

STATUS OF FRESHWATER MUSSELS IN THE COAL MINING BASIN OF
THE NEW RIVER (BIG SOUTH FORK CUMBERLAND RIVER DRAINAGE)
IN PORTIONS OF SCOTT, ANDERSON, MORGAN AND
CAMPBELL COUNTY, TENNESSEE (2006-2008)

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ABSTRACT

This study presents the results of a freshwater mussel survey of the New River basin, Tennessee (Big South Fork Cumberland River drainage) from 2006-2008. Historically, mussels are reported from the drainage in 1924, and 1938-1939. The 1938-1939 sampling years consisted of an intensive chemical and biological study of the drainage assessing coal mining wastes entering the river from deep mine portals. This represents the only information on what pre-existing conditions were prior to strip-mining that followed World War II. Thirteen mussel species are documented from the drainage (nine pre-1940 and four are new distribution records). New mussel distributions were found in Buffalo, Brimstone, and Smith Creeks including live federally listed *Alasmidonta atropurpurea* present in Buffalo Creek. A new drainage record for a rare previously unrecognized mussel, *Anodontoides denigrada*, occurs in Buffalo and Smith Creeks. Mussels in the drainage are rare and exist in isolated pockets separated by past and present resource extraction. Mussels measured consisted of larger individuals, indications of limited reproduction and recruitment. Naturally occurring environmental conditions (*i.e.*, stream gradient, seasonal low flows, and low calcium levels) may account for low mussel diversity, but biological communities and water quality was severely impaired prior to 1940 and the only identified perturbation was coal mining wastes. Continued on-going resource extraction for coal, oil and gas, land development, recreation (*i.e.*, all-terrain vehicles, dirt bike motorcycles) and haul road construction add pollutants to the drainage basin which have shown only limited biological recovery from past disturbances.

Key words: New River, Tennessee, coal mining impacts, resource extraction, Unionidae, endangered species.

INTRODUCTION

The effects of deep-mining and resulting acid mine water from both surface and ground water entering the Big South Fork Cumberland River drainage from deep-mine portals located in the New River drainage was recognized in 1938 as to its severity on biological communities and degraded water quality (Shoup, 1940; Shoup and Peyton, 1940). They reported that damage to the river from acid mine drainage was especially severe from its headwaters northeast of Fork Mountain in Anderson County downstream to the confluence of Buffalo Creek, a tributary of the New River draining a large portion of Scott County, a distance of approximately 32 km. Eleven mine drains were observed open and draining into Montgomery Fork in Campbell and Scott counties along small stream branches including mine pollution from Roach Creek, tributary of the New River at Norma, Scott County. Shoup (1940) reported that it seems probable that the New River is periodically swept through most of its entire length by acid mine drainage at intermittent intervals, possibly many months apart, when new mine drains are opened or when low water discharge of the flow prevents adequate dilution of toxic acids. Water drainage from coal mines commonly contains sulfuric

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acid, acid salts, iron, aluminum, other chemicals, and sediment (Warner, 1971). Winger *et al.* (1977) reported that a combination of problems associated with chemicals and sedimentation from mine drainage was evident in virtually all the New River watershed. At present, the New River watershed contains abandoned underground and surface mines and since the 1980s active mining had declined in the watershed. However, coal mining has rebounded in the drainage given the recent demand for cheap energy production and high prices paid for coal. A more recent environmental change in the drainage since the 1970s was the discovery of oil and gas deposits that may also be contributing to water quality degradation resulting from drilling wastes and sedimentation from road access construction. Other on-going resource extraction which further complicates faunal recovery is logging and coal washing at preparation plants.

Shoup (1950) reported that the clear natural waters of the state with but little measurable alkalinity and total buffering capacity may be found in the uplands of the Great Smoky Mountains and in the sandstones and shale of the Cumberland Plateau. The headwater streams of the Cumberland Plateau have little or no alkali reserve which limits mussel growth and are consequently susceptible to acid mine drainage. In the New River, these conditions existed only in high sulfur coal seams (Big Mary) in areas where most mining operations were being carried out. Shoup (1950) reported that at no point does the New River come into contact with soluble limestone, so that it remains at nearly all times throughout its length in an adverse somewhat acid state due to mining operations at its headwaters (primarily the Big Mary coal seam). At present, no coal is currently being mined from the Big Mary and the New River is somewhat alkaline from calcium carbonate imbedded in alkaline shale.

Shoup (1940) and Shoup and Peyton (1940) provide the most definitive field survey information on the biological and chemical characteristics at 87 sampling sites in the Big South Fork Cumberland River drainage including its two largest tributaries, New and Clear Fork rivers, and smaller tributaries. Prior to their study, no previous sampling of this magnitude was done in this drainage area and consequently information was completely lacking on many ecological factors controlling aquatic life in the streams as they existed before the beginning of intensive commercial utilization of land on the north Cumberland Plateau. The only previous record of mussels in the New River prior to Shoup and Peyton is a 1924 record for Cumberland elktoe, *Alasmidonta atropurpurea* (Rafinesque, 1831), currently federally listed. Shoup and Peyton (1940) did find mussels in 1938-1939 during their study of the New River including seven species at New River Station and one eroded individual at Cordell. It is reasonable to assume that at least the lower portion of the New River may have had a more diverse faunal assemblage based on stream-size and access to the rich assemblage of mussels documented both historically and recent in the Big South Fork Cumberland River drainage (Ahlstedt *et al.*, 2003-2004). Previous studies by Shoup and Peyton lament on the extreme difficulty of gaining access to these streams because of the lack of roads and steep rugged terrain.

The objectives of this study were to: (1) determine the historical occurrence of freshwater mussels in the New River drainage; (2) determine their current distribution, diversity, abundance, and measured size-class (as evidence of recent reproduction and recruitment); and (3) provide valuable baseline information for future monitoring of improvements or declines in water quality. The overall purpose is to document the existence of freshwater mussels in the upper river, including areas that have never been surveyed, and the goals are to pinpoint areas with unique mussel diversity and habitat where potential restoration activities may be implemented.

STUDY AREA

The New River originates as a series of small mountain streams bordering Morgan and Anderson counties in the northeastern corner of Tennessee near Petros and Fork Mountain (Fig. 1). The river has a drainage area of 396 mi² (382 mi² at the U.S. Geological Survey New River gage) and winds through a narrow basin for approximately 88 km where it joins with the Clear Fork River in Scott County to form the headwaters of the Big South Fork Cumberland River. The river is situated in the northeast corner of the Cumberland Plateau and represents one of six major physiographic provinces in Tennessee. Only the lower portions of the New and Clear Fork Rivers are bounded by the boundaries of the Big South Fork National River and Recreation Area (BSFNRA), a unit of the National Park Service.

The New River Basin is part of the Cumberland Mountain eco-region and on a smaller scale is included with the Central Appalachian eco-region that stretches from northern Tennessee to central Pennsylvania. Topography consists of steep mountain slopes having narrow crests with elevations ranging from 306-1080 m above sea level and relief ranging from 500-700 m. The upper 21 km of the New River above the confluence of Beech Fork is relatively high-gradient, narrow and deep with little alluvial flood plain. In the lower 67 km below Beech Fork, the river becomes wider, averaging 35 m in width, with some alluvial flood plains increasingly wider to 360 m in some locations and stream-bank heights varying from 6-10 m (Tung, 1975). River substrate generally consisted of imbedded rounded boulders or habitat scoured down to bedrock, usually upstream and downstream from deep pools. In areas where the gradient change was not as severe with adjoining floodplains, substrate consisted of a mixture of cobble, gravel and sand, that is more conducive for biological communities to colonize and exist.

Tennessee's coal reserves are contained in rocks of Lower and Middle Pennsylvanian age in the Appalachian coal region of the Cumberland Plateau physiographic province (Luther, 1959). The geology of the area consists primarily of Pennsylvanian age shale followed in order of predominance by sandstones, siltstones, and coal. The New River drainage has extensive deposits of coal and approximately 5% of the basin had been disturbed by mining activities as of 1976 (Minear and Tschantz, 1976), and 70% of the coal mined in Tennessee back in 1975 originated in this drainage (Larson *et al.*, 1976). According to the Office of Surface Mining (OSM) in 2007, the total acreage of abandoned mines, active mines, and anticipated coal mining within the New River basin was 15,864 acres or 6.3% of the total basin (R. Liddle, pers. comm.).

Access to the river in this sparsely populated region is limited to three highways (U.S. Highway 27, Tennessee Highways 63 and 116). Many of the remaining roads are unimproved gravel and gravel/dirt haul roads for coal, oil and gas exploration and transmission, recreation, and logging. Most underground mining was level or up-dip dating back to the late 1800s so that water could drain directly from the mine and coal could easily be hauled out by mule. After 1977, mines were no longer allowed to mine up-dip and drift mines became popular. However, in the New River, most coal seams are flat therefore drift mining is not common. New River sub-watersheds Straight Fork and Brimstone Creek were strip-mined following World War II (Kimball, 1979; Pomerene, 1964a,b). The important coal beds in the New River watershed back in the 1970s include the Big Mary, Jellico, Pewee, and Coal Creek (Kimball, 1979; Nodvin *et al.*, 1992) and of these, Big Mary is high in ash and sulfur (Luther, 1959). Mining of the Big Mary coal seam was the primary source of acid mine drainage prior to 1980

due to its high sulfur content. At present, the Windrock, Walnut Mountain, and Pewee coal seams are the major coal beds mined, and there is no active or projected mining of the Big Mary seam in the New River basin. This is due to federal regulations requiring the prevention of acid mine drainage. Major coal seams and mining activities are found in the area between U.S. Highway 27 west, Tennessee Highway 63 north, Tennessee Highway 116 south, and U.S. Highway 25 east (Minear and Tschantz, 1976).

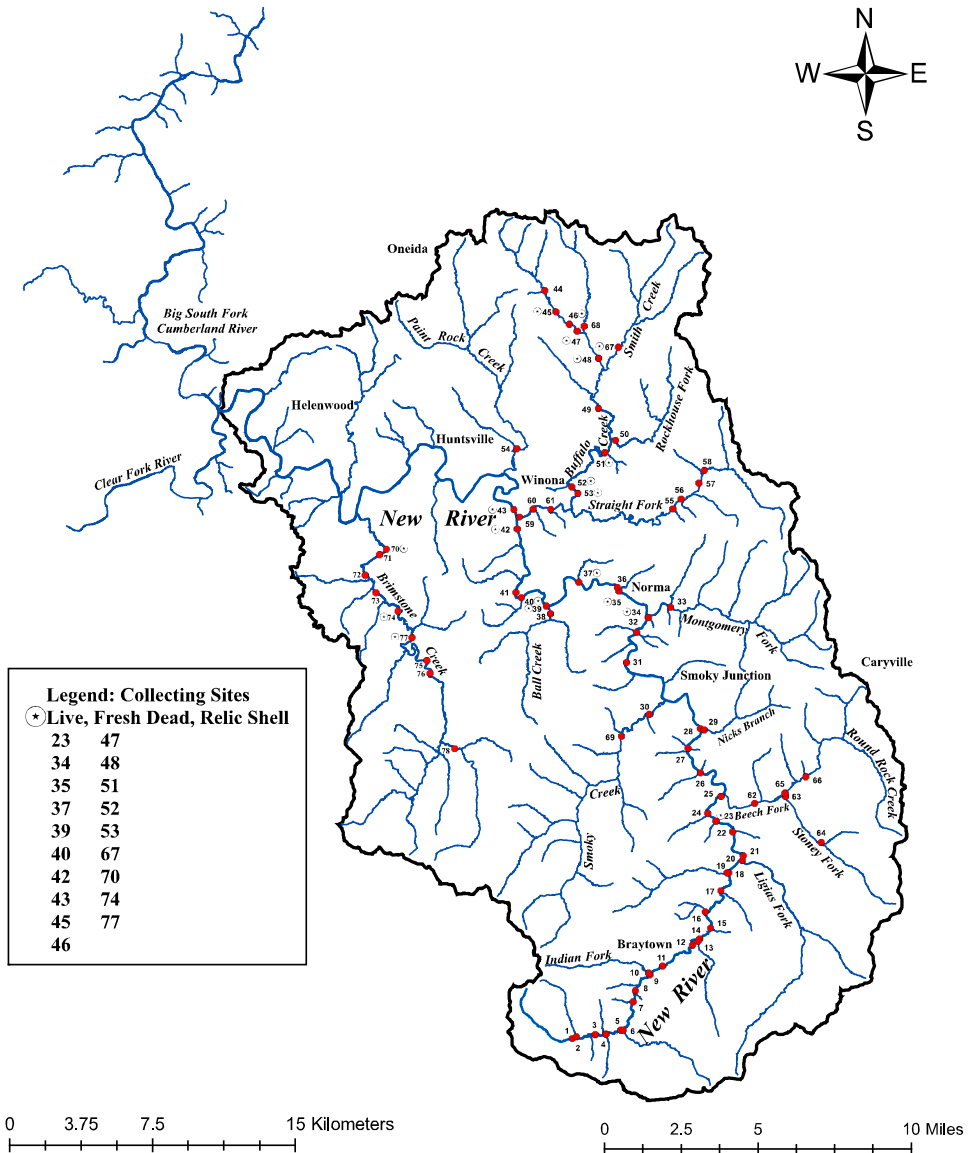


Figure 1— Freshwater mussel collecting sites in the New River, Big South Fork Cumberland drainage, Tennessee (2006-2008).

MATERIALS AND METHODS

Mussel sampling consisted of visually searching river habitat and stream-banks (muskrat feeding stations) looking for any indications that mussels may be present (live, fresh dead, relict, or pieces of shell). The high stream gradient in the upper portions of this drainage is not conducive for mussel colonization at a number of sampling sites because of large imbedded boulder substrate. Level areas of the river with adjoining floodplains consisting of cobble and gravel shoals or runs are more desirable habitat for mussel colonization. Generally, the flat level areas were adjacent to farmland in the rivers floodplain. The presence of exotic Asian clam, *Corbicula fluminea* (Müller, 1774) was an indication that native mussels may be present given that Asian clams are filter feeders and occupy the same or similar habitat but are more tolerant.

Sampling commenced during winter (December 2006) during extreme low flow drought conditions and excellent water clarity. Rakes were used to disturb large areas of substrate for determining the presence of Asian clams or native mussels. Each sampling site was thoroughly examined visually for mussels. At sampling sites where Asian clams were abundant and habitat was deemed suitable for mussels, those sites were sampled by snorkel equipped divers in dry or wet suits. Divers actively fanned the substrate looking for mussels partially buried in the substrate or visually looking for mussels siphoning. All live, fresh dead (shiny nacre with hinge ligament intact), relict (weathered nacre no longer lustrous), or pieces of shell that could be identified were recorded in a field notebook. All live and fresh dead mussels were measured in millimeters (mm) for total shell length (anterior-posterior) for size-class distribution using a digital dial caliper. After measuring mussels, all live individuals were returned back into the river substrate. All fresh dead and relict shell found are deposited at the McClung Museum, The University of Tennessee, Knoxville, Tennessee. The total person hours spent sampling mussels (timed search) were recorded by site for determining Catch Per Unit Effort (CPUE). This technique is best applied where spatial coverage is needed for finding mussels in rivers that have low population densities, diversity or rare species.

All sites sampled were identified by latitude and longitude (degrees, minutes, seconds) using a hand-held Global Positioning System (GPS) unit. Sampling sites also were identified by natural landmarks, roads, towns, bridges and ford crossings using U.S. Geological Survey (USGS) 7.5 minute topographic maps. Sites were numerically numbered on USGS topographic maps and cross-checked with GPS coordinates. Additional recorded data: site number, date, sampling time, biologists, notes concerning substrate conditions and riparian habitat, and observed fish, crayfish, and snails (Appendix II).

Historical Mussel Fauna

Shoup and Peyton (1940) reported eight mussel species from the New River during sampling in 1938 and 1939. The following seven species were documented from New River Station in Scott County: *Elliptio dilatata* (Rafinesque, 1820), *Lampsilis cardium* Rafinesque 1820, *Lasmigona costata* (Rafinesque, 1820), *Ligumia recta* (Lamarck, 1819), *Quadrula pustulosa* (Lea, 1831), *Tritogonia verrucosa* (Rafinesque, 1820), and *Villosa taeniata* (Conrad, 1834). An eroded individual of *Actinonaias ligamentina* (Lamarck, 1819) was noted from Cordell in Scott County. Unfortunately, no account is given as to the abundance of mussels found.

The University of Michigan Museum of Zoology (UMMZ), Ann Arbor, Michigan, has in its mollusk collections some records of freshwater mussels collected from the New River by A.E. Ortmann in 1924 and C.S. Shoup in 1939. They include the following mussels, museum catalogue ascension numbers, and locations:

Alasmidonta atropurpurea (UMMZ 62174): New River at New River Station, Ortmann, 1924.

- Elliptio dilatata* (UMMZ 134856): New River at New River Station, C.S. Shoup, 1939.
Elliptio dilatata (UMMZ 134861): New River at Cordell, C.S. Shoup, 1939.
Lampsilis cardium (UMMZ 134859): New River at New River Station, C.S. Shoup, 1939.
Lasmigona costata (UMMZ 134853): New River at New River Station, C.S. Shoup, 1939.
Ligumia recta (UMMZ 133128): New River at New River Station, C.S. Shoup.
Quadrula pustulosa (UMMZ 133129): New River, Scott County, C.S. Shoup.
Quadrula pustulosa (UMMZ 134858): New River at New River Station, C.S. Shoup.
Tritogonia verrucosa (UMMZ 134854): New River at New River Station, C.S. Shoup, 1939.

Lokey (1979) studied the effects of acid coal mine drainage on benthic macro-invertebrate populations in the New River drainage during 1977. He sampled eight New River sites and 10 tributary streams: Indian Fork Creek, Cage Creek, Ligias Fork, Beech Fork Creek, Smokey Creek, Montgomery Fork, upper and lower Buffalo Creek, Straight Fork, Paint Rock Creek, and upper and lower Brimstone Creek. The presence of mollusks including native mussels, fingernail clams, Asian clams, pond and pleurocerid riversnails are reported from five New River sites and none found at three sites. Native freshwater mussels were found at two sites: Station 3 (*Elliptio dilatata*), located in the upper New River upstream from Cage Creek and Station 6 (*Lasmigona costata*, listed as fragment), located downstream from Montgomery Fork (Lokey, 1979). The *Elliptio dilatata*, listed as occurring at Station 3, had no indication if the specimens were live, dead, or relict. Of the 10 tributary streams sampled by Lokey, fingernail clams and snails were found to occur in only three tributary streams: Cage Creek, upper Buffalo Creek and Paint Rock Creek.

RESULTS

New River

A total of 78 sites were sampled for freshwater mussels in the New River drainage (Fig. 1, Appendix I: Tables 1-3). Sample site descriptions with locality information and observations are presented in Appendix II. Size-class measurement data for all live and fresh dead mussels found is presented in Appendix I: Table 4, and mussels identified historically and recent are presented in Appendix I: Table 5.

Seven sites were sampled repetitively when mussels were observed or habitat looked favorable for mussel colonization: 23, 34, 39, 42, 43, 51 and 70. Fresh-water mussels in the main-stem New River upstream from Winona are uncommon or rare. Three were found live: *Lampsilis cardium*, *L. fasciola* Rafinesque, 1820, and *Lasmigona costata*, and two relicts *Elliptio dilatata* and *Quadrula pustulosa*. The relict *Q. pustulosa* is of questionable identification because of severe shell erosion.

The largest concentration of mussels in this portion of the New River exists downstream from the confluence of Bull Creek (site 39) where 35 live individuals of three species occur. It is speculated that water from the Bull Creek drainage entering this shoal is currently unaffected by past-mining perturbations (no mining of the Big Mary coal seam) although stream habitat was observed to be destabilized with the presence of coal fines and yellow boy. Most of the mussels found here exist in a narrow band along the left descending bank in habitat consisting of cobble, gravel, and sand downstream from the confluence of the creek. Three live female *Lampsilis fasciola* was observed spawning and trying to attract a host fish with their artificial

fish-like lure. This is the same location where one live federally protected Cumberland elktoe, *Alasmidonta atropurpurea*, was discovered in 2004 (by the senior author) and is one of only three locations in the New River where it was found other than its recent discovery in Buffalo Creek. The remaining habitat downstream below the confluence of Bull Creek consists of bedrock, imbedded boulders and slab rock, a reflection of a stream gradient change.

Some of the best mussel habitat observed in the New River exists upstream from the confluence of Buffalo Creek (sites 42 and 35). Site 42 contained nine live mussels of two species, *Lampsilis cardium* and *L. fasciola*, and site 35 reported one live *L. cardium*. The New River at sites 42 and 35 is relatively wide and consists of long shallow riffle and shoal habitat downstream from deep pools. Both locations adjoin a large floodplain. Stream gradient is much reduced allowing for the accumulation of cobble, gravel, and sand and appears less scouring from high surface flows. Both sites should have had greater diversity and number of mussels but acid mine drainage originating from sources in Straight Fork draining into lower Buffalo Creek may present a water quality barrier in the New River for upstream mussel colonization via host fish.

Buffalo Creek

A total of 19 sites were sampled for mussels in the Buffalo Creek drainage: 12 sites in Buffalo: 45-49, 51-53, 59-61; one in Rockhouse Fork (site 50); four in Straight Fork (55-58); and one in Smith Creek (site 67) (Fig. 1, Appendix I: Table 2). Seven live mussels and one relict were reported from Buffalo Creek and one live found in Smith Creek. Mussels are uncommon or rare but site 51 contained six species including federally endangered Cumberland elktoe, *Alasmidonta atropurpurea* (five live individuals). One fresh dead Cumberland elktoe also was reported from site 52. A currently unrecognized mussel species, *Anodontoides denigrada* (Lea, 1852), was reported live from three sites in Buffalo Creek (sites 46-48), and in Smith Creek (site 67). This mussel is relatively rare and endemic to the Cumberland River system. It was previously known to occur only above the falls of the Cumberland and had never been reported in Tennessee or the Big South Fork Cumberland River drainage. A few individuals were collected for DNA sequencing in order to confirm its identification. All mussels found in the Buffalo Creek watershed are new distribution records and only exist upstream from the confluence of Straight Fork. Straight Fork appeared biologically dead from acid mine wastes, which severely affects lower Buffalo Creek.

Brimstone Creek

At the request of the Office of Surface Mining, mussel sampling was done in Brimstone Creek which drains into the New River upstream from New River Station. Historically, Brimstone Creek was severely affected by acid mine drainage but the presence of live mussels are indications that acid water has become neutralized to allow for the survival of mussels. A total of nine sites were sampled: 70-78 (Fig. 1; Appendix I: Table 3). Live mussels were found at three sites in Brimstone Creek: sites 70, 74 and 77. This is the first report of mussels in Brimstone Creek including live *Lasmigone costata* and *Villosa taeniata*, one fresh dead *Lampsilis fasciola*, and one relict *Tritogonia verrucosa*. This is the first report of *T. verrucosa* occurrence in the New River drainage since 1939 (Shoup and Peyton, 1940). Freshwater mussels are relegated to the lower 6 km of Brimstone Creek where the stream gradient is more

gradual adjoining a broad floodplain. A few sites are considered good potential mussel habitat with numerous fish consisting mostly of darters, minnows and some spotted bass; however, along portions of the creek downed trees and point bar formations are evidence of streambed destabilization.

Smoky Creek

No mussels were found in Smoky Creek, but the landowner (R. Lowe, pers. comm.) reported that in 1961 as a 13-year-old boy, he found living mussels described as long and flat-sided in the creek. The mussel species fits the possible description of spike, *Elliptio dilatata*, previously reported from the New River by Shoup and Peyton (1940). Examination of this site found no evidence of native mussels, but the habitat was suitable for mussel colonization, including the presence of Asian clams. The upper Smokey Creek drainage is prone to natural landslides identified in 1977, but a significant one occurred as recently as 2005. The stream bottom was reportedly covered with several inches of sand and silts that appear to be non-toxic (R. Liddle, Office of Surface Mining [OSM], pers. comm.).

Shell Length Measurement Data

All live and fresh dead mussels were measured in millimeters for total shell length (Appendix I: Table 4). This methodology is important for determining size-class distribution for each species and is needed for determining successful reproduction and recruitment over time. Successful reproduction and recruitment of healthy mussel populations are represented by multiple size classes between young and older individuals. Typically, mussels measured <45 mm, indicating active recruitment, an indication of the last 2-3 years of age, but most mussels measured, with the exception of *Andontoides denigrada* and *Villosa taeniata*, consisted of large older individuals. Both *A. denigrada* and *V. taeniata* are probably more short-lived species and do not attain the size of some of the other mussels. All live or relict mussel species found are relatively thin-shelled with the exception of *Elliptio dilatata*, *Tritogonia verrucosa*, and the questionable identification of *Quadrula pustulosa*. Many thin-shelled species have fish hosts that migrate or move throughout a river drainage that allows for the dispersal of mussels (the primary method mussels utilize for dispersal). Bass species in general serve as hosts for *Lampsilis fasciola*, *L. cardium*, *Villosa iris* and *V. taeniata*, and hogsucker is identified as a host for endangered *A. atropurpurea* (Gordon and Layzer, 1993). Viable, healthy fish assemblages (critical stage in the life-cycle of a mussel) are slowly returning to some areas of the New River (Evans, 1998) but some mussels are at such low population densities and isolated in the drainage that they may no longer be viable and may eventually perish over time.

Total Mussel Species Reported Historically and Recent

The total number of mussel species reported from the New River drainage consists of 13 species, including Ortmann's 1924 record for *Alasmidonta atropurpurea* (Appendix I: Table 5). Two mussels reported by Shoup and Peyton (1940), *Actinonaias ligamentina* and *Ligumia recta*, were not found during the present study or in the lower New River from previous

studies (Ahlstedt *et al.*, 2003-2004). The following six species were not found by Shoup and Peyton but reported in the lower New River at Silcott Ford (Ahlstedt *et al.*, 2003-2004) and during the present study: *A. atropurpurea*, *A. denigrada*, *L. cardium*, *L. fasciola*, *P. alatus* (Say, 1817), and *V. iris*.

DISCUSSION

The New River drainage has a long history of coal mining that dates back to the late 1800s. Some of the first mining took place in what is known as the Big Mary coal seam, coal that is high in sulfur that when exposed results in acid water and the lowering of pH. Approximately 70% of the coal mined in Tennessee during the 1970s was mined in the New River drainage. Prior to the Surface Mining Control and Reclamation Act (SMCRA) of 1977, large areas of this drainage suffered from past mining perturbations. Without exception, practically every stream sampled during the present study showed some evidence of past mining in the form of coal fines, slate deposition, erosion, scouring, point-bar formation, stream-bank destabilization, acidic water draining mine portals (observed near the Devonian coal preparation facility), silt pond overflow, spoil piles and the presence of iron precipitate (yellow boy) seeping out of the substrate and stream-banks. A more recently identified problem observed in the drainage is sedimentation from past logging operations (1902-1918, 1950s and 1970s), oil and gas exploration and extraction, and recent logging and haul road construction across streams accessing current logging operations. Landslides are a new threat in the New River drainage one of which occurred in Smokey Creek in 2005 (R. Liddle, pers. comm.).

The historically rich mussel fauna of the Cumberland River provided the seed source for mussel colonization in the Big South Fork Cumberland River drainage prior to extensive human modification of the basin. A major limiting factor affecting mussel diversity and abundance in the New River drainage is the size of the drainage, stream gradient and flows, elevations (Hynes, 1970; Strayer, 1983) and nutrients. Abrupt changes in stream gradient are major physical barriers for mussel species distributions in headwaters streams (Ahlstedt, 1991). Freshwater mussels are unable to colonize some of these areas because of changes in the fish fauna (lack of suitable host fish), unsuitable substrate consisting of embedded boulders or bedrock, nutrient loss, scouring action during periods of heavy rainfall, and poor water quality. Mussels observed in the drainage were often correlated with a broad flood plain that is not a common characteristic feature of the watershed, and perceived clean water entering the New River from tributary streams (*i.e.*, Bull Creek). New distributional records for the drainage were all basically found in the wider floodplains or adjacent to farmland of the New and Buffalo Rivers, and Smith and Brimstone Creeks in reaches where the stream gradient is more moderate and the movement of water consisted of shallow riffle and shoal areas. This allows for the accumulation of cobble, gravel and sand habitat necessary for the colonization of mussels, fish and aquatic insects.

The biological and chemical characteristics of the New River drainage were considered severely affected by past mining operations which largely consisted of underground mining prior to surface mining which began after World War II (Shoup and Peyton, 1940). The rugged terrain and remoteness of this drainage has kept this region isolated to the point of low human habitation. Prior to 1940, the only industry in the drainage was coal mining and logging. The New River Timber Company constructed a dam on the New River at Norma which backed

water up the river for several kilometers. Water from the dam provided power for a large saw-mill that eventually burst during a flood event. Logging had other effects on the river basin causing channel widening, sedimentation, and bank instability. Logging and coal mine “boom towns” dumped their sewage into the river and construction of the New River railroad was first constructed to haul timber out of the basin. All above mentioned activities probably had some impacts on biological communities and water quality in the watershed. However, one major fact concerning the New River watershed is that the *only identified perturbations affecting biological communities and water quality prior to 1940 were acid mine wastes*. Current human population levels in the drainage are still low with no commercial industry that would produce industrial wastes or require sewage treatment plants. However, surface-mining became prevalent in the drainage after World War II and was largely unregulated until the passing of mining and reclamation laws in the 1960s. The Tennessee Strip Mine Law of 1967 required backfilling of high-walls, establishment of vegetation, some erosion control, and posting of a reclamation bond. The Tennessee Surface Mining Law of 1972 amended the 1967 Law to require mine discharge permits, toxic material segregation, stable slopes re-vegetation and a bond of \$600 per acre for reclamation performance. The Tennessee Surface Mining Law of 1974 increased the environmental requirements to include landslide prevention, no mining within 30 m of flowing streams, steep slope mining limits, and \$1,000 per acre reclamation bond. The 1977 Surface Mining Control and Reclamation Act (SMCRA) required uniform mining and reclamation standards across the country. SMCRA also requires more stringent inspection and enforcement of regulations. Surface and underground mining is increasing in the New River basin. With the recent demand for cheap energy and high prices paid for coal, scrubbers recently installed on several power plants allow for higher sulfur coal to be burned. As a result, several coal-washing facilities (located at Devonia and Smoky Junction) and coal slurry impoundments have become operational. On December 14, 2006, coal fine sludge was observed trapped in leaf debris downstream from Devonia (site 9). The U.S. Geological Survey gauging station located on the New River at Cordell (below Devonia) recorded a spike in flows and turbidity measurements, although no rain had fallen in the drainage for two weeks and December was exceptionally dry. Examination of a settling pond at Devonia the previous week showed it full, but examination of the settling pond after observing coal fine sludge in the river showed two-thirds of it drained. However, the Crossville Experimental Station rain gage showed that it had rained in the upper drainage 0.35 inches the day before. The consideration is that the amount of water needed to cause the spike at the USGS gage at Cordell is so great that the wash plant could not discharge that amount of water in such a short time period. However, one plausible theory is that the rain and discharge happened concurrently but this is mere speculation. Other perturbations perceived as hampering biological and water quality recovery include drilling wastes from oil and gas exploration and extraction which began in the 1970s, construction of haul roads, and logging. These activities have recently expanded exponentially throughout the watershed whereas logging has remained relatively constant.

CONCLUSIONS

The New River upstream from Winona may never have had a diverse mussel fauna prior to any mining or human impact in the watershed based upon previous naturally occurring environmental conditions. However, the lower larger portion of the river has access to the Big South Fork where 27 mussel species are currently extant but historically, the river contained

as many as 55 species. The mussel fauna is very limited in the New River basin and consists of relatively older individuals that exist in isolated pockets separated by long deep pools, gradient change, or coal waste. Stream habitats where mussels occur are the best that remains for mussel colonization and any attempts for mussel restoration should include sites where they currently exist. Mussel reproduction is probably limited due to their small population size and their reproductive life-cycle may continually be disrupted by chronic water quality degradation and non-availability or, loss of host fish during spawning periods. In terms of mussel species diversity, Buffalo Creek is the best site in the upper New River drainage but this fauna is completely isolated by chronic coal mining wastes that enter from Straight Fork. The fish fauna is slowly recovering despite the increase in mining the last few years and colonizing previously degraded stream habitat. The complex life-cycle of freshwater mussels and their dependence upon fish as their hosts during their reproductive life-cycle are complicated by natural factors that existed in the drainage previous to man. These conditions still exist in the drainage but were magnified by unrestricted pre-law mining and logging of the drainage. Given the extent of the affected area pre-law with current on-going activities, it may take many years of major land reclamation projects to restore and stabilize the drainage. Water flowing from the New River into the Big South Fork is critical for maintaining critically rare species and providing clean drinking water for wildlife and human consumption. Mussels are indicators of water quality and only survive if clean water and host fish exists, an increasingly rare combination affecting the most endangered faunal group in North America.

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LITERATURE CITED

- AHLSTEDT, S.A. 1991. Twentieth century changes in the freshwater mussel fauna of the Clinch River (Tennessee and Virginia). *Walkerana*, 5: 73-122.
- AHLSTEDT, S.A., S. BAKALETZ, M.T. FAGG, D. HUBBS, M.W. TREECE and R.S. BUTLER. 2003-2004. Current status of freshwater mussels (Bivalvia:Unionidae) in the Big South Fork National River and Recreation Area of the Cumberland River, Tennessee and Kentucky (1999-2002). Evidence of faunal recovery. *Walkerana*, 14(31): 33-77.
- CONRAD, T. A. 1834. *New Freshwater Shells of the United States, with lithographic illustrations; and a monograph of the genus Anculotus of Say; also a synopsis of the American naiades*. J. Dobson, Philadelphia, Pennsylvania. May 3, 1834. 76 pp., 8 pls.
- EVANS, R. B. 1998. *Distribution of fishes and changes in biotic integrity in the New River, Tennessee*. M.Sc. Thesis, unpublished. The University of Tennessee, Knoxville, Tennessee. 169 pp.
- GORDON, M.E. and J.B. Layzer. 1993. Glochidial host of *Alasmidonta atropurpurea* (Bivalvia: Unionidea: Unionidae). *Transactions of the American Microscopical Society*, 112(2): 145-150.
- HYNES, H.B.N. 1970. *The Ecology of Running Waters*. University of Toronto Press, Toronto, Canada. 555 pp.

- KIMBALL, L.R., and Associates. 1979. *New River comprehensive study, Phase II, Final Report, plus appendices*: L. Robert Kimball and Associates Consulting Engineers and Architects, Ebensburg, Pennsylvania, Part II: 13 -23, D 4-5.
- LAMARCK, J.B.P.A. 1815-1822. *Histoire naturelle des Animaux sans Vertebres*. 8 volumes. [Les nayades, 1819. 5: 67-100.]
- LARSON, F.C., R.A. MINEAR and B.A. TSCHANTZ. 1976. *Impact of coal strip mining on water quality and hydrology in east Tennessee*. The University of Tennessee, National Research and Resource Center, Knoxville, Tennessee. Report No. 47.
- LEA, I. 1831. Observations on the naiades, and descriptions of new species of that and other families. *Transactions of the American Philosophical Society*, 4 (New Series) (1): 63-121, plates 3-18.
- LEA, I. 1852. Descriptions of new species of the family Unionidae. *Transactions of the American Philosophical Society*, 10 (New Series) (Part 2): 253-294, plates 12-29.
- LOKEY, N.C. 1979. *Benthic macroinvertebrate populations of the New River, Tennessee, a system receiving acid coal mine drainage*. M.Sc. Thesis, unpublished. Tennessee Technological University, Cookeville, Tennessee. 134 pp.
- LUTHER, E.T. 1959. *The coal reserves of Tennessee*. Tennessee Department of Conservation and Commerce, Division of Geology, Nashville, Tennessee. Bulletin 63: 294 pp.
- MINEAR, R.A. and B.A. TSCHANTZ. 1976. The effect of coal surface mining on the water quality of mountain drainage basin streams. *Journal Water Pollution Control Fed.*, 48: 2549-2570.
- MÜLLER, O.F. 1773-1774. *Vermium terrestrium et fluviatilium, seu animalium infusorium, helminthicorum et testaceorum, non marinorum, succincta historia*. Heineck et Faber, Havniae et Lipsiae. Vol. 2, i-xxxvi, 214 pp.
- NODVIN, S.C., M.C. LEARY and C.P. HARDEN. 1992. *Effects of abandoned coal mines on stream water chemistry at Big South Fork National River and Recreation Area*. National Park Service – Southeast Region, Research/Resources Management Report SER-92/XX, National Park Service – Cooperative Park Studies Unit, Department of Forestry, Wildlife, and Fisheries, The University of Tennessee, Knoxville, Tennessee. 57 pp.
- POMERENE, J.B. 1964a. *Geology of the Barhell Quadrangle and part of the Oneida North Quadrangle, Kentucky*. U.S. Geological Survey, prepared in cooperation with the Commonwealth of Kentucky, University of Kentucky, and Kentucky Geological Survey, map GQ-314, 1:24,000, one sheet.
- POMERENE, J.B. 1964b. *Geology of the Whitely City Quadrangle, Kentucky and the Kentucky part of the Winfield Quadrangle*. U.S. Geological Survey, prepared in cooperation with the Commonwealth of Kentucky, University of Kentucky, and the Kentucky Geological Survey, Map GQ-260, 1:24,000, one sheet.
- RAFINESQUE, C.S. 1820. Monographie des coquilles bivalves fluviatiles de la Riviere Ohio, contenant douze genres et soixante-huit especes. *Annales generales des sciences Physiques, a Bruxelles*, 5(5): 287-322, pls. 80-82.
- RAFINESQUE, C.S. 1831. *Continuation of a monograph of the bivalve shells of the River Ohio, and other rivers of the western states. By Prof. C. S. Rafinesque*. (Published at Brussels, September 1820.) Containing 46 species, from Number 76 to Number 121. Including an appendix on some bivalve shells of the rivers of Hindustan, with a supplement on the fossil bivalve shells of the Western states, and the *Tulosites*, a new genus of fossils. Philadelphia, Pennsylvania. 8 pp.
- SAY, T. 1817. Conchology, 15 pages, 4 plates. In: William Nicholson, *American edition of the British encyclopedia, or dictionary of arts and sciences comprising an accurate and popular view of the present improved state of human knowledge*. First edition. Volume 2. Samuel A. Mitchel and Horace Ames, Philadelphia, Pennsylvania.
- SHOUP, C.S. 1940. *Biological and chemical characteristics of the drainage of the Big South Fork of the Cumberland River in Tennessee*. Tennessee Department of Conservation, Division of Game and Fish, Knoxville, Tennessee. Miscellaneous Publication 1: 76-105.

- SHOUP, C.S. 1950. Field examination of the waters in Tennessee streams. *Journal of the Tennessee Academy of Science* 25(1): 1-55.
- SHOUP, C.S. and J.H. PEYTON. 1940. *Collections from the drainage of the Big South Fork of the Cumberland River in Tennessee*. Tennessee Department of Conservation, Division of Game and Fish, Knoxville, Tennessee, Miscellaneous Publication 2: 106-116.
- STRAYER, D. 1983. The effects of surface geology and stream size on freshwater mussel distribution in southeastern Michigan, USA. *Freshwater Biology*, 13: 253-264.
- TUNG, H-S. 1975. *Impacts of contour coal mining on stream flow, a case study of the New River Watershed, Tennessee*. Ph.D. Dissertation, unpublished. The University of Tennessee, Knoxville. 138 pp.
- WARNER, R. W. 1971. Distribution of biota in a stream polluted with acid mine drainage. *Ohio Journal of Science*, 71: 202-215.
- WINGER, P.V., P. BETTOLI, M.J. BRAZINSKI and N.C. LOKEY. 1977. *Fish and benthic populations of the New River, Tennessee*. Final Report: Tennessee Technological University, Cookeville, Tennessee and U.S. Fish and Wildlife Service, Atlanta, Georgia. 285 pp.

APPENDIX I - TABLES

TABLE 1. Freshwater mussels identified from collecting sites in the New River (Big South Fork Cumberland River drainage) upstream from Winona, Scott County, Tennessee (2006-2008). [L - live, FD - fresh dead, R - relict]

Mussels	Collecting Sites								
	23	34	35	37	39	39a	42	42a	43
<i>Lampsilis cardium</i>	1R	-	1L, 1R	1R	4L	18L	2L	-	1R
<i>Lampsilis fasciola</i>	1R	-	-	-	1L, 1FD	11L	3L	4L	-
<i>Lasmigona costata</i>	-	-	-	-	1R	1L	-	-	-
<i>Elliptio dilatata</i>	1R	-	-	-	-	-	-	-	-
<i>Quadrula pustulosa</i>	-	1R?	-	-	-	-	-	-	-
Total live	-	-	1	-	5	30	5	4	-
Sampling hours	3.0	2.0	4.0	1.0	3.0	6.0	3.0	4.0	1.5
CPUE/hr	-	-	4.0	-	0.6	0.2	0.6	1.0	-

TABLE 2. Freshwater mussels identified from collecting sites in Buffalo and Smith creeks, tributary to the New River upstream from Winona, Scott County, Tennessee (2006-2008). [L-live, FD-fresh dead, R-relict]

Mussels	Collecting Sites								
	45	46	47	48	51	51a	52	53	67
<i>Alasmidonta atropurpurea</i> *	-	-	-	-	1L	4L	1FD	-	-
<i>Anodontooides denigrata</i>	-	1R	6L	8L, 2R	4L, 1FD	-	-	-	1L
<i>Elliptio dilatata</i>	-	-	-	-	-	3L	-	-	-
<i>Lampsilis cardium</i>	-	-	-	-	-	2L, 1R	-	-	-
<i>Lampsilis fasciola</i>	-	-	-	-	-	-	-	2R	-
<i>Lasmigona costata</i>	-	-	-	-	2L	8L, 1FD	1FD	2R	-
<i>Villosa iris</i>	-	-	-	-	-	1L	-	-	-
<i>Villosa taeniata</i>	-	-	-	-	-	20L	1FD	-	-
Total live	-	6	8	4	3	38	-	-	1
Sampling hours	1.5	1.5	1.5	1.5	1.5	3.0	1.0	0.5	1.5
CPUE/hr	-	0.25	0.19	0.38	0.5	0.07	-	-	1.5

*Federally endangered

TABLE 3. Freshwater mussels identified from collecting sites in Brimstone Creek, tributary to the New River upstream from New River Station, Scott County, Tennessee (2006-2008). [L - live, FD - fresh dead, R - relict]

Mussels	Collecting Sites		
	70	74	77
<i>Lampsilis fasciola</i>	-	1R	1FD, 1R
<i>Lasmigona costata</i>	2L	1L	-
<i>Tritogonia verrucosa</i>	-	1R	-
<i>Villosa taeniata</i>	-	-	2L, 1FD, 7R
Total live	2	1	2
Sampling hours	4.0	2.0	3.0
CPUE/hr	2.0	1.0	1.5

TABLE 4. Shell lengths measured in millimeters (mm) for all live and fresh dead mussels found in the New River basin study (2006-2008). [* federally endangered]

<i>Alasmidonta atropurpurea</i> *(total 7) 72, 94, 80, 61, 51, 62, 57 [range 51-94, mean 68.1 mm]
<i>Anodontooides denigrada</i> (total 20) 30, 47, 42, 45, 49, 53, 36, 37, 41, 42, 44, 42, 48, 54, 46, 47, 47, 47, 45, 55 [range 30-55, mean 44.9 mm]
<i>Elliptio dilatata</i> (total 3) 112, 75, 74 [range 74-112, mean 87.0 mm]
<i>Lasmigona costata</i> (total 16) 93, 67, 89, 132, 143, 132, 140, 105, 95, 102, 117, 140, 91, 120, 118, 134 [range 67-140, mean 113.6 mm]
<i>Lampsilis cardium</i> (total 27) 111, 86, 90, 123, 127, 103, 114, 114, 97, 117, 115, 116, 97, 103, 120, 106, 112, 97, 105, 117, 87, 101, 123, 117, 38, 107, 104 [range 38-127, mean 105.4 mm]
<i>Lampsilis fasciola</i> (total 17) 84, 74, 85, 80, 92, 65, 87, 79, 50, 70, 65, 69, 67, 95, 103, 107, 107 [range 50-107, mean 81.1 mm]
<i>Villosa iris</i> (total 1) 60
<i>Villosa taeniata</i> (total 25) 43, 63, 64, 66, 64, 65, 65, 63, 53, 76, 66, 51, 62, 64, 70, 65, 81, 71, 70, 55, 80, 64, 56, 62, 57 [range 43-81, mean 63.8 mm]

TABLE 5. List of freshwater mussel species documented from the New River drainage. [*federally endangered]

<i>Actinonaias ligamentina</i> (not found)
<i>Alasmidonata atropurpurea</i> *(live)
<i>Anodontooides denigrada</i> (live)
<i>Elliptio dilatata</i> (live)
<i>Lasmigona costata</i> (live)
<i>Lampsilis cardium</i> (live)
<i>Lampsilis fasciola</i> (live)
<i>Ligumia recta</i> (not found)
<i>Potamilus alatus</i> (relict)
<i>Quadrula pustulosa</i> (relict)
<i>Tritogonia verrucosa</i> (relict)
<i>Villosa iris</i> (live)
<i>Villosa taeniata</i> (live)

Total number documented in the New River drainage: 13
 Total number extant in the New River drainage (live species): 8
 Total number documented historically in the Big South Fork Cumberland River: 55
 Total number extant in the Big South Fork Cumberland River: 27

APPENDIX II - SITE DATA

Freshwater mussel sampling sites in the upper New River basin of the Big South Fork Cumberland River drainage, upstream and downstream from Winona, Scott County, Tennessee (2006-2008). [bold * = presence of native mussels]

Site 1: New River at state route 116 bridge crossing N of Petros, Anderson County, TN.

GPS Location: 36.0730N-84.2521W; Date: 12-14-06; Sampling Effort: 1 person hour.

Biologists: Steven Ahlstedt, Craig Walker.

No mollusks observed. Habitat channelized upstream from bridge and scoured to boulders with pockets of sand and gravel mixed in with coal fines. Yellow boy is present, including a few darters and minnows.

Site 2: Stallion Branch, tributary to the New River at state route 116 bridge crossing N of Petros, Anderson County, TN.

GPS Location: 36.0733N-84.2513W; Date: 12-14-06; Sampling Effort: 1 person hour.

Biologists: Steven Ahlstedt, Craig Walker.

No mollusks observed. Stream channelized and substrate consisting of imbedded boulders mixed with coal fines. Yellow boy present and old settling ponds next to stream overflow and drain into the creek. No fish.

Site 3: New River at access off state route 116 at island downstream from Beech Grove Church, Anderson County, TN.

GPS Location: 36.0736N-84.2433W; Date: 12-14-06; Sampling Effort: 1 person hour.

Biologists: Steven Ahlstedt, Craig Walker.

No mollusks observed. Island channel severely eroded and scoured down to boulder field. Good gravel and cobble substrate with coal present at mid-point of island on main river side. A few darters and crayfish present.

Site 4: New River at logging road ford off state route 116 directly across from Beech Grove Cemetery, Anderson County, TN.

GPS Location: 36.0737N-84.2411W; Date: 12-14-06; Sampling Effort: 1 person hour.

Biologists: Steven Ahlstedt, Craig Walker.

No mollusks observed. Obvious gravel removal and vehicle traffic in river. Riparian corridor severely eroded with large trees collapsed in the river. Stream habitat consisted of point-bar formations of sand and coal. A few darters and crayfish present.

Site 5: New River at concrete bridge crossing to Windrock off state route 116, Anderson County, TN.

GPS Location: 36.0743N-84.2340W; Date: 12-14-06; Sampling Effort: 1 person hour.

Biologists: Steven Ahlstedt, Craig Walker.

No mollusks observed. Stream habitat consisted of boulders and bedrock with large deposits of coal fines and yellow boy. A few small fish (shiners) and rock bass present. Habitat conducive for mussel colonization exists upstream from bridge that leads into a deep pool.

Site 6: Laurel Fork, tributary to the New River at low-head concrete bridge, Anderson County, TN.

GPS Location: 36.0743N-84.2335W; Date: 12-14-06; Sampling Effort: 1 person hour.

Biologists: Steven Ahlstedt, Craig Walker.

No mollusks observed. Stream habitat mostly scoured and consisted of large boulders. Coal fines are abundant in stream. Riparian corridor severely eroded. Stream is probably flashy due to gradient. A few minnows and aquatic insects present.

Site 7: New River at Steve Miller property (blue house) off state route 116 below unnamed tributary stream (Benchmark on topo 1434 below Buffalo), Anderson County, TN.

GPS Location: 36.0831N-84.2313W; Date: 12-14-06; Sampling Effort: 1 person hour.

Biologists: Steven Ahlstedt, Craig Walker.

No mollusks observed. River habitat was favorable for mussel colonization but substrate was imbedded along with coal fines present. Riparian zone was in good shape and intact. Some fish and crayfish noted.

Site 8: New River at abandoned steel bridge just upstream from the coal preparation plant at Devonia, Anderson County, TN.

GPS Location: 36.0850N-84.2308W; Date: 12-14-06; Sampling Effort: 1 person hour.

Biologists: Steven Ahlstedt, Craig Walker.

No mollusks observed. Stream habitat consisted of imbedded boulder field. Manganese present on underside of rocks. Coal fines present throughout the substrate and yellow boy was noted leaching out of stream-banks. Fish appeared more common here, as well as crayfish.

Site 9: New River upstream from Indian Fork confluence and located a short distance below the coal preparation plant at Devonia, Anderson County, TN.

GPS Location: 36.0916N-84.2236W; Date: 12-14-06; Sampling Effort: 1 person hour.

Biologists: Steven Ahlstedt, Craig Walker.

No mollusks observed. Stream destabilized, eroded and some habitat imbedded. Large amounts of sand and coal fines present including coal fine sludge trapped in leaf litter. The coal fine sludge was considered a release from a settling pond located at the Devonia coal preparation plant. The settling pond was previously observed full but was approximately 75% drained when we visited. This showed up as a spike in flows and turbidity at the USGS gage located at Cordell since no rainfall had occurred in the river for three weeks prior. A few fish (darters) noted.

Site 10: Indian Fork, tributary to the New River at state route 116 bridge crossing, Anderson County, TN.

GPS Location: 36.0919N-84.2239W; Date: 12-14-06; Sampling Effort: 1 person hour.

Biologists: Steven Ahlstedt, Craig Walker.

No mollusks observed. Stream destabilized, large amounts of bed-load movement including coal and sand deposited at the confluence of the creek. A few fish (minnows) noted.

Site 11: New River at Shiloh Church Ford, Anderson County, TN.

GPS Location: 36.0931N-84.2210W; Date: 12-15-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

No mollusks observed. Substrate imbedded with large cobble point bar formations. Coal fines abundant and yellow boy present. Extreme riparian zone erosion with trees collapsed into the river. No fish or crayfish, but a two-lined salamander was observed.

Site 12: New River at Opal Hite residence (white house and large field with power-lines), upstream from Rosedale, Anderson County, TN.

GPS Location: 36.1006N-84.2106W; Date: 12-15-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

No mollusks observed. Long gravel shoal mixed with large concentrations of sand and coal fines. Severe bank erosion and trees downed in the river. Point-bar formations present with yellow boy seeping out of the substrate and along stream-banks. A few fish (darters) noted, including one dead minnow.

Site 13: New River, below the confluence of Double Camp Creek ford, behind Rosedale School, Anderson County, TN.

GPS Location: 36.1016N-84.2051W; Date: 12-15-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

No mollusks observed. Substrate consisted of large imbedded cobble with manganese present on the underside of rocks. Yellow boy present along stream-banks and coal fines present in depositional pools. Severe stream-bank erosion was noted, including ATV traffic all over the shoal. A few fish were noted.

Site 14: Double Camp Branch, tributary to the New River upstream from railroad bridge, Anderson County, TN.

GPS Location: 36.1012N-84.2054W; Date: 12-15-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

No mollusks observed. Large-island was dissected, eroded, and substrate imbedded with coal fines. Shoreline erosion was severe with trees in creek. A few fish were noted, including minnows and hogsucker.

Site 15: New River at low-head concrete bridge crossing, downstream from Rosedale, Anderson County, TN.

GPS Location: 36.1034N-84.2027W; Date: 12-15-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

No mollusks observed. Substrate destabilized and consisted of sand and coal fines. During storm events, recent evidence of massive bedload movement of substrate probably occurs here. Stream-banks eroded with trees falling into river. Yellow boy was prominent in substrate and leaching out of stream-banks. A few fish noted, including minnows and hogsucker.

Site 16: New River at confluence of Reynolds Branch, downstream from blown-out concrete bridge, Anderson County, TN.

GPS Location: 36.1102N-84.2038W; Date: 12-15-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

No mollusks observed. Habitat consisted of imbedded boulders with coal fines covering river substrate. Yellow boy seeping in from stream-banks and was prominent in substrate. A few fish noted, including darters and hogsuckers.

Site 17: New River at river crossing downstream from Charley's Branch, Anderson County, TN.

GPS Location: 36.1137N-84.2004W; Date: 12-15-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

No mussels observed but live Planorbid aquatic snails found. Substrate consisted of imbedded boulders with coal fines extending all along the right descending bank. A few fish noted including minnows and darters and crayfish. This was the first report of live planorbid aquatic snails found during this study.

Site 18: New River at confluence of Gage Creek off state route 116, Anderson County, TN.

GPS Location: 36.1207N-84.1947W; Date: 12-15-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

No mussels observed but live Planorbid aquatic snails found. Substrate consisted of imbedded boulders with coal fines and sand present all along eroded stream-banks extending into the pools. A few fish noted, including minnows and darters and one dead hogsucker.

Site 19: Gage Creek, tributary of the New River at state route 116 bridge crossing, Anderson County, TN.

GPS Location: 36.1207N-84.1950W; Date: 12-15-06; Sampling Effort: 1 person hour.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

No mollusks observed. Gage Creek is a high gradient stream with imbedded boulder substrate. Coal fines and sand were present but not in the quantities previously observed at other sampling locations. One fish (darter) was noted.

Site 20: New River at bridge crossing near Shea, upstream from confluence of Ligias Fork, Anderson County, TN.

GPS Location: 36.1236N-84.1916W; Date: 12-18-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

No mollusks observed. Substrate consisted of large boulder field with imbedded substrate. Point bar formations of sand and coal fines exist here including manganese on underside of rocks. Stream-banks along the right descending bank were eroded. A few fish noted including minnows and darters; also crayfish.

Site 21: Ligias Fork, tributary of the New River above the confluence with the New River, upstream from railroad bridge crossing, Anderson County, TN.

GPS Location: 36.1228N-84.1919W; Date: 12-18-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Gene Lane.

No mollusks observed. Substrate consisted of good gravel and cobble but imbedded. Point bar formations were noted in the lower end of the creek. Yellow boy is fairly common including coal fines. More fish (minnows and darters) were present here than in previous sampling locations.

Site 22: New River at confluence of unnamed tributary, Campbell County, TN.

GPS Location: 36.1317N-84.1938W; Date: 12-18-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Gene Lane.

No mollusks observed. Substrate consisted of slab rock with coal fines under the rocks between shallow pools. Stream-banks are severely eroded with trees falling in the river. A few fish noted including minnows, darters, and one rock bass.

Site 23*: New River at unnamed island off logging haul road that runs along the left descending bank, Reynolds cabin visible on hillside on right descending bank, Campbell County, TN.

GPS Location: 36.1336N-84.2012W; Date: 12-18-06; Sampling Effort: 3 person hours

Biologists: Steven Ahlstedt, Craig Walker, Gene Lane.

First report of relict mussels found but no snails. Excellent shoal habitat below island consisting of cobble, gravel, and sand substrate mixed with coal fines. Habitat around the island was scoured and upstream from the island habitat was all large boulders, coal, and sand leading into a deep pool. Riparian zone was intact but yellow boy prominent along shoreline and seeping out of the banks. A few fish were observed including minnows and darters. This is the first location where mussels were found during this study.

Mussels

Elliptio dilatata, 1 relict

Lampsilis cardium (piece of shell tentative identification)

Site 23a*: (same as site 23) New River at unnamed island off logging haul road that runs along the left descending bank, Reynolds cabin visible on hillside on right descending bank, Campbell County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.1336N-84.2012W; Date: 3-30-07; Sampling Effort: 3 person hours.

One freshwater mussel valve found and identified as *Lampsilis cardium*. No live or other relict mussels observed.

Large concentrations of coal fines were noted including greater diversity of fish: minnows, darters, logperch, long-eared sunfish, smallmouth bass; also crayfish.

Site 24: New River at confluence of Little Creek, Campbell County, TN.

GPS Location: 36.1349N-84.2029W; Date: 12-18-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Gene Lane.

No mollusks observed. River habitat consisted mostly of bedrock and boulders mixed in with some sand and coal fines. Coal fines are prominent in the pools and the riparian zone is relatively intact. One hogsucker noted, and crayfish.

Site 25: New River at Robert's Ford crossing near Shea, Campbell County, TN.

GPS Location: 36.1418N-84.2001W; Date: 12-18-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Gene Lane.

First report of live Asian clams, *Corbicula fluminea*, but no snails found. River habitat consists mostly of scoured bedrock and large boulders leading into a large deep pool. Coal fines and sand blanket the substrate including stream-banks. Riparian zone in fair shape but scoured on the right descending bank. The finding of Asian clams is an indication that river conditions may be suitable for native mussels from this portion of the New River downstream.

Site 26: New River upstream from Brookside at Adkins Branch ford crossing, Campbell County, TN.

GPS Location: 36.1458N-84.2043W; Date: 12-18-06; Sampling Effort: 1.5 person hours.

Biologists: Steven Ahlstedt, Craig Walker, Gene Lane.

Live Asian clams present but no snails. River habitat scoured to bedrock and boulders with coal fines deposited in depositional areas. Prominent gradient change occurs here. Riparian zone was intact. A few fish observed, including minnows and darters.

Site 27: New River at ford crossing downstream from Hicks Branch, Campbell County, TN.

GPS Location: 36.1540N-84.2109W; Date: 12-19-06; Sampling Effort: 2 person hours.

Biologists: Steven Ahlstedt, Craig Walker.

Live Asian clams present but no snails. River habitat consists of a large boulder field that drops off into a depositional area at ford crossing. Coal fines and yellow boy numerous along stream-banks and the riparian zone is severely degraded at crossing. A few fish noted, including minnows, darters, and hogsucker.

Site 28: New River, upstream from confluence of Nick's Branch, Campbell County, TN.

GPS Location: 36.1613N-84.2042W; Date: 12-19-06; Sampling Effort: 1 person hour.

Biologists: Steven Ahlstedt, Craig Walker.

Live Asian clams present but no snails. Large shoal consists mostly of imbedded boulders with coal fines washed up along the stream-banks. Riparian zone was relatively intact. A few fish noted, including minnows and darters.

Site 29: Nick's Branch, tributary to the New River at lower road bridge crossing, Campbell County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.1611N-84.2034W; Date: 12-19-06; Sampling Effort: .5 person hour.

No mollusks observed. Major point-bar formation in the stream and yellow boy was present in the creek and seeping out of stream-banks. Flows extremely low, but a few minnows and darters noted.

Site 30: Smokey Creek, tributary to the New River at low-head bridge crossing in lower creek on Ronald Lowe property, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.1639N-84.2229W; Date: 12-19-06; Sampling Effort: 1 person hour.

Live Asian clams present, but no snails. Discussion with the property owner, who stated that as a 13-year old in 1961

he saw live mussels in Smoky Creek (description matching *Elliptio dilatata*) but no relicts were found during present study. Stream habitat consists of gravel and large quantities of sand and coal fines. Yellow boy is prominent in the stream and seeping out of the stream-banks. However, the gradient is gradual enough in the lower portion of the creek to have had mussels in it. A few fish noted, including minnows, sunfish; also a crayfish.

Site 31: New River at bridge crossing below Smokey Junction, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.1808N-84.2315W; Date: 12-19-06; Sampling Effort: 1 person hour.

Live Asian clams present and fairly common, but no snails. Substrate consisted of imbedded cobble and gravel on shoal upstream from the bridge. Yellow boy present with heavy sand deposition on stream-banks mixed with coal fines. Riparian zone appeared relatively intact. A few fish noted, including minnows and darters.

Site 32: New River at unnamed tributary directly across from Love Branch, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.1859N-84.2252W; Date: 12-19-06; Sampling Effort: 1 person hour.

Live Asian clams present and fairly common, but no snails. Substrate consists of large imbedded boulder field that drops off into a deep pool. Coal fines deposited along stream-banks. A riparian zone which was extremely scoured. A few fish noted, including minnows, darters, and crayfish.

Site 33: Montgomery Fork, tributary to the New River at access road bridge crossing, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.1941N-84.2140W; Date: 12-19-06; Sampling Effort: 1 person hour.

No mollusks observed. Substrate is primarily imbedded boulders with point bar formations. Coal fines present along stream-banks, including yellow boy seeping out of the substrate. Riparian zone is relatively intact. A few fish (minnows) noted.

Site 34*: New River at shoal upstream from confluence of Montgomery Fork, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz, Hannah Simmons.

GPS Location: 36.1924N-84.2227W; Date: 12-20-06; Sampling Effort: 2 person hours.

Relict native mussel present along with live Asian clams that were fairly common but no snails. Substrate consists of a large, imbedded boulder field at scoured island at the end of a long pool. Coal fines and yellow boy deposited along stream-banks and in substrate. Riparian zone intact in long pool but scoured downstream on the left descending bank with trees falling in the river. A few fish noted including minnows, darters; also crayfish.

Mussels

Quadrula pustulosa?, 1 eroded valve

Site 34a*: (same site as site 34) New River at shoal upstream from confluence of Montgomery Fork, Scott County, TN.

Biologists: Steven Ahlstedt, Steve Bakaletz.

GPS Location: 36.1924N-84.2227W; Date: 5-3-07; Sampling Effort: 2 person hours.

No live or relict freshwater mussels found. Fish appeared more plentiful than previous sampling, and included minnows, darters, small-mouth bass; also crayfish.

Site 35*: New River at ford crossing below Hatfield Cemetery, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz, Hannah Simmons.

GPS Location: 36.2010N-84.2329W; Date: 12-20-06; Sampling Effort: 4 person hours.

Live and relict mussels present including Asian clams. This site has very good mussel habitat consisting of gravel, cobble, and sand that extends upstream from a ford crossing. Point bar formations occur here but the riparian zone was relatively intact. Yellow boy and coal fines were observed. A few fish noted including minnows, darters, one dead smallmouth bass; also crayfish.

Mussels

Lampsilis cardium, 1 live (measured at 90 mm), 1 relict

Lampsilis fasciola, 1 relict

Site 36: New River at downstream end of ford crossing (long shoal) below Hatfield Cemetery, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz, Hannah Simmons.

GPS Location: 36.2016N-84.2332W; Date: 12-20-06; Sampling Effort: 1 person hour.

Live Asian clams present but no snails. This site is located at the lower end of a long shoal as an extension of the previous site. Substrate consisted largely of sand and coal fine deposits including the presence of yellow boy along stream-banks.

Site 37*: New River at confluence of Mill Branch, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz, Hannah Simmons.

GPS Location: 36.2026N-84.2452W; Date: 12-20-06; Sampling Effort: 1 person hour.

Relict native mussel and live Asian clams present, but no snails. Substrate consists of imbedded boulders with a large deep pool at the head of the shoal. Riparian zone was relatively intact, except at the confluence of the creek. A few fish noted, including minnows, darters; also crayfish.

Mussel

Lampsilis cardium, 1 fragment

Site 38: Bull Creek, tributary to the New River at access ford crossing, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

GPS Location: 36.1933N-84.2553W; Date: 2-9-07; Sampling Effort: 1.5 person hours.

No mollusks observed. Substrate completely destabilized with coal fines and yellow boy prominent. A few fish noted, including minnows and darters.

Site 39*: New River at downstream from confluence of Bull Creek, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

GPS Location: 36.1946N-84.2602W; Date: 2-9-07; Sampling Effort: 3 person hours.

Live mussels found, including Asian clams, but no snails. Substrate consists of good patches of gravel and sand substrate among some cobble and boulders that are imbedded. Coal fines observed here, but not as much as reported from other sites. This site was sampled for mussels two years ago and federally listed *Alasmidonta atropurpurea* occurs here. During present sampling only two common species were found. A few fish were noted including darters, minnows, stonecat, hogsucker; also crayfish.

Mussels

Lampsilis cardium, 4 live (measurements 123, 127, 103, 114 mm)

Lampsilis fasciola, 1 live, 1 fresh dead (measurements 84, 74 mm)

Lasmigona costata, 1 relict

Site 39a*: (same site as 39) New River at downstream from confluence of Bull Creek, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.1946N-84.2602W; Date: 4-23-07; Sampling Effort: 6 person hours.

Three live mussel species were found, but no federally listed *Alasmidonta atropurpurea*. The Asian clam was considered abundant in the depositional area on the left descending stream-bank, basically where most of the native mussels occur. Fish were relatively common, including minnows and darters.

Mussels

Lampsilis cardium, 18 live (measurements 38, 87, 97, 97, 97, 101, 103, 105, 106, 112, 114, 115, 116, 117, 117, 117, 120, 123 mm)

Lampsilis fasciola, 11 live (measurements 50, 65, 70, 79, 80, 85, 87, 92 mm). Three live gravid females displaying and spawning so they were not removed and measured.

Lasmigona costata, 1 live (measurements 134 mm)

Site 40*: New River at below the confluence of Byrges Creek, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

GPS Location: 36.2001N-84.2654W; Date: 2-9-07; Sampling Effort: 1.5 person hours.

Relict pieces of mussels were found, but not able to identify. Asian clams exist here, but appear rare. Substrate consists of large rock and rubble shoal at the downstream end of a long deep pool. Coal fines are mixed in with the substrate and washed up along stream-banks. Riparian zone is intact. A few fish noted, including minnows and darters.

Site 41: New River at USGS gauge at Cordell bridge crossing, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz, Hannah Simmons.

GPS Location: 36.2010N-84.2705W; Date: 12-20-06; Sampling Effort: 2 person hours.

Live Asian clams present, but no snails. This is a fairly large shoal with mostly embedded boulders and cobble. Sand deposits exist along stream-banks mixed with coal fines. Yellow boy is seeping out of stream-banks. A few fish noted, including minnows and darters.

Site 42*: New River, upstream from the confluence of Buffalo Creek, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

GPS Location: 36.2158N-84.2700W; Date: 2-9-07; Sampling Effort: 3 person hours.

Live mussels found including Asian clams, but no snails. This is perhaps the best most extensive shoal seen in terms of habitat needs for mussels (cobble, gravel, and sand) with very low stream gradient. Coal fines are present here and the riparian zone was somewhat intact. A few fish noted including minnows and darters.

Mussels

Lampsilis cardium, 2 live (measurements 104, 107 mm)

Lampsilis fasciola, 3 live (measurements 65, 67, 69 mm)

Site 42a*: (same site as 42) New River, upstream from the confluence of Buffalo Creek, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2158N-84.2700W; Date: 4-24-07; Sampling Effort: 4 person hours.

Live mussels are present but habitat is completely destabilized with large concentrations of coal fines present. Fish noted as relatively common including minnows and darters.

Mussels

Lampsilis fasciola, 4 live (measurements 95, 103, 107, 107 mm)

Site 43*: New River at Winona bridge crossing, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

GPS Location: 36.2231N-84.2707W; Date: 2-9-07; Sampling Effort: 1.5 person hour.

One relict mussel found here including live Asian clams but no snails. This is a fairly extensive shoal that exists downstream from the bridge crossing. Substrate is somewhat imbedded with large accumulations of sand and coal deposited in shoreline areas. It is presumed that the lower end of Buffalo Creek and Straight Fork, its major tributary, send large quantities of coal and sand out of that tributary drainage since Buffalo Creek is located a short distance upstream from Winona. A few fish noted including minnows and darters.

Mussel

Lampsilis cardium, 1 relict

Site 43a*: (same site as 43) New River at Winona bridge crossing, Scott County, TN.

GPS Location: 36.2231N-84.2707W; Date: 4-24-07; Sampling Effort: 3 person hour.

No live or relict mussels found. A large depositional area of sand and coal fines exists on the left descending bank, and the main channel of the river is scoured down to bedrock.

Site 44: Buffalo Creek at bridge crossing near Acres School, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2842N-84.2554W; Date: 2-09-07; Sampling Effort: 0

Date: 2-9-07; Sampling Effort: 0

This site could not be sampled because of beaver dams.

Site 45*: Buffalo Creek, tributary to the New River at Laxton Cemetery bridge crossing off Buffalo Creek Road, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2806N-84.2531W; Date: 2-28-07; Sampling Effort: 1.5 person hours.

One relict mussel found. No Asian clams or snails. This is the first report of a freshwater mussel in Buffalo Creek.

Buffalo Creek is relatively small at this location with large concentrations of sand and some coal fines. Just upstream from this site habitat is scoured down to bedrock. Beaver dams are present up-stream. No fish observed.

Mussels

Anodontooides denigrada, 1 relict and pieces of shell

Site 46*: Buffalo Creek, tributary to the New River at bridge crossing to private property (Kathy Litton residence) off Buffalo Creek Road, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2744N-84.2504W; Date: 2-28-07; Sampling Effort: 1.5 person hours.

Live mussels found, including dead fingernail clams (*Sphaerium* sp.). No Asian clams or snails. Stream entrenched with beaver dams upstream. Substrate consists of soft mud and sand with small amounts of coal fines, but habitat is scoured down to bedrock. Riparian zone was completely cut-down by the landowner. A few fish (minnows) noted.

Mussels

Anodontooides denigrada, 6 live (measurements 30, 47, 42, 45, 49, 53 mm)

Site 47*: Buffalo Creek, tributary to the New River at Buffalo Road bridge crossing, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2733N-84.2447W; Date: 2-28-07; Sampling Effort: 1.5 person hours.

Live mussels found but no Asian clams or snails. Substrate consisted of cobble, gravel, sand, and mud downstream from bridge crossing. Coal fines are present, but apparently not in large concentrations. A large beaver dam exists directly under bridge. Riparian habitat appears relatively intact. A few fish noted including minnows and darters.

Mussels

Anodontooides denigrata, 8 live, 2 relicts (measurements 37, 41, 42, 44, 42, 48, 59 mm)

Site 48*: Buffalo Creek, tributary to the New River at New Salem Church road bridge crossing, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2646N-84.2403W; Date: 2-28-07; Sampling Effort: 1.5 person hours.

Live mussels found but no Asian clams or snails. Substrate consisted of bedrock with imbedded boulders, gravel and pockets of sand/mud. Coal fines evident along stream-banks and riparian zone in good condition. A few fish noted including minnows, darters and crayfish (female carrying young).

Mussels

Anodontooides denigrata, 4 live, 1 fresh dead, 2 relicts (measurements 46, 47, 47, 47, 45 mm)

Site 49: Buffalo Creek, tributary to the New River at bridge crossing on Sugar Grove Road, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2521N-84.2405W; Date: 2-28-07; Sampling Effort: 1 person hour.

Live Asian clams present (numerous) but no snails. Substrate consists of imbedded boulders covered with silt mixed with coal fines. Filamentous algae are becoming more prominent, probably a result of nutrient enrichment from farming and cattle access to the stream. Large pool exists both upstream and downstream at bridge crossing. Cattle have access to the stream at this site. No fish observed.

Site 50: Rockhouse Fork, tributary to Buffalo Creek at bridge crossing on Sugar Grove Road, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2426N-84.2330W; Date: 2-28-07; Sampling Effort: 1 person hour.

No mollusks observed. Substrate consists mostly of gravel and sand mixed with abundant coal fine deposits. Mussels may have been present here at some point in time but the stream-bed is completely destabilized and the riparian zone shows severe stream erosion. No fish observed.

Site 51*: Buffalo Creek, tributary to the New River at logging ford crossing (Mike Washam property) off Sugar Grove Road, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2450N-84.2353W; Date: 2-28-07; Sampling Effort: 1.5 person hours.

Live mussels found including federally protected *Alasmidonta atropurpurea*, Asian clams (numerous), but no snails.

This is a large rocky shoal with imbedded boulders mixed with gravel, cobble, and sand. Mussels were found at the head of the shoal in soft substrates. Coal fines observed here mixed in with sand and mud. A few fish noted including minnows, darters, and rock bass.

Mussels

Alasmidonta atropurpurea, 1 live, 1 fresh dead (measurements 72, 94 mm)

Lasmigona costata, 2 live (measurements 132, 143 mm)

Villosa taeniata, 1 live (measurements 66 mm)

Site 51a*: (same as site 51) Buffalo Creek, tributary to the New River at logging ford crossing (Mike Washam property) off Sugar Grove Road, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2450N-84.2353W; Date: 3-7-07; Sampling Effort: 3 person hours.

This was a more intensive sampling effort since it showed promise that more species may occur here.

Mussels

Alasmidonta atropurpurea, 4 live (measurements 51, 61, 62, 80 mm)

Elliptio dilatata, 3 live, 2 relicts (measurements 74, 75, 112 mm)

Lampsilis cardium, 2 live, 1 relict (measurements 86, 111 mm)

Lasmigona costata, 8 live, 1 fresh dead (measurements 91, 95, 102, 105, 117, 120, 140, 140 mm)

Villosa iris, 1 live (measurements 60 mm)

Villosa taeniata, 20 live (measurements 65, 64, 65, 63, 53, 76, 66, 51, 62, 64, 70, 65, 81, 71, 70, 55, 80, 64, 56, 62 mm)

Site 52*: Buffalo Creek at abandoned Buffalo Bridge School, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2308N-84.2504W; Date: 3-7-07; Sampling Effort: 1 person hour.

Fresh dead native mussels present including federally protected *Alasmidonta atropurpurea*, Asian clams but no snails. Substrate consists of rocky cobble and gravel mixed with abundance of sand and coal fines along the stream-banks. Apparently there was an old mill dam or bridge blocks present here since the riparian zone was fairly intact upstream. No fish observed because water was slightly turbid.

Mussels

Alasmidonta atropurpurea, 1 fresh dead (measurements 57 mm)

Lasmigona costata, 1 fresh dead (measurements 118 mm)

Villosa taeniata, 1 fresh dead (measurements 57 mm)

Site 53*: Buffalo Creek at state route 63 bridge crossing, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2257N-84.2451W; Date: 3-7-07; Sampling Effort: 0.5 person hour.

Relict native mussels found including live Asian clams (rare) but no snails. Substrate under the bridge crossing consists of large imbedded boulders. A gradient change occurs here since very little gravel or sand exists for mussel colonization. Coal fines were evident along stream-banks. Riparian zone consisted of steep rocky banks. A few fish noted including minnows, darters and one unidentified large fish.

Mussels

Lampsilis fasciola, 2 relicts

Lasmigona costata, 2 relicts

Site 54: Paint Rock Creek, tributary to Buffalo Creek at old bridge crossing just upstream from state route 63 bridge crossing, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2414N-84.2659W; Date: 3-7-07; Sampling Effort: 0.5 person hour.

Live Asian clams present but no snails. Substrate consists of imbedded boulders with sand deposits along the stream-banks mixed with coal fines. A few fish noted including minnows and darters. This creek has excellent flows but no indication of native mussels.

Site 55: Straight Fork, tributary to Buffalo Creek at bridge crossing near Straight Fork Church off state route 63, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2228N-84.2132W; Date: 3-8-07; Sampling Effort: 0.5 person hour.

No mollusks observed. River substrate consisted of heavy deposits of sand and silt. Beaver dams present but apparently blown-out. A few fish noted (minnows) but were considered rare. Riparian zone was relatively intact with no erosion observed.

Site 56: Straight Fork, tributary to Buffalo Creek, approximately 0.5 mile upstream from bridge crossing off state route 63, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2244N-84.2114W; Date: 3-8-07; Sampling Effort: 1 person hour.

No mollusks observed. River substrate looks good but gravel and sand was imbedded in substrate with large concentrations of coal. Riparian zone intact and no fish noted. Superficially, this site looked sterile!

Site 57: Straight Fork, tributary to Buffalo Creek, approximately 0.1 mile upstream from Straight Fork Road Bridge crossing to Norma, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2311N-84.2036W; Date: 3-8-07; Sampling Effort: 0.5 person hour.

No mollusks observed. Stream is impacted by heavy silt and sand. Gravel substrate was hard-packed including coal fines present in stream-bed. Riparian habitat destroyed and no fish were seen.

Site 58: Straight Fork, tributary to Buffalo Creek, approximately 0.5 mile upstream from Straight Fork Road Bridge crossing to Norma, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2332N-84.2024W; Date: 3-8-07; Sampling Effort: 0.5 person hour.

No mollusks observed. Heavy silt mixed with hard-packed gravel and sand. Coal fines present throughout river substrate. Riparian habitat destroyed and no fish were seen.

Site 59: Buffalo Creek, tributary to the New River, upstream from the confluence with the New River at bridge crossing to Winona, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2218N-84.2655W; Date: 3-8-07; Sampling Effort: 1 person hour.

Live Asian clams present but no snails. River habitat scoured down to bedrock and boulders with loose gravel, sand, and coal present. A few fish observed including minnows and darters.

Site 60: Buffalo Creek, tributary to the New River at river ford crossing off Floyd Jeffers Road (Byrd property), Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2231N-84.2626W; Date: 3-8-07; Sampling Effort: 1 person hour.

Live Asian clams present but no snails. River substrate consisted of depositional cobble, gravel, and sand mixed with coal fines. Riparian zone intact but stream-banks undercut. A few fish observed including minnows and darters.

Site 61: Buffalo Creek, tributary to the New River at island off Floyd Jeffers Road (Leonard Crump property), Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2230N-84.2549W; Date: 3-8-07; Sampling Effort: 1 person hour.

Live Asian clams present but no snails. This is a large braided island complex with loose rock, gravel, sand and coal fines. Obvious gradient change occurs here since the island complex is scoured. Riparian zone is intact. A few fish noted including minnows and darters. Leonard Crump stated that the Tennessee Water Pollution Control reported heavy manganese in the stream. The lower end of Buffalo Creek is severely affected by water quality problems draining from Straight Fork

Site 62: Beech Fork, tributary to the New River at Welch Camp creek crossing, Campbell County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

GPS Location: 36.1405N-84.1850W; Date: 3-29-07; Sampling Effort: 1.5 person hour.

No mollusks observed. River substrate consisted of large scoured boulder field with point bar formations of gravel, sand, and coal fines. Riparian habitat is relatively intact. A few fish noted including darters, hogsuckers, and crayfish.

Site 63: Stony Fork, tributary to Beech Fork, near the confluence with Stony Fork upstream from railroad-bridge crossing and downstream from Stony Fork School, Campbell County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

GPS Location: 36.1416N-84.1745W; Date: 3-29-07; Sampling Effort: 0.5 person hour.

No mollusks observed. River substrate consisted of large boulder field with major point bar formations. Habitat scoured with prominent sand and coal deposition along stream-banks. A few fish noted including minnows and darters.

Site 64: Stony Fork, tributary to Beech Fork at ford crossing upstream from Clinchmore just below confluence of Ward Branch, Campbell County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

GPS Location: 36.1256N-84.1632W; Date: 3-29-07; Sampling Effort: 1 person hour.

No mollusks observed. River habitat scoured to bedrock and boulder field. Large concentrations of coal enter Stony Fork from Ward Branch. A few fish noted including minnows and darters.

Site 65: Round Rock Creek, tributary to Beech Fork, just above confluence of Beech Fork and Stony Fork and downstream from Stony Fork School, Campbell County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

GPS Location: 36.1421N-84.1746W; Date: 3-29-07; Sampling Effort: .5 person hour.

No mollusks observed. River habitat scoured and habitat shifting. A pool exists here that was filled with sand and gravel. Coal fines were minimal. A few fish noted including minnows.

Site 66: Round Rock Creek, tributary to Beech Fork at low-head bridge crossing upstream from Tackett Branch and across from McGee Cemetery, Campbell County, TN.

Biologists: Steven Ahlstedt, Craig Walker, Steve Bakaletz.

GPS Location: 36.1449N-84.1702W; Date: 3-29-07; Sampling Effort: 1.5 person hour.

No mollusks observed. A large scoured boulder field exists downstream from a low-head bridge crossing. River

habitat upstream from bridge was considered fairly nice with cobble, gravel and sand. Coal fines were minimal. Riparian zone was largely intact with little bank scour. A few fish noted including minnows and darters.

Site 67*: Smith Creek, tributary to Buffalo Creek, upstream from field access bridge downstream from New Salem Church, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2704N-84.2321W; Date: 3-30-07; Sampling Effort: 1.5 person hour.

Live native mussels present and consisted of one species. More individuals of this mussel are probably present in creek. This is a beautiful small creek with excellent cobble, gravel, and sand habitat. Some coal was observed in depositional areas along stream-banks. Riparian habitat is intact. Saw numerous minnows, darters; also crayfish.

Mussels

Anodontoides denigrata, 1 live (measurements 55 mm)

Site 68: Stanley Creek, tributary to Buffalo Creek at road bridge crossing near Mt. Zion Church, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.2741N-84.2432W; Date: 3-30-07; Sampling Effort: 1 person hour.

No mollusks observed. Stream habitat scoured down to bedrock and slate. Riparian habitat was intact upstream from the bridge. Many minnows, darters and crayfish were observed.

Site 69: Smoky Creek, tributary to New River at low-head bridge crossing upstream from Smoky Creek School, Scott County, TN.

Biologists: Steven Ahlstedt, Steve Bakaletz.

GPS Location: 36.1603N-84.2328W; Date: 5-3-07; Sampling Effort: 0.5 person hour.

No mollusks observed. Stream habitat superficially looks good but is all unconsolidated with point bar formations located downstream from bridge crossing. Heavy silt and sediment covers habitat and is probably the result of previous land-slide in drainage. A few fish (minnows) noted but rare and habitat looked relatively sterile.

Site 70: Brimstone Creek, tributary to New River, upstream from confluence with Number One Hollow, Scott County, TN.

Biologists: Steven Ahlstedt, Steve Bakaletz.

GPS Location: 36.2127N-84.3137W; Date: 4-24-08; Sampling Effort: 2 person hours.

Live Asian clams present but no snails. Excellent gravel and cobble riffle habitat with a light dusting of sediment on top of substrate. Riparian habitat intact and lump coal and some fines observed along shoreline including yellow boy seeping from stream-banks. Water flows were low with excellent water clarity on warm sunny day. Many fish observed, consisting mostly of darters, and minnows; also crayfish. A bat was noted flying and skimming the surface of the water.

Site 70a: (same as site 70) Brimstone Creek, tributary to New River, upstream from confluence with Number One Hollow, Scott County, TN.

Biologist: Steven Ahlstedt, Craig Walker

GPS Location: 36.2127N-84.3137W; Date: 5-6-08; Sampling Effort: 2 person hours.

This was a more intensive sampling effort since previous sampling (site 70) showed promise that live mussels might be present here.

Mussels

Lasmigona costata, 2 live (measurements 67 and 93 mm)

Site 71: Brimstone Creek, tributary to New River at access ford to Pemberton Cemetery, Scott County, TN.

Biologists: Steven Ahlstedt, Steve Bakaletz.

GPS Location: 36.2118N-84.3151W; Date: 4-24-08; Sampling Effort: 1 person hour.

Live Asian clams present but no snails. Nice gravel and sand shoal, but grossly affected by vehicular traffic crossing creek. Riparian zone relatively intact, but trees were observed down in the river immediately below the crossing. Pools were noted to contain sediment and coal fines and yellow boy seeps from stream-banks and substrate. Some darters and minnows observed.

Site 72: Brimstone Creek, tributary to New River at Walker Bridge, Scott County, TN.

Biologists: Steven Ahlstedt, Steve Bakaletz.

GPS Location: 36.2043N-84.3222W; Date: 4-24-08; Sampling Effort: 2 person hours.

Relict piece of a mussel found but could not identify. Live Asian clams present but no snails. Stream habitat consists

of cobble, gravel and sand substrate. Large pool extends upstream from bridge. Riparian habitat good but some trees observed down in the creek. Some darters and minnows noted and chunks of coal are scattered along the stream banks and yellow boy observed seeping from substrate.

Site 73: Brimstone Creek, tributary to New River, downstream from Pond Hollow, Scott County, TN.

Biologists: Steven Ahlstedt, Steve Bakaletz.

GPS Location: 36.2013N-84.3159W; Date: 4-24-08; Sampling Effort: 2 person hours.

Live Asian clams abundant but no snails. Excellent riffle and shoal habitat consisting of cobble, gravel and sand covered by a light dusting of sediment. Riparian habitat excellent and many fish observed including darters, minnows, bass and one redbreast. Some yellow boy observed seeping from stream-banks. This might be a good location for mussel reintroduction.

Site 74*: Brimstone Creek, tributary to New River, downstream from Cal Branch, Scott County, TN.

Biologists: Steven Ahlstedt, Steve Bakaletz.

GPS Location: 36.1941N-84.3114W; Date: 4-24-08; Sampling Effort: 2 person hours.

Live native mussels present representing three species. Asian clams present but no snails. Stream habitat severely degraded with high sediment concentrations. Riparian habitat degraded with many trees down in the stream along with stream-bank collapse.

Mussels

Lasmigona costata, 1 live (measurements 89 mm)

Lampsilis fasciola, 1 relict

Tritogonia verrucosa, 1 relict

Site 75: Brimstone Creek, tributary to New River, upstream from Slick Rock Creek Bridge, Scott County, TN.

Biologists: Steven Ahlstedt, Steve Bakaletz.

GPS Location: 36.1816N-84.3014W; Date: 4-24-08; Sampling Effort 2 person hours.

Live Asian clams present but no snails. Stream habitat consisted of large imbedded slab rock with some patches of gravel and sand at a large island upstream from the bridge. A large pool exists at the head of the island. Riparian habitat is relatively intact but stream habitat and flows are more riverine due to gradient change. A few fish noted including darters and minnows.

Site 76: Brimstone Creek, tributary to New River at Griffeth Ford Bridge, Scott County, TN.

Biologists: Steven Ahlstedt, Steve Bakaletz.

GPS Location: 36.1755N-84.3009W; Date: 4-24-08; Sampling Effort: 2 person hours.

Live Asian clams present but no snails. Nice shoal but higher stream gradient with substrate imbedded with heavy sediment and coal fines. Yellow boy observed seeping out of substrate. Riparian habitat intact but trees were observed down in the creek. A few fish noted, including darters and minnows.

Site 77*: Brimstone Creek, tributary to New River at single lane bridge crossing above Hughett, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.1856N-84.3045W; Date: 5-6-08; Sampling Effort: 3 person hours.

Riffle/run habitat exists below bridge. Riparian habitat completely destroyed below bridge but intact upstream. Live mussels found in shallow riffle/run pool in mid-channel upstream from bridge. Heavy sedimentation noted along shoreline with downed trees in creek. Asian clams are common including numerous minnows, darters, spotted bass; also crayfish.

Mussels

Lampsilis fasciola, 1 fresh dead (measurements 71 mm), 1 relict

Villosa taeniata, 2 live (measurements 43 and 64 mm), 1 fresh dead (measurements 63 mm), 7 relicts

Site 78: Brimstone Creek, tributary to New River at Lonesome Bridge Church Road, Scott County, TN.

Biologists: Steven Ahlstedt, Craig Walker.

GPS Location: 36.1546N-84.29.19W; Date: 5-6-08; Sampling Effort: 0.5 person hours.

No mollusks observed. Stream is very shallow and scoured with point bar formations. Riparian habitat fair upstream from bridge. Heavy bed-load movement of sand, gravel and cobble with some coal fines observed. Observed a few fish mostly minnows and darters.

