indices were calculated using only all live mussels encountered. Species richness, diversity, and evenness using all mussels were regressed against distance from the confluence with the Ouachita River in PAST to test for any significant upstream-downstream trends in distribution.

RESULTS

A total of 9,218 native mussels (2,438 dead valves and 6,780 live animals) representing 35 species in 23 genera were encountered (Tables 1 and 2). Of the 35 species, eight are considered species of special concern in Arkansas. Black sandshell (*Ligumia recta*) and the federally endangered pink mucket (*L. abrupta*) were represented by shells of dead mussels only. *Lampsilis teres* was the most widely distributed species, being found at 43 sites. *Megalonaias nervosa* was the most abundant species with 1,729 individuals encountered, followed closely by *Amblema plicata* (1,710 individuals) and *Plectomerus dombeyanus* (1,591 individuals). These three species accounted for 54 % of all mussels encountered.

No mussels were found at two urban sites (sites 5 and 6). Species richness ranged from $S = 1$ (sites 4 and 14) to $S = 25$ at site 49 (Table 3). Site 49 also had the highest Shannon index ($H' = 2.51$). Species evenness for sites with more than one species of mussels ranged from $J = 0.30$ at site 1 to $J = 0.95$ at site 9. Site 22 had the highest CPUE with 202 individuals encountered per hour surveying (Table 3). All three diversity measures showed a negative relationship with distance from the Ouachita River confluence (i.e., downstream values were higher than upstream values). While the relationship was significant ($p < 0.001$) for all three measures, distance from confluence did not explain a large amount of variability in any measure: species richness ($r^2 = 0.44$), Shannon diversity ($r^2 = 0.39$), and evenness ($r^2 = 0.20$).

DISCUSSION

Our survey indicated that the Arkansas portion of Bayou Bartholomew contains thirty-five native freshwater mussel species. Diversity ranged from taxa that are both regionally common to those with more restricted or local-

ized ranges. Points of concern include our finding only valves of the federally endangered *L. abrupta* while George and Vidrine (1993) had found live individuals in the Louisiana portion of the Bayou. The urbanization and lack of mussels at sites 5 and 6 also raises concerns that continued human development could lead to further declines in mussel diversity in the region. The overall increase in mussel diversity from upstream to downstream is typical of many healthy aquatic systems. Bayou Bartholomew harbors relatively undisturbed habitats that may serve as both a source of species for other streams in the region and may provide important refugia for species sensitive to environmental changes.

The preservation of this unique system is therefore vital in maintaining local mussel populations though several anthropogenic effects are readily noticeable in Bayou Bartholomew. Sedimentation from intensive agriculture practices may pose the largest threat to this river system. Human pollution sources in the form of refuse, old appliances, and abandoned cars are present in the river, especially at bridge sites. Dewatering of the bayou for irrigation is also likely affecting the river negatively. During the survey, many large pumps were noticed withdrawing water from the river. The combination of irrigation and drought led to the discovery of beached or stranded mussels at several sites. Since the end of our survey these impacts may have been exacerbated because of the occurrence of a significant drought in the region (National Weather Service, 2007). Currently, steps are being taken to preserve and restore land that lies within the Bayou Bartholomew watershed. In the last four years, thousands of acres in the watershed have been enrolled in programs such as Environmental Quality Incentives Program and Conservation Reserve Program (Bayou Bartholomew Alliance, 2000). These programs will support the planting of trees along the riparian areas to reduce sedimentation and increase the streamside water table level.

As a whole, freshwater mussels remain one of the most imperiled groups of animals in the world and their plight parallels similar conservation problems with Southeastern freshwater fishes. In 1997, only 25 percent of the mussel fauna in the southeastern United States was considered stable (Neves et al., 1997). Like freshwater fishes such as minnows and darters, the extinction, extirpation, or decline of most freshwater mollusks can be attributed to biological attributes and ecological requirements that make species especially vulnerable to anthropogenic effects (Neves et al., 1997). Because of the unique life cycle of freshwater mussels, the organisms themselves do not directly have to be harmed in order to disrupt their life cycle. For example, the extirpation of host fishes ultimately leads to the decline of mussel populations. Host specificity is the rule rather than the exception in freshwater mussels (Hogarth, 1992). Although the number of parasitic glochidia varies among species, few attach to the appropriate host fish. Therefore the presence and abundance of a wide diversity of fish species are crucial for survival of mussel assemblages (Neves et al., 1997).

The information obtained in this survey is important in understanding the status and distribution of freshwater mussels in Bayou Bartholomew in Arkansas. Since this river system represents relatively stable habitat for many species of mussels, we recommend that follow-up surveys be conducted to assess the status and distributions of current populations. Future work should also include combining mussel, fish, and invertebrate studies on the entirety of Bayou Bartholomew to target potential diversity hotspots in the drainage.

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TABLE 1. Native freshwater mussel species identified from the Arkansas portion of Bayou Bartholomew. State and global heritage ranks taken from NatureServe (2007) range from rare and imperiled (S1/G1) to widespread and common (S5/G5). Species of special concern (SSC) in Arkansas are indicated.

Species	Common Name	State Rank	Global Rank	SSC
Amblema plicata	threeridge	S5	G5	
Anodonta suborbiculata	flat floater	S3	G5	
Arcidens confragosus	rock pocketbook	S3	G4	
Elliptio dilatata	spike	S4	G5	
Fusconaia ebena	ebonyshell	S3/S4	G4/G5	
Fusconaia flava	Wabash pigtoe	S4	G5	
Lampsilis abrupta	pink mucket	S2	G2	
Lampsilis cardium	plain pocketbook	S4	G5	
Lampsilis hydiana	Louisiana fatmucket	S3	G4	
Lampsilis teres	yellow sandshell	S4	G5	
Leptodea fragilis	fragile papershell	S4	G5	
Ligumia recta	black sandshell	S2	G5	X
Ligumia subrostrata	pondmussel	S4	G4/G5	
Megalonaias nervosa	washboard	S3	G5	
Obliquaria reflexa	threehorn wartyback	S4	G5	
Obovaria jacksoniana	Southern hickorynut	S2	G1/G2	X
Plectomerus dombeyanus	banckclimber	S4	G4	
Pleurobema rubrum	pyramid pigtoe	S2	G2	X
Potamilus purpuratus	bleufer	S4	G5	
Pyganodon grandis	giant floater	S5	G5	
Quadrula apiculata	Southern mapleleaf	S2	G5	X
Quadrula metanevra	monkeyface	S3/S4	G4	X
Quadrula nodulata	wartyback	S4	G4	
Quadrula pustulosa	pimpleback	S5	G5	
Quadrula quadrula	mapleleaf	S5	G5	
Quadrula verrucosa	pistolgrip	S4	G4	
Strophitus undulatus	creeper	S3	G5	
Toxolasmus parva	liliput	S4	G5	
Toxolasmus texasensis	Texas liliput	S3	G4	
Truncilla donaciformis	fawnsfoot	S3	G5	
Truncilla truncata	deertoe	S4	G5	
Uniomerus declivis	tapered pondhorn	S2	G5	X
Uniomerus tetralasmus	pondhorn	S2	G4	X
Utterbackia imbecillis	paper pondshell	S3/S4	G5	
Villosa lienosa	little spectaclecase	S3	G5	X

TABLE 2. Species and total number of native freshwater mussel species identified from 50 sampling sites in the Arkansas portion of Bayou Bartholomew. Site number increases from upstream to downstream. See Appendix for locality information. Numbers of dead mussels (i.e., valves) shown in parentheses.

	Sites																
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Amblema plicata											7(2)	13(1)	11(1)			1(1)	37(4)
Anodonta suborbiculata												5			1	1	
Arcidens confragosus												1				2(2)	
Elliptio dilatata																	
Fusconaia ebena																	
Fusconaia flava													1				8(9)
Lampsilis abrupta																	
Lampsilis cardium																	
Lampsilis hydiana																1	
Lampsilis teres			4				1(4)	1(1)	2	4(40)	8(3)		32(4)	(3)	27(13)	17(5)	10
Leptodea fragilis																16(19)	7(5)
Ligumia recta																	
Ligumia subrostrata			(1)				7(5)	14(7)	(1)	2(3)		4(4)				5(10)	
Megalonaias nervosa												1					27(2)
Obliquaria reflexa																	
Obovaria jacksoniana																	
Plectomerus dombeyanus											14(1)		8(1)			4	79(7)
Pleurobema rubrum																	
Potamilus purpuratus													(1)		(1)	4	15(10)
Pyganodon grandis							(7)				7(1)	2(1)	(1)		3	13(8)	3(2)
Quadrula apiculata																	
Quadrula metanevra																	
Quadrula nodulata																	
Quadrula pustulosa											(1)	2	(1)		4		13(1)
Quadrula quadrula															1	2	2
Quadrula verrucosa												(1)				3	
Strophitus undulatus																	
Toxolasmus parva	1	1(1)	1(1)	1			18(5)	13(8)	(2)	14(22)	(2)				3(2)	18	
Toxolasmus texasensis			1					2(5)				16(3)	2			2(4)	3(1)
Truncilla donaciformis																	
Truncilla truncata															2	6	
Uniomerus declivis								3(1)		16	(1)				(1)		3(2)
Uniomerus tetralasmus	17(1)																
Utterbackia imbecillis							3(3)	10			(1)					7(2)	(1)
Villosa lienosa																	

TABLE 2. (Continued)

	Sites																
Species	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Amblema plicata	135(9)	35(8)	26(18)	83(6)	92(17)	78(1)	13(13)	72(10)	57(2)	78(11)	56(7)	2	57(37)	36(10)	1(32)	37(16)	16(4)
Anodonta suborbiculata																	
Arcidens confragosus	1	2	5	3	5(1)	2(3)	(1)	1	1	3		3	1	5	(1)	5(1)	(1)
Elliptio dilatata			(3)			(1)	1				(4)		2(5)	3(4)	(1)	1(4)	
Fusconaia ebena													(1)	(1)			
Fusconaia flava	34(9)		10(19)	15(2)	14(1)	1(2)	17(8)	15	2	4	26	1	52(19)	102(17)	(7)	3(11)	(2)
Lampsilis abrupta																	
Lampsilis cardium													3(1)	6(2)			
Lampsilis hydiana					5			(1)					2				
Lampsilis teres	2(1)	7(4)	7(5)	6(8)	13(3)	5(9)	2	2(3)	(6)	2(1)	6(1)	3	18(3)	17(6)	1	4(3)	(11)
Leptodea fragilis	5(11)	2(1)	8(8)	5	7(5)	(6)	1(2)	2(2)	7(6)		4	1(1)	5	12(1)	1(1)	2(1)	2(4)
Ligumia recta																	
Ligumia subrostrata																	
Megalonaias nervosa	39(6)	5(2)	51(6)		48(2)		56	5(1)	11		28(3)	7	42(12)	78(11)	3(13)	20(4)	21(4)
Obliquaria reflexa						4(1)		(1)	2				(2)			1(1)	
Obovaria jacksoniana			1													(1)	
Plectomerus dombeyanus	71(5)	77(31)	67(52)	42(6)	105(9)	57(18)	42(25)	55(13)	37(6)	55(2)	32(4)	7	31(10)	27(3)	11(10)	22(10)	29(6)
Pleurobema rubrum					1								(3)			(1)	
Potamilus purpuratus	29(5)	22(4)	2(3)	17(3)	3	7(2)	1(1)	3(1)	2	3	1(1)	2	2(4)	4(2)	1(1)	(5)	1(6)
Pyganodon grandis		2		(1)	1(1)	1		1		2		2			2		
Quadrula apiculata	34(1)				1									3		3	
Quadrula metanevra																	
Quadrula nodulata	3												1			(3)	
Quadrula pustulosa	11	6(2)	18(51)	1	18(4)	4(1)	9(10)	1	17(2)	5	47(3)	1	60(47)	96(3)	1(9)	6(21)	(6)
Quadrula quadrula	28	4	8(10)	1(1)	10(1)	15(2)	1	1	5(1)	2	6		19(3)	41(1)	(4)	14(4)	5(2)
Quadrula verrucosa	48(7)	1(2)	6(4)	4	21(5)	3(1)	1(1)	2(1)	8(2)	(1)	20(9)		17(6)	35(1)	(2)	2(2)	
Strophitus undulatus																	
Toxolasmus parva				3							(1)	4	2	2			
Toxolasmus texasensis		(1)				1		1	1		1	(1)	1				
Truncilla donaciformis																	
Truncilla truncata	42(14)		5	1	3(2)	(3)		1	1(1)		4		9	6		2	1
Uniomerus declivis	(4)		1(1)		1(4)	2(2)				1			3(1)	(1)			
Uniomerus tetralasmus																	
Utterbackia imbecillis												1					
Villosa lienosa	1												1	1			

TABLE 2. (Continued)

	Sites																
Species	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	
Amblema plicata	21(4)	1(4)	2(1)	32(24)	24(7)	17(6)	3(1)	1(15)	11(12)	40(2)	72(19)	22(17)	21(3)	68(27)	35(30)	8(7)	
Anodonta suborbiculata																	
Arcidens confragosus		4	1		(1)	1			1	1	1(1)	(1)			4	3	
Elliptio dilatata		(1)						(7)		2(1)	(6)	(8)	3	6	26(21)	5(14)	
Fusconaia ebena						3(1)		(2)				1(2)	1(1)	2	6(31)	(17)	
Fusconaia flava	(3)	4(4)		1(19)		7	2	1(19)	(1)	4	6(12)	17(9)	24(31)	24(18)	64(7)	38(10)	
Lampsilis abrupta															(4)		
Lampsilis cardium															(1)		
Lampsilis hydiana									1						(1)		
Lampsilis teres	5(1)	10(4)	(2)	(3)	6(2)	6	2(2)			1	4	1(1)	(2)	4(1)	2(2)	1(2)	
Leptodea fragilis	10(5)	2(4)	4(8)	2(8)	2(1)	5(1)	3(1)	(1)	2(1)	(3)	3	3(2)	2(2)	1	2	2(1)	
Ligumia recta														(1)	(1)		
Ligumia subrostrata																	
Megalonaias nervosa	25(2)	1(4)	42(5)	28(3)	17(2)	14(4)	28	2(4)	18(2)	308(10)	241(7)	63(1)	122(8)	118(12)	79(13)	24(14)	
Obliquaria reflexa	2							1	(1)						1	1	
Obovaria jacksoniana	(1)			(1)								1			(2)		
Plectomerus dombeyanus	47(17)	4(16)	10(1)	17(24)	31(4)	9	4	1(30)	10(25)	9(1)	24(8)	13(13)	18	16(39)	15(71)	17(6)	
Pleurobema rubrum				(1)		9(4)		(1)		2(1)	11(4)	1(4)	19(11)	(4)	29(54)	2(20)	
Potamilus purpuratus	3	6(2)	2	2(1)	1	2(1)	2		1(1)			1	1(1)	1	2		
Pyganodon grandis							1										
Quadrula apiculata										5	3		2	4	7	(1)	
Quadrula metanevra										(1)	1	(2)	(2)	(1)	11(13)	3(6)	
Quadrula nodulata	1			(1)				(1)						(1)	1(1)		
Quadrula pustulosa	14(7)	(4)		3(11)	(4)	11(4)	10(1)	6(6)	(2)	23(1)	31	11(9)	81(4)	48(14)	64(20)	32(10)	
Quadrula quadrula	10(1)	6		4(1)	(1)	6	1	(3)	(1)	6	1	11(1)	3(1)	3(2)	13(2)	3(1)	
Quadrula verrucosa	6(3)	(1)		1(1)		4(1)	4	5(1)		10	1	1(3)	1		15(6)	18(9)	
Strophitus undulatus											(1)						
Toxolasmus parva																	
Toxolasmus texasensis			(1)														
Truncilla donaciformis															3	1	
Truncilla truncata		(1)						3		2(1)		1		2	8	4(3)	
Uniomerus declivis	(2)																
Uniomerus tetralasmus											1	(1)					
Utterbackia imbecillis	(1)				1												
Villosa lienosa																	

TABLE 3. Species richness (S), Shannon diversity (H'), Pielou's evenness (J), and catch per unit effort (CPUE) for freshwater mussel assemblages at 50 sampling sites in the Arkansas portion of Bayou Bartholomew. Indices were calculated for both live and dead mussels (i.e., valves) combined and live mussels only. Site number increases from upstream to downstream. CPUE was calculated as the total number of mussels encountered at each site divided by the total number of hours surveying each site.

	Live and Dead			Live only					Live and Dead			Live only			
Site	S	H'	J	S	H'	J	CPUE	Site	S	H'	J	S	H'	J	CPUE
1	2	0.21	0.30	2	0.21	0.31	6.33	26	14	1.98	0.75	13	1.83	0.71	88.50
2	2	0.64	0.92	1	-	-	1.50	27	11	1.28	0.53	10	1.27	0.55	85.00
3	4	1.12	0.88	3	0.87	0.79	4.00	28	14	2.10	0.80	12	2.03	0.82	132.00
4	1	-	-	0	-	-	0.33	29	13	2.34	0.91	12	2.25	0.90	18.00
5	0	-	-	0	-	-	-	30	23	2.29	0.73	20	2.31	0.77	160.67
6	0	-	-	0	-	-	-	31	19	2.27	0.77	17	2.23	0.79	179.00
7	5	1.44	0.89	4	0.99	0.71	26.50	32	13	1.96	0.77	8	1.57	0.75	102.00
8	6	1.54	0.86	5	1.25	0.77	21.67	33	18	2.33	0.81	14	2.07	0.78	105.00
9	3	1.04	0.95	0	-	-	2.50	34	11	1.98	0.82	7	1.46	0.75	121.00
10	4	1.17	0.84	4	1.13	0.82	50.50	35	15	2.08	0.77	11	1.97	0.82	95.50
11	9	1.75	0.80	4	1.34	0.97	49.00	36	13	2.26	0.88	9	1.99	0.91	41.50
12	9	1.72	0.79	8	1.65	0.79	18.00	37	8	1.29	0.62	6	1.02	0.57	39.50
13	8	1.29	0.62	5	1.11	0.69	63.00	38	13	1.94	0.76	9	1.57	0.71	94.00
14	1	-	-	0	-	-	1.50	39	10	1.64	0.71	7	1.44	0.74	104.00
15	9	1.20	0.55	7	1.21	0.62	58.00	40	13	2.33	0.91	13	2.37	0.92	116.00
16	16	2.33	0.84	16	2.38	0.86	51.00	41	11	1.86	0.78	11	1.79	0.75	32.50
17	13	2.04	0.80	12	1.92	0.77	83.67	42	14	2.12	0.80	8	1.82	0.88	55.00
18	16	2.28	0.82	15	2.20	0.81	185.00	43	11	1.59	0.66	7	1.45	0.74	30.00
19	12	1.61	0.65	11	1.60	0.67	109.00	44	15	1.12	0.41	13	1.05	0.41	108.50
20	15	2.10	0.77	14	2.04	0.77	131.67	45	16	1.52	0.55	14	1.34	0.51	114.50
21	13	1.72	0.67	12	1.64	0.66	69.33	46	18	2.18	0.75	14	1.78	0.68	55.25
22	18	2.09	0.72	17	2.29	0.81	202.00	47	15	1.82	0.67	13	1.67	0.65	91.00
23	16	1.88	0.68	13	1.58	0.62	116.00	48	17	1.86	0.66	13	1.71	0.67	104.25
24	12	1.73	0.70	11	1.60	0.67	102.50	49	25	2.51	0.78	20	2.39	0.80	166.74
25	16	1.57	0.57	13	1.45	0.57	97.50	50	18	2.45	0.85	16	2.20	0.79	142.00

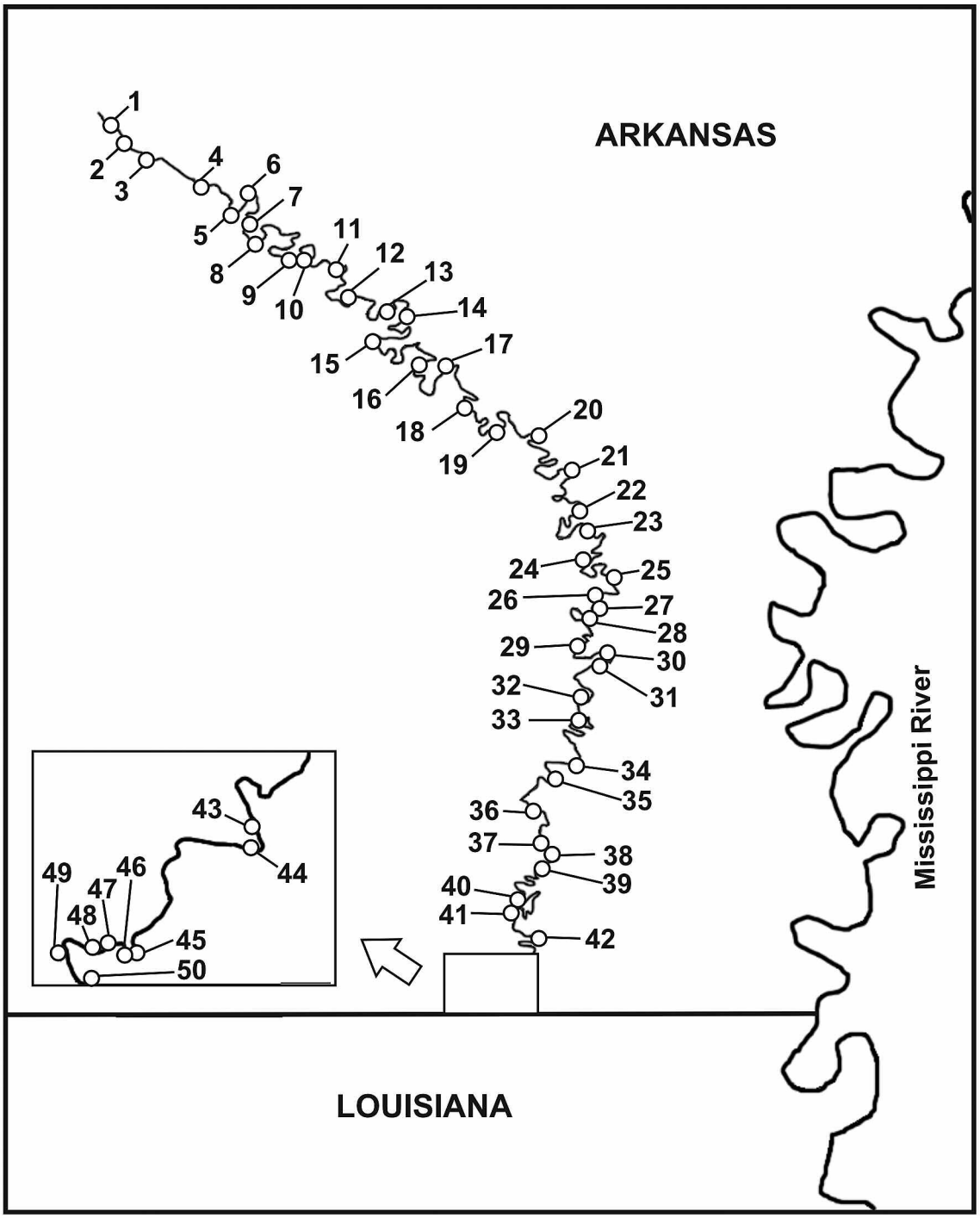

FIGURE 1. Map of the Arkansas portion of Bayou Bartholomew. Sampling sites are numbered starting at the headwaters. See Appendix for locality information.

APPENDIX. Bayou Bartholomew collection sites along with location description and date sampled.

Site 1. Hardin Rd bridge crossing, 3.7 km N of Princeton Pike, NW of Pine Bluff, Jefferson Co., AR (34.25912ºN, 92.15047ºW). 03 Sept 2004. **Site 2.** 2.4 km along Princeton Pike Rd. off Int. 530, W of Pine Bluff, Jefferson Co., AR (34.23594ºN, 92.13336ºW). 15 Oct 2004. **Site 3.** 0.4 km behind private fence at the end W 13th St., W of Pine Bluff, Jefferson Co., AR (34.21440ºN, 92.10303ºW). 17 Sept 2004. **Site 4.** Haze St. bridge crossing, 0.1 km N of 530 bypass in Pine Bluff, Jefferson Co., AR (34.17494ºN, 92.02402ºW). 03 Sept 2004. **Site 5.** 0.5 km along Behanon Rd., E of Hwy 63, S of Pine Bluff, Jefferson Co., AR (34.13651ºN, 91.98112ºW). 17 Sept 2004. **Site 6.** 1.0 km along Wilbur West Rd. off of Grider Field Rd., S of Pine Bluff, Jefferson Co., AR (34.16578ºN, 91.96042ºW). 15 Oct 2004. **Site 7.** 0.05 km off of Gibb Anderson Rd., 3.9 km off Grider Field Rd., SW of Pine Bluff, Jefferson Co., AR (34.12109ºN, 91.95349ºW). 15 Oct 2004. **Site 8.** CR 12 bridge crossing, SE of Pine Bluff, Jefferson Co., AR (34.09604ºN, 91.94732ºW). 03 Sept 2004. **Site 9.** Bridge crossing 6.0 km along CR 70 off Hwy 425,W of Tarry, Lincoln Co., AR (34.67228ºN, 91.96155ºW). 15 Oct 2004. **Site 10.** 4.2 km along CR 70, W of Tarry, Lincoln Co. AR (34.07162ºN, 91.88061ºW). 17 Sept 2004. **Site 11.** Bridge crossing 1.9 km along CR 11, N of Star City, Lincoln Co., AR (34.05941ºN, 91.83381ºW). 22 Sept 2004. **Site 12.** Hwy 425 bridge crossing at Yorktown, Lincoln Co., AR (34.02000ºN, 91.81514ºW). 04 Sept 2004. **Site 13.** 2.4 km along Bloomfield Rd off of CR 1, NW of Star City, Lincoln Co., AR (34.00131ºN, 91.76230ºN). 22 Sept 2004. **Site 14.** 6.8 km along CR 2, off of CR 1, NW of Star City, Lincoln Co., AR (33.99249ºN, 91.73670ºW). 17 Sept 2004. **Site 15.** Hwy 11 bridge crossing, N of Cane Creek Lake, Lincoln Co., AR (33.96129ºN, 91.78561ºW). 22 Sept 2004. **Site 16.** Hwy 293 bridge crossing (Person's Bridge), SE of Star City, Lincoln Co., AR (33.92592ºN, 91.71605ºW). 18 Sept 2004. **Site 17.** CR 82 bridge crossing off of Hwy 293, near Avery, Lincoln Co., AR (33.92040ºN, 91.62815ºW). 04 Sept 2004. **Site 18.** Hwy 54 bridge crossing (Garrett's Bridge), NW of Tyro, Lincoln Co., AR (33.86692ºN, 91.65615ºW). 18 Sept 2004. **Site 19.** Hwy 273 bridge crossing, SW of Gould, Lincoln Co., AR (33.83352ºN, 91.60882ºW). 24 Sept 2004. **Site 20.** CR 36 bridge crossing off of Hwy 65, W of Pickens, Desha Co., AR (33.82449ºN, 91.55177ºW). 04 Sept 2004. **Site 21.** Hwy 138 bridge crossing, 2.1 km W of Winchester, Drew Co., AR (33.77288ºN, 91.50455ºW). 18 Sept 2004. **Site 22.** CR 77 bridge crossing, W of Tillar, Drew Co., AR (33.72000ºN, 91.49610ºW). 24 Sept 2004. **Site 23.** Hwy 277 bridge crossing, 3.7 km SW of Tillar, Drew Co., AR (33.69215ºN, 91.48332ºW). 05 Sept 2004. **Site 24.** 5.1 km N of Hwy 278 on M & J Farms Rd., 6.4 mi W of McGehee, Drew Co., AR (33.64784ºN, 91.48609ºW). 26 Sept 2004. **Site 25.** Hwy 278 bridge crossing, W of McGehee, Drew Co., AR (33.62883ºN, 91.44675ºW). 05 Sept 2004. **Site 26.** 4.2 km along CR 67 off of Hwy 278, SW of McGehee, Drew Co., AR (33.60079ºN, 91.47034ºW). 09 Oct 2004. **Site 27.** 2.1 km off of CR 67, 4.2 km W of Masonville, Drew Co., AR (33.57537ºN, 91.47815ºW). 19 Sept 2004. **Site 28.** Hwy 35 bridge crossing, W of Dermott, Drew Co., AR (33.52835ºN, 091.49712ºW). 05 Sept 2004. **Site 29.** 4.3 km along Rose Hill Rd off of Hwy 165, SE of Dermott, Drew Co., AR (33.50259ºN, 91.46763ºW). 26 Sept 2004. **Site 30.** CR 59 bridge crossing off of Hwy 922, near Lake Wallace, Drew Co., AR (33.45450ºN, 91.48953ºW). 06 Sept 2004. **Site 31.** 0.4 km downstream of CR 59 bridge crossing off of Hwy 922, near Lake Wallace, Drew Co., AR (33.45473ºN, 91.49160ºW). 06 Sept 2004. **Site 32.** 5.3 km along Silver Mt. Church Rd., off of CR 52, NW of Jerome, Drew Co., AR (33.42259ºN, 91.49488ºW). 29 Sept 2004. **Site 33.** 0.5 km along Cotton Gin Rd., W of Boydell, Ashley Co., AR (33.36215ºN, 91.49749ºW). 08 Oct 2004. **Site 34.** CR 104 bridge crossing, NW of Montrose, Ashley Co., AR (33.34659ºN, 91.53061ºW). 29 Sept 2004. **Site 35.** Hwy 82 bridge crossing, W of Montrose, Ashley Co., AR (33.29817ºN, 91.56237ºW). 01 Oct 2004. **Site 36.** 10.1 km along Hwy160, NW of Portland, Ashley Co., AR (33.52272ºN, 091.45662ºW). 09 Oct 2004. **Site 37.** 4.2 km along Hwy 160 off of Hwy 165, W of Portland, Ashley Co., AR (33.24860ºN, 91.54837ºW). 08 Oct 2004. **Site 38.** Hwy 160 bridge crossing, W of Portland, Ashley Co., AR (33.23590ºN, 91.53512ºW). 01 Oct 2004. **Site 39.** 5.1 km along CR 48 across from Wilson Brake boat ramp, SW of Portland, Ashley Co., AR (33.21893ºN, 91.54545ºW). 07 Oct 2004. **Site 40.** 2.7 km along CR 33 off of Hwy 8, NW of Parksdale, Ashley Co., AR (33.17610ºN, 91.57961ºW). 07 Oct 2004. **Site 41.** 0.1 km off of Hwy 8, 6.6 km W of Parksdale, Ashley Co., AR (33.15835ºN, 91.59049ºW). 25 Sept 2004. **Site 42.** Hwy 8 bridge crossing, in Parksdale, Ashley Co., AR (33.12150ºN, 91.55402ºW). 25 Sept 2004. **Site 43.** 0.4 km upstream of Hwy 173 bridge crossing, NW of Wilmot, Ashley Co., AR (33.07555ºN, 91.58027ºW). 27 Aug 2004. **Site 44.** 2.4 km downstream of Hwy 173 bridge, NW of Wilmot, Ashley Co., AR (33.06750ºN, 91.58082ºW). 28 Aug 2004. **Site 45.** 5.6 km downstream of Hwy 173 bridge, W of Wilmot, Ashley Co., AR (33.02520ºN, 91.62608ºW). 28 Aug 2004. **Site 46.** 7.2 km downstream of Hwy 173 bridge, W of Wilmot, Ashley Co., AR (33.025545ºN, 91.63111ºW). 29 Aug 2004. **Site 47.** 8.0 km downstream of Hwy 173 bridge, W of Wilmot, Ashley Co., AR (33.02976ºN, 91.63848ºW). 29 Aug 2004. **Site 48.** 11.3 km downstream of Hwy 173 bridge, SW of Wilmot, Ashley Co., AR (33.02870ºN, 91.64340ºW). 29 Aug 2004. **Site 49.** 4.0 km N of AR state line on CR 365, SW of Wilmot, Ashley Co., AR (33.02450ºN, 91.65600ºW). 02 Oct 2004. **Site 50.** 0.05 km N of the AR state line at the end of CR 364, SW of Wilmot, Ashley Co., AR (33.00710ºN, 91.62750ºW). 02 Oct 2004.