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## Status of the Freshwater Mussel Fauna Pendleton Island Mussel Preserve, Clinch River Virginia

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### INTRODUCTION

During August of 1987, at the request of the Virginia Nature Conservancy, I instituted an evaluation of the freshwater mussel fauna of The Nature Conservancy Preserve in the Clinch River at Pendleton Island (CRM 226), Scott County, Virginia. The purpose of this evaluation was to provide background data which would be useful in monitoring the condition of the mussel fauna of this river reach. While it is the particular aim of the Conservancy to keep track of rare and endangered mussel species inhabiting this preserve, most of these species do not occur in sufficient abundance to allow reliable monitoring of their status. Rare species are not easily sampled quantitatively (Kovalak et al. 1986) and, therefore, population parameters such as age-class structure cannot be determined with any degree of reliability for them. For this reason, a sampling program was designed to evaluate community structure. Changes in percent composition of species and in age-class structure of the more abundant species can, it is hoped, be used to detect changes in habitat quality.

### ACKNOWLEDGEMENTS

The Virginia Chapter of The Nature Conservancy provided expense money and personnel to aid in the sampling at Pendleton Island. I am grateful for the support and assistance of Faye Cooper and Ann Lewis of the Nature Conservancy and Michael Lipford, now of the Department of Conservation and Historic Resources Natural Heritage Program. I also wish to thank John Bates, Ecological Consultants, Inc., for his help with field work and for keeping a photographic record of the sampling efforts. Mr. Don Manning, Buchannon Tennessee, also volunteered assistance in sampling.

### METHODS

During the August, 1987, sampling period, one full day was spent in qualitative sampling of the Pendleton Island area, and two days were spent collecting quantitative data using a quadrat sampling technique described by Dennis (1985). A one-half meter square frame was placed randomly within predetermined areas, and all mussels were removed by hand (by three to four persons). The substrate within the sampler was carefully examined for small specimens, and all mussels were identified, enumerated, aged and the data recorded. Gravel removed from the quadrat during sampling was replaced and all live mussels carefully replaced in the substrate in the same area from which they had been removed. Care was taken to keep habitat disturbance to a minimum. Five persons were involved in collecting and recording data from 22 quadrat samples. The site was revisited in September of 1988, when limited sampling was carried out for comparative purposes.

For sampling purposes, four separate river reaches were defined as indicated on the site sketch (Figure 1). Reaches A and B, which were the most productive, were sampled quantitatively. Quadrat samples 1-14 were taken from reach A; samples 14a-21 from reach B. Reach C includes the narrower (north) side of the island, and reach D the lower end.

### RESULTS

Table I lists all mussel species found during the 1987 sampling period. A total of 30 living species were collected, with records of two additional species represented by dead shells only. Of these, *Dynommia brevidens* may exist in low abundance at the site; *D. torulosa gubernaculum* is probably extinct, and *D. capsaeformis* is near extinction. Table II summarizes species

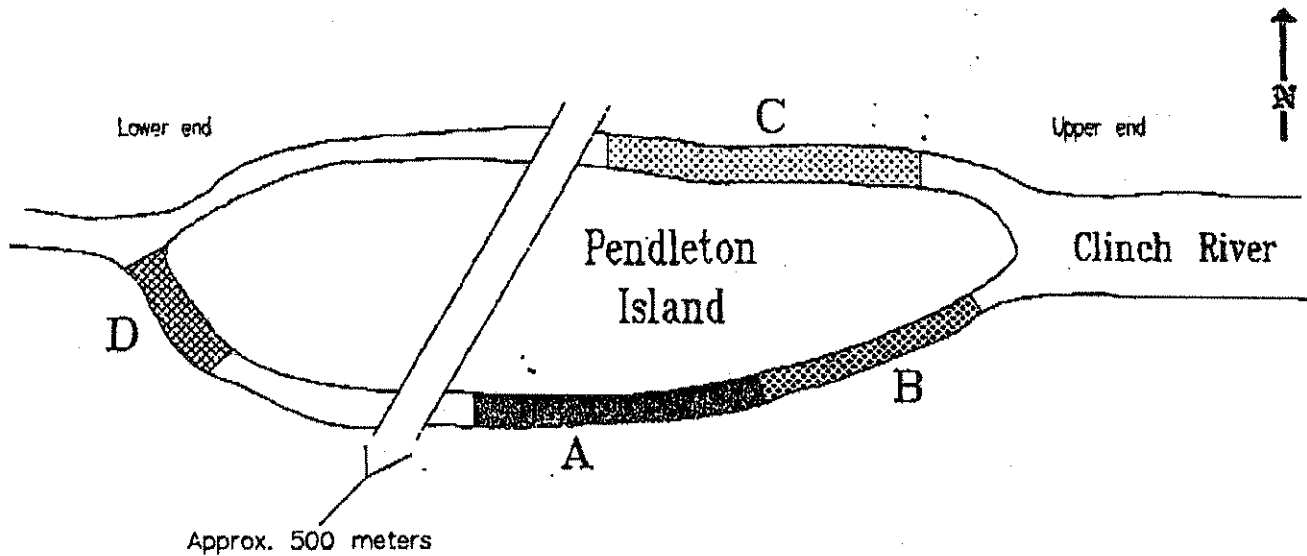


Figure 1. Sketch of river reaches sampled at Pendleton Island, Clinch River (not to scale). Dimensions of Island: 804 m long by 193 m wide.

taken in 1987 from 22 quadrat samples (note: two samples numbered 14 are listed as 14 and 14a). The average density of mussels was 18.7 per  $M^2$  sampled. This compares favorably with densities found at other sites in the Clinch River. Quantitative sampling in 1986, revealed mussel densities of approximately 30 per  $M^2$  at Kyles Ford, TN. Comparative samples taken at Speers Ferry VA in 1987 yielded only 3.7 mussels per  $M^2$ .

In Table III mussel species taken from quadrat samples are listed in order of relative abundance with the percent occurrence given for each species. It can be seen that only 5 species accounted for more than 70% of the specimens collected. Many of the species were represented by only one specimen. This is characteristic of the pattern observed in other mussel communities (Dennis, 1985). Of the 5 dominant species, one (*Fusconaia cuneolus*) is

listed as Federally Endangered. The two species of *Actinonaias* (*A. pectorosa*, and *A. carinata*) have been found among the dominant species at other locations in the Clinch and Powell Rivers.

Results of analysis of age-class structure of the mussels sampled are presented graphically in Figure 2. In this histogram, age is plotted against number for all mussel species combined. Results indicate that few young specimens were collected in quadrat samples.

## DISCUSSION

The best historical account of the fauna of the Clinch River is given by Ortmann (1918). Since then, there have been a number of mussel surveys of this river (Ahlstedt, 1984; Bates and Dennis, 1978; Jenkinson and Ahlstedt, 1988; Neves, et al., 1980; Stansbery, 1973). Additional

unpublished reports on various aspects of water quality as well as several master's thesis dealing with mussel life histories (as cited by Kosztarab, 1987) make this one of the most studied rivers in the Upper Tennessee System. Despite the tremendous effort and expense that has gone into producing these studies, we know almost nothing as to the cause of the obvious decline in the native unionid fauna of this and other rivers in the system. Distributional data col-

Table 1

Mussel Species collected at Pendleton Island,  
Clinch River, September, 1987

Species	Live	Dead only
<i>Actinonaias carinata</i>	X	
<i>Actinonaias pectorosa</i>	X	
<i>Amblema costata</i>	X	
<i>Conradilla caelata</i>	X	
<i>Cyclonaias tuberculata</i>	X	
<i>Cyprogenia irrorata</i>	X	
<i>Dysnomia brevidens</i>		X
<i>Dysnomia capsaeformis</i>		X
<i>Dysnomia triquetra</i>	X	
<i>Dysnomia torulosa</i>		
<i>gubernaculum</i>		X (relic)
<i>Elliptio dilatatus</i>	X	
<i>Fusconaia barnesiana</i>	X	
<i>Fusconaia cuneolus</i>	X	
<i>Fusconaia edgariana</i>	X	
<i>Fusconaia pilaris</i>	X	
<i>Lampsilis fasciola</i>	X	
<i>Lampsilis ventricosa</i>	X	
<i>Lasmigona costata</i>	X	
<i>Leptodea fragilis</i>	X	
<i>Lexingtonia</i>		
<i>dolabelloides</i>	X	
<i>Ligumia recta latissima</i>	X	
<i>Medionidus conradicus</i>	X	
<i>Plethobasus cyphus</i>	X	
<i>Pleurobema cordatum</i>	X	
<i>Pleurobema oviforme</i>	X	
<i>Proptera alata</i>	X	
<i>Psychobranchus</i>		
<i>fasciolaris</i>	X	
<i>Psychobranchus</i>		
<i>subtentum</i>	X	
<i>Quadrula cylindrica</i>	X	
<i>Quadrula pusillus</i>	X	
<i>Truncilla truncata</i>	X	
<i>Villosa trabalis</i>	X	
<i>Villosa nebulosa</i> (complex)	X	
Totals: (Grand = 33)	30	3

lected over the past ten years do indicate, however, that significant changes in the mussel fauna of the Upper Tennessee River Drainage have been underway. There has been an alarming reduction in the amount of suitable mussel habitat, and several sensitive species appear to be on the decline. Most members of the genus *Dysnomia* have been extirpated from this region (Dennis, 1987). At present, the mussel fauna at the Pendleton Island Site in the Clinch River represents one of the richest in mussel density and diversity remaining in the State of Virginia.

Unfortunately we do not have historic records of mussel populations at Pendleton Island, which would allow us to determine the extent of recent water quality changes on this community. This is undoubtedly owing to the inaccessibility of the site. We can, however, compare this site to two others in the Clinch River (Speers Ferry, VA and Kyles Ford, TN) for which we do have historical records. The result of quantitative sampling at these sites during the period 1973-1975 was reported by Dennis (1985). During this period, Kyles Ford supported a rich and diverse mussel fauna of 36 species averaging 29.7 mussels per M<sup>2</sup>. This community appears to have remained stable in terms of mussel density over the past 10 years, although there has been a shift in species composition. Speers Ferry, approximately 20 miles upstream supported approximately 28 species at this time, averaging only 7.7 mussels per M<sup>2</sup> (Dennis, 1985). The Speers Ferry community has declined in density to 3.7 mussels per M<sup>2</sup> over the past 10 years. If this decline continues, this community may disappear.

At both sites, there has been a dramatic shift in species dominance within the past decade. *Dysnomia capsaeformis* which was among the dominant species in 1973-75, comprising more than 34% of mussels sampled at Speers Ferry and 17.7% at Kyles Ford, is all but extirpated from both areas.

Pendleton Island is approximately 20 miles upstream from Speers Ferry in an area which has not been sampled in the past. This area appears intermediate between the other two in terms of mussel diversity and abundance. In recent collections, 30 species were reported at a density of 18.7 mussels per M<sup>2</sup>. No living specimens of *Dysnomia capsaeformis* were found here indicating that this species is at least very rare at Pendleton Island and may be extirpated from this site. This species may have been more abundant here in the past and is probably undergoing the same decline throughout its range.

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Table II  
Mussels Collected in Quadrat samples, Clinch River  
Pendleton Island, August, 1987

Species:	Number collected:																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14a	15	16	17	18	19	20	21
<i>Actinonaias carinata</i>	2	2		1	5		4	2		1	2	3	3	1	2	1	4	1	3	2		3
<i>Actinonaias pectorosa</i>	2					1	3	4	1	2		1	4		5	2	7	3	4	2		3
<i>Amblyema costata</i>		1											1	1								3
<i>Conradilla caelata</i>				1																		1
<i>Cyclonaias tuberculata</i>					1							1										
<i>Dysnomia triquetra</i>					1												2	1		1		1
<i>Elipito dilatatus</i>	3	2	3	1	3		1	2	1	2		3	7	1								
<i>Fusconaias barrealana</i>	1					1	2	2		2												
<i>Fusconaias cuneolus</i>	2	1				2	1	2		1		3	1		3		4		1	5	2	
<i>Fusconaias pitaris</i>	1		1			1					1	2	1	3			1			4	1	
<i>Lampsilis fasciola</i>						1										1						
<i>Lampsilis ventricosa</i>					1	1													1			
<i>Lasmigona costata</i>						1	1															
<i>Ligumia recta latissima</i>						1					1			2					1	2		2
<i>Pichtobasus cyphus</i>																						
<i>Pleurobema curdatum</i>																						
<i>Psychobranchus fasciolaris</i>																						
<i>Psychobranchus subventum</i>																						
<i>Quadrula cylindrica</i>																						
<i>Villosa trabalis</i>																						
<i>Villosa nebulosa</i>					1					1												
Totals:	11	7	7	3	12	9	10	13	3	9	4	13	17	8	11	3	18	5	11	16	7	9

Average Number per m<sup>2</sup> = 18.7

Grand total = 206

Age Frequency, Freshwater Mussels\*  
Clinch River, Pendleton Island, 1987

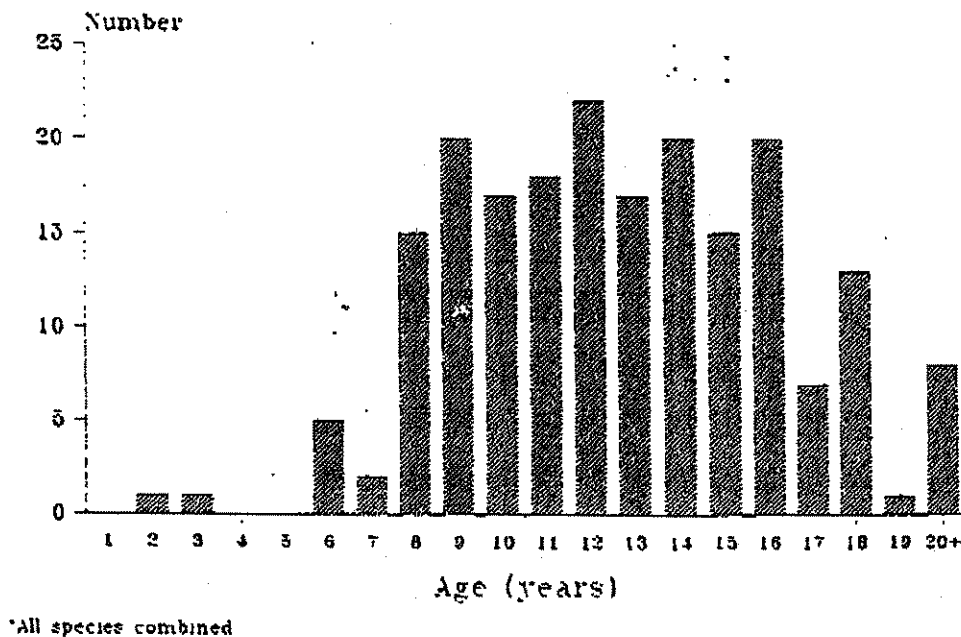


Figure 2. Age Frequency of mussels collected from the Clinch River at Pendleton Island, 1987.

The other river in the upper Tennessee drainage which has supported many of the endemic Cumberlandian species found in the Clinch is the Powell River. Recent collections from this river indicate that the fauna here is also declining. The richest site on the Powell River in 1975 was at McDowell Shoal, Tennessee. In a recent visit to this site, only three live mussels (*Actinonaias carinata*) were found. The mussel community here has been completely destroyed by unknown causes. The only remaining remnants of the Powell River fauna now reside in the State of Virginia. The rapid disappearance of endemic species throughout the Cumberlandian region makes preservation of the fauna at Pendleton Island all the more important.

The Pendleton Island Fauna:

Of the 30 species reported from Pendleton Island during 1987, three (*Conradilla caelata*, *Fusconata cuneolus*, and *F. edgariana*) are presently listed as Endangered nationally, and several others are deserving of Endangered status. The three day effort undoubtedly did not turn up every species present at this site. Some very rare species require repeated efforts to collect. Future sampling efforts may, therefore, add species to this list. Some species which were not collected live but which can be expected to occur in this area include *Dynomia brevidens* and *Lusena lata*.

For the purpose of discussion, the site has been subdivided into four separate reaches, as indicated on the site sketch (Figure 1). Quantitative samples were taken at reaches A (quadrat samples 1-14) and B (samples 14a-21). Reach A, which consists of a long, shallow, shoal area with substrate of bedrock, gravel and mud, supports the greatest number of mussels. Reach B is an area with slightly swifter water, coarser substrate, and more riffles. The fauna in this area was similar to that of Reach A except for the absence of *Elliptio dilatatus*, a species which was abundant in reach A. The dramatic segregation of this species is probably related to

Table III

Numbers and Species of Mussels Collected from 22 Quadrat Samples Pendleton Island, Clinch River (Listed in Order of Abundance)

Species	Total	Percent
1. <i>Actinonaias pectorosa</i>	47	21.9
2. <i>Actinonaias carinata</i>	42	19.5
3. <i>Elliptio dilatatus</i>	29	13.5
4. <i>Fusconaiia cuneolus</i>	25	11.6
5. <i>Fusconaiia barnesiana</i>	14	6.5
6. <i>Fusconaiia pilaris</i>	11	5.1
7. <i>Lasmigona costata</i>	9	4.2
8. <i>Cyclonaias tuberculata</i>	7	3.3
9. <i>Amblyema costata</i>	4	1.9
10. <i>Lampsilis fasciola</i>	3	1.4
11. <i>Lampsilis ventricosa</i>	2	0.9
12. <i>Pychobranchus fasciolaris</i>	2	0.9
13. <i>Quadrula cylindrica</i>	2	0.9
14. <i>Villosa nebulosa</i>	2	0.9
15. <i>Pychobranchus subtentum</i>	1	0.5
16. <i>Dysnomia triquetra</i>	1	0.5
17. <i>Plethobasus cyphus</i>	1	0.5
18. <i>Pleurobema cordatum</i>	1	0.5
19. <i>Villosa trabalis</i>	1	0.5
20. <i>Ligumia recta latissima</i>	1	0.5
21. <i>Conradilla caelata</i>	1	0.5
Totals:	206	100.0
Ave No/M <sup>2</sup>	18.7	

distribution of the fish host which may prefer quiet shoals to turbulent riffle areas.

Reaches C and D supported fewer mussels and were sampled qualitatively only. Reach C, which occupies the narrower side of the island, maintains a lower flow than the other reaches, and, consequently, more silt was observed on the surface of the substrate in this region. The river here also receives more shade from trees

along the bank on both sides. There was not as much shallow shoal and riffle habitat. Species found here include the more common members of the community with *Actinonaias carinata* and *A. pectorosa* dominating the assemblage. Also abundant were *Elliptio dilatatus*, *Lampsilis ventricosa*.

Reach D, at the lower end of the island consisted of a good sized riffle habitat with swift water flowing over rock and gravel substrate. Mussels were surprisingly sparse here considering the apparent suitability of the habitat. It is possible that the gravel substrate was too shallow here to support a mature community; there was more bedrock exposed than at the upstream locations. The only unique occurrence here was *Truncilla truncata*, a species not found at the other reaches.

Most of the species reported from Pendleton Island in recent samples are typical of the fauna reported from the Clinch and Powell Rivers. Some of these, however, deserve special comment.

#### 1. The *Dysnomia* group.

This entire genus appears to be nearing extinction throughout its range (Johnson, 1978; Dennis, 1988). The once abundant *D. capsaeformis* is now all but extinct. No specimens were found at Pendleton Island in quadrat samples, only one freshly dead male specimen was found in qualitative samples. Likewise, *D. torulosa gubernaculum* appears to be extinct. This headwater form of *D. torulosa* has always been rare in the Clinch River. While collecting quadrats at Pendleton Island, however, an unusually high number of relic shells of this species were observed. Many of the specimens were buried in the substrate where they had apparently died in place. The age of these specimens cannot be determined with accuracy, but it is likely that they had been dead for ten years or more. Many relic shells were observed on the river bottom, but none that appeared recent (within the past 2 years). Since many more shells of *D. torulosa gubernaculum* were found than shells of *D. capsaeformis* it is possible that this species once occupied the niche held by *D. capsaeformis* at other sites. Another member of this genus which appears to be on the decline is *D. brevidens*. While it occurs in low abundance at other sites in the Clinch it is becoming increasingly rare. No live specimens were found at Pendleton Island. *Dysnomia niqettra*, a widespread species inhabiting the

Ohio River Drainage as well as the Tennessee, is the only member of this genus which seems to be holding its own.

## 2. The *Fusconaia* species complex.

This genus is represented by four species, two of which are listed as Federally Endangered. Of these, *Fusconaia cuneolus* was one of the more abundant species found (11.6 % of the sample) while *F. edgariana* (= *F. cor*) was extremely rare. The former species is relatively abundant at other sites in the Clinch River, while *F. edgariana* is becoming increasingly difficult to find anywhere. This species may be declining and should be given special attention.

*Fusconaia bamesiana* was once widespread and locally abundant within the headwaters of the Tennessee River system but is becoming increasingly rare. *Fusconaia pilaris* (form *bursa pastoris*) was recognized by Ortmann (1918) as the headwater form of *Fusconaia subrotunda* which occurs in the Tennessee and Cumberland Rivers, and these two taxa should be regarded as synonyms.

## 3. Other species of concern.

Several endemic species not currently listed as Endangered appear to be declining in abundance and should be offered protection. These include: *Psychobranchius subentum*, *Medionidus conradicus*, *Lexingtonia dolabelloides*, *Pleurobema oviforme*, and *Dysnomia brevidens* (previously mentioned). The relative absence of *Pleurobema subentum* from this site (1 specimen found) is particularly disturbing since this Cumberlandian endemic was once abundant at both Kyles Ford and Speers Ferry. It still occurs in fair abundance at Kyles Ford, but its absence in other areas indicates that the species may be in trouble. Likewise, I expected to find *Medionidus conradicus* in much greater abundance than was observed. It appears that all of the endemic species in this faunal assemblage are becoming increasingly rare in areas where they were once abundant.

In addition, the entire *Pleurobema cordatum* complex appears to be in danger of extirpation. A number of forms of this species complex have been reported in the literature, one of these, *P. plenum*, is listed as Federally Endangered. *Pleurobema cordatum* once abundant in the Tennessee River is now found only in relic populations below dams. The headwater repres-

entatives of this complex referred to variously as *P. pyramidatum* and *P. rubrum*, are also increasingly rare. The taxonomic status of these two forms is at present not clear; they may represent two color variations of the same taxon.

One living specimen of a rare species *Villosa nabalts* was found during the study. This is the first record of this species from the upper Clinch River. The specimen was carefully examined, photographed, and returned to the river. This species is closely related to another, somewhat more common species, *Villosa perpurpurea*, which has been reported from tributary streams. It is distinguished from the later species primarily by nacre color. While the specimen collected at Pendleton Island was not sacrificed to confirm its identification, my determination is based on examination of specimens of both species housed in the University of Michigan Museum of Zoology Mussel collections. The status of this species in the Clinch River is presently unknown due to its rarity.

## Age Class data:

In examining population and community structure of freshwater mussels, I prefer to use age class structure rather than the easier to measure length class structure which is now popular with many workers in the field of malacology. While ages are more difficult to determine, especially for older specimens (which are, therefore, often lumped), it is the critical younger age classes that are most important in determining the status of a community. Since mussels grow more rapidly when they are younger, exhibiting increasingly smaller growth increments as they get older, length measurements of older specimens, suffer from some of the same inaccuracies. Since length measurements are species specific, lengths of one species cannot be directly compared to those of another species as can age, which is independent of growth rate. Using age has the distinct advantage of allowing all species to be combined in an analysis of community age class structure. Since most communities consist of a few abundant species and many species of low occurrence, lumping is the only way to include rare species in this type of community analysis. Length frequencies have the added disadvantage of exhibiting inconsistencies at a given site due to differences in habitat (water depth, current velocity, patterns of flow, etc). This problem will be addressed in greater detail in another publication.

The age-class structure of the mussel com-

munity at Pendleton is skewed towards the older age-classes. When compared to earlier samples taken at Kyles Ford and Speers Ferry in the Clinch River, the number of young mussels collected is far below what was expected. During the period of 1973-75, I found that approximately 25% of the mussels at Kyles ford and 50% of those collected at Speers Ferry were less than 4 years old. Another 20% of the mussels from these sites were in the 4-5 year class. The percentage of young mussels (1-5 years) collected at Pendleton Island was very low by comparison (less than 1.0%), which may indicate a general decline in recruitment of all mussel species at this site.

#### Conclusions:

In light of the recent observed decline in the range and species abundance of the Cumberlandian mussel fauna, it is clear that protected areas such as that at Pendleton Island are needed to conserve this fauna. It is hoped that such areas can not only serve to shelter species from overt disturbance, but will serve as a base for research aimed at answering questions as to why so many species are declining. The most likely cause for the recent disappearance of a number of species is deteriorating water quality. Despite the plethora of studies conducted on the Clinch River fauna to date, we are not close to a solution to this problem. If this deterioration is not identified and stopped, many more species may follow in the footsteps of the *Dysnomias* which are near extinction.

The mussel preserve at Pendleton Island is precariously located in a river reach which has been subjected to severe pollution problems in the past (Dennis, 1985). There have been two documented spills from a power plant at Carbo, Virginia, and other industries are being developed within the watershed. The mussel community at Pendleton Island should continue to be monitored on an annual basis, with follow-up quantitative sampling at two year intervals to discern subsequent shifts in community structure. Conservancy efforts should be aimed at working with State and Federal regulatory agencies to identify potential threats to the habitat. If possible, a mussel preserve should be established in an upstream river reach which would provide a greater degree of protectability. A preserve is also needed within the Powell River watershed to monitor the status of Cumberlandian species which do not occur at Pendleton Island (i.e. *Quadrula intermedia*, *Dromus*

*dromas*).

The emphasis in fresh water mussel studies over the past 20 years has been on distribution, only recently focusing on community structure as a means of monitoring the status of this fauna. It is clear that if we wish to preserve this faunal assemblage, future research should focus on the biology and ecology of these organisms. Otherwise, we can do little more than document their extinction.

#### REFERENCES

- Ahlstedt, S. A. 1986. Cumberlandian Mollusk Conservation Program, Activity 1: Mussel Distribution Surveys. Unpublished Report Tennessee Valley Authority, Norris TN.
- Bates, J. M. and S. D. Dennis. 1978. The mussel fauna of the Clinch River, Tennessee and Virginia. *Sterkiana*. 69/70:3-23.
- Dennis, S. D. 1985. Distributional Analysis of the Freshwater Mussel Fauna of the Tennessee River System, with special reference to possible limiting effects of siltation. Tenn. Wldl. Res Agency. Nash, TN. No 85-2. 71pp.
- Dennis, S. D. 1987. An unexpected decline in populations of the Freshwater mussel, *Dysnomia* (= *Epioblasma*) *capsaeformis*, in the Clinch River of Virginia and Tennessee. *Virginia Jour. Sci.* 38(4):281-288.
- Jenkinson, J. J. and S. A. Ahlstedt. 1988. Quantitative Reassessment of the Freshwater Mussel Fauna in the Clinch River, Tennessee and Virginia. Unpublished report, Tennessee Valley Authority, Knoxville, TN
- Johnson, R. I. 1978. Systematics and zoogeography of *Plagiola* (= *Dysnomia* = *Epioblasma*), an almost extinct genus of freshwater mussels (Bivalvia: Unionidae) from Middle North America. *Bull. Mus. Comp. Zool., Harvard U.* 148(6): 239-321.
- Kosztarab, M. 1987. Status and Needs of Invertebrate Studies in Virginia. *Virginia Jour. Sci.* 38(4):266-280.
- Kovalak, W. P., S. D. Dennis, and J. M. Bates. 1986. Sampling Effort Required to Find Rare Species of Freshwater Mussels. *In*