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The recent decline of the native mussels (Unionidae) of Copper Creek, Russell and Scott Counties, Virginia

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ABSTRACT: Twenty sites within a 81-km reach of Copper Creek were surveyed in July and August 1998 to document the present status of freshwater mussel populations. Using snorkeling techniques and shoreline searches for muskrat middens, 11 species were identified from live or fresh dead specimens and an additional 6 species were represented by relict shells. Of 5 federally listed mussel species (*Epioblasma capsaeformis, Fusconaia cor, Fusconaia cuneolus, Quadrula cylindrica strigillata,* and *Villosa perpurpurea*) found in 1980, live specimens of 2 listed species (*F. cuneolus* and *V. perpurpurea*) and 1 fresh dead specimen of *F. cor* were found in 1998. At least 7 species collected in 1980 may be extirpated from Copper Creek, including *E. capsaeformis* and *Q. c. strigillata*. In 1980, Copper Creek was relatively pristine with the greatest mussel diversity occurring in the lower 19-km reach. The 1998 survey showed the greatest species loss within the same lower reach. The declining mussel fauna in Copper Creek may reflect increased watershed and stream-bank erosion due to cattle grazing and the destruction of riparian vegetation. Widespread evidence of sediment accrual and near total destabilization of the streambed were observed. Untreated household wastes were also observed entering the stream via "straight pipes."

Keywords: mussel, survey, creek, diversity, inventory

Freshwater mussel populations in Copper Creek were first surveyed in May 1980, by the Tennessee Valley Authority (Ahlstedt 1981, 1986). The 1980 survey identified 19 native mussel species, including 2 species, *Fusconaia cor* (Conrad 1834) and *Fusconaia cuneolus* (Lea 1840), listed endangered by the US Fish and Wildlife Service (USFWS). Three additional species also identified in the 1980 survey: *Epioblasma capsaeformis* (Lea 1834), *Quadrula cylindrica strigillata* (Wright 1898) and *Villosa perpurpurea* (Lea 1861), have since been added to the federal list of endangered species. The present study was initiated to assess the current status of these and other mussel populations in Copper Creek. Survey results and notes on habitat conditions are compared with conditions in 1980 and differences are also discussed.

Study Area

Located in the Ridge and Valley physiographic province of southwestern Virginia, Copper Creek is a large tributary of the Clinch River. Copper Creek is approximately 97 km long and has a drainage area of 345 square km. Copper Creek flows from its headwaters in Russell County southwest into Scott County, draining the valley between Copper and Moccasin Ridges, to its confluence with the Clinch River near Speers Ferry (Clinch River Mile 211.6). Geology of the highlands drained by Copper Creek is predominately Knox dolomite, while the central valley is Ordivician limestones with shale ridges of the Russell formation in the lower end (USGS 1894). The topography of much of the upper and middle valley is characteristically karst, with steep rolling hills, sinkholes, and frequent springs and caves.

In July and August 1998, 20 sites were surveyed within an 81-km reach of Copper Creek (Fig. 1, Table 1). Sites were chosen by availability of access, proximity to sites surveyed in the 1980 study, and presence of suitable mussel habitat. Fourteen sites were at the same locality as sites surveyed in 1980.

Methods

Survey methods were comparable to those used in 1980 (Ahlstedt 1986). Sites were surveyed by timed random searches using snorkeling and wading techniques. Search time averaged 3.1 person h (range =1-8 person h) and were performed within a variety of habitats favored by species previously collected in Copper Creek. Habitats intensely searched included gravel/cobble riffles and runs, gravel bars and other substrata adjacent to American water willow (*Justicia* sp.) beds, and underneath large rocks in runs and shallow pools. Shorelines were searched for dead shells in muskrat shell middens and elsewhere. Live mussels were removed from the substrate and held underwater in mesh bags until data collection was complete. Live mussels and dead

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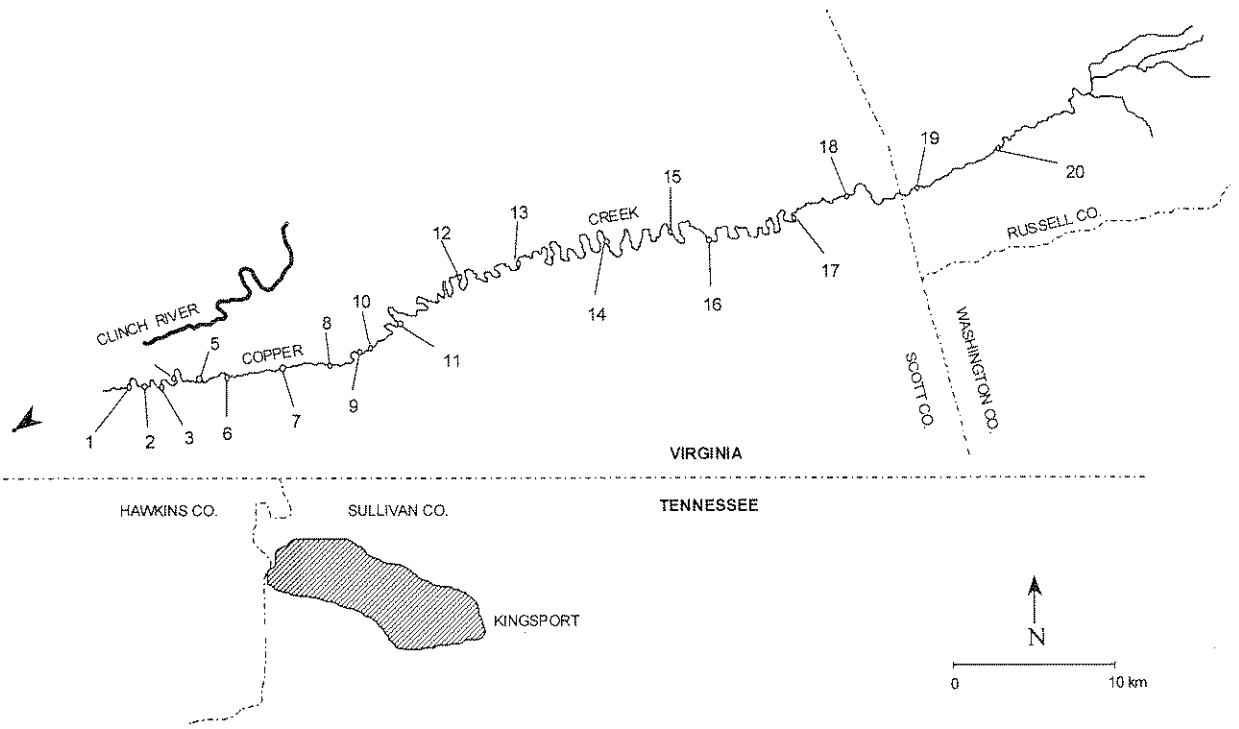

Figure 1. An illustration of Copper Creek, indicating mussel sampling sites.

shells were identified and tallied by species. Each specimen counted was recorded as live, fresh dead, or relict. Fresh dead was determined by the presence of tissue or by fresh, shining nacre; and all other shells were deemed relic. All live mussels were returned to the substrate at the approximate location they were found. Qualitative observations of instream habitat, riparian conditions, and surrounding land use were recorded in field notes at each survey site and from observations made in transit between sites. Nomenclature follows Turgeon *et al.* (1998).

Results and Discussion

Mussel populations

A total of 651 individual mussels were collected from all sites. Seventeen native species were identified from live, fresh dead, and relict specimens (Table 2). Ten species were represented by live specimens and 1 species was represented by fresh dead shells only. Relict shells of another 6 species were collected. No live or fresh dead specimens were collected for 7 species previously collected in 1980 (Table 3). Three species *Actinonaias ligamentina* (Lamarck 1819), *Fusconaia subrotunda* (Lea 1831), and *Lasmigona holstonia* (Lea 1838) represented by single relict specimens, were not reported from Copper Creek in 1980 (Ahlstedt 1981).

Live specimens of 2 federally endangered species and fresh dead shell of another were found during this survey. Present at 13 sites in 1980, *Villosa perpurpurea* was considered "relatively common" (Ahlstedt 1986). The present survey produced only 2 large, eroded specimens collected at a single locality (Site 9 CCM 13.4). One live *Fusconaia cuneolus* was found at Site 1 (CCM 1.2). A single fresh dead *Fusconaia cor* was collected at site 4 (CCM 4.3), suggesting it may persist at very low densities.

The greatest species richness was at site 9 (CCM 13.4) with 6 live species found. Overall, *Villosa iris* (Lea 1829) and *Fusconaia barnesiana* (Lea 1838) were the most common species with live specimens present at 18 and 13 sites, respectively. The remaining 8 live species were each collected at less than half of the sites.

At the 14 sites previously sampled in 1980, species richness decreased an average of 4.6 species per site between 1980 and 1998, with the greatest declines occurring in the lower reaches (Table 4). The lower sites (CCM 1.2-13.8) lost an average of 6.4 species (70%). Maximum number of species lost (15) was at site 2 (CCM 2.0). Relative abundance was also generally much lower at the lower sites (Table 2).

Mussel species diversity is typically lower in the headwaters of most streams (Starnes and Bogan 1982,

Table 1. Site locations surveyed in 1998. (CCM = Copper Creek Mile)

Site	CCM	Location	Surveyed in 1980
1	1.2	Above swinging bridge	X
2	2.0	Above VA 627 bridge	X
3	2.7	Jenning's Ford VA 627	X
4	4.3	First VA 627 access above Spivey Ford	X
5	5.8	Above swinging bridge and ford	X
6	7.7	Below Spivey Mill	X
7	9.7	Above Lark Creek	
8	11.8	Carter Cemetery	X
9	13.4	Below VA 72 bridge	
10	13.8	Above VA 72 bridge	X
11	15.5	Holland Property at bend	
12	21.0	At swinging bridge	X
13	23.9	At VA 671 bridge	X
14	29.1	At VA 674 bridge	X
15	33.2	At first VA 670 bridge below Dorton Fort	
16	34.6	Above VA 71 bridge at Dorton Fort	X
17	40.1	Below VA 682 bridge	X
18	42.0	Above VA 612 bridge	X
19	46.8	Below mouth of unnamed tributary	
20	50.3	At VA 679 ford	

Warren, *et al.* 1984). Results of the 1980 Copper Creek survey generally followed this trend (Ahlstedt 1981). Historically, the upper reaches of Copper Creek may have contained a few more species typical of smaller stream environments (e.g., *Pegias fabula* (Lea 1838); Ortmann 1918) but none have been reported. No live *Alasmidonta viridis* (Rafinesque 1820) and *Villosa vanuxemensis* (Lea 1838) and few *Medionidus conradicus* (Lea 1834) and *Lampsilis fasciola* Rafinesque 1820, were collected in this survey. Aside from these differences, the mussel assemblage in the upper 21 miles of Copper Creek has remained similar to 1980 observations. Relative abundance, inferred from catch per unit effort, were generally higher at the upper sites than at sites in the lower reach (Table 2). In particular, sites 13-18 (CCM 23.9-42.0) had substantially higher catch rates than sites both upstream and downstream.

Habitat observations

Instream habitat conditions have deteriorated since 1980. Ahlstedt (1986) described Copper Creek in 1980 as "relatively pristine and free from extensive human impacts except for some silt runoff from farmland scattered throughout the watershed." Silt runoff has since become widespread and chronic. Consequently, Copper Creek is no longer pristine. Extensive silt deposition was observed at all sites. However, site 18 (CCM 42.0) had noticeably less silt deposition, relative to the other sites. Riffle areas encountered throughout the study were generally swept clean of surface silt deposits, but interstitial spaces had large amounts of fine particles. Larger substrate constituents in run areas were highly embedded in silt, sand, and fine gravel. Pool substrates were entirely silt covered. Degradation of interstitial habitat and a general increase in siltation may have negatively impacted mussel recruitment since 1980.

Extensive movement of the substrate was evident at most sites. Formation of gravel bars and "windrow" deposition of gravel and finer sediments in the heads of pools was widespread. Many cobble shoals that appeared to be good mussel habitat were unstable and shifting underfoot, showed evidence of recent mass movement, and were generally devoid of mussels. At several sites, most mussels were found under very large slab rocks (1-1.5 m in diameter), which provide the only stable substrate in the area. Ten of the eleven live mussels collected at site 3 (CCM 2.7) were found under slab rocks.

Table 2. Number of mussel species located at each site during qualitative sampling of Copper Creek, Virginia, August 1998. (R = Relict, FD = Fresh Dead)

Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
Stream mile	1.2	2.0	2.7	4.3	5.8	7.7	9.7	11.8	13.4	13.8	15.5	21.0	23.9	29.1	33.2	34.6	40.1	42.0	46.8	50.3	
Search time (person hours)	8	4	3	3	2	3	2	4	5	4	4	2	2	3	2	4	2	2	1	2	62
Species																					
Actinonaias ligamentina	R																				R
A. pectorosa	R	R	R																		R
Amblema plicata	R	R																			R
Elliptio dilatata	2	R	1			R	R		R	R	5										8
Fusconaia barnesiana	1	2	R	3	1	1FD	7	3	15	5	R		10			1	2	4	2	12FD	56 (13FD)
*F. cor**	R	R		1FD																	1FD
*F. cuneolus**	1	R																			1
F. subrotunda								R													R
Lampsilis fasciola	R	R		1	1FD	R	R		R	R	1FD			1	1	2			R	2FD	5 (4FD)
Lasmigona holstonia																				R	R
Medionidus conradicus	1FD	R	R	1					3	R	10		1FD		3	7	3	1	R	3(5FD)	31 (7FD)
Pleurobema oviforme		R				R		3	8	2	1	3	22	13	32	17		R			101
Ptychobranchus subtentum	R	R					R		1	R	4(1FD)										5 (1FD)
*Quadrula cylindrica strigillata**		R		R																	R
Villosa iris	6	3	9	8	1FD	1FD	14	7	24	18	42	8	39	50	62	54	53	38	3	6(147FD)	444 (149 FD)
*V. perpurpurea**		R	R	R	1FD	R	R	R	2	R											2 (1FD)
V. v. vanuxemensis	1FD	R	1	2	1FD						R										3 (2FD)
Total live species	4	2	3	5	1	0	2	3	6	3	5	2	3	3	4	5	3	3	2	2	10
Total live mussels	10	5	11	15	1	0	21	13	53	25	57	11	71	64	98	81	58	43	5	9	651
Live mussel CPUE	1.3	1.3	3.7	5	0.5	0	10.5	3.3	10.6	6.3	14.3	5.5	35.5	21.3	49	20.3	29	21.5	5	4.5	10.5

* Federally endangered

Table 3. Live and fresh dead mussel species collected from Copper Creek in 1980 and 1998. (FD= fresh dead)

	1980	1998
	Actinonaias pectorosa	*Elliptio dilatata*
	Alasmidonta viridis	*Fusconaia barnesiana*
	Amblema plicata	*F. cor** (FD)
	Elliptio dilatata	*F. cuneolus**
	*Epioblasma capsaeformis**	*Lampsilis fasciola*
	Fusconaia barnesiana	*Medionidus conradicus*
	*F. cuneolus**	*Pleurobema oviforme*
	*F. cor**	*Ptychobranchus subtentum*
	Lampsilis fasciola	*Villosa iris*
	L. ovata	*V. perpurpurea**
	Lasmigona costata	*V. v. vanuxemensis*
	Medionidus conradicus	
	Pleurobema oviforme	
	Ptychobranchus fasciolaris	
	P. subtentum	
	*Quadrula cylindrica strigillata**	
	Villosa iris	
	*V. perpurpurea**	
	V. v. vanuxemensis	
Total	19	11

* Indicates Federally endangered species

Cattle had direct access to the stream at 5 sites (sites 1, 12, and 14-16). Direct cattle access, enabling cattle to move freely from bank to bank, was also observed at many localities between sites. Mortality to mussels from cattle was implied by the abundance of broken shell in cattle access areas. Accelerated stream bank erosion was evident in cattle access areas and riparian vegetation was absent at many localities, also contributing to bank erosion. Silt and fine sediments may also be entering Copper Creek from open excavated areas. One such area was observed at the mouth of Obeys Creek, under and just downstream of the State Route 72 bridge (site 13, CCM 13.8), immediately adjacent to the right descending bank. Other such areas may be present periodically during road or other construction activities. Recent road construction activities associated with the improvement of State Route 72 may have contributed silt and sediment-laden runoff to Copper Creek. Agricultural, timber extraction, and other soil disturbing activities on steep slopes and within floodplains drained by tributary streams also likely contribute silt and sediments.

Water quality problems may also be a factor in the decline of mussel populations. Nutrient enrichment from cattle pastures and human sources may be increasing. "Straight pipes" discharging household effluents directly into the stream were observed at three sites (sites 5, 6, and 9). Soapy "gray" water was discharged directly into the stream at site 6 during our survey. Based on these and other observations, it is very likely that many homes along Copper Creek have straight pipes draining directly into the creek.

The karst geology of the watershed could facilitate the introdution of pollutants into Copper Creek from remote sources. For example, pollutants dumped into a sinkhole miles from the stream may flow directly into it via groundwater. Water chemistry and sediment transport data collected along the length of Copper Creek would be valuable information in assessing the nature and source of impacts to biological communities.

Table 4. Number of mussel species collected at sites sampled in both 1980 and 1998. Means are given for upper and lower reaches and overall.

Site	1980	1998	Species lost	% loss
1	11	4	7	64
2	17	2	15	88
3	7	3	4	57
4	7	5	2	29
5	9	1	8	89
6	2	0	2	100
8	9	3	6	67
10	10	3	7	70
Lower reach mean			6.4	70
12	3	2	1	33
13	5	3	2	40
14	6	3	3	50
16	6	5	1	17
17	6	3	3	50
18	6	3	3	50
Upper reach mean			2.2	40
Overall mean			4.6	57

Conclusion

A significant decline in native mussel populations occurred in Copper Creek between 1980 and 1998. Of the 19 species present in 1980, only 10 were collected in the current study. Two federally endangered species (*Epioblasma capsaeformis* and *Quadrula cylindrica strigillata*) may be extirpated from Copper Creek. The federally endangered *Fusconaia cuneolus*, and *Villosa perpurpurea* are still extant in Copper Creek, but are extremely rare.

Reasons for this decline appear to be partially attributable to erosion and excessive silt deposition resulting from an increase in poorly managed human activities (primarily agriculture) within the watershed. An apparent destabilization of the substrate and accelerated bedload movement have disrupted stable mussel habitat. Other factors, such as water quality, may also play a role in the decline of mussel populations. Mussels and other aquatic fauna will continue to decline until human activities in the Copper Creek watershed are effectively managed to insure compatibility with the health of aquatic communities.

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