Sickel 1995

# MÜSSEL SURVEY FOR 1995 AT MULZER CRUSHED STONE, INC. FLEETING AREA, OHIO RIVER MILE 746.0 NEAR ROCKPORT, INDIANA

Reference: Permit No. 91-IN-03040
Louisville District Corps of Engineers

Prepared for:

Mulzer Crushed Stone, Inc.
6th and Mozart Street
Tell City, Indiana

Prepared by:

James B. Sickel, Ph.D.
Department of Biological Sciences
Murray State University
Murray, KY 42071

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# MUSSEL SURVEY FOR 1995 AT MULZER CRUSHED STONE, INC. FLEETING AREA, OHIO RIVER MILE 746.0 NEAR ROCKPORT, INDIANA

## ABSTRACT

On October 1, 1995, a mussel survey was conducted at the Mulzer Crushed Stone, Inc. fleeting area along the right descending bank of the Ohio River at mile 746.0 near the city of Rockport, Spencer County, Indiana. The survey repeated the investigation conducted on October 23, 1993. The survey consisted of 5 transects set perpendicular to shore and extending from 100 to 370 feet from the normal pool shoreline. Ten, 1 $m^2$ quadrats, 30 feet apart, were searched by a diver along each transect. The transects were located approximately 390 ft. apart with transect 1 located 100 ft. upstream from the upstream property boundary and transect 5 at the downstream property boundary. A total of 103 live mussels representing 11 species was collected compared to the 56 individuals in 15 species collected in 1993. The mean mussel density throughout the area was 2.06 mussels per $m^2$ in the 1995 survey compared to 1.12 mussels per $m^2$ in 1993. A mean of approximately 1.0 mussels per $m^2$ is characteristic of a mussel bed. The mean density found in this survey was significantly less than that found by Young-Morgan & Associates in September 1990 at which time they reported a density of 4.56 mussels/$m^2$. However, because of other activities at the site such as the bridge construction just upstream, and the colonization by zebra mussels, and because of the patchy distribution of the mussels in the bed, the lower density of mussels found in 1995 cannot conclusively be attributed to the activities of Mulzer Crushed Stone at this time. The nearly doubling of the number of mussels collected in 1995 compared to 1993 indicates the activities at the site are not having an adverse effect on the mussels. The increases in younger mussels also suggest no adverse impact. Also, the age distribution suggests that recruitment is continuing. Unlike the 1990 survey, in the 1993 and 1995 survey zebra mussels were abundant and attached to most of the native unionid mussels. The density of zebra mussels has increased since 1993. There was no evidence of excessive mortality of native mussels; however, it is likely that the high density of zebra mussels will result in a loss of some unionid mussels. A comparison of Ohio River mussels from the site with Tennessee River mussels indicates that individuals of the species *Fusconaia ebena* with attached zebra mussels have lost approximately 30% of their tissue mass. This may reduce reproductive success and eventually lead to mortality. Additional surveys should be examined to determine if the reduction in density from the 1990 survey is significant and attributable to barge activity or to zebra mussels at the site. No federally-listed endangered species were found and it is unlikely that any occur within the project area.

## INTRODUCTION

Mulzer Crushed Stone, Inc., Tell City Indiana, has modified its fleeting area by constructing 2 mooring cells on the right descending bank of the Ohio River, mile 746.0, near Rockport, in Spencer County, Indiana (Reference: U. S. Army Engineer District, Louisville Corps of Engineers Permit 91-IN-03040). Construction was permitted under the special conditions that an annual survey of the existing mussel bed be conducted to determine the size, extent and population density of the bed. A survey was conducted in September 1990 by Young-Morgan & Associates (Hubbs, et al., 1991) which yielded 114 mussels representing 13 species. The average density from that survey was reported to be 4.56 mussels/$m^2$. This estimated density qualifies the existing mussel community, as of 1990, as a mussel bed. No federally-listed endangered species were collected during that survey. The same area was resurveyed on October 23, 1993 and 56 mussels in 15 species were found (Sickel and Leek, 1994). The mussel density appeared to have decreased from 4.56 mussels/$m^2$ to 1.12 mussels/$m^2$. However, since bridge construction was occurring just upstream from the site, zebra mussels had invaded, and because of the patchiness of mussel beds, the apparent decrease in native mussel density was not considered significant or attributable to the activities at the Mulzer Crushed Stone facility. The present survey reported here is the second survey since the mooring cells have been constructed. Additional surveys may be conducted each fall when river conditions are favorable, and the results will be compared to this study to assess the impact of the barge activities.

Zebra mussels were first reported from the lower Ohio River in the fall of 1991 by Tennessee Valley Authority divers. Since then, zebra mussels have colonized in high densities much of the lower Ohio River. In the Great Lakes, zebra mussels have devastated some native unionid mussel species (Mackie, 1990; Hebert, et al., 1991; Hunter and Bailey, 1992). So far zebra mussels have not become abundant in the Tennessee River. This allows comparison between native mussels colonized by zebra mussels with those that are not colonized.

## METHODS

On October 1, 1995, a mussel survey team consisting of a malacologist (James B. Sickel) and assistant (Jeffrey Herod) and a diving crew (Mainstream Commercial Divers, Murray, Kentucky) conducted a mussel survey at Ohio River mile 746.0 near Rockport, Spencer County, Indiana, for Mulzer Crushed Stone, Inc. Five transects, each transect being 270 feet in length, were set out perpendicular to shore starting at the bottom of the bank approximately 100 feet from the normal pool shoreline. Transects were approximately 390 feet apart with transect 1 located 100 ft. upstream from the upstream property boundary and transect 5 located at the downstream property boundary (Figure 1). Ten 1 $m^2$ quadrats were sampled along each transect. Quadrats were placed 30 feet apart along the transects. A diver searched each quadrat frame, digging into the gravel and placing all mussels, alive and dead, into the bags which were attached to the anchored transect line. All mussels were identified to species, aged, and returned to the river. A sample of the mussels was returned to the lab for analysis of zebra mussel effects. Zebra mussels were removed, counted, measured and weighed. Native mussels, mostly *Fusconaia ebena*, were measured, aged, weighed, and the tissue removed from the shell, weighed, dried and reweighed. A sample of 39 *F. ebena* which did not have zebra mussels attached were collected from the Tennessee River at mile 21.25. These were used for comparison to estimate zebra mussel effects.

Mean densities per quadrat were compared to that found in 1990 and 1993 using single factor analysis of variance (Zar, 1984). Other statistics used to compare the two surveys were Species Diversity, Shannon Index, and Evenness.

## RESULTS AND DISCUSSION

A summary of the species found and the number of each species found in the 1995, 1993 and 1990 surveys is presented in Table 1. In the present survey, 103 live mussels were found in 50, 1 $m^2$ quadrats while 56 were found in 50, 1 $m^2$ quadrats in 1993 and 114 mussels were found in 50, 0.5 $m^2$ quadrats in the 1990 survey. Only 11 species were found in 1995 compared to 15 in 1993 and 13 in 1990. This decrease in species richness is also reflected in a smaller Shannon Diversity Index of 2.966 compared to 3.514 in 1993 and 3.315 in 1990. The evenness values of 0.858, 0.899, and 0.896 for the three surveys are comparable and not significantly different. Because several species are rare and are represented by only 1 or 2 individuals in the 50 quadrats, it is expected that species richness will vary with each sample. The species that were not found in 1995 but were found in 1993, *Lampsilis ovata, Ligumia recta, Tritogonia verrucosa*, and *Truncilla truncata*, only occurred as a few individuals in 1993. Their absence in the 1995 sample is not significant. The most abundant species found in 1995 was *Fusconaia ebena*, which comprised 29% of the community. Its percentage composition has been increasing from 12% in 1990 and 14% in 1993. This species may be able to tolerate the zebra mussel better than some of the other species. Figure 2 shows a *Fusconaia ebena* collected in the survey. The native mussel has more than 100 zebra mussels attached to it each measuring greater than 2 mm. There were many more zebra mussels less than 1 mm in length that had recently settled, but these were not counted. Figure 3 shows the mussel under water with its siphons open. From this photograph it appears that the native mussel can continue to filter water and obtain the necessary food and oxygen. However, the zebra mussels are removing much of the food supply. Figure 4 is a comparison of tissue dry weight plotted against shell length for a sample of *F. ebena* collected in the survey and compared with specimens from the Tennessee River which did not have zebra mussels attached to them. Analysis of the graphs indicates that the Ohio River mussels weigh approximately 30% less at a given shell length than the Tennessee River mussels. Figure 5 is a comparison of the same mussels for shell weight plotted against shell

length. Shell mass is similar for the two samples at each shell length. This suggests that the Ohio River mussels have lost tissue mass compared to the Tennessee River mussels. Most likely, the presence of zebra mussels has resulted in loss of tissue mass in the native mussels. If this continues, reproductive success of the native mussels should decline and their mortality should increase.

Although the number of mussels collected in 1995 was nearly twice that collected in 1993, the difference in mean density, 2.06 mussels/$m^2$ in 1995 and 1.12 mussels/$m^2$ in 1993, is statistically insignificant when tested using a single factor ANOVA (Zar, 1984), with P-value = 0.173. The differences are most likely caused by sampling error resulting from the patchy distribution of the mussels and the sample size. It does suggest, however, that the operation of the Mulzer facility has not had an adverse effect on the mussels.

Age distribution of all 103 mussels is shown in Table 2. Over half of the mussels are seven years in age or younger. Since mussels in the Ohio River reach reproductive age at 6 - 8 years, this age distribution represents a healthy community with reasonable recruitment occurring. In future surveys, some samples of sediment should be collected so that mussels smaller than 1 cm can be found. This would provide a better indication of recruitment.

Tables 3 - 7 present the number of each species collected from each quadrat along each transect. A total of 103 live mussels representing 11 species was collected. Not shown in the tables is the fact that only 18 dead mussels were collected in the quadrats. These were shells that had been dead for some time and may have died of being covered with zebra mussels although this could not be confirmed. Transect 1, the most upstream transect, yielded 26 mussels and 9 species; transect 2 yielded 9 mussels and 7 species; transect 3 yielded 18 mussels and 7 species; transect 4 yielded 13 mussels and 6 species; and transect 5 yielded 37 mussels and 7 species. As future surveys are conducted, a better understanding of the distribution of mussels in the bed will be obtained.

The mean mussel density throughout the area was 2.06 mussels /$m^2$. A mean of approximately 1.0 mussel /$m^2$ is generally considered to be characteristic of a mussel

bed. The mean density found in this survey was nearly twice that of 1993 but the difference was not statistically significant. However the mean density of 2.06 mussels/$m^2$ is significantly less (P-value = 0.041) than that found by Young-Morgan & Associates in September 1990 at which time they reported a density of 4.56 mussels/$m^2$. However, because of other activities at the site such as the bridge construction just upstream, and the colonization by zebra mussels, and because of the patchy distribution of the mussels in the bed, the lower density of mussels found in 1995 cannot conclusively be attributed to the activities of Mulzer Crushed Stone at this time. The nearly doubling of the mussel number in 1995 compared to 1993, and the age distribution of the mussels indicate that the mussel bed is healthy and increasing.

Table 8 presents the number of mussels collected in each quadrat summed over all 5 transects. Quadrat I is farthest from shore approximately 370 ft. from the normal pool shoreline. Quadrate X is located approximately 100 ft. from shore at the bottom of the bank at a depth of 18 ft. (at normal pool elevation). Table 8 shows the distribution of the mussels parallel to shore looking at each quadrat series across all five transects. Quadrat series II, III, IV and V along each transect contained 92 of the 103 mussels collected, or 89.3%. This indicates that the mussel bed is located within a band approximately 100 feet wide located 150 feet from the bottom of the bank.

Table 9 presents the number of mussels found on each transect, and gives an indication of the horizontal distribution parallel to shore. The number of mussels per transect is quite variable and patchy. The diver reported a bottom of irregular contours with patches of loose gravel and sand.

Zebra mussels have recently invaded the Ohio River. The first specimens in the lower Ohio River were found by Tennessee Valley Authority divers in September 1991. Colonization has been rapid, comparable to that in the Great Lakes. Zebra mussels were common to abundant on rocks, snails and native unionid mussels in 1993. The numbers had increased in 1995. However, no snails were found. All of the native mussels had zebra mussels attached. Attached zebra mussels apparently interfere with the feeding, respiration and behavior of the native mussels. Zebra mussels have devastated some native mussel populations in the Great Lakes. It is likely that the

same may occur in the Ohio River.

## CONCLUSION

A total of 103 mussels representing 11 species was found within the searched area of this survey. These 11 species are common in the Ohio River, and no federally-listed endangered species were found. The density of mussels sampled in the mussel bed was nearly twice that of 1993 (2.06 mussels/$m^2$ compared to 1.12 mussels/$m^2$ in 1993), however, it is still significantly lower than in 1990 (4.56 mussels/$m^2$). Based on the increase in the number of individuals and their age distribution, the mussel bed appears healthy with increasing density. The lower density of mussels found in this survey compared to 1990 cannot be attributed to activities of Mulzer Crushed Stone, Inc. at this time. Other activities such as the bridge construction just upstream and the invasion of zebra mussels may have contributed to the decline. Zebra mussels have colonized the area and occur in densities greater than 130,000/$m^2$ on suitable surfaces. It is likely that the zebra mussels will negatively affect the native mussel fauna. This study suggests that at least one species of native mussel, *Fusconaia ebena*, is experiencing starvation as a result of the presence of zebra mussels. This has resulted in an approximately 30% loss in tissue mass. It is likely that this will have a negative impact on reproduction in the future and probably increase mortality. Additional surveys are needed to determine if the activities of Mulzer Crushed Stone, Inc., are affecting the mussel bed, and if zebra mussels will increase the mortality and reduce reproductive success of the native mussels.

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TABLE 1

SCIENTIFIC AND COMMON NAMES, AND TOTAL NUMBER OF UNIONID MUSSELS FOUND IN SURVEY AT OHIO RIVER MILE 746.0 FOR MULZER CRUSHED STONE, Oct. 1, 1995, OCT. 1993 AND SEPT. 1990.

| Scientific Name | Common Name | Number Found 1995 | 1993 | 1990* |
|---|---|---|---|---|
| *Amblema plicata* (Say, 1817) | Threeridge | 17 | 12 | 16 |
| *Ellipsaria lineolata* (Rafinesque, 1829) | Butterfly | 7 | 6 | 10 |
| *Fusconaia ebena* (Lea, 1831) | Ebonyshell | 30 | 8 | 14 |
| *Fusconaia flava* (Rafinesque, 1820) | Wabash pigtoe | 2 | 1 | 5 |
| *Lampsilis ovata* (Say, 1817) | Pocketbook | 0 | 2 | 0 |
| *Ligumia recta* (Lamarck, 1819) | Black sandshell | 0 | 1 | 0 |
| *Megalonaias nervosa* (Rafinesque, 1820) | Washboard | 3 | 2 | 1 |
| *Obliquaria reflexa* Rafinesque, 1820 | Threehorn wartyback | 8 | 5 | 22 |
| *Obovaria olivaria* (Rafinesque, 1820) | Hickorynut | 1 | 1 | 3 |
| *Quadrula metanevra* (Rafinesque, 1820) | Monkeyface | 7 | 3 | 3 |
| *Quadrula nodulata* (Rafinesque, 1820) | Wartyback | 11 | 3 | 9 |
| *Quadrula pustulosa* (Lea, 1831) | Pimpleback | 14 | 4 | 17 |
| *Quadrula quadrula* (Rafinesque, 1820) | Mapleleaf | 3 | 3 | 7 |
| *Tritogonia verrucosa* (Rafinesque, 1820) | Pistolgrip | 0 | 4 | 5 |
| *Truncilla truncata* Rafinesque, 1820 | Deertoe | 0 | 1 | 2 |
| | TOTAL | 103 | 56 | 114 |
| | Diversity: Shannon (H') ($log_2$) | 2.966 | 3.511 | 3.312 |
| | $H'_{max}$ ($log_2$) | 3.458 | 3.907 | 3.697 |
| | Evenness (J') | 0.858 | 0.899 | 0.896 |

* Data from 1990 survey by Young-Morgan & Associates using 0.5 $m^2$ quadrats.

TABLE 2

AGE DISTRIBUTION OF MUSSELS COLLECTED FROM TRANSECTS 1 - 5
OHIO RIVER MILE 746.0
OCTOBER 1, 1995

| | AGE (years) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIES | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 18 | TOTAL |
| *A. plicata* | - | 1 | 1 | 1 | 2 | 1 | - | 2 | 2 | 2 | 1 | 1 | 2 | 1 | - | 17 |
| *E. lineolata* | - | - | - | 2 | 1 | 1 | 1 | 1 | - | 1 | - | - | - | - | - | 7 |
| *F. ebena* | - | - | 4 | 3 | 7 | 2 | 6 | 1 | 5 | 1 | 1 | - | - | - | - | 30 |
| *F. flava* | - | - | - | - | - | - | 1 | - | - | 1 | - | - | - | - | - | 2 |
| *M. nervosa* | - | - | 1 | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 3 |
| *O. reflexa* | 1 | 3 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | - | 8 |
| *O. olivaria* | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Q. metanevra* | - | 1 | 2 | 1 | 1 | - | 2 | - | - | - | - | - | - | - | - | 7 |
| *Q. nodulata* | - | 2 | 3 | 1 | 4 | - | 1 | - | - | - | - | - | - | - | - | 11 |
| *Q. pustulosa* | - | 2 | 2 | 3 | 4 | 1 | 1 | 1 | - | - | - | - | - | - | - | 14 |
| *Q. quadrula* | - | - | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | 3 |
| TOTAL MUSSELS | 1 | 9 | 16 | 14 | 20 | 6 | 12 | 6 | 7 | 5 | 2 | 1 | 2 | 1 | 1 | 103 |

Numbers indicate # of individuals at each age

TABLE 3

TRANSECT 1

NUMBER OF EACH SPECIES COLLECTED PER SQUARE METER QUADRAT
(Quad No. I towards channel -- Quad No. X near shore)

| | QUADRAT NUMBER | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIES COLLECTED | I | II | III | IV | V | VI | VII | VIII | IX | X | TOTAL |
| *A. plicata* | - | 1 | 2 | 2 | - | - | - | - | - | - | 5 |
| *E. lineolata* | - | - | - | 1 | - | 1 | - | - | - | - | 2 |
| *F. ebena* | - | - | 2 | 2 | - | - | - | - | - | - | 4 |
| *F. flava* | - | - | - | - | 1 | - | - | - | - | - | 1 |
| *M. nervosa* | - | - | 1 | 1 | - | - | - | - | - | - | 2 |
| *O. reflexa* | - | - | - | 1 | 1 | - | - | - | - | - | 2 |
| *Q. nodulata* | - | - | 1 | 2 | 1 | - | - | - | - | - | 4 |
| *Q. pustulosa* | - | - | - | 2 | 2 | - | - | - | - | - | 4 |
| *Q. quadrula* | - | - | 1 | - | 1 | - | - | - | - | - | 2 |
| TOTAL MUSSELS | 0 | 1 | 7 | 11 | 6 | 1 | 0 | 0 | 0 | 0 | 26 |

TABLE 4

TRANSECT 2

NUMBER OF EACH SPECIES COLLECTED PER SQUARE METER QUADRAT
(Quad No. I towards channel -- Quad No. x near shore)

| | QUADRAT NUMBER | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIES COLLECTED | I | II | III | IV | V | VI | VII | VIII | IX | X | TOTAL |
| *E. lineolata* | - | - | - | - | - | - | 1 | - | - | - | 1 |
| *F. ebena* | - | 1 | - | - | - | - | - | - | - | - | 1 |
| *M. nervosa* | - | 1 | - | - | - | - | - | - | - | - | 1 |
| *O. reflexa* | - | - | - | - | - | 1 | - | - | - | - | 1 |
| *Q. metanevra* | - | - | - | - | 1 | - | 1 | - | - | - | 2 |
| *Q. nodulata* | - | 1 | - | 1 | - | - | - | - | - | - | 2 |
| *Q. pustulosa* | - | - | - | 1 | - | - | - | - | - | - | 1 |
| TOTAL MUSSELS | 0 | 3 | 0 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 9 |

TABLE 5

TRANSECT 3

NUMBER OF EACH SPECIES COLLECTED PER SQUARE METER QUADRAT
(Quad No. I Toward Channel -- Quad No. X Near Shore)

| | QUADRAT NUMBER | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIES COLLECTED | I | II | III | IV | V | VI | VII | VIII | IX | X | TOTAL |
| *A. plicata* | 1 | 3 | 1 | 1 | - | - | - | - | - | - | 6 |
| *E. lineolata* | 2 | 1 | - | - | - | - | - | - | - | - | 3 |
| *F. ebena* | - | 1 | - | 1 | - | - | - | - | - | - | 2 |
| *F. flava* | - | 1 | - | - | - | - | - | - | - | - | 1 |
| *O. reflexa* | - | 1 | - | - | - | - | - | - | - | - | 1 |
| *Q. nodulata* | - | - | - | - | - | 1 | - | - | - | - | 1 |
| *Q. pustulosa* | - | 2 | - | - | 1 | 1 | - | - | - | - | 4 |
| TOTAL MUSSELS | 3 | 9 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 18 |

TABLE 6

TRANSECT 4

NUMBER OF EACH SPECIES COLLECTED PER SQUARE METER QUADRAT
(Quad No. I Toward Channel -- Quad No. X Near Shore)

| | QUADRATS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIES COLLECTED | I | II | III | IV | V | VI | VII | VIII | IX | X | TOTAL |
| *A. plicata* | 1 | - | 2 | - | - | - | - | - | - | - | 3 |
| *E. lineolata* | - | - | 1 | - | - | - | - | - | - | - | 1 |
| *F. ebena* | - | - | 5 | - | 1 | - | - | - | - | - | 6 |
| *O. olivaria* | - | - | - | - | - | - | 1 | - | - | - | 1 |
| *Q. metanevra* | - | - | - | 1 | - | - | - | - | - | - | 1 |
| *Q. nodulata* | - | - | - | 1 | - | - | - | - | - | - | 1 |
| TOTAL MUSSELS | 1 | 0 | 8 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 13 |

TABLE 7

TRANSECT 5

NUMBER OF EACH SPECIES COLLECTED PER SQUARE METER QUADRAT
(Quad No. I Toward Channel -- Quad No. X Near Shore)

| | QUADRATS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIES COLLECTED | I | II | III | IV | V | VI | VII | VIII | IX | X | TOTAL |
| *A. plicata* | - | 1 | 1 | - | 1 | - | - | - | - | - | 3 |
| *F. ebena* | - | 14 | 1 | 2 | - | - | - | - | - | - | 17 |
| *O. reflexa* | - | 2 | - | 2 | - | - | - | - | - | - | 4 |
| *Q. metanevra* | - | 1 | 1 | 1 | 1 | - | - | - | - | - | 4 |
| *Q. nodulata* | - | 2 | 1 | - | - | - | - | - | - | - | 3 |
| *Q. pustulosa* | - | 4 | 1 | - | - | - | - | - | - | - | 5 |
| *Q. quadrula* | - | 1 | - | - | - | - | - | - | - | - | 1 |
| TOTAL MUSSELS | 0 | 25 | 5 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 37 |

TABLE 8

TRANSECTS I - V

TOTAL NUMBER OF EACH SPECIES COLLECTED AT EACH QUADRAT POSITION FOR ALL TRANSECTS
(Quad No. I Toward Channel -- Quad No X Near Shore)

| | QUADRATS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIES COLLECTED | I | II | III | IV | V | VI | VII | VIII | IX | X | TOTAL |
| *A. plicata* | 2 | 5 | 6 | 3 | 1 | - | - | - | - | - | 17 |
| *E. lineolata* | 2 | 1 | 1 | 1 | - | 1 | 1 | - | - | - | 7 |
| *F. ebena* | - | 16 | 8 | 5 | 1 | - | - | - | - | - | 30 |
| *F. flava* | - | 1 | - | - | 1 | - | - | - | - | - | 2 |
| *M. nervosa* | - | 1 | 1 | 1 | - | - | - | - | - | - | 3 |
| *O. reflexa* | - | 3 | - | 3 | 1 | 1 | - | - | - | - | 8 |
| *O. olivaria* | - | - | - | - | - | - | 1 | - | - | - | 1 |
| *Q. metanevra* | - | 1 | 1 | 2 | 2 | - | 1 | - | - | - | 7 |
| *Q. nodulata* | - | 3 | 2 | 4 | 1 | 1 | - | - | - | - | 11 |
| *Q. pustulosa* | - | 6 | 1 | 3 | 3 | - | - | 1 | - | - | 14 |
| *Q. quadrula* | - | 1 | 1 | - | 1 | - | - | - | - | - | 3 |
| TOTAL MUSSELS | 4 | 38 | 21 | 22 | 11 | 3 | 3 | 1 | 0 | 0 | 103 |

TABLE 9

NUMBER OF EACH SPECIES COLLECTED FROM EACH TRANSECT
OHIO RIVER MILE 746.0, OCTOBER 1, 1995
(Transect 1 is upstream, Transect 5 is at downstream property boundary)

| SPECIES | TRANSECT | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| *A. plicata* | 5 | - | 6 | 3 | 3 |
| *E. lineolata* | 2 | 1 | 3 | 1 | - |
| *F. ebena* | 4 | 1 | 2 | 6 | 17 |
| *F. flava* | 1 | - | 1 | - | - |
| *M. nervosa* | 2 | 1 | - | - | - |
| *O. reflexa* | 2 | 1 | 1 | - | 4 |
| *O. olivaria* | - | - | - | 1 | - |
| *Q. metanevra* | - | 2 | - | 1 | 4 |
| *Q. nodulata* | 4 | 2 | 1 | 1 | 3 |
| *Q. pustulosa* | 4 | 1 | 4 | - | 5 |
| *Q. quadrula* | 2 | - | - | - | 1 |
| TOTALS | 26 | 9 | 18 | 13 | 37 |

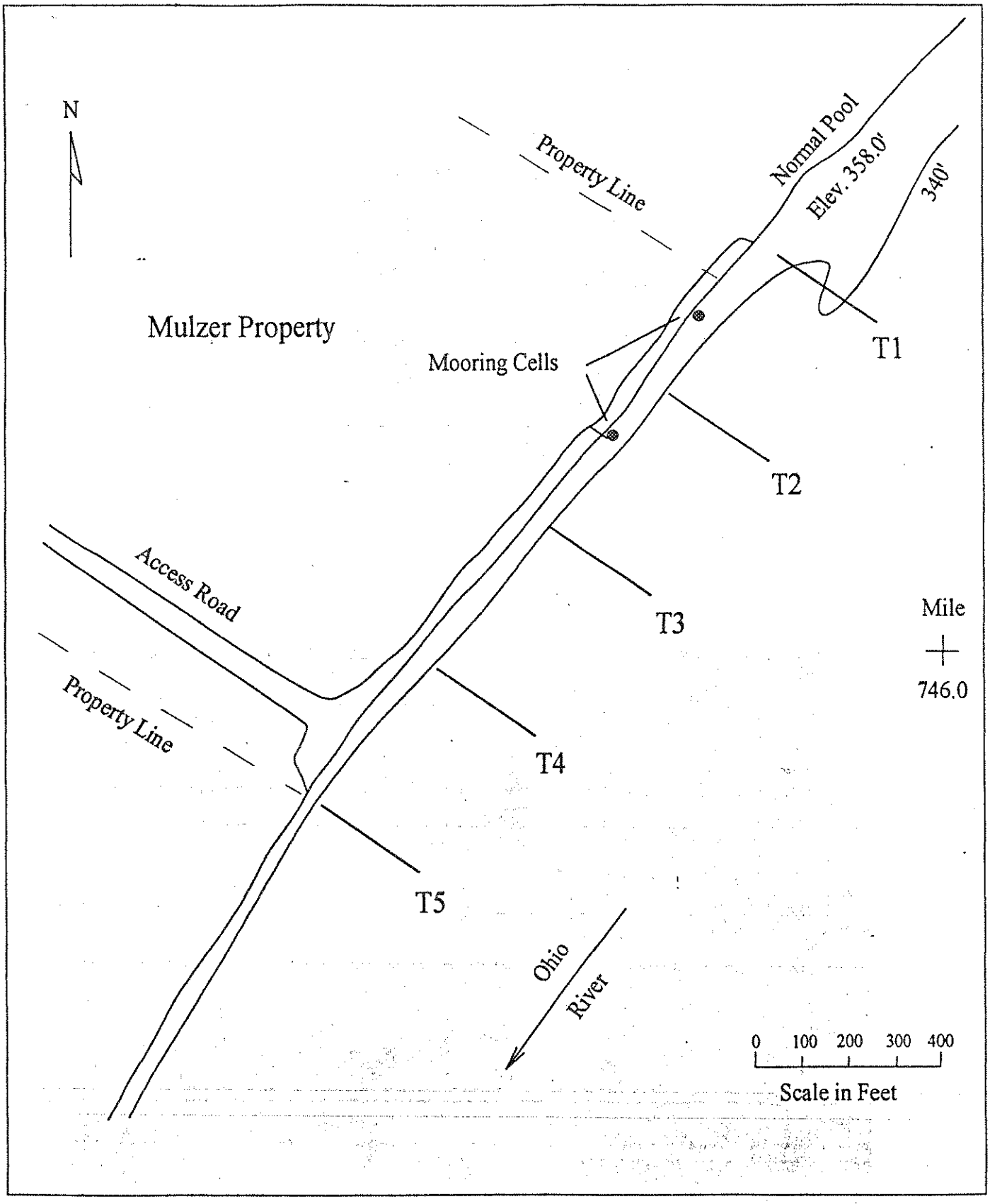


Figure 1. Location of transects T1-T5 sampled on 10-1-95 at Ohio River Mile 746.0.

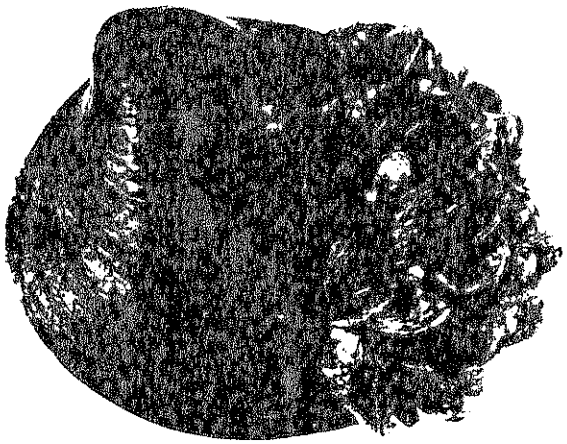

Fig. 2. Zebra mussels attached to a *Fusconaia ebena* from Transect 5 collected October 1, 1995, at Ohio River mile 746.0.

Fig. 3. Zebra mussels attached to a *Fusconaia ebena* collected October 1, 1995, at Ohio River mile 746.0 and showing the siphonal opening of the native mussel through which it filters river water for food and oxygen.

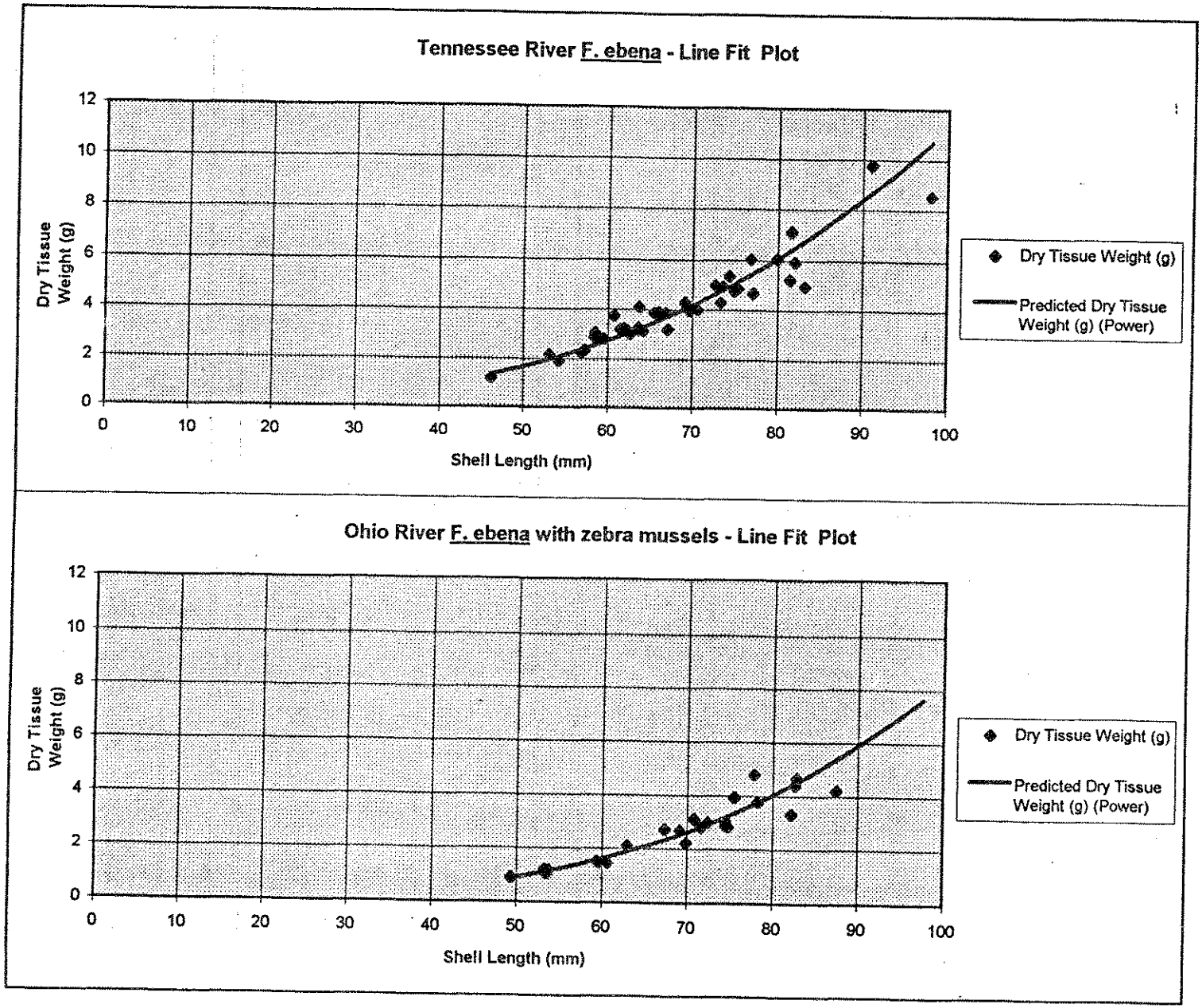


Fig. 4. Comparison of dry tissue weight and shell length of *Fusconaia ebena* collected from Ohio River mile 746.0 with zebra mussels attached to shells and from Tennessee River mile 21.25 without zebra mussels.

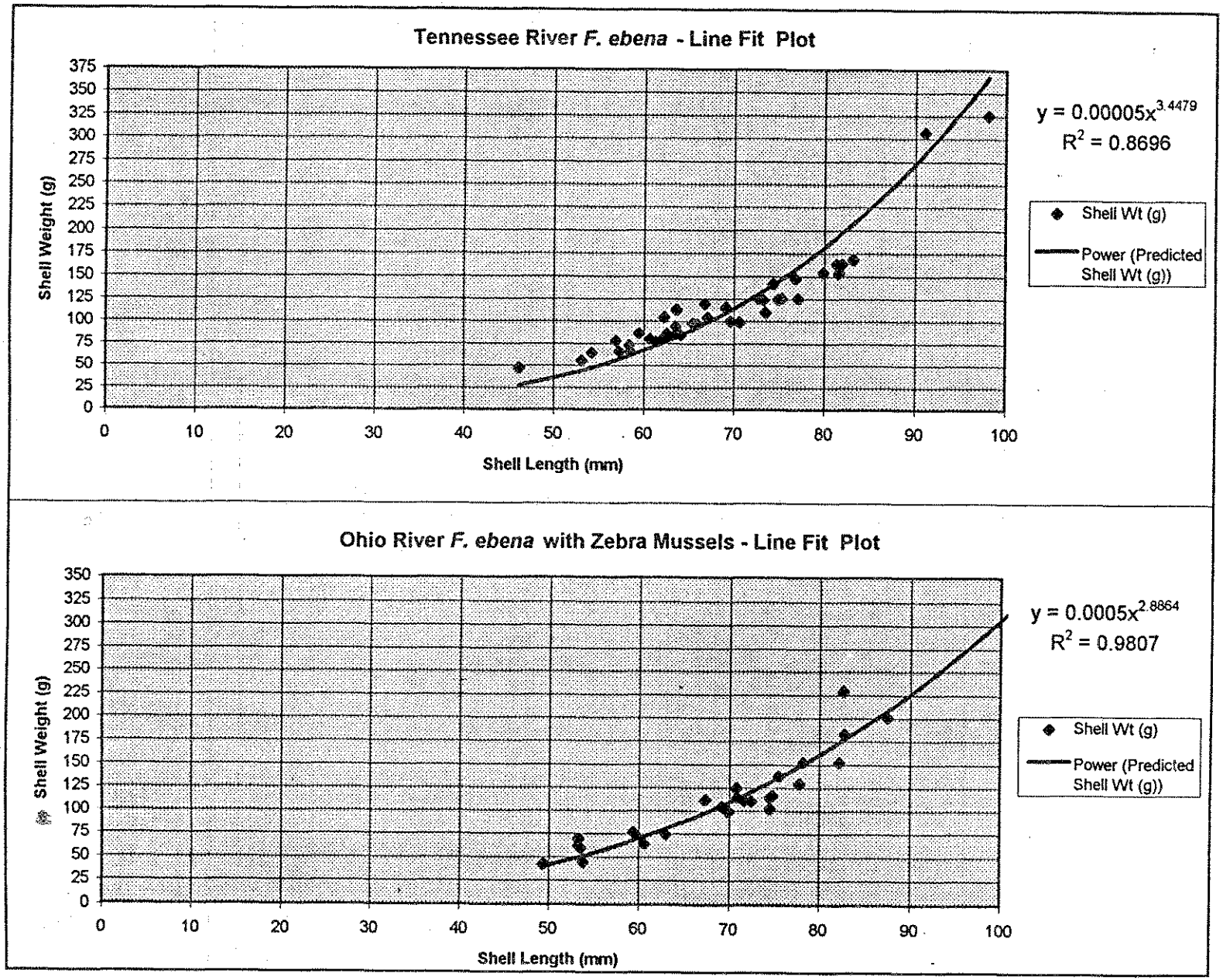


Fig. 5. Comparison of dry shell weight and shell length of *Fusconaia ebena* collected from Ohio River mile 746.0 with zebra mussels attached to shells and from Tennessee River mile 21.25 without zebra mussels.