

STATUS SURVEY FOR FEDERALLY LISTED ENDANGERED FRESHWATER MUSSEL SPECIES IN THE PAINT ROCK RIVER SYSTEM, NORTHEASTERN ALABAMA, U.S.A.

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ABSTRACT – The U.S. Department of Interior, Fish and Wildlife Service, Jackson Area Office contracted with the Tennessee Valley Authority to a conduct a freshwater mussel survey for federally listed endangered species known to occur in the Paint Rock River system, northeastern Alabama. Survey results will provide information necessary for future recovery and management of these species and enhance distributional information of other freshwater mussel species collected. The survey included qualitative sampling at 25 mainstem and tributary sites throughout the river system.

Forty-one mussel species were found during the present survey and three of these were relicts. Four federally listed endangered species (*Fusconaia cor*, *F. cuneolus*, *Lampsilis virescens* and *Toxolasma cylindrellus*) were reported alive or fresh-dead. Four additional federally listed species (*Lampsilis abrupta*, *Epioblasma walkeri*, *Pleurobema plenum* and *Villosa trabalis*) reported historically from the Paint Rock, were not found.

The mussel fauna and river habitat of the Paint Rock River system has not recovered from extensive stream channelization in the mid-1960s. This problem is continually aggravated by nonpoint source pollution resulting from agricultural land usage along the river. Cattle access have caused streambank erosion and destabilization of river substrate. The mussel fauna may continue to decline until appropriate measures are taken to minimize stream perturbations.

Key words: mussels, endangered species, Paint Rock River system, Alabama.

INTRODUCTION

In January 1991, the U.S. Department of Interior, Fish and Wildlife Service (USFWS), Jackson Area Office, entered into a cooperative agreement (No. 14-16-0004-90-959) with the Tennessee Valley Authority (TVA Contract No. TV-83O85V) to conduct a freshwater mussel survey in the Paint Rock River system, Alabama. The purpose of the survey was to update the current status of five federally listed endangered mussel species including: *Lampsilis abrupta*, *L. virescens*, *Toxolasma cylindrellus*, *Fusconaia cor* and *F. cuneolus*. All five species were reported during the last 15 years by TVA biologists and documented in USFWS recovery plans. Three additional federally

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listed species (*Epioblasma walkeri*, *Pleurobema plenum* and *Villosa trabalis*) are reported in the literature as occurring in the river system. Results from the present survey will provide information necessary for future recovery and management of these species and enhance distributional information of other freshwater mussel species.

Literature Review

The Paint Rock River and three of its largest tributaries (Larkin and Estill Forks, and Hurricane Creek) have a number of federally listed or candidate mussel species reported either from the literature or individual field collection records. Eight species are federally listed, three are candidate species for federal listing, and two were former candidate species which are now considered extinct. The state of Alabama also lists 14 mussel species found in the Paint Rock River system for special protection status (Table 1) (Cox, 1990). Cox did not include two federally listed endangered species (*Epioblasma walkeri* and *Pleurobema plenum*) which have not been reported from the Paint Rock since Ortmann (1925). Three extensive mussel surveys have been conducted in the Paint Rock River system (Ortmann, 1925; Isom & Yokley, 1973; and Ahlstedt, 1991). Ortmann (1925) during his study of the naiad fauna of the Tennessee River system below Walden Gorge reported 46 freshwater mussel species, including subspecies. Ortmann's species list included museum records from shell material collected by H.H. Smith, H.E. Wheeler, B. Walker, and Simpson (1914). Six mussel species in his report are now federally listed.

During the mid-1960s, Isom & Yokley (1973) reported 30 mussel species in the Paint Rock and five in Larkin Fork. Of these, three are currently listed federally. In their survey, which also included the Flint River, they reported the mussel fauna had declined by approximately 42% over the number of species reported by Ortmann.

In 1980, TVA initiated the Cumberlandian Mollusk Conservation Program (CMCP) to update the status of Cumberlandian mussel species in selected streams in the Tennessee Valley and to identify stream reaches potentially suitable to receive mussel transplants (Jenkinson, 1981). The Paint Rock River and tributaries (Estill Fork and Hurricane Creek) were extensively surveyed in 1980 (Ahlstedt, 1991). Twenty-five mussel species were found, including four federally listed endangered species. One additional federally endangered species, *Lampsilis abrupta* (one specimen), was later found in the lower Paint Rock (PRRM 17.0) in 1983 by USFWS and TVA biologists (USFWS 1985a). This

TABLE 1. Endangered, threatened, and other sensitive status mussel species known from the Paint Rock River drainage (Cox, 1990).

Scientific Name	Common Name	Status	
		Federal	Alabama
<i>Actinonaias pectorosa</i>	pheasantshell	—	Endangered
<i>Alasmidonta marginata</i>	elktoe	—	Special concern
<i>Epioblasma biemarginata</i>	angled riffleshell	Former candidate	Extinct
<i>Epioblasma lenior</i>	narrow catspaw	Former candidate	Extinct
<i>Epioblasma triquetra</i>	snuffbox	—	Endangered
<i>Fusconaia barnesiana</i>	Tennessee pigtoe	—	Endangered
<i>Fusconaia cuneolus</i>	fine-rayed pigtoe	Endangered	Endangered
<i>Fusconaia cor</i>	shiny pigtoe	Endangered	Endangered
<i>Lampsilis abrupta</i>	pink mucket	Endangered	Endangered
<i>Lampsilis ovata</i>	pocketbook	—	Endangered
<i>Lampsilis virescens</i>	Alabama lamp	Endangered	Endangered
<i>Lexingtonia dolabelloides</i>	slabsided	Candidate, category 2	Endangered
<i>Medionidus conradicus</i>	pearly mussel Cumberland moccasinshell	—	Endangered
<i>Obovaria subrotunda</i>	round hickorynut	—	Endangered
<i>Pleurobema oviforme</i>	Tennessee clubshell	Candidate, category 2	Endangered
<i>Ptychobranchus fasciolaris</i>	kidneyshell	—	Special concern
<i>Quadrula cylindrica</i>			
<i>cylindrica</i>	rabbitsfoot	—	Endangered
<i>Toxolasma cylindrellus</i>	pale lilliput	Endangered	Endangered
<i>Toxolasma lividus</i>	purple lilliput	Candidate, category 2	Endangered
<i>Trucilla truncatus</i>	deertoe	—	Threatened
<i>Villosa taeniata</i>	painted creekshell	—	Endangered
<i>Villosa trabalis</i>	Cumberland bean	Endangered	Endangered

was the first documentation of this species in the river.

Three site-specific surveys for freshwater mussels have been reported from the Paint Rock River. In 1981, TVA biologists conducted quantitative mussel habitat mapping at one site in the upper Paint Rock (PRRM 60.0). Ten mussel species (none endangered) were observed (Barr *et al.*, 1986). Two site assessments for mussels were performed on the Paint Rock by TVA in 1984 and 1986. During the 1984 survey at Alabama highway 72 bridge crossing (PRRM 26.5), six mussel species were moved upstream from a proposed new bridge site. One fresh-dead specimen of endangered *Fusconaia cor* was found. In 1986, a mussel survey was conducted in the Paint Rock River (PRRM 56.4) in the vicinity of a road diversion project. Ten mussel species were found in-

cluding a relict specimen of endangered *Lampsilis virescens*.

Two other sources of information concerning freshwater mussels in the Paint Rock are provided by Herb Athearn and Don Manning (personal communication). Herb Athearn's field collection records from the mid-1950s through 1969 contain four species from the Paint Rock, five from Larkin Fork, and one from Estill Fork. Three federally endangered species (*Lampsilis virescens*, *Fusconaia cor* and *Toxolasma cylindrellus*) were included in his records. Don Manning collected 29 mussel species from the Paint Rock (no site locations) in 1990, including federally endangered *Fusconaia cor*, *F. cuneolus* and *Lampsilis virescens*. Four mussel species, including endangered *Toxolasma cylindrellus*, were also reported by Manning from Larkin Fork.

Project Area

The Paint Rock River is located in northeast Alabama and flows southwest 60 river miles where it enters the Tennessee River at Tennessee River Mile (TRM) 343.2 (Wheeler Reservoir). The lower 13 miles of the river is in the impounded portion of the reservoir. The drainage area for the Paint Rock encompasses 458 square miles and borders the southern edge of the Cumberland Plateau physiographic province (TVA, 1970). Two major tributaries, Estill Fork and Hurricane Creek flow south from Tennessee and join to form the headwaters of the Paint Rock. The river is surrounded by forested mountains while the river valley floodplain is flat and almost entirely in agricultural production for soybeans, cotton, corn, milo, and beef cattle.

The freshwater mussel fauna in the Paint Rock River system was probably severely impacted by extensive stream channelization and removal of snags and riverbank timber by the U.S. Army Corps of Engineers (USACOE) during the mid-1960s. Included in the channelization project were the lowermost reaches of Larkin and Estill Forks and Hurricane Creek. The mussel fauna in the river continues to be jeopardized by siltation from agricultural nonpoint sources and bank erosion from previous channelization and poor farming practices. Another threat to the mussel fauna is the spraying of herbicides and pesticides on cotton and bean fields as well as the application of fertilizers. Cotton and bean spraying is a common practice throughout agricultural farmland in the watershed. The potential damage to aquatic organisms from runoff or the accidental spillage of chemicals when filling water tank trucks during low-flow condi-

tions at river access points may be adding to the demise of the mussel fauna in the river. It is uncertain what effects agricultural chemicals have upon juvenile or adult freshwater mussels. Mussels have never been used as test animals to determine what concentrations or levels are safe.

MATERIALS AND METHODS

Initially, the Paint Rock River was scheduled for float-survey by boat, but due to extreme low-flows, fallen trees, and drift, the river was sampled at road, ford, and foot trail access points. Topographic maps (7.5-minute) were used for navigation and sample site location.

Freshwater mussel sampling was conducted from July 15-26, 1991. Water levels were extremely low, with excellent water clarity at most sites for snorkeling. Because of time constraints and funding, sites where endangered species were previously reported were sampled first. Each site was sampled by a three-man crew consisting of a biologist and two biological technicians. Methods used for collecting mussels included snorkeling, visual searching, digging, and walking the streambanks for shells in muskrat middens.

Collecting continued in all habitats at each site (minimum three man-hours) until the crew leader was satisfied that no additional species were present. At sites reported to contain endangered species, six man-hours was spent searching for and determining the areal extent of the population. All freshwater mussels encountered were sorted by species, identified by the crew leader, and counted. Records kept on the qualitative search included site location, number of man-minutes of search time, collection techniques, and numbers of live, fresh-dead (shells with shiny nacre and meat present), and relict (dull nacre, broken shell) specimens of each mussel species found. Live specimens were returned to suitable habitat at the site. Fresh-dead and relict shells were labeled and taken to the TVA Aquatic Biology Lab in Norris, Tennessee for cataloging and storage. All live and fresh-dead endangered mussel species were photographed, measured to the nearest 0.1 millimeter using a dial caliper, and aged. Measurements taken included maximum anterior-posterior length, maximum height from anterior of umbos to ventral margin, and maximum thickness across the two valves. Age of each species was determined by counting the external growth increments (annuli) on the shell. Because of the scarcity and the amount of time spent searching for endangered freshwater mussels, no quantitative samples were taken.

RESULTS AND DISCUSSION

Mussel sampling was conducted for federally listed endangered species at 25 sites in the Paint Rock River system: 18 sites in the Paint Rock River, one in Larkin Fork, two in Estill Fork, and four in Hurricane Creek (Table 2, Fig. 1).

A total of 41 mussel species (1370 specimens) were found including: 35 species in the Paint Rock, 7 in Larkin Fork, 10 in Estill Fork, and 15 in Hurricane Creek (Table 3). Fresh-dead shells were so recent with meat still present in shell that both live and fresh-dead to-

TABLE 2. Location of all freshwater mussel collecting sites in Paint Rock River (PRRM), Larkin Fork (LFRM), Estill Fork (EFRM), and Hurricane Creek (HCM), July 1991.

Site	River Mile	Location
PRRM		
1	13.3	Buck Ford – Madison/Marshall County, Ala.
2	16.0	Fishtrap Ford – Madison/Marshall County, Ala.
3	16.9	Near Maple Ford at Whittaker Narrows – Marshall County, Ala.
4	20.9	Butler Mill – Madison/Marshall County, Ala.
5	24.5	Hellum Ford – Madison County, Ala.
6	26.4	Downstream U. S. Route 72 bridge – Jackson County, Ala.
7	30.5	Ford in town of Paint Rock – Jackson County, Ala.
8	32.5	Upstream from Cole Spring Branch – Jackson County, Ala.
9	38.7	Walker Mill Ford – Jackson County, Ala.
10	43.1	Upstream Paint Rock River oxbow – Jackson County, Ala.
11	44.8	Upstream bridge at Little Nashville – Jackson County, Ala.
12	46.3	Ford upstream from private bridge construction – Jackson County, Ala.
13	47.9	One mile downstream from bridge at Hollytree Jackson County, Ala.
14	50.4	1.5 miles upstream from bridge at Hollytree Jackson County, Ala.
15	51.4	Above bridge – Jackson County, Ala.
16	59.0	Downstream of Ford – Jackson County, Ala.
17	59.6	Ford to Henshaw Cove – Jackson County, Ala.
18	60.0	Confluence of Estill Fork and Hurricane Creek – Jackson County, Ala.
LFRM		
19	0.5	State Route 65 Bridge – Jackson County, Ala.
EFRM		
20	0.1	Above Paint Rock River Confluence – Jackson County, Ala.
21	1.1	Freedom Bridge – Jackson County, Ala.
HCM		
22	0.1	Above Paint Rock River confluence – Jackson County, Ala.
23	1.6	Ford to Anderson Cemetary – Jackson County, Ala.
24	3.0	Ford to Bishop Spring – Jackson County, Ala.
25	4.0	Private Ford – Jackson County, Ala.

tals were combined. Age and growth measurements for federally listed endangered species are presented in Table 4.

Nineteen species were represented by five or fewer specimens; however, the rarity of six of these species (*Anodonta grandis*, *Ellipsaria lineolata*, *Lampsilis teres*, *Ligumia recta*, *Quadrula metanevra* and *Quadrula nodulata*) can be attributed to stream size since all are more often associated with larger rivers. Three of the 19 species (*Lasmigona complanata*, *Quadrula quadrula* and *Truncilla donaciformis*) were reported as relicts (stained or broken shells), and are also components of larger streams.

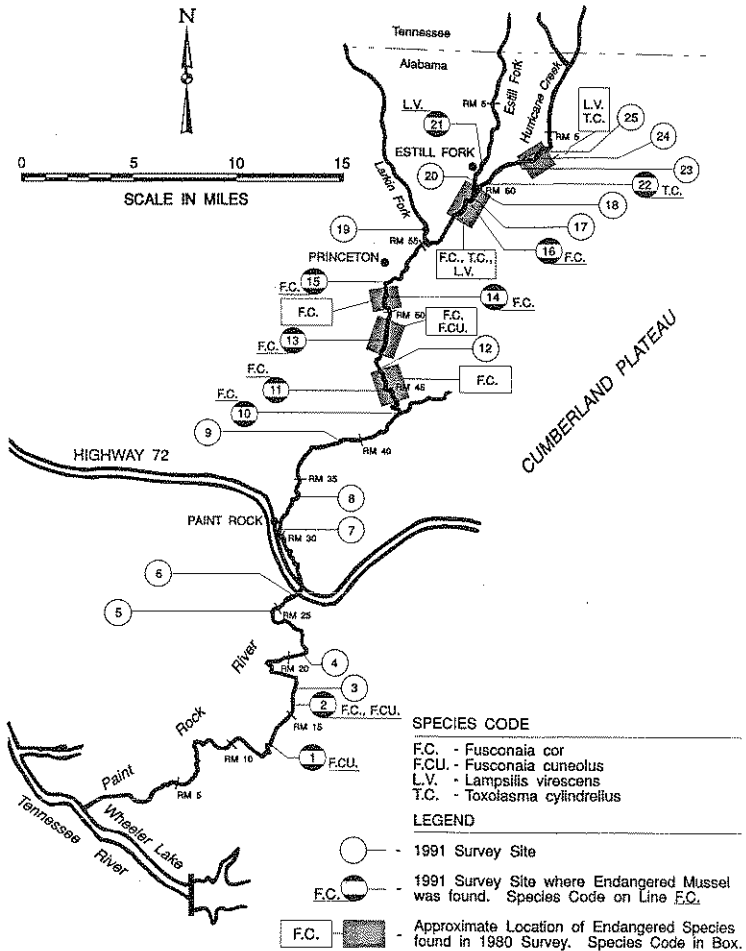


FIG 1. Paint Rock River, Larkin Fork and Hurricane Creek mussel sampling sites.

The single specimen of *Lasmigona holstonia*, a small headwaters species is a new record for the drainage with one live specimen found in Hurricane Creek (site 25).

The most abundant species found was *Lexingtonia dolabelloides* which comprised 23 percent of the total, followed by *Amblema plicata* (13%), *Villosa iris* (8%) and *Potamilus alatus* (8%). Sites 2, 4 and 10 (Table 3) contained the most diverse fauna with between 18 and 20 mussel species. Some pool habitats downstream from site 10 contained good concentrations of *Cyclonaias tuberculata*, *Amblema plicata* and *Potamilus alatus*. These species are more typically found in deeper pools con-

TABLE 3. Paint Rock River, Larkin Fork, Estill Fork, and Hurricane Creek qualitative mussel survey data.

Species	Paint Rock River														
	Site River Mile	1 13.3	2 16.0	3 16.9	4 20.9	5 24.5	6 26.4	7 30.5	8 32.5	9 38.7	10 43.1	11 44.8	12 46.3	13 47.9	14 50.4
<i>Alasmidonta viridis</i>															
<i>Amblyema plicata</i>	5			1	9	6	1	2	17	14	68		R	1	6
<i>Anodonta grandis</i>															
<i>Cyclonaias tuberculata</i>	6	10	47	7	10			3	7		7		R		2
<i>Epioblasma triquetra</i>	2	6	2	2	2										
<i>Elliptaria lineolata</i>	1		2					1							
<i>Elliptia dilatata</i>						1									
<i>Elliptia crassidens</i>	2	3	2	2					1		2				
<i>Fusconia barnesiiana</i> *															
<i>Fusconia cor</i> *+			2				R	R			21	1	R	1	1
<i>Fusconia cuneobus</i> *+	1	1													
<i>Lampsilis fasciola</i>		5	3	2	1		1			R	5			R	1
<i>Lampsilis ovata</i>	4	4	1	5				2	4	1	16	1	2	2	3
<i>Lampsilis teres</i>	2				2										
<i>Lampsilis virescens</i> *+															
<i>Lasmigona complanata</i>										R					
<i>Lasmigona costata</i>				1	1		R	1	1		23			1	2
<i>Lasmigona holstonia</i> *															
<i>Leptodan fragilis</i>		3			2			1	2						
<i>Lexingfonia dolabelloides</i> *	10	53	13	21	10			3	1		26		2		
<i>Ligumia recta</i>			1												
<i>Medionidus conradicus</i> *															
<i>Megalomaias nervosa</i>	3	7	16	8	3	1	2	4	5		2				
<i>Obliquaria reflexa</i>	4	1	1	1				4	R		26				
<i>Obovaria subrotunda</i>								R			1			R	
<i>Pleurobema cordatum</i>		R	7						1						

TABLE 4. Individual measurements of federally listed endangered mussel species found during the freshwater mussel survey of the Paint Rock River system, July 1991.

Sites	River	Mile	Species	Length	Height	Thickness	Age
1	PRRM	13.3	<i>Fusconaia cuneolus</i>	46.3	39.3	26.6	13
2	PRRM	16.0	<i>Fusconaia cuneolus</i>	49.6	38.4	23.5	14
			<i>Fusconaia cor</i>	43.8	35.2	20.5	12
			<i>Fusconaia cor</i>	22.2	18.4	12.0	4
10	PRRM	43.1	<i>Fusconaia cor</i>	40.4	32.8	19.3	7
			<i>Fusconaia cor</i>	54.6	46.6	25.4	11
			<i>Fusconaia cor</i>	69.0	54.9	31.1	25+
			<i>Fusconaia cor</i>	71.4	55.4	28.3	25+
			<i>Fusconaia cor</i>	33.3	25.9	16.5	5
			<i>Fusconaia cor</i>	58.6	47.8	28.0	15
			<i>Fusconaia cor</i>	66.5	51.1	29.0	18
			<i>Fusconaia cor</i>	71.4	60.7	35.4	25
			<i>Fusconaia cor</i>	50.1	40.6	21.1	11
			<i>Fusconaia cor</i>	60.0	46.3	26.8	18
			<i>Fusconaia cor</i>	56.8	44.7	27.4	20
			<i>Fusconaia cor</i>	56.1	47.5	29.7	17
			<i>Fusconaia cor</i>	66.6	51.8	33.7	23
			<i>Fusconaia cor</i>	70.3	55.8	33.0	23
			<i>Fusconaia cor</i>	67.0	51.9	31.9	19
			<i>Fusconaia cor</i>	70.1	54.9	31.3	16
			<i>Fusconaia cor</i>	70.5	57.2	32.5	19
			<i>Fusconaia cor</i>	61.9	49.9	28.5	17
			<i>Fusconaia cor</i>	78.2	60.2	35.6	23
			<i>Fusconaia cor</i>	75.6	55.1	30.1	22
11	PRRM	44.8	<i>Fusconaia cor</i>	69.0	49.2	32.6	20+
13	PRRM	47.9	<i>Fusconaia cor</i>	66.3	50.8	28.7	18
14	PRRM	50.4	<i>Fusconaia cor</i>	72.7	61.7	39.0	30+
15	PRRM	51.4	<i>Fusconaia cor</i>	64.8	52.1	29.8	20+
16	PRRM	59.0	<i>Fusconaia cor</i>	40.1	30.9	18.7	12
			<i>Fusconaia cor</i>	41.3	31.0	19.8	12
			<i>Fusconaia cor</i>	48.2	36.8	19.3	14
21	EFRM	1.1	<i>Lampsilis virescens</i>	73.1	27.3	27.2	11
22	HCRM	0.1	<i>Toxolasma cylindrellus</i>	31.4	18.6	11.3	6

taining loose sand, mud, and silt. At sites 12, 14 and 21, blue-green algae covered the river substrate in shallow pools, and this was especially a problem in Estill Fork (site 21). At stream access fords the mussel fauna is depressed for a considerable distance downstream, suggesting severe impacts from possible spillage of agricultural chemicals during the filling of tank trucks used for spraying farm crops. Mussels were usually found upstream from access fords.

The Paint Rock River system was channelized in the mid-1960s and

riffle and shoal habitats have not stabilized. Shifting substrate is a problem in the drainage and probably a major factor affecting riffle-dwelling mussels, especially Cumberlandian species. Flooding is also a problem in the drainage system. The Paint Rock River experienced close to a 100 year flood event in spring 1991 (Don Porter, TVA personal communication). As a result of the flood, live and dead mussels (including endangered species) were observed stranded in pools on top of gravel bars, and in many instances mussels and substrate were carried out of the streambed and deposited onto islands and shoal habitats. Streambanks were heavily scoured in some areas with no vegetation to keep the banks from collapsing. Cattle access has pockmarked and destabilized river substrate and streambanks at a number of sites, especially in Larkin and Estill Forks (sites 19 and 21), and Hurricane Creek (site 23). Cow manure was also observed covering river substrate in Hurricane Creek (site 23) and numerous dead shells of *Amblema plicata* were found in Estill Fork (site 21), upstream from the area where cattle frequent. Judging by the condition of relict shells, the mussels had been dead for a long time.

Commercial mussel fishermen harvest shell from the lower 40 miles of the Paint Rock River in search of commercially valuable washboards (*Megaloniaias nervosa*), three-ridge (*Amblema plicata*), and pigtoes (*Pleurobema cordatum*). One landowner near Walker Mill Ford (site 9), reported mussel fishermen collecting shell from the river in late spring. Presently, the extent of mussel fishing in the river is unknown.

Of the eight federally listed endangered species only four (*Fusconaia cor*, *F. cuneolus*, *Lampsilis virescens* and *Toxolasma cylindrellus*) were found. *Fusconaia cor* was the most numerous (14 live, 16 fresh-dead) and widespread in distribution. Of the total, twenty-one specimens (8 live, 13 fresh-dead) were found at site 10 in the Paint Rock. A long, shallow, unstable riffle extends upstream from a deep pool at this site. Streambanks in this area were characterized by deep cuts as a result of scouring from high-flows. This species was also found in low numbers from ten other sites in the Paint Rock with similar habitat conditions, and was not found in any of the tributary streams. *Fusconaia cor* is an endemic Cumberlandian riffle species, generally found in moderate to fast-flowing streams and rivers with stable substrate. The number of specimens found is encouraging, but persisting habitat perturbations threaten their continued survival. The fish hosts for *F. cor* have been tentatively identified as the common shiner (*Luxilus cornutus*) and whitetail shiner (*Cyprinella galactura*) (Kitchel, 1983; USFWS 1984b). Both fish species are present in the Paint Rock River (Charles Saylor, TVA, personal communication).

Fusconaia cuneolus was found in the lower Paint Rock with one live specimen from site 2 and one fresh-dead from site 1. Because of the rarity of this species in the river, it may be on the verge of extirpation from the Paint Rock. The single live specimen was found along the edge of water willow in unstable sand and gravel at the head of a shoal. *Fusconaia cuneolus* is closely related to *F. cor* and is also an endemic Cumberlandian riffle species typically found in moderate to fast-flowing streams which contain stable substrates (USFWS 1984c). The fish hosts for *F. cuneolus* are tentatively identified as fathead minnow (*Pimephales promelas*), river chub (*Nocomis micropogon*), central stoneroller (*Campostoma anomalum*), telescope shiner (*Notropis telescopus*), Tennessee shiner (*N. leuciodus*), white shiner (*Luxilus albeolus*), whitetail shiner (*Cyprinella galactura*), and mottled sculpin (*Cottus bairdi*) (Bruenderman 1989). At least three of these species (stoneroller, telescope shiner, and whitetail shiner) are present in the Paint Rock (Charles Saylor, TVA, personal communication).

Lampsilis virescens is an extremely rare mussel presently restricted to the Paint Rock River system. Historically in the Paint Rock, this species occurred in the upper mainstem, Estill and Larkin Forks, and Hurricane Creek (USFWS 1985b). One fresh-dead and one relict specimen was found in Estill Fork (sites 21 and 20). The fresh-dead specimen was observed stranded on a sandbar at the downstream end of a pool. *Lampsilis virescens* is an endemic Cumberlandian species which probably inhabits smaller tributary streams in pools containing sand or loose substrate. The species appears to have always been uncommon or rare wherever it occurred. The possibility exists that *L. virescens* may still survive in inaccessible reaches of upper Paint Rock tributaries; however, perturbations in these streams during recent years may have already reduced the only known extant population of this species to relict status. The life history for the species remains unknown.

One fresh-dead and one relict *Toxolasma cylindrellus* specimen was found at sites 22 and 24 in Hurricane Creek. Historically in the Paint Rock, this species occurred in the upper mainstem, Larkin and Estill Forks, and Hurricane Creek. This endemic Cumberlandian species inhabits smaller tributary streams and has always been considered uncommon or rare (USFWS 1984a). Stansbery (1976) reported collecting 26 shells of *T. cylindrellus* from a muskrat midden in Larkin Fork during 1966. This is the largest known collection of specimens reported for the species, and during that time, it may have been an indication of how common the species was in Larkin Fork before

channelization. Virtually nothing is known about the habitat requirements of *T. cylindrellus*; however, *T. lividus* overlaps in distribution and may live in similar habitat with *T. cylindrellus* in the Paint Rock. Numerous specimens of *T. lividus* were found living in pools, along the edge of water willow, and in sand or fine gravel in the stillwater zone along the very edges of the streambank almost out of the water. The fish host(s) for *T. cylindrellus* are unknown, but host species have been identified for *T. lividus* including, the longear sunfish (*Lepomis megalotis*) and green sunfish (*Lepomis cyanellus*) (Hill 1986). Both fish species occur in the Paint Rock (Charles Saylor, TVA, personal communication). The possibility exists that other populations of *T. cylindrellus* may still be present in inaccessible reaches of upper Paint Rock tributaries since the mussel is often associated with headwaters streams. However, because of stream perturbations, the continued survival of this species remains tenuous.

The remaining four federally listed endangered species (*Lampsilis abrupta*, *Epioblasma walkeri*, *Pleurobema plenum*, and *Villosa trabilis*) were not found. Both *L. abrupta* and *P. plenum* are big river species which occasionally occur peripherally in larger tributaries (USFWS 1984d). Habitat is available for both species in the lower reaches of the Paint Rock and both may still be present. *Lampsilis abrupta* was first reported from the lower Paint Rock River in 1983 (USFWS 1985a), when one five-year-old specimen was collected fresh-dead from a muskrat midden. *Pleurobema plenum* was reported historically from the Paint Rock by Ortmann (1925) and has not been found since. A closely related big river species, *Pleurobema cordatum*, occurs in the lower Paint Rock and suggests that *P. plenum* may also continue to survive in the river since both species have overlapping distributions. *Pleurobema plenum*, *P. cordatum* and *L. abrupta* occur a short distance downstream in the impounded reaches of the Tennessee River (Wheeler Reservoir) as well, so host fish species have potential access to the lower Paint Rock. Fish host(s) for *P. plenum* are unknown; however, the sauger (*Stizostedion canadense*) is reported in the literature as one host for *L. abrupta* (Coker *et al.*, 1921).

The remaining two endangered Cumberlandian species that were not found in the Paint Rock River are *Epioblasma walkeri* (USFWS 1984e) and *Villosa trabilis* (USFWS 1984f). It is believed that both species no longer occur in the river, since no specimens or shell fragments were found. Freshwater mussels in the genus *Epioblasma* sp., many of which are endemic Cumberlandian riffle species, have suffered drastic declines because of poor water quality and habitat degradation

throughout their range during the last 50 years. Only one *Epioblasma* species (*E. triquetra*) was found (12 fresh-dead) specimens in the lower Paint Rock. This species is more widespread and not endemic in distribution but is becoming increasingly rare throughout its range. Fish host(s) for *E. walkeri* are unknown.

Villosa trabalis is also believed extirpated from the Paint Rock although two *Villosa* species (*Villosa vanuxemensis* and *V. iris*) survive in the river system. Six fish species of darters (*Etheostoma virgatum*, *E. obeyesense*, *E. olivaceum*, *E. kennicotti*, *E. simoterum* and *E. flabellare*) are identified as fish hosts for *V. trabalis* (Jim Layzer, USFWS, personal communication). Three of these fish species (*E. kennicotti*, *E. simoterum* and *E. flabellare*) are reported from the Paint Rock (Barr *et al.*, 1986).

Population Structure of Endangered Species

Lengths of 29 *Fusconaia cor* specimens measured ranged from 22.2 to 78.2 millimeters and included individuals in each ten millimeter interval between these extremes (Table 4). Age of specimens varied from 4 to 30# years with specimens in the 20-50 mm (4-11 years). This is an indication of limited reproduction in the Paint Rock. All measured specimens appeared healthy with excellent growth increments and no shell erosion.

Shell lengths and age of two (one live, one fresh-dead) of *Fusconaia cuneolus* were similar 49.6 mm (14 years) and 46.3 mm (13 years), respectively. Both individuals were in excellent condition showing good growth and little shell erosion. This species is presently restricted in distribution to the lower Paint Rock.

The remaining two endangered species, *Lampsilis virescens* and *Toxolasma cylindrellus*, were found only as single fresh-dead specimens. Shell length for *L. virescens* from Estill Fork was measured at 73.1 mm and aged at 11 years and *T. cylindrellus* reported from Hurricane Creek measured 31.4 mm in length and aged at 6 years. Both species appear near extirpation in these tributary streams.

SUMMARY

Forty-one mussel species were reported from the Paint Rock River system at 25 collecting sites. The most abundant species was *Lexingtonia dolabelloides*, followed by *Amblema plicata*, *Villosa iris* and *Potamilus alatus*. Deeper pools in the Paint Rock contained populations of *Cyclonaias tuberculata*, *Amblema plicata* and *Potamilus alatus*. Nineteen species were represented by five or fewer specimens, and three of these (*Lasmigona*

complanata, *Quadrula quadrula* and *Truncilla donaciformis*) were relicts. One species, *Lasmigona holstonia*, is a new record for this drainage.

Four of the eight federally listed endangered mussel species reported from the Paint Rock River system were found during the present survey. *Fusconaia cor* and *F. cuneolus* were both found alive only in the Paint Rock River. *Fusconaia cor* was the most abundant (30 specimens) and included ages ranging from 4 to 30 years. The two specimens of *F. cuneolus* were aged at 13 and 14 years. One fresh-dead specimen of *Lampsilis virescens* reported from Estill Fork was aged at 11 years and one fresh-dead specimen of *Toxolasma cylindrellus* found in Hurricane Creek was aged at six years. Both mussel species are extremely rare and may be on the verge of extirpation from these streams.

The mussel fauna and river habitat of the Paint Rock River system has not recovered from extensive stream channelization, snag removal, and riverbank clear-cutting in the mid-1960s. Substrate in riffles and shoals have not stabilized and in many instances flooding has resulted in deposition of mussels on islands or into depressions adjacent to river channels. Cattle access to the river and tributary streams is a problem because of streambank erosion and river substrate destabilization. At stream access fords the mussel fauna is depressed for a considerable distance downstream suggesting severe impacts from spillage of agricultural chemicals during the mixing with water in tank trucks. Mussels were usually found upstream from access fords, but not for a considerable distance downstream.

Because of nonpoint source pollution from agricultural land usage in the Paint Rock River system and destabilization of river substrate, riffle species are especially vulnerable. It appears that the mussel fauna is trying to make a recovery in the Paint Rock but is periodically affected by these activities. In general, the mussel fauna may continue to decline until appropriate measures are taken to minimize stream impacts.

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LITERATURE CITED

- AHLSTEDT, S. A. 1991. Cumberlandian Mollusk Conservation Program: Mussel surveys in six Tennessee Valley streams. *Walkerana*, 5(13): 123-160.
- BARR, W.C., AHLSTEDT, S.A., HICKMAN, G.D. & HILL, D.M. 1986. Cumberlandian

- Mollusk Conservation Program, Activity 8: Analysis of Macrofauna Factors. Tennessee Valley Authority, Division of Air and Water Resources and Division of Services and Field Operations. Knoxville, Tennessee. TVA/ONRED/AWR-86/23. 96 pp.
- BRUENDERMAN, S.A. 1989. Life history of the endangered fine-rayed pigtoe pearly mussel *Fusconaia cuneolus* (Lea 1840), in the Clinch River, Virginia. Master's Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 114 pp.
- COKER, R.E., SHIRA, A.F., CLARK, H.W. & HOWARD, A.D. 1921. Natural history and propagation of freshwater mussels. Bulletin U.S. Bureau Fisheries, 37: 77-181. Separately issued as Bureau Fisheries Document No. 893.
- COX, J.P. 1990. Surface water resources issues analysis: Wheeler Reservoir Watershed Region. Tennessee Valley Authority, Resource Development, River Basin Operations, Water Resources. Chattanooga, Tennessee. TVA/WR/WQ-90-6. 41 pp., Appendixes A47-F121.
- HILL, D.M. 1986. Cumberlandian Mollusk Conservation Program, Activity 3: Identification of Fish Hosts. Tennessee Valley Authority, Office of Natural Resources and Economic Development. Knoxville, Tennessee. 57 pp.
- ISOM, B.G. & YOKLEY, P. Jr. 1973. The mussels of the Flint and Paint Rock River systems of the southwest slope of the Cumberland Plateau in north Alabama - 1965 and 1967. *The American Midland Naturalist*, 89(2): 442-446.
- JENKINSON, J.J. 1981. The Tennessee Valley Authority Cumberlandian Mollusk Conservation Program. *Bulletin of the American Malacological Union*, 1980:62-63.
- KITCHELL, H.E. 1983. The life history of *Fusconaia edgariana* (Mollusca: Bivalvia) from the North Fork Holston River, Smyth County, Virginia. Master's Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 118 pp.
- ORTMANN, A.E. 1925. The naiad fauna of the Tennessee River system below Walden Gorge. *The American Midland Naturalist*, 9:3 21-372.
- SIMPSON, C.T. 1914. A descriptive catalog of the naiades, or pearly freshwater mussels. Bryant Walker, Detroit, Michigan. 1540 pp.
- STANSBERY, D.H. 1976. Status of endangered fluviatile mollusks in central North America: *Toxolasma cylindrellus* (Lea 1868). Ohio State University Research Foundation, Report to Department of Interior, Fish and Wildlife Service, Bureau of Sport Fish and Wildlife. 9 pp.
- Tennessee Valley Authority. 1970. Drainage areas for streams in Tennessee River basin. Division of Water Control Planning, Hydraulic Data Branch. Knoxville, Tennessee. 116 pp.
- U.S. Fish and Wildlife Service. 1984a. Pale lilliput pearly mussel recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 46 pp.
- U.S. Fish and Wildlife Service. 1984b. Shiny pigtoe pearly mussel recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 67 pp.
- U.S. Fish and Wildlife Service. 1984c. Fine-rayed pigtoe pearly mussel recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 67 pp.
- U.S. Fish and Wildlife Service. 1984d. Rough pigtoe pearly mussel recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 51 pp.
- U.S. Fish and Wildlife Service. 1984e. Tan riffle shell pearly mussel recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 59 pp.
- U.S. Fish and Wildlife Service. 1984f. Cumberland bean pearly mussel recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 58 pp.
- U.S. Fish and Wildlife Service. 1985a. Pink mucket pearly mussel recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 47 pp.
- U.S. Fish and Wildlife Service. 1985b. Alabama lamp pearly mussel recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 41 pp.