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Memo

To: Ann Jennings, FWS - White Marsh
From: Dick Neves, Virginia Coop. Fish & Wildlife Research Unit
Date: August 28, 1995
Subject: Dwarf wedgemussel reports on Cedar Run (Stevenson reports)

I have reviewed the sequence of reports prepared by Phil Stevenson (1993, 1994, 1995) on the mussel surveys of Cedar Run, Fauquier County, Virginia. Stevenson (1993) reports the collection of 1 live specimen of Alasmidonta heterodon in a small, shallow pooled area with coarse substrate adjacent to a riffle. The subsequent survey (Stevenson 1994) found no A. heterodon, and concludes that the original identification of this species was incorrectly applied to a specimen of the eastern floater (Pyganodon cataracta). This reported misidentification followed from "an examination of this year's data and the find of specimens of easter floater with unusual shell morphology and color from Cedar Run." The supplemental report to these surveys (Stevenson 1995) is a discussion of the reported misidentification of the specimen of A. heterodon, to include photographs and rationale for the re-assessment.

After reviewing these reports and examining the photographs in the last report, I provide my opinion on the specimen re-identified as an aberrant eastern floater.

1. Using calipers to measure the specimen in Figure 3, I calculate that this animal was roughly 24 mm in length. The specimen is probably age 4 (Michaelson and Neves 1995) and exhibits many of the conchological traits of the dwarf wedgemussel: ventral margin flatly curved or straight, dorsal margin slightly curved, beaks low but projecting slightly above the hinge line, rounded posterior ridge, periostracum with evidence of rays, and a concavity (in lateral view) between the umbo and anterio-dorsal margin. Although shell obesity cannot be ascertained from the photograph, Stevenson (1995) noted that "the shell seemed more inflated with a more prominent posterior ridge than recently seen comparably-sized eastern floater shells."

2. The eastern floater (P. cataracta) is characterized by a smooth, shiny periostracum (typically yellow-green), green rays (especially in young specimens), a relatively straight hinge line, thin valves, distinct growth rests externally, and rounded ventral margin. This species is much larger in size, achieving about 150 mm in total length when compared to ~45 mm total length for A. heterodon. Thus the specimen in Figure 3 would be probably age 2, if it was an eastern floater. Unfortunately, the quality of Figure 4 is such that traits useful to compare specimens are blurred or shadowed, so I must rely primarily on Figure 3 for identification.

Although it is difficult to identify a unionid strictly from a lateral view of one valve, I believe that the specimen in question looks more like a dwarf wedgemussel than an eastern floater. My reasons for believing so are as follows.

1. Based on the size of the animal (24 mm), umbonal erosion, and evidence of growth rests on the periostracum, the specimen appears to be a young adult of a small species rather than a juvenile of a large species.

2. The dorsal margin is definitely curved rather than straight (Figure 3).

3. There is no statement in the report telling whether the specimen was cleaned for the photographs or not. If the periostracum was cleaned of debris and discoloration, coloration and rays could depict either species. Color tends to be a very variable trait within and among populations. However, I would expect to see more light green and yellow on a juvenile eastern floater vs dark green on a young adult dwarf wedgemussel.

4. Ventral margin appears more flatly curved than rounded (Figure 3).

5. Umbo position is more similar to dwarf wedgemussel than eastern floater (Figure 3).

6. Shell inflated with posterior ridge (Stevenson 1995, p. 8).

Although Phil Stevenson changed his identification based on finding a similar specimen during the second survey, I am unable to corroborate this because a photograph of that specimen is not included in the 1995 report. A photo of that specimen alongside the specimen in Figure 3 would have been more convincing than his verbal discussion (Stevenson 1995, p. 9).

Because he found no A. heterodon in the second survey of greater effort, he infers that this is supporting evidence for a misidentification in the original survey. The absence of a dwarf wedgemussel in the second survey really has no bearing on the specimen found in the initial survey. Rare mussels are commonly found at one time and not at another, even when their location is marked in a stream. The discovery of one dwarf wedgemussel specimen in a small, widespread population is a low probability event, no matter how much time or distance is included in a survey.

In my opinion, the photograph (Figure 3) and description of the specimen lead me to believe that the mussel was more likely a young adult dwarf wedgemussel than a juvenile eastern floater.

cc: Phil Stevenson

Stevenson
1995

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July 28, 1995

Richard J. Neves
Virginia Polytechnic Inst. & State Univ.
Fisheries and Wildlife Cooperative Unit
Blacksburg, VA 24061

Dick,

Here are the two reports you asked for. Let me know if you want any others.

Phil

A Survey of the Freshwater Mussel Fauna in Cedar Run, Fauquier County, Virginia

(Contract SCS-37-VA-93)

Technical Report to:

U. S. Department of Agriculture
Soil Conservation Service
Culpeper Building, Suite 209
1606 Santa Rosa Road
Richmond, Virginia 23229-5014

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Submitted by:

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October 25, 1993

Introduction

The Soil and Conservation Service currently seeks to build a proposed flood control impoundment on Cedar Run, Fauquier County, Virginia, near the town of Auburn. As part of the environmental assessment of the proposed project, the Soil Conservation Service funded a survey of Cedar Run to determine the presence of the federally listed-endangered dwarf wedgemussel (*Alasmidonta heterodon*), the state endangered brook floater (*Alasmidonta varicosa*), and other freshwater mussel species within and adjacent to the pool area of the proposed reservoir. The area surveyed extended from the County Route 670 crossing of Cedar Run upstream to the confluence of Cedar Run and Mill Run. Field surveys occurred on September 29 and October 5, 1993. Philip H. Stevenson conducted the field survey.

Five species of freshwater mussel were found, including the federally listed endangered dwarf wedgemussel (*Alasmidonta heterodon*). The species found in order of decreasing abundance are:

Atlantic spike (*Elliptio producta*)
eastern floater (*Anodonta cataracta*)
eastern elliptio (*Elliptio complanata*)
squawfoot (*Strophitus undulatus*)
* dwarf wedgemussel (*Alasmidonta heterodon*)

Only one live specimen of dwarf wedgemussel was found. The specimen was found near the upstream end of the proposed reservoir pool. The brook floater (*Alasmidonta varicosa*) was not found during the mussel survey.

Cedar Run is located within the Potomac Basin. The dwarf wedgemussel has been collected previously from the Potomac Basin nearby in Aquia Creek (U. S. Fish and Wildlife Service, 1993). The brook floater has been collected in Broad Run, Prince William County, Virginia(P.H. Stevenson, unpublished data). Broad Run and Cedar Run join to form the Occoquan River, a Potomac tributary, well downstream of the survey area. Given the proximity of Cedar Run to documented populations of the two rare mussel species, local

ecological conditions are the determinants for the presence of either species. The overall quality of riffle/run habitats in Cedar Run is fair. There are a significant number of beaver dams of recent construction which are altering the stream habitat, converting generally slow flowing habitats to still water. Stream conditions appear affected somewhat by siltation, especially in the lower reaches. The riffle areas frequently have significant amounts of exposed bedrock which is a poor habitat for mussels. Cedar Run seems to be in better condition within the uppermost portions of the survey area, above the proposed reservoir pool.

Survey Techniques

The survey focused on the dwarf wedgemussel (*Alasmidonta heterodon*) and the brook floater (*Alasmidonta varicosa*). General survey sites within the survey area are indicated in Figure 1, a selected portion of the U.S. Geological Survey topographic map of the Catlett, Virginia 7.5 minute quadrangle. The general survey sites depicted are discussed in the Evaluation of Findings section later in the report.

Intensive searching was largely limited to those areas which are considered to be significant for the brook floater and dwarf wedgemussel. Areas of run and riffle habitat are considered most significant for the brook floater(Clark and Berg, 1959; Johnson, 1970). Dwarf wedgemussel also occur in relatively silt-free pool areas(U.S. Fish and Wildlife Service, 1993). Survey methods included waterscoping, handpicking, and raking the substrate. In addition, stream banks were searched for muskrat middens of discarded shells and shells cast on bars by flood. The entire survey area was traversed by foot to search for specimens. Voucher specimens will be deposited in the Virginia Museum of Natural History, Martinsville, Virginia.

Visual searches proved to be most effective, as spent shells were easily visible in the shallow waters of the riffle areas. Bank and bar searches were equally productive. Very few mussels were

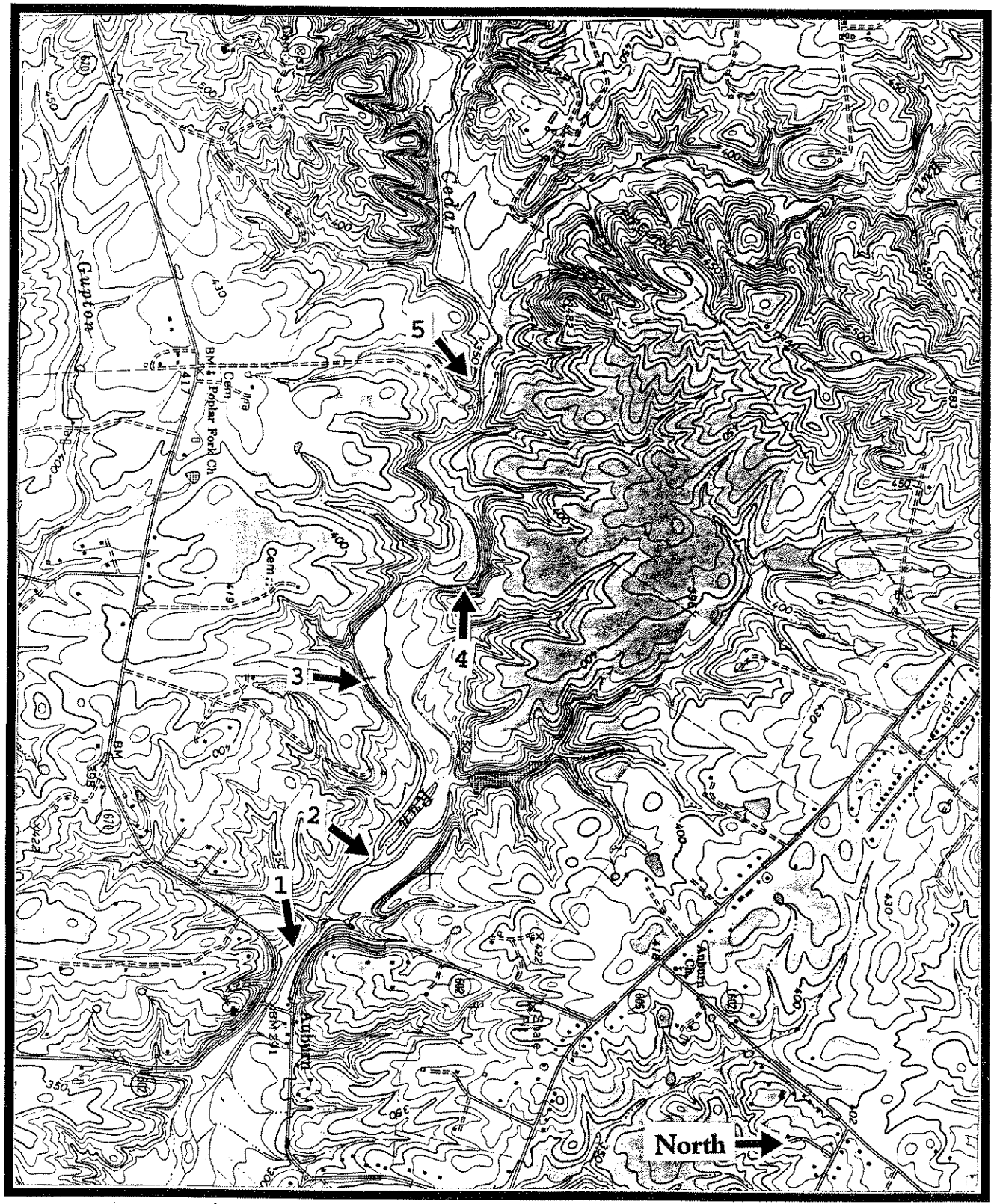

Figure 1. Mussel Survey Sites in Cedar Run, Fauquier County, Virginia

found waterscoping; however, most live mussels were found this way. In well-lighted pool areas, visual searching complemented waterscoping. The deepest areas of large pools and beaver ponds were not searched as these silty habitats are inappropriate for the focus species.

Inventory of Species

The survey found five mussel species, including the endangered dwarf wedgemussel (*Alasmidonta heterodon*). Table 1 lists the species found and their federal and state legal status. In Table 2, the presence of mussels is indicated for each site where intensive searching was performed. Sites are identified by the numerical labels displayed in Figure 1. Table 2 indicates whether the given species was found as live specimens, or shell only. Shell here refers to both relict shells and recent shells. No fresh dead specimens were found.

The most common species is the Atlantic spike (*Elliptio producta*). The Atlantic spike can be considered to be a moderately common species in the survey area; however, few live individuals were found. This species frequently occurs in silty or muddy pool areas which were not well searched during this survey. Specimens of this species were found at the uppermost and lowermost ends of the survey area.

The eastern floater (*Anodonta cataracta*) was the second most commonly observed species. This species was found throughout the survey area. More live individuals were found of this species than of any other. All live individuals were found associated with sandy or muddy pools, a typical habitat for this species.

The eastern elliptio (*Elliptio complanata*) was the next most commonly observed species. This is a relatively large species, which makes the shells of this species relatively easy to find. Given that no live individuals were found, this species would be considered uncommon. This species is one of the most common mussels of North America and has broad ecological tolerances. The lack of

Common Name	Scientific Name	Federal Status	State Status
Alasmidonta heterodon	dwarf wedgemussel	Endangered	Endangered
Anodonta cataracta	eastern floater		
Elliptio complanata	eastern elliptio		
Elliptio producta	Atlantic spike		
Strophitus undulatus	squawfoot		

Table 1. Mussel Species Found in Cedar Run, Fauquier County, Virginia

Species	Mussel Survey Sites					
	1	2	3	4	5	Total
Alasmidonta heterodon	0	0	0	1L	0	1L
Anodonta cataracta	3L,5S	0	3S	1L,1S	1L	5L,9S
Elliptio complanata	1S	0	4S	3S	2S	10S
Elliptio producta	1L,1S	2S	6S	7S	2S	1L,18S
Strophitus undulatus	0	1S	2S	0	1L	1L,3S

Table 2. Mussel Distribution by Survey Site in Cedar Run, Fauquier County, Virginia

L = Live specimens, S = Shell found.

observations here probably reflects a low population in the headwater environment of Cedar Run. Unobserved individuals likely occurred in some of the large pools not thoroughly searched. Similar to the Atlantic spike, the eastern elliptio was found at the lowermost and uppermost ends of the survey area.

The squawfoot (*Strophitus undulatus*) was encountered very rarely. The find of an immature live specimen indicates recent reproduction of this species in Cedar Run. This species is uncommon to rare in Cedar Run. The squawfoot tends to prefer quieter waters; and, the few finds of this species may partly result from the concentration of search effort in riffle habitats. The only live specimen found was in the headwater of a beaver pond in site 5.

The dwarf wedgemussel (*Alasmidonta heterodon*) was the rarest mussel in Cedar Run. This species was found at only one site. Only one specimen was found; and, it was a live animal. In Figure 1, the arrow for site 4 points directly at the spot where the mussel was found. The habitat was a small, shallow, pooled area with coarse cobble/pebble substrate adjacent to a riffle. This area undoubtedly experiences good flow during moderate to high water conditions.

Evaluation of Findings

Site 1 was the downstream-most area investigated. This site includes a moderate sized riffle located immediately downstream of the Route 670 bridge. The site extends upstream to the confluence of two intermittent tributaries 0.4 kilometers west of the Route 670 bridge. The upstream terminus is a relatively long pool, circa 100 meters long. A long riffle area is located above the bridge and extends to the upstream pool. The riffle areas tend to be very narrow, under 2 meters wide, and very shallow. The downstream areas of the long riffle and the bridge riffle were the best habitats as there was good substrate. The middle to upper part of the long riffle had a significant amount of exposed bedrock, reducing its suitability as a mussel habitat.

Site 2 extends from the upstream end of Site 1 to the downstream end of a large seasonal island at Site 3. In general, pools dominate this section. The exception is the central area where two intermittent tributaries join Cedar Run. Here, the habitat is largely lotic in character. Siltation tends to be low in this area. Above this area there are three small riffles, each under 20 meters in length, which separate much longer pools. These riffles tend to be somewhat silted. Cattle have access to Cedar Run in this area; and, the cattle access points likely contribute to siltation here.

Site 3 includes the stream adjacent to a large seasonal island. The more northerly channel indicated on the U.S.G.S. map of the area was dry at the time of the survey. It appears that this channel would be dry in most years during typical summer flow conditions. This site is bordered on both upstream and downstream ends by long pools. Both pools are formed by apparently natural cobble bars. The upstream pool begins at the point were the seasonal channel diverges from Cedar Run. The head of the downstream pool is just above the downstream confluence of the seasonal channel and the main channel. The habitat adjacent to the seasonalisland is entirely shallow riffle/run habitat. The most negative factor here for mussels is that there is much exposed bedrock throughout this site. The site is also somewhat silty. Livestock obviously have access here contributing to both siltation and eutrophication. The lack of pleurocerid snails, typical of good flowing conditions, lends support to the interpretation of this site as being somewhat degraded. While mussel shells were found here, this site is poor habitat. The shells found here probably originate upstream of this site.

Site 4 includes the area where the sole specimen of dwarf wedgemussel was found. The habitat here was a relatively long flowing reach with small rocky riffles. Stream substrate was cobbles, pebbles, gravel, and sand. No influences of livestock were observed here. Siltation was moderate here, even out of strong flow. This site has been defined to be relatively small as it is

limited to the better habitats in the immediate vicinity of the dwarf wedgemussel find. The site is bordered on its upper end by a very long beaver pond whose dam is located roughly 70 meters above the dwarf wedgemussel location. Habitat in this area was generally fair.

Site 5 was the uppermost area investigated. Included within this area is the large beaver pond which borders the upstream end of Site 4. There were three beaver ponds between Site 4 and the farm road crossing in Site 5. Lotic habitats were located from roughly 200 meters below the farm road crossing to about 200 meters above the crossing. There was frequent bedrock exposure in this area, making it a generally fair to poor habitat for mussels. The upper end of Site 5 was also a beaver pond which extended to the confluence with Mill Run. All live mussel found within Site 5 were associated with the beaver ponds in the downstream area.

Overall, the conditions of Cedar Run appear to be that of a stream which is in a somewhat degraded but stable state. Aquatic macrophytes, which are indicators of water quality, were very uncommon; however, the shading of much of the stream influences this. Another indicator of good water quality is the presence of pleurocerid snails; none were observed indicating either poor conditions or previously poor conditions. A possible source of some of the negative impacts is the adjacent farmland and pasture. Runoff from these lands probably contributed to the siltation of the creek. This seems to be more prominent in the lower survey area. It is also possible that past practices had more severe impacts on the stream and the stream has improved more recently.

Recommendations

The impoundment of Cedar Run will affect the mussel fauna of this area in several ways. Populations of the eastern elliptio and the eastern floater will likely be increased by the presence of the impoundment. The Atlantic spike population will likely remain approximately the same as it tolerates impoundments, but does not

tend to flourish there. The squawfoot will likely be negatively influenced, because it seems to tolerate pool condition which are somewhat influenced by stream flow; it likely will populate headwater areas of the impoundment pool. Any populations of dwarf wedgemussel which occur within the impoundment pool will be eliminated as this species does not tolerate living in these conditions (U.S. Fish and Wildlife Service, 1993). A possible mitigation of the impacts to the dwarf wedgemussel may be the lowering of the normal pool area should the current find of the dwarf wedgemussel prove to represent an extant and localized population.

Given the find of an endangered species within the pool area of the proposed reservoir, the primary recommendation is to conduct additional survey work to determine the population center for dwarf wedgemussel. This effort should be divided so as to determine if the population center is within the reservoir pool or if the individual found was at the extreme end of a population found in either the headwaters or tailwaters of the proposed impoundment. Reconnaissance survey should be conducted within Cedar Run and Mill Run upstream of their confluence. Survey should also be conducted below the Route 670 crossing of Cedar Run. Intensive survey should be conducted within the appropriate habitats of the original survey area. Areas which should receive intensive re-examination should include site 4 in the area of the dwarf wedgemussel find, the tributary confluence area of Site 2, and the riffle areas of Site 5 and Site 1. Selected pool areas can be examined while performing the intensive surveys. An estimated 7-10 days of field work should satisfy the above recommended survey work. As the intensive field surveys are needed to verify if the impoundment will extirpate a population of an endangered species, this field work should be performed under good to excellent conditions. The recommended time for initiation of this field work is 1994 after spring flows are reduced as current conditions have begun to deteriorate with leaf fall. The Soil Conservation Service should coordinate any proposed survey effort with the U.S. Fish and Wildlife Service and the

Virginia Department of Game and Inland Fisheries to ensure the requirements of these agencies are met regarding this effort.

References

Clarke, Arthur H. and Berg, Clifford O. 1959. The freshwater mussels of Central New York with an illustrated key to the species of northeastern North America. Cornell University Agricultural Experiment Station Memoir 367. 79 pages.

Johnson, Richard I. 1970. The systematics and zoogeography of the Unionidae (Mollusca: Bivalvia) of the southern Atlantic slope region. Bulletin of the Museum of Comparative Zoology 140(6): 263-450.

United States Fish and Wildlife Service. 1993. Dwarf Wedge Mussel (Alasmidonta heterodon) Recovery Plan. Hadley, Massachusetts. 52 pp.

Stevenson 1994

A Second Survey for Freshwater Mussel Fauna in Cedar Run and Mill Creek, Fauquier County, Virginia (Contract SCS-10-VA-94)

Technical Report to:

U. S. Department of Agriculture
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October 1, 1994

Introduction

The Soil Conservation Service currently seeks to build a proposed impoundment on Cedar Run, Fauquier County, Virginia, near the town of Auburn. As part of the environmental assessment of the proposed project, the Soil Conservation Service(SCS) funded an initial survey of Cedar Run to determine the presence of the federally listed-endangered dwarf wedgemussel (*Alasmidonta heterodon*), the state endangered brook floater (*Alasmidonta varicosa*), and other freshwater mussel species within and adjacent to the pool area of the proposed reservoir. The initial survey reported a single live dwarf wedgemussel from within the proposed pool of the reservoir (Stevenson, 1993a).

The dwarf wedgemussel has been collected previously from the Potomac Basin nearby in Aquia Creek (U. S. Fish and Wildlife Service, 1993). Cedar Run is located within the Potomac Basin. The brook floater has been collected in Broad Run, Prince William County, Virginia (Johnson, 1970; Stevenson, 1993b; P.H. Stevenson, unpub. data). Broad Run and Cedar Run join to form the Occoquan River, a Potomac tributary, well downstream of the survey area. Given the proximity of Cedar Run to documented populations of the two rare mussel species, local conditions determine the presence of either species.

This study encompasses a much larger survey area than the original survey. To find the full range of any rare mussel populations, reaches of Cedar Run and Mill Run continuous with the 1993 survey area needed examination. Searches of Cedar Run at road crossings not immediately adjacent to the reservoir site were used to expand the study area. The road crossing searches generally followed the VDGIF impact study criteria. This criteria specifies a survey area from 200 meters upstream of a proposed impact site to 500 meters downstream of a proposed impact site. Determining the exact nature of any dwarf wedgemussel population in the proposed reservoir pool required more intensive survey methods for specific sites there. Field surveys occurred on August 4, 8, 9, 10, 11 and

September 4, 1994. Philip H. Stevenson conducted the field survey with assistance from John Meyers and George Sutton of the SCS.

Five species of freshwater mussel were found. The species found, in order of decreasing abundance are:

eastern elliptio (*Elliptio complanata*)
Carolina lance (*Elliptio angustata*)
eastern floater (*Anodonta cataracta*)
squawfoot (*Strophitus undulatus*)
triangle floater (*Alasmidonta undulata*)

No specimens of dwarf wedgemussel (*Alasmidonta heterodon*) were found. The brook floater (*Alasmidonta varicosa*) was not found during either mussel survey. I conclude that the original identification of the dwarf wedgemussel was incorrectly applied to a specimen of the eastern floater. This conclusion follows from an examination of this years data and the find of specimens of eastern floater with unusual shell morphology and color from Cedar Run.

The overall quality of riffle/run habitats in Cedar Run is fair. Beavers alter the stream habitat significantly. These dams convert generally slow flowing habitats to still water. Stream conditions appear affected by siltation and possibly eutrophication, especially where cattle have unrestricted access to the stream. Small dense patches of mussels always resided in the best habitats adjacent to well-fenced pasture or woodlands. Many lotic stream areas contain significant amounts of exposed bedrock substrate which constitutes poor habitat for mussels.

Survey Techniques

Cedar Run received the primary survey effort with two tributaries being partially investigated. Table 1 lists all survey areas within the overall study area. Each entry lists the appropriate figure number that depicts each survey area; and, these figures follow Table 1. In the caption of each figure appears the name of the appropriate U.S.G.S. 7.5 minute series topographic map(s) from which I derived the figure. The scale for all figures is 1:24,000. Annotations on each figure indicate specific location

information. The Evaluation of Findings section describes these survey sites in more detail.

Survey Site	Figure	Boundaries
Route 603	1	Cedar Run, from Route 603 bridge upstream to 300 meters above Turkey Run confluence, and Turkey Run from Cedar Run confluence upstream 200 meters.
Lower Auburn	2	Cedar Run, from the Longwood Farm road crossing upstream to Route 602.
1993 (Original)	3	Cedar Run, from Route 602 bridge upstream to Mill Run confluence.
Confluences	3	Cedar Run, at confluence of 2 unnamed tributaries, 1.2 air km west northwest of Auburn
Riffles	3	Cedar Run, riffles below beaver pond, 2.0 air kilometer west northwest of Auburn.
Mill Run	4	Mill Run, from Cedar Run confluence upstream to Route 605 crossing.
Frytown	5	Cedar Run, from Mill Run crossing upstream to Route 674 crossing.
Route 683	6	Cedar Run, from 500 meters downstream of Route 683 ford upstream to dam 50 meters above ford.
Route 29	6	Cedar Run, from 500 meters downstream of Route 29 upstream to 500 meters upstream of Route 29.

Table 1. Mussel Survey Sites in Cedar Run and its tributaries

The survey focused on the dwarf wedgemussel (*Alasmidonta heterodon*) and the brook floater (*Alasmidonta varicosa*). Intensive searching concentrated on those habitat areas most significant for the brook floater and dwarf wedgemussel. Reported observations indicate that throughout its range dwarf wedgemussel depends on environments that are lotic to seasonally lotic in nature (Michaelson, 1993). Areas of run and riffle habitat are considered

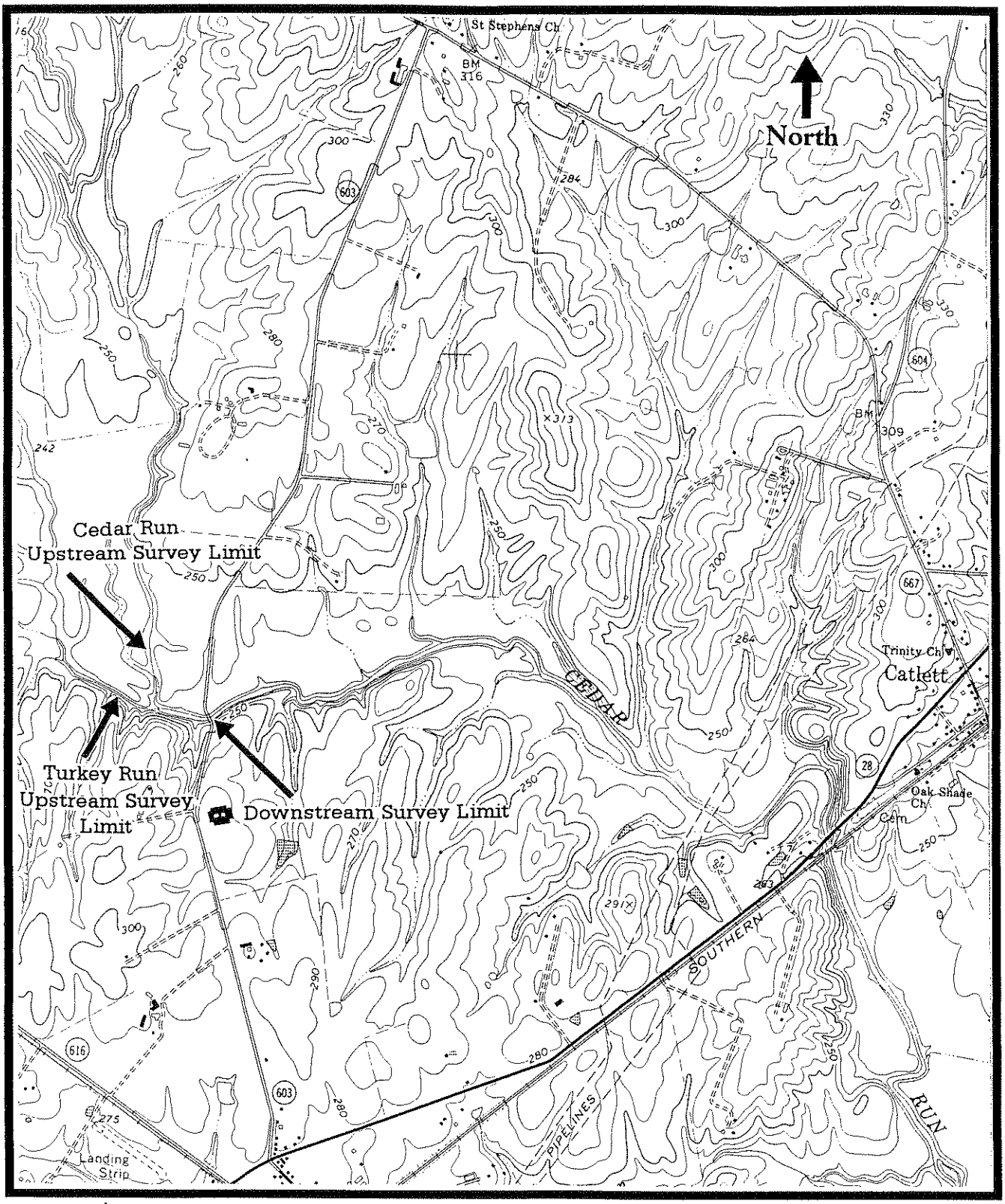

Figure 1. Route 603 Survey Area, Cedar Run and Turkey Run, Fauquier County, Virginia (Catlett, Va. 1978)

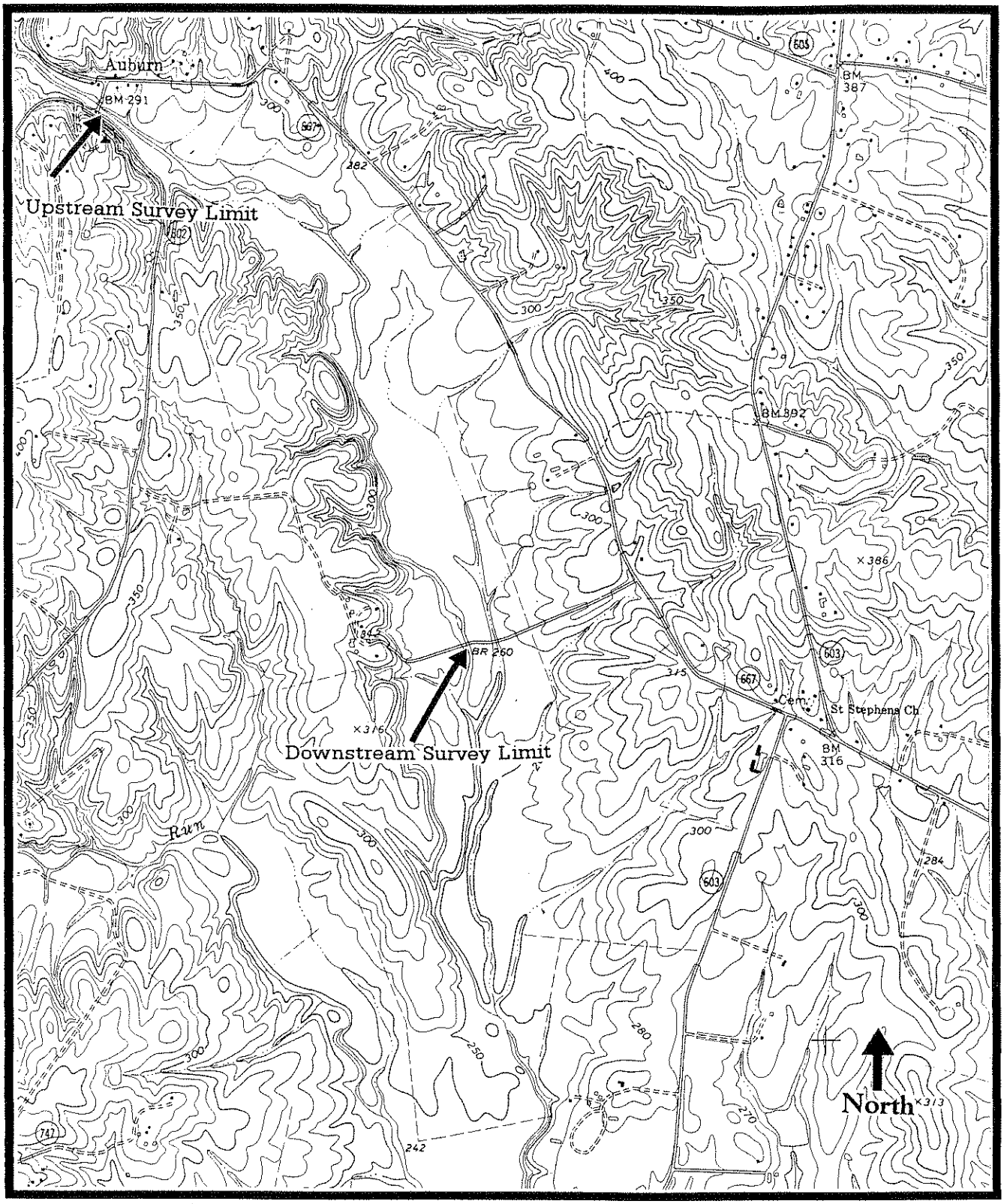

Figure 2. Lower Auburn Survey Area, Cedar Run, Fauquier County, Virginia (Catlett, Va. 1978)

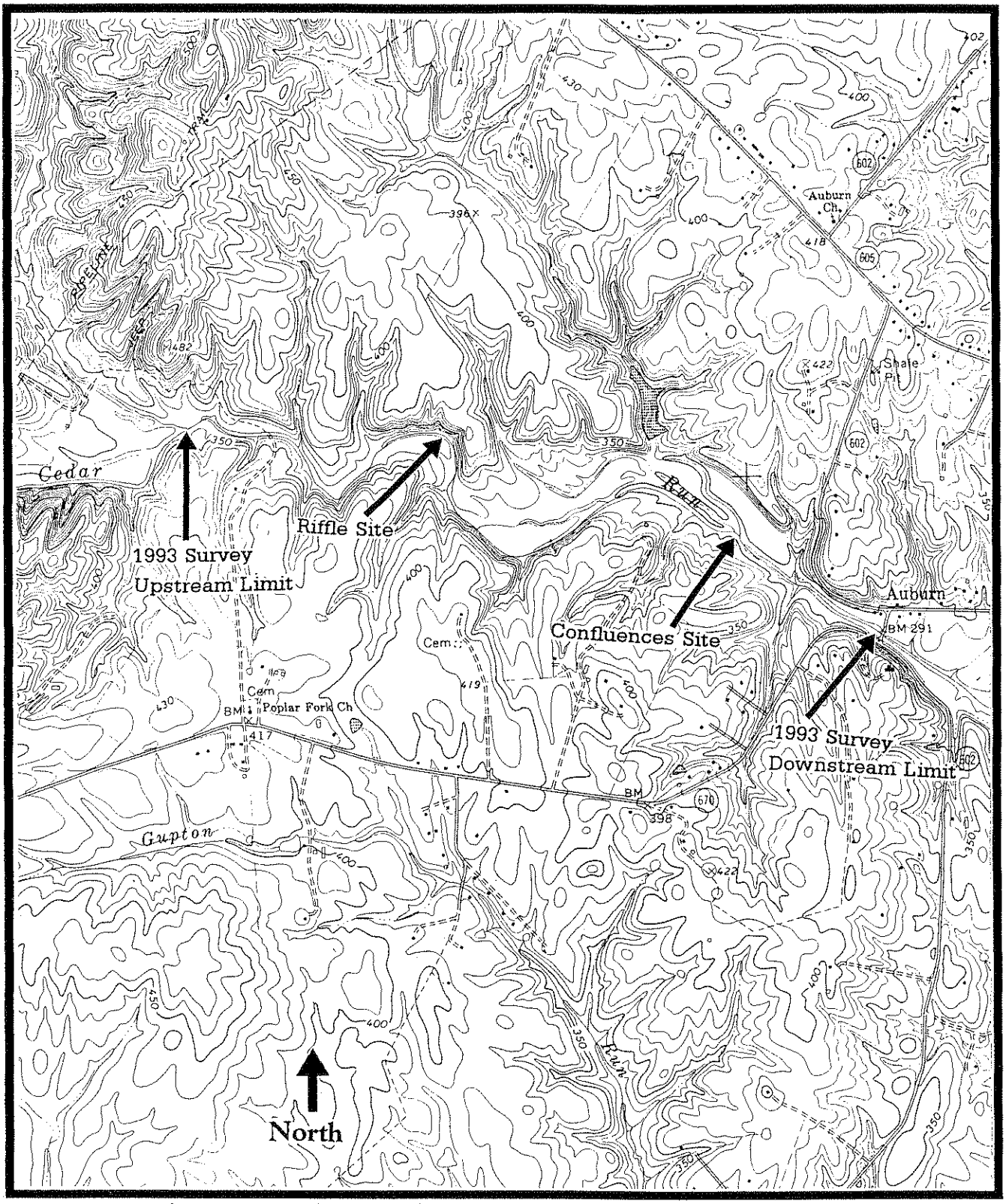

Figure 3. Riffle Site and Confluences Site, with 1993 Survey Limits shown, Cedar Run, Fauquier County, Virginia (Catlett, Va. 1978)

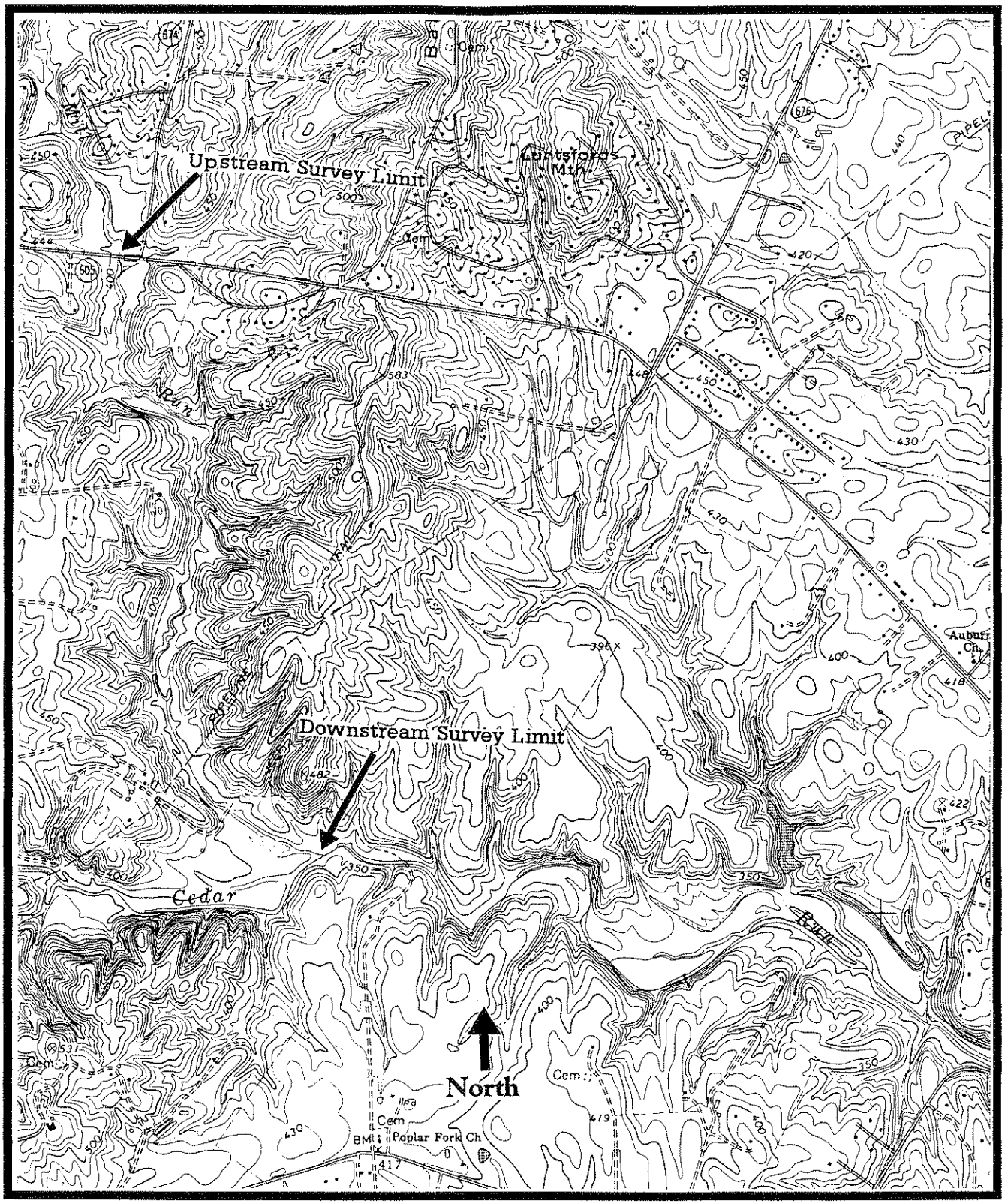

Figure 4. Mill Run Survey Area, Mill Run, Fauquier County, Virginia (Catlett, Va. 1978)

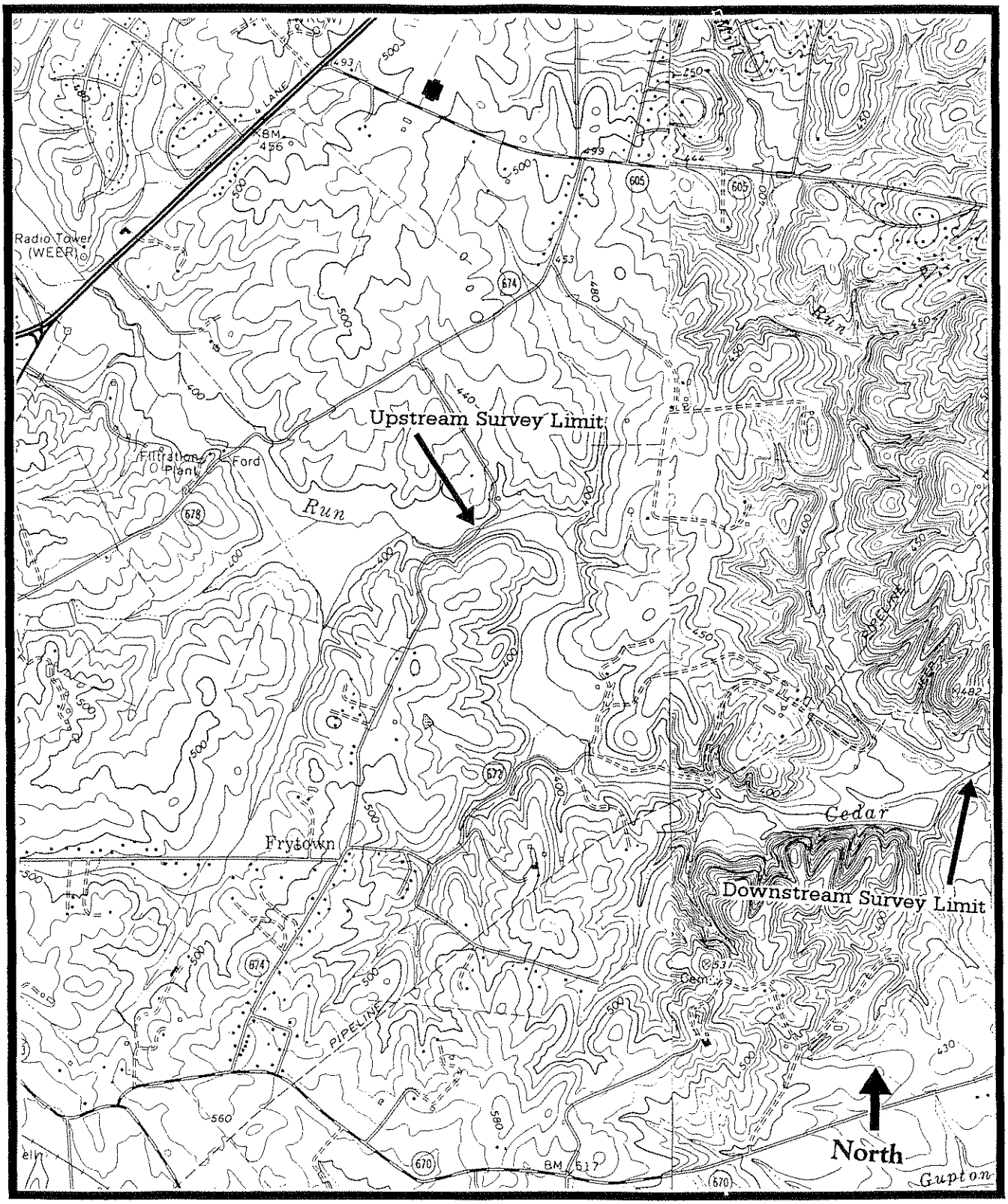

Figure 5. Frytown Survey Area, Cedar Run, Fauquier County, Virginia (Catlett, Va. 1978; Warrenton Va. 1978)

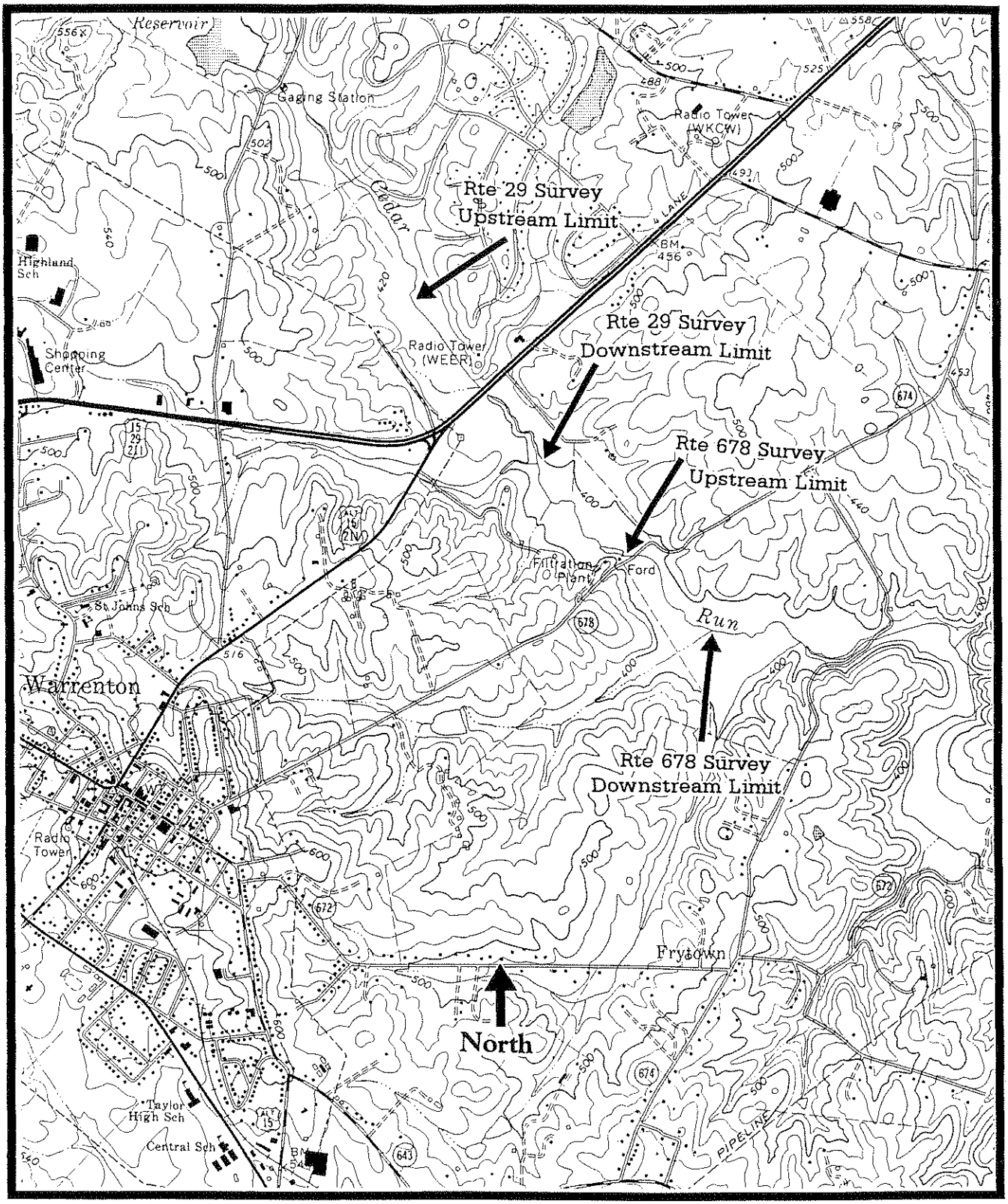

Figure 6. Route 678 Survey Area and Route 29 Survey Area, Cedar Run, Fauquier County, Virginia (Warrenton, Va. 1978)

most significant for the brook floater(Clark and Berg, 1959; Johnson, 1970). Survey methods included waterscoping, handpicking, and raking the substrate. Snorkeling produces the highest confidence in survey results; however, it is overly burdensome. Only sites requiring higher reliability of results received searches using this method. In addition, stream banks were searched for muskrat middens of discarded shells and shells cast on bars by flood.

The typical search involved traversing a search area by foot from the downstream end to the upstream end. Visual scanning and waterscoping predominated as search techniques. The searches of the Riffle Site and the Confluences Site used snorkeling as a method. The Riffle Site represents the location of the previously reported dwarf wedgemussel. The Confluences Site seemed to represent the next best available habitat in the 1993 search area; and, the reliable determination of the status of the dwarf wedgemussel and other rare mussels in the proposed pool warranted revisiting the site.

Visual searches proved to be most effective, as spent shells were easily visible in the shallow waters of the riffle areas. The 1993 survey found very few mussels via waterscoping; however, this survey found many. Bank and bar searches produced relatively few shells. In well-lit areas, visual searching complemented waterscoping. The deepest areas of large pools and beaver ponds were not searched as these silty habitats are inappropriate for either of the focus species. The snorkel surveys produced very few specimens.

Inventory of Species

This survey found five mussel species. Table 2 lists the number of mussels recorded for each separate survey area. Included is the summary of all specimens found in the 1993 survey. Table 2 indicates whether the given species was found as live specimens, or shell only. Shell here refers to both relict shells and recent shells. Shell includes one fresh dead specimen of *Elliptio angustata* found in the Frytown Survey Area. Table 2 provides

Site	*Alasmidonta undulata*	*Anodonta cataracta*	*Elliptio angustata*	*Elliptio complanata*	*Strophitus undulatus*	Site Total	Search Time*
Rte 603 Site	0	0 1R	41L, 12R	93L, 25R	3L 0	137L, 38R	1.5
Lower Auburn Survey Area	2L 0	2L 0	57L, 21R	60L, 35R	3L, 1R	124L, 57R	6.9
Confluences Site	0	0 3R	0 3R	1L, 2R	0	1L, 8R	1.3
Riffle Site	0	0 2R	8L, 4R	3L, 4R	0	11L, 10R	2.2
Mill Run Survey area	1L 0	36L, 7R	0 1R	4L, 1R	33L, 1R	74L, 10R	5.6
Frytown Survey Area	1L, 1R	4L, 6R	51L, 36R	35L, 26R	0	91L, 69R	5.0
Rte 674 Survey Area	0	0	3L, 11R	0 2R	0	3L, 13R	1.0
Rte 29 Survey Area	0	7L, 7R	1L, 2R	18L, 5R	0	26L, 14R	2.4
Species Total	4L, 1R	49L, 26R	161L, 90R	214L, 100R	39L, 2R	467L, 219R	25.9

Table 2. Mussels observed in Cedar Run and Mill Run, Fauquier County, Virginia.

L = live, R = relict shell. *Search Time = hours to nearest 0.1 hour

separate totals for each given survey area and for each species over the entire survey. Search time recorded in Table 2 represents the cumulative total for each site, regardless of method.

The eastern elliptio (*Elliptio complanata*) was the most commonly observed species. A relatively large species, its shells are easy to find. As one of the most common mussels of North America, this species exhibits broad ecological tolerances. This mussel occurred throughout Cedar Run and in Mill Run. Its abundance varied considerably, with areas of largely exposed bedrock being least favored. This mussel did occur in some of the more obviously impacted stream reaches bordering unfenced pasture and with heavy alga growths.

The second most common species is the Carolina lance (*Elliptio angustata*). In the first survey, I identified similar specimens as the Atlantic spike (*Elliptio producta*). Recently, electrophoretic analysis at the Savannah River Ecology Laboratory identified the dark periostracum, lanceolate elliptio species of eastern Virginia to have a close affinity to specimens putatively of the Carolina lance and not the Atlantic spike (M. Mulvey, pers. comm). All observations attributed to the Atlantic spike in the 1993 report should be attributed to the Carolina lance.

The Carolina lance exhibited a strange distribution. It occurred in some very swift, very shallow areas with clean-swept coarse substrate, although it more generally occupies muddy conditions here and elsewhere. Its virtual absence from Mill Run is peculiar, as this species will ascend headwaters.

The eastern floater (*Anodonta cataracta*) generally associated with lentic habitats such as sandy or muddy pools. Throughout the survey area, this species occurred somewhat uncommonly. This species demonstrates a preference for muddy pool habitats; and the low search effort applied to such environs contributes to the lack of observations. A relatively thin-shelled species, the relict valves will not persist as long as those of the other, thicker-shelled species. This likely adds to the sampling bias.

Of particular note, I believe that the identification of the dwarf wedgemussel from 1993 stemmed from an unusual specimen of eastern floater. The live specimen found in 1993, being shaped and of similar size as a dwarf wedgemussel precluded collection, given the endangered species collecting permit requirements. Since no other live specimens could be located, this single specimen had to be left at the site. The find of a very similar specimen, one year older and slightly larger than the 1993 specimen, provides the basis for overturning the identification. Although from separate locales, the 1994 specimen came from the same type of environment as the 1993 specimen. This habitat can be characterized as a well-flowing riffle/run habitat with cobble/pebble substrate. Possibly, ecological conditions cause this somewhat aberrant morphology. In 1993, searches of pools habitats produced typical appearing specimens of similar size. An analysis of this morphological difference currently in preparation will be delivered to the Richmond office of the SCS to complement this report.

The squawfoot (*Strophitus undulatus*) seemed to inhabit somewhat higher quality habitat. This species is uncommon to rare in Cedar Run and Mill Run. The squawfoot tends to prefer quieter waters; however, it avoids thick mud substrate. Usually, very few finds of this species resulted from any given search effort at any particular place; however, in one very limited section of upper Mill Run, 20 live squawfoot were counted.

The triangle floater (*Alasmidonta undulata*) occurred least commonly. The 1993 survey did not report this species. This species seems to have a stronger preference for higher quality lotic habitats than the other species seen. As such, it represents a general indicator of conditions. Its scarcity probably reflects the generally lower quality of many habitats in this watershed. This species does co-occur with the dwarf wedgemussel and the brook floater at other sites in Virginia; however, its distribution and population levels far surpass those of either rarer congeneric species.

Evaluation of Findings

The survey areas varied greatly in the quality of habitats. In general, the diversity of habitats seemed high, although lotic environments prevailed. Throughout the study area, most pools had relatively short lengths and shallow depths. Stream flow strongly influenced the pools with exceptions including some beaver-dammed areas and one portion of Cedar Run near Frytown. Local geologic factors, mainly through the exposure and nature of the basement layer, strongly influence habitat.

Table 1 lists the separate survey sites. These site delineations follow from the design requirements to explore unexamined areas of stream and to carefully re-examine specific sites within the original 1993 survey area. The order of sites in Table 1 follows the order in which sites are encountered as one proceeds upstream. The description of the individual sites follows this same general order.

Route 603 Survey Area appears on Figure 1. Cedar Run below its confluence with Turkey Run provides a larger amount of stable, riverine type habitat than upstream within the study area. The mussel fauna reflects this in the relatively large number of eastern elliptios and Carolina lances observed. The stream had a width of 14 meters with water depths from 0.1 to 0.4 meters in riffle and run habitat. Gravel and sand substrate predominate; however, an exposed sedimentary bedrock occurred along the left ascending side. Siltation did not appear to influence the site extremely negatively.

The examination of both Cedar Run and Turkey Run in the immediate upstream reach from the confluence seems to confirm size effects. Both streams had much narrower widths being six to eight meters wide. Riffle/run water depths ranged from 0.1 to 0.3 meters deep, generally toward the shallow end of the scale. Mussels were very uncommon in either stream above the confluence point. Using a roughly equal amount of search time, I found only 33 live animals above the confluence as compared to 104 live mussels found in the downstream area.

Lower Auburn Survey Area represents a continuous survey of a long length of moderate size stream from 8 to 11 meters wide. Water depth ranged from 0.1 to 0.5 meters in depth with some deeper pools up to 1 meter maximum. The habitat varied but followed trends based on the apparent underlying bedrock.

Four major zones differ generally in gradient and substrate with consequent broad implications for the fauna. The lowermost area had cobble and gravel substrate in riffles with mud and sand bottomed pools. This creek overlays an area of conglomerate here. The land along the stream tends to be pasture here with some stream areas of considerable active use by cattle.

Cedar Run flows adjacent to steep uplands 0.4 kilometers upstream from the downstream boundary. The gradient increases and the creek narrows. Mostly bordered by woodland, siltation seems low here; however, the predominance of exposed igneous/metamorphic bedrock makes poor mussel habitat. The main exception involves where small ravines enter Cedar Run. Deposits of gravel and cobble occur in these typically lower gradient areas. From the topography of Figure 2, one can locate these places. Such a patch of clean swept gravel and sand substrate yielded a diverse collection of mussel species, including both specimens of the triangle floater found in this survey area.

Above this transition, the substrate generally resembled the substrate of the lowermost area; however, much of the substrate actually represents very poor mussel habitat. Exposed conglomerate, while appearing to be a suitable mix of particles sizes, actually is a coherent well- compacted mass nearly as impenetrable as well lithified bedrock. Some deep pools lie in this section which might support mussels; however, searching in this section revealed virtually no mussels or shells. About 0.5 kilometers below the Route 602 bridge, this section yielded to the last section, a very uniform reach of shallow run habitat overlying exposed igneous rock with virtually no suitable substrate for mussels.

In the Lower Auburn Survey Area, both fingernail clams and *Corbicula* clams were found, although neither were common. The snail

E. virginica occurred very uncommonly, with only a few live individuals observed. Fish appeared common. Little evidence of beavers was seen here.

Confluences Site falls within the boundary of the 1993 survey. The nature of the habitats observed then warranted its inclusion in this study as a site needing re-examination. This site had a much less silted substrate than downstream areas.

In both studies, this site produced very few mussels. Snorkeling produced no mussels. A lengthy seasonal channel cuts into the left ascending side here. Searching this largely dry channel gave the best result overall. Both fingernail clams and *Corbicula* clams were seen. I noted no *E. virginica* snails.

Riffle Site included the exact location of the specimen identified as a dwarf wedgemussel in 1993. Flagging placed at streamside in 1993 was present allowing precise relocation of the site. This area consist of some narrow, long riffles with coarse cobble/gravel substrate between riffles and at the upstream end. The upstream end of this area is bounded by a considerable beaver dam impounding a lengthy pool.

Snorkeling a 50 meter transect in the shallow riffle habitat produced one live eastern elliptio. Most live mussels were found waterscoping near the beaverdam. Given the low production of mussels relative to search effort, this seems to be poor habitat. While seeing no *E. virginica* snails, I found fingernail clams and *Corbicula* clams here.

Mill Run Survey Area largely consisted of relatively shallow, long runs or pools with small riffle segments. Water depth rarely exceeded 0.5 meters in depth; and, stream width varies from 5-8 meters. The creek bed apparently lies over conglomerate bedrock. While this does provide good parent material, exposures of the conglomerate did occur with the same general effect as bedrock elsewhere on the fauna. Conglomerate exposures provide poor mussel habitat.

Streamside pasture dominates the riparian zone in the lower third of the Mill Run Survey Area. The influence of pasture and

cattle on the stream here does not appear as great as in other parts of the Cedar Run watershed; nonetheless, eroding banks and the lack of canopy combine to create an environment of silty substrate with dense alga growth. Much of the upper portion of this survey area has well-wooded riparian zones. While this prevents some of the negative impacts of cattle, beaver dams appeared in this area, enlarging pool habitat and reducing stream flow.

Generally, mussels seemed scattered over the length of the stream. One significant exception presented itself near the upstream end of the survey. A relatively short stream reach, under 50 meters in length, produced 46 of the 74 live mussels found in this entire survey area. In Mill Run, no *Corbicula* or *E. virginica* snails seemed to be present; and, fingernail clams occurred only in the very lowermost reaches.

Frytown Survey Area contains a stream somewhat similar to Mill Run. Cedar Run exhibits more variability, again based on the underlying geology. The stream is slightly wider, being 8-11 meters wide. Water depth is generally under 0.1 meter in riffles. Water depth in runs varies from 0.1 to 0.3 meters. Pools typically are 0.5 meter deep or less. Igneous bedrock creates areas of higher gradient typically not found in Mill Run. Additional factors in determining habitat quality here is the openness of the canopy and the prevalence of unfenced streamside pasture. Beavers exert some influence here also.

The lowermost section of this survey area consists of shallow, riffle/run habitat with coarse substrate and exposed bedrock. This area also borders a well-fenced pasture with moderate riparian buffers. The stream substrate seemed clean and unsilted. The most significant cluster of freshwater mussels occurred in an eddy with sand substrate in this reach.

The lower gradient, middle section straddled the Route 674 crossing. The creek had a conglomerate-derived cobble and gravel substrate. The largely unshaded section below this road had few mussels. Upstream, a small concentration of mussels occurred in an area of generally clean sand and gravel. This habitat occurred in

a wooded riparian area which gave way to the more typical unfenced, open, riparian pasture. Mussel density always remained low along the pasture.

Near the upstream end of this middle section, exposure of igneous rock coincided with steep uplands abutting the right ascending side of the stream. Here, the substrate largely consisted of exposed bedrock. This steep zone abruptly changed to a long, moderately deep pool, partially elevated by a beaver dam. Aquatic vegetation filled this pool over a mud-covered bedrock substrate.

Route 674 Survey Area falls mainly within active pasture. The scarcity of mussels seems to demonstrate the influence of numerous impacts on Cedar Run here. While the general nature of the substrate looked uniform, siltation seemed to have buried much of the small cobble and gravel substrate of the slower flowing areas. With little canopy present, heavy growths of alga covered suitable substrates and aquatic vegetation.

Cattle obviously enter the stream at numerous points. Bank erosion appears to be considerable here. The substrate does appear churned in part in some shallow gravel bar areas where the few trees provide shade over cowpaths leading into the stream. *Corbicula* clams occurred at this site. No fingernail clams were found or *E. virginica* snails.

Route 29 Survey Area produced few mussels of any kind. This survey area divides into roughly three sections. Again, a strong interaction with geology and land use affects the stream.The lower section extends from the downstream survey limit upstream to the Route 29 bypass. Note that Figure 6 does not indicate a large on ramp to Route 29. Its location is circa 50 meters downstream of the northbound lanes of Route 29. The creek noticeably decreases in size upstream of Route 29.

The downstream section generally had a moderate gradient. The stream flowed through pasture throughout. Cattle have created some areas of bank erosion. Very little canopy covered the stream and alga and vegetation growths were often thick. The substrate natively seems to be a good mix of cobble, gravel, and sand. Silt

and mud deposition along with some eutrophication seem to impact the suitability of the habitat. Few mussel occurred here.

Beneath the bridges of Route 29, Cedar Run consisted largely of pools with very thick mud deposits unsuitable for mussels. This changed relatively abruptly on the upstream side to a moderate gradient stream. The stream had a good mix of generally lotic environments with cobble and gravel substrate in riffles. Long, shallow runs and pools had a pebble or gravel substrate. Occasional bedrock outcrops did occur. Very few mussels seemed to inhabit this reach.

Fish could be seen commonly above the Route 29 bridges; but, I observed them less commonly downstream. In notes of other mollusks, *Corbicula* occurred below the bridges but not upstream of them. No fingernail clams were found or *E. virginica* snails.

In all the study area, mussels seem to be distributed according to where good substrate with low land use impacts coincide. Fenced pasture or woodlands always bordered a stream when a cluster of mussels could be found.

Generally, much of the stream lengths examined represent poor habitat. The disappearance of the pleurocerid snail *Elimia virginica* from the upper reaches of the watershed possibly results form the effects of silt or some other, unknown agent. This snail occurs at Broad Run sites where rare mussels occur. The low or nonexistent populations of fingernail clams combined with the widespread presence of *Corbicula* clams also indicate poor habitat. *Corbicula* may compete with native bivalves. Fingernail clams are typically present at dwarf wedgemussel sites.

These factors in concert imply that the area is not now good habitat for rare mussels. Additionally, the level of search effort combined with finding nearly 700 mussel specimens also indicates rare species are not present. Mussels typically can be found in proportional numbers. This level of effort should have revealed any populations of rare species present. I conclude that none occur.

Recommendations

The impoundment of Cedar Run will not affect an existing population of rare mussels. The previous report of the dwarf wedgemussel in the impoundment pool seems based on the misidentification of a small, somewhat aberrant specimen of the eastern floater. In general, the proposed impoundment seems likely to impact one of the least productive reaches of Cedar Run.

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Stevenson 1995

Supplemental Report to a Survey for Freshwater Mussel Fauna in Cedar Run, Fauquier County, Virginia: Descriptive Analysis of Re-assignment of the Identification of a Specimen of the Atlantic Floater

(Contract SCS-10-VA-94)

Technical Report to:

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Introduction

The Soil Conservation Service currently seeks to create an impoundment of Cedar Run, Fauquier County, Virginia, near the town of Auburn. For the environmental assessment of the proposed project, the Soil Conservation Service funded a survey to determine the presence of the federally listed-endangered dwarf wedgemussel (*Alasmidonta heterodon*), the state endangered brook floater (*Alasmidonta varicosa*), and other freshwater mussel species (family Unionidae) within and adjacent to the pool area of the proposed reservoir.

The initial survey reported a single live dwarf wedgemussel from within the proposed pool of the reservoir (Stevenson, 1993). A second survey performed in 1994 found no further specimens of Unionidae attributable to the dwarf wedgemussel (Stevenson, 1994). Additionally, the findings of the second survey indicate that the mussel specimen originally designated as a specimen of the dwarf wedgemussel is in error.

Methods

This report provides a descriptive analysis of the specimen of eastern floater (*Anodonta cataracta*) originally designated as a specimen of dwarf wedgemussel (*Alasmidonta heterodon*). I will report the analysis in relation to included photography of specimens of dwarf wedgemussel (*Alasmidonta heterodon*) and eastern floater (*Anodonta cataracta*). All photography was reproduced by color xerography from original figures created using enlargements of original print negatives or negatives prepared from slide photography.

The mussel specimens referenced in this report appear in Figures 1-4. These figures appear on the following pages and illustrate the differences between dwarf wedgemussels, typical eastern floater specimens, and the specimen misidentified in 1993. All figures indicate the dorsal and anterior sides of the specimens. All specimens in a given figure are oriented identically and are three times life size.

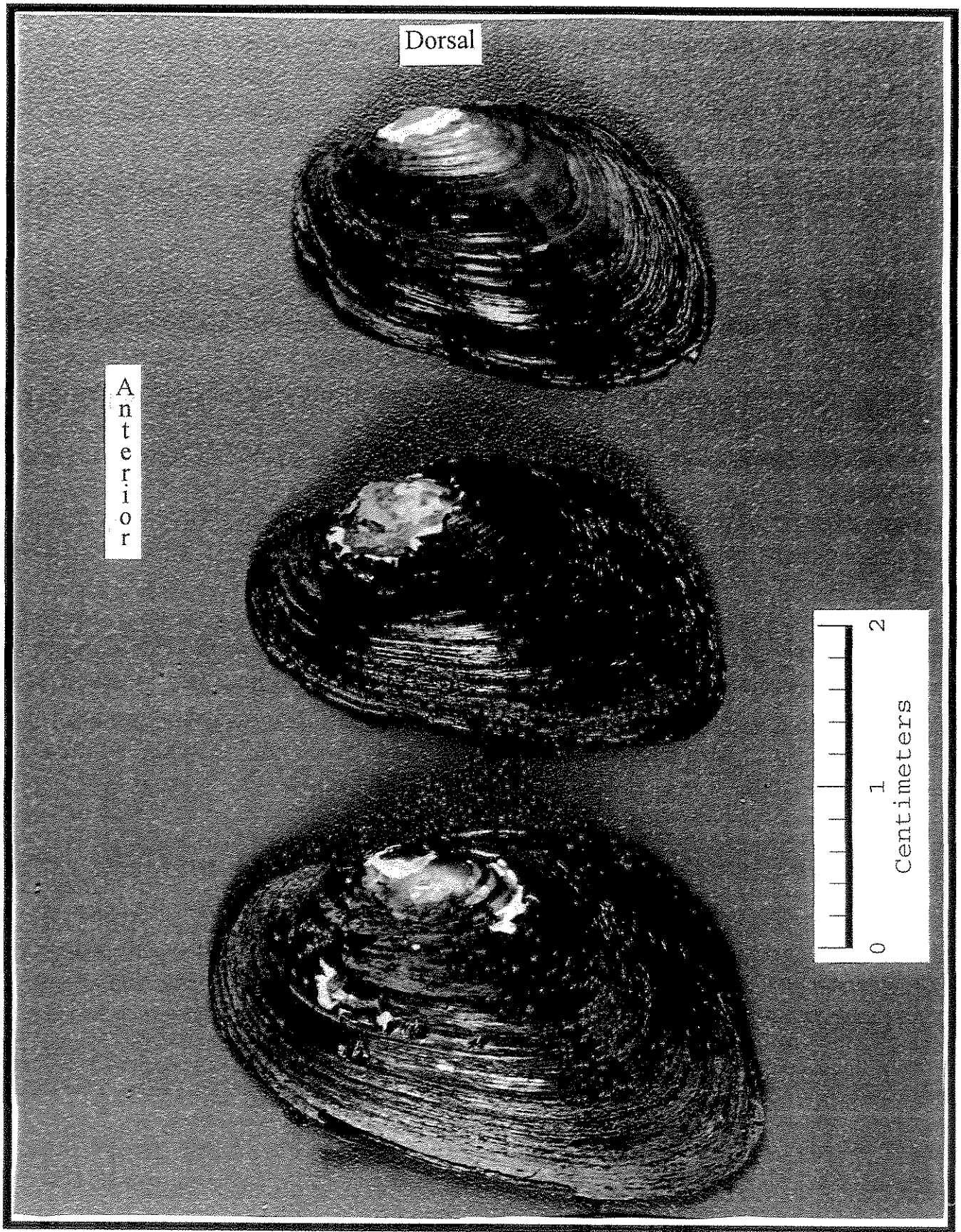

Figure 1. Dwarf Wedgemussel(*Alasmidonta heterodon*), 3X life size.

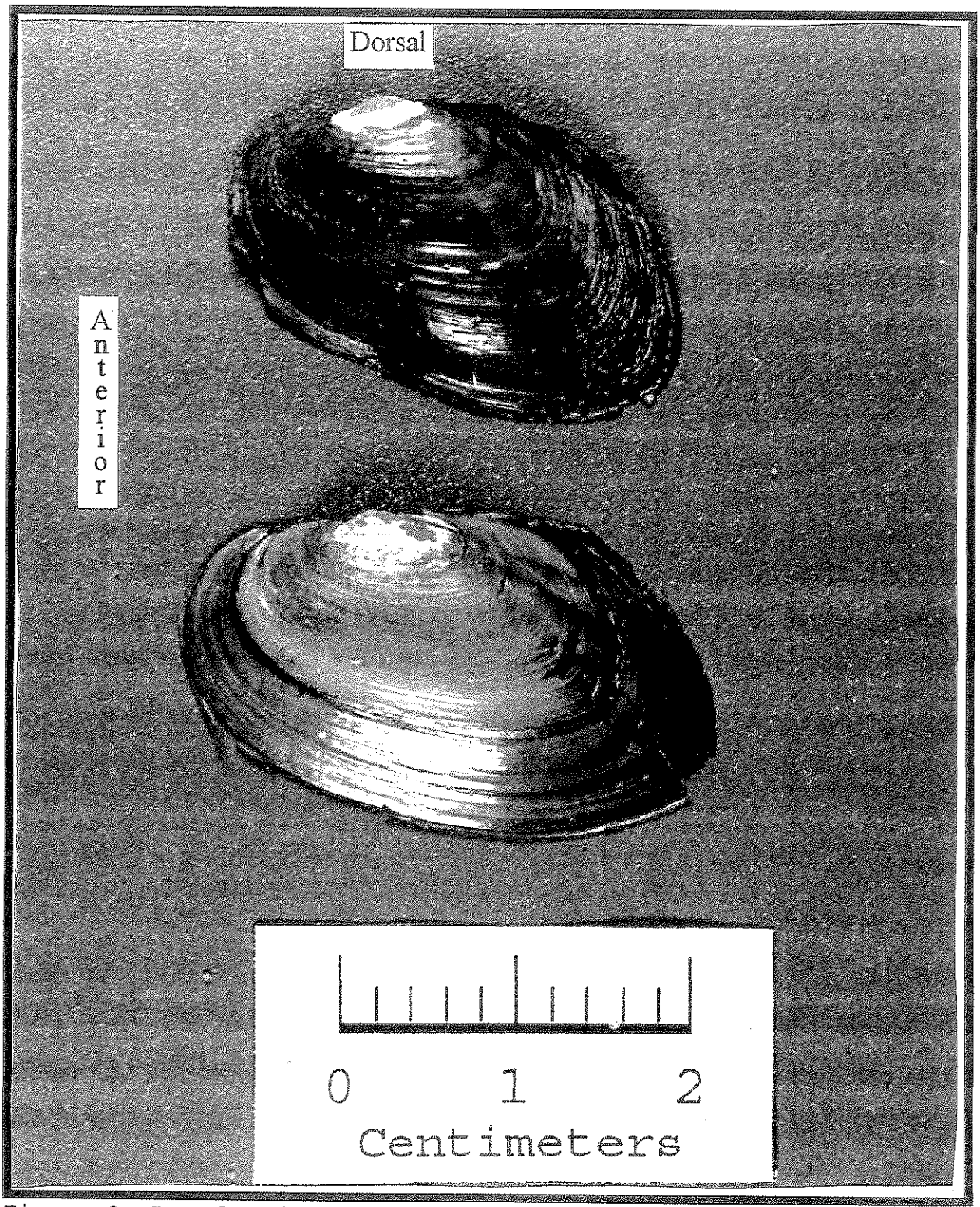

Figure 2. Dwarf wedgemussel(*Alasmidonta heterodon*)(upper specimen) and normal eastern floater(lower specimen) (*Anodonta cataracta*). 3X life size.

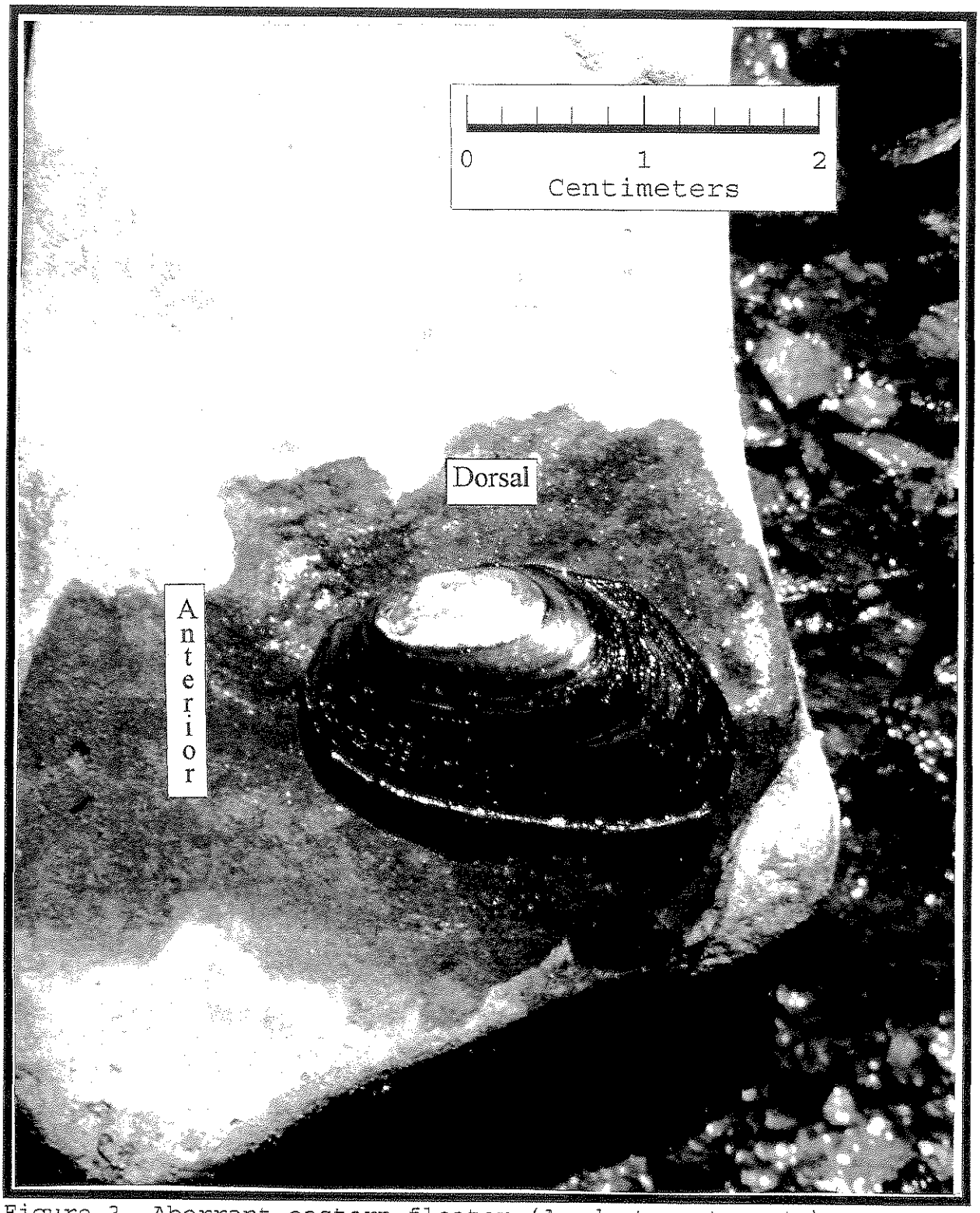

Figure 3. Aberrant eastern floater (*Anodonta cataracta*), misidentified as a dwarf wedgemussel in 1993. 3X life size.

Figure 4. Aberrant eastern floater (*Anodonta cataracta*), smaller specimen, and a normal eastern floater, larger specimen. Note orientation change from earlier figures. specimen. 3X life size.

Discussion and Analysis

Figure 1 shows three dwarf wedgemussels (*Alasmidonta heterodon*). The specimens depict the generalized typical form of the dwarf wedgemussel and its variation. Of particular note, the uppermost specimen is the least typical while the lower two are more typical in shape.

The lowermost specimens each clearly depict the standard shape. One notable feature is the descending ventral margin. This feature combined with the truncated and obliquely descending posterior margin give the shells the characteristic "wedge" shape. Note how the more rounded shape of the uppermost specimen of Figure 1 makes the general wedge shape obscure.

The position and orientation of the umbo is also noteworthy. The umbos of the Figure 1 mussels are the somewhat eroded areas near the dorsal margin. The umbo represents the oldest portion of the valve and is naturally at the center of the generally concentric growth of the valve. The umbos relatively forward position should be noted as well as the somewhat pointed shape. The umbo tends to have somewhat typical shape, position, and orientation for a particular species, species group, or genera.

Another significant feature is the prevalence of green color in the uppermost specimen. Close inspection also reveals a tendency for the ventral margin to be somewhat concave in the anterior portion of both upper specimens. Other features to observe are the roughness of the periostracum (the outer covering of the shell), the number and close spacing of growth rings, and the slightly recurved dorsal margin (partially obscured by the umbo).

Figure 2 shows the uppermost dwarf wedgemussel of Figure 1 with a similar-sized typical specimen of eastern floater (*Anodonta cataracta*). The eastern floater differs markedly from the dwarf wedgemussel. Many features differ from those described earlier.

The eastern floater has a more convexly rounded ventral margin and posterior margin. The furthest extension posteriorly of the shell is more toward the dorsal side than in the wedgemussel. The umbo is also more centrally located along the dorsal margin.

Another feature where the typical eastern floater differs from the dwarf wedgemussel is the smoothness of the shell. There are fewer growth annuli. The shell is a much lighter color that is yellowish and light green. Also, there is a greater sharpness with which the dorsal margin angles to meet the rounded descending posterior margin. The sharp angle is the basis of a slight wing or alation that may be present in larger shells.

Features which are difficult to graphically depict also differ between the two species. The eastern floater is more compressed than the dwarf wedgemussels. The shell is thinner and flexes more when pressed between one's fingers.

The dwarf wedgemussel also will generally have a more distinct posterior ridge and steeper posterior slope than the eastern floater. The posterior ridge is the general area of the shell which extends usually from the umbo to the meeting of the posterior and ventral margins. The posterior slope refers to the area of the shell which slopes from the posterior ridge toward the posterior margin. The form of the posterior ridge and the posterior slope tend to be related to the relative width of the shell and have typical characteristics for many species.

Figure 3 shows the specimen of eastern floater which was misidentified. Figure 4 shows the same specimen alongside a larger and more typically shaped specimen of the eastern floater. Both specimens were found in Cedar Run near the same location on October 5, 1993.

The Figure 3 specimen more closely resembles a dwarf wedgemussel in general shape than a typical eastern floater. The ventral margin is straighter and there is some concavity to the shell along this margin in its anterior portion. The dark green appearance of Figure 3 slightly exaggerates the green of the specimen; nonetheless, the specimen's color and darkness more closely resemble that of the dwarf wedgemussel.

This aberrant specimen seems to have a more anteriorly positioned umbo than typical for eastern floater. The shell seems to have more crowded growth lines. When found, the shell felt more

solid to the touch than what I would expect for the eastern floater. Also, the shell seemed more inflated with a more prominent posterior ridge than recently seen comparably-sized eastern floater shells.

Some features more closely resemble those of the eastern floater. The sharpness of the angle where the dorsal margin meets the posterior margin seems closer to that of the eastern floater than the dwarf wedgemussel. While the growth rings are more closely crowded on the Figure 3 specimen, the periostracum surface seems smoother like that of the eastern floater. The straightness of the dorsal margin concurs more with the eastern floater than the dwarf wedgemussel.

The erosion of the umbo area makes this feature hard to decipher for the Figure 3 specimen. The position does not preclude either species. The umbo's flatness and an interpretation of the umbo as rounded and oriented dorsally seems more consistent with an eastern floater shell than the dwarf wedgemussel.

Additional factors led to the initial identification. I handled very typical eastern floaters of similar and smaller size the prior week while sampling at Cedar Run. As such, this specimen's shape is surprisingly different. As shown in Figure 4, I had discovered a relatively typical eastern floater at the same site. The habitat where the aberrant specimen was found was very rocky lotic habitat, more appropriate in general for dwarf wedgemussel than eastern floater. No similar shells were found which I could compare to the specimen. The specimen never gaped during the time which I observed it in hand and or after returned to the stream. I do not believe that any observations of such would have been definitive inasmuch that detailed color observations of neither species soft parts are available which would definitively separate them. The conditions of my collecting permit would not allow me to collect such a specimen, if I believed it to be a dwarf wedgemussel.

The most significant factor in weighing for a re-identification of the 1993 specimen consisted of finding a similar

specimen with an additional year's growth that resembled that of typical eastern floater. This specimen was discovered during the second survey prompted by the initial survey report. Many features observable on the newly discovered and collected specimen correlate to those which rendered the 1993 aberrant specimen difficult to correctly identify.

The newer specimen exhibited the same darkness of color, crowded growth annuli, and ventral margin concavity as the 1993 specimen. It appears that such features may result from living in faster waters with rocky substrate. The concavity is most likely the result of some shell damage from shifting rock. The darkness of color and the crowding of annuli seem to be the result of stunting of growth.

Another factor consistent with the re-identification of the specimen is the subsequent survey results. The subsequent mussel survey did not reveal any specimens of dwarf wedgemussel. As such, given the increased search effort and an intensive search of the original site of the aberrant specimen, the evidence weighs heavily against the specimen being a dwarf wedgemussel.

All factors considered, the original 1993 report of a dwarf wedgemussel from Cedar Run seems erroneous. The shell morphology, while not wholly inconsistent with the dwarf wedgemussel is neither wholly inconsistent with the eastern floater. The find of another aberrant specimen and the overall fauna survey results are consistent with the original identification being misapplied. The reasonable conclusion from the information is that the 1993 specimen should be reported as an eastern floater.

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