RESULTS OF THE NINETEEN NINETY-ONE MUSSEL MONITORING PROGRAM IN THE MISSISSIPPI RIVER AT PRAIRIE DU CHIEN, WISCONSIN

A REPORT PREPARED FOR DIDION, INC., McFARLAND, WISCONSIN

BY A. H. CLARKE, ECOSEARCH INC., PORTLAND, TEXAS

December 30, 1991

RESULTS OF THE 1991 MUSSEL MONITORING PROGRAM IN THE MISSISSIPPI RIVER AT PRAIRIE DU CHIEN, WISCONSIN

Arthur H. Clarke

ECOSEARCH, INC.

1. INTRODUCTION

In 1990 ECOSEARCH, Inc. was engaged by the law firm of DeWitt, Porter, & Company of Madison, Wisconsin to develop and carry out a quantitative mussel monitoring program in the East Channel of the Mississippi River at Prairie du Chien, Wisconsin. The survey was designed to assess the impact, if any, of barges used by Didion, Inc. on the local freshwater mussel community in general and on the federally-listed endangered species Lampsilis higginsi (Lea) in particular. The results of the work in 1990 have been described in an Environmental Impact Statement and a Supplement both completed in 1990.

The major objective of the 1990 work was to provide statistically reliable data on the species composition, diversity, richness, age group structure, and growth rates of the mussels, and the abundance of L. higginsi, in three areas traversed by Didion barges and one similar area not traversed by these barges so that subsequent changes in those parameters could be recognized and properly evaluated for statistical significance. See the Sampling Plan in the Appendix. That objective was accomplished. The 1991 work, reported here, is the first comprehen-

sive subsequent effort to sample these areas in a rigorous manner and to assess whether or not significant changes have occurred which are attributable to Didion barge traffic.

Acknowledgments:- Dr. J. Loter provided the excellent statistical analyses included in this report, Mr. James Duckworth carried out the diving in an exemplary manner, and Mrs. Judith Clarke provided valuable general assistance. I am grateful for all of these fine contributions.

2. MATERIALS AND METHODS

On September 22, 1991, the ECOSEARCH team, consisting of Dr. A. H. Clarke, malacologist; Judith J. Clarke, field assistant; and Mr. James Duckworth, diver; arrived in Prairie du Chien and on the next day we began work.

Sampling was carried out in the four areas quantitatively sampled in December, 1990, viz. Locations 7, 4, 3, and 2 (identified as Stations 2570-2573 respectively, see map in Appendix). Using a rope 70 meters long, with 30 randomized points marked by chain links fastened into the rope, a Z-shaped transect was laid out prior to sampling at each of these survey locationss. The rope was anchored at the ends and the angles (each 20 meters from the nearest end) with concrete blocks and the ends were marked with bouys. The diver was equipped with SCUBA gear and a bright aircraft landing light attached to his helmet. Using a 1/4 square meter quadrat, the diver would place the quadrat adjacent to each marked randomized point and collect

all living and dead mollusks within that quadrat down to a depth of about 8 inches. The mussels were placed in a mesh bag, hoisted into the boat, the live specimens sorted out by Mr. Roger Blimling and Mr. Donald Lessard, they were then identified and the small specimens (35 mm or less in length) were measured by the writer, and the results were tabulated on standard data sheets. Additional observaions regarding gravidity and shell damage were also recorded. Except for about 30 live specimens of Amblema plicata from each transect, to be used for growth and condition studies, the live specimens were then promptly returned to the diver in a bag and replaced in a natural position in the substrate. .

TABLE 1

Locational and Ecological Data at Sampling Locations

Sta. No.	Loc. No.	Location	Depth (ft)	Bottom
2570	7	50-100 ft off City Dock, E Channel	14-16	soft mud
2571	4	just below Hwy 18 bridge, " "	14	sh,gr,cind
2572	3	nr. 3rd bouy below Turn. Basin, " "	16	sh,gr,sand
2573	2	nr. 2nd bouy below Turn. Basin, " "	16	muddy sand
2574	-	in ship chan., mile 639, Main Channel	20	sand
2575	-	off N end Rhino.I.outside ship chan.**	17	sand bar
2576	-	500 ft S of 2575 outside ship chan.**	15	sand
2577	-	in ship chan., 400 ft W of 2576, **	17	sand
2578	-	in ship chan., 500 ft W of 2575, **	12-13	sh,hd sd

In addition to the quantitative samples, five new sites in the Main River Channel in the vicinity of Rhinoceros Island north of Prairie du Chien were also visited and sampled qualitatively. These were identified as Stations 2574-2578. General data about each sampling location are given in Table 1.

Where possible, at least 30 live specimens of Amblema plicata were retained from each of the quantitative stations and from the two qualitative stations from which they were available. In accord with initial agreements with regulatory agencies these specimens were to be sent to the Waterways Experiment Station, Army Corps of Engineers, for growth studies and condition (body to shell weight ratios) studies. Because I was in Prairie du Chien on September 24 and had that day available for the task, I began to measure the lengths of each of these specimens at each annulus and to age each specimen. The task proved too time-consuming for completion in one day, however, so it was soon simplified to call for length measurements at each of the final 6 annuli plus ageing, and finally restricted further to call only for total length measurement and ageing.

After our return to Texas it was decided that because of expected delays in production of the growth data by the COE, the specimens should be measured and aged, as required, by me. The containers were then shipped to ECOSEARCH, Inc. by use of a private shipping company (UPS) but delivery was never made and the shipping company lost the shipment. It is impossible,

therefore, to provide measurements of length at each of the last 6 annulus locations, plus age assignments, as requested by the Fish and Wildlife Service. For reasons discussed on later pages, however, I believe that such data, if they had been available, would not have been useful anyway.

The species recorded and their numbers in each of the quadrats in the quantitative transects and numbers of juveniles are given in Tables 2A through 2D along with statistical summaries. Quantitative observations regarding damaged shells and numbers of gravid specimens in the transects in the East Channel are given in Table 3. Qualitative observations about damaged shells seen at sites in the Main Channel are given in Table 4. (Station 2574 has been omitted from Table 4 because no mussels were found there).

3. RESULTS

For the purposes of Tables 2A-2D, specimens have been tabulated as juveniles if they are 35 mm long or less. This is consistent with previous practice in our surveys in this region and with those of the Water Experiment Station, Army Corps of Engineers and the results therefore have comparative value. It must be pointed out, however, (1) that several species may attain ages of 2 or 3 years before the 35 mm length is reached and (2) that in Megalonaias gigantea some specimens in their first year of growth exceed 35 mm in length. In the case of M. gigantea, however, those specimens longer than 35 mm but

A. Damaged Mussels.

Examination of Table 3 shows that no damaged specimens occurred in the three sites traversed by Didion barges but that 3 specimens with centrally-located dents occurred in the control site (Location 7). Such dents are characteristic of brail notches inflicted in past years but which have been healed. The results of sampling in the Main River Channel (i.e. Main Branch) of the Mississippi River near River Mile 639, presented in Table 4, are similar. They indicate that more shell damage is seen where no barges travel (i.e. outside of the main shipping channel) than in areas traversed by barges.

Obviously commercial mussel harvesting by use of brails is a major cause of damage to mussels. Barge traffic, except in instances where a barge accidentally scrapes the bottom, does not cause physical damage to shells.

B. Presence of Lampsilis higginsi.

The numbers of L. higginsi seen in the quantitative transects in December,1990 and September, 1991, are given below.

TABLE 3

Numbers of Damaged Specimens (D), Numbers of Specimens Examined for Gravidity (E), Numbers Found to be Gravid (G), and Sexes Examined for Gravidity (Sex) (See Text) in Quantitative Transects.

Species	Loc. 2			Loc. 3			Loc. 4			Loc. 7			Sex
	D	E	G	D	E	G	D	E	G	D	E	G	
Megalonaias gigantea	0	1	0	0	0	0	0	0	0	0	0	0	m&f
Elliptio dilatata	0	0	0	0	0	0	0	0	0	2[a]	0	0	m&f
Lasmigona costata	0	0	0	0	0	0	0	0	0	0	1	0	m&f
Strophitus undulatus	0	0	0	0	0	0	0	2	0	0	0	0	m&f
Obliquaria reflexa	0	2	0	0	2	0	0	0	0	0	7	0	m&f
Truncilla truncata	0	0	0	0	0	0	0	0	0	0	1	0	m&f
Proptera alata	0	0	0	0	0	0	0	0	0	1[a]	3	2	m&f
Obovaria olivaria	0	2	1	0	2	1	0	1	0	0	0	0	m&f
Ligumia recta	0	3	3	0	1	1	0	1	1	0	0	0	f
Lamp. r. siliquoidea	0	1	1	0	0	0	0	0	0	0	0	0	f
Lampsilis ventricosa	0	3	3	0	1	0	0	1	1	0	1	0	f
Lampsilis higginsi	0	0	0	0	2	1	0	3	2	0	1	0	f

(A) Centrally-located dents.

TABLE 4

Damaged Specimens Seen in Qualitatitave Samples From Sites in the Main Channel of the Mississippi River Near River Mile 639

(E = Number Examined, D = Number damaged)

Species	Outside Ship Channel				In Ship Channel			
	2575		2576		2577		2578	
	E	D	E	D	E	D	E	D
Amblema plicata	1	1[a]	28	0			30	0
Megalonaias gigantea			1	0			1	0
Quadrula quadrula			1	0				
Anodonta imbecillis	1	1[b]						
Obovaria olivaria	1	0						
Ligumia recta			1	0				
Lampsilis ventricosa	3	2[c]	1	0	2	2[c]		
Lampsilis higginsi							2	0
TOTALS	6	4	32	0	2	2	36	0

(A) Shell badly scraped. (B) Edges chipped. (C) Prominent brail notches.

Table 7

Lampsilis higginsi

Location	1990	1991	Change	Stat. Signif.
2	0	2	+	no
3	4	3	–	no
4	3	5	+	no
7	0	1	+	no

The combined total for L. higginsi at the test sites (Sites 2, 3, & 4) increased from 4 to 6 and the overall total increased from 7 to 11. Since the total numbers of mussels collected in the quantitative transects in 1990 was only 762, and in 1991 it was 1389, the proportion of L. higginsi declined from about 0.90% to 0.80%, but the decline was not statistically significant.

C. Densities of All Species Exclusive of the Three Ridge and Washboard.

The mean densities, both for 1990 and 1991, of all species in the 30 one-fourth square meter quadrats in each transect, are given below, together with the standard deviations of the means, statistical comparisons of the means using the Student's T-Test, and notations about the statistical significance of the results of those tests.

Table 8

Mean Mussel Densities in One-Fourth Meter Quadrats

(Exclusive of A. plicata and M. gigantea)

Location	1990	1991	T-Test	Signif.
2	0.50 (0.73)	5.43 (2.50)	10.37	yes
3	4.60 (2.21)	4.93 (2.50)	0.44	no
4	2.90 (1.95)	5.00 (2.53)	3.60	yes
7	1.43 (1.45)	2.13 (1.61)	1.77	no

Analyses of the raw data show increases in mean numbers of mussels at every location but these increases are statistically significant only at Locations 2 and 4. Analyses of log-transformed data (see Table 6A-6D) show statistically significant increases at Locations 2, 4, and 7, however, and a small (but not significant) decrease at Location 3.

D. Recruitment.

The following comparison of species represented by specimens 35 mm long or less in the 1990 and 1991 quantitative samples may be useful. (It should be noted that specimens of M. gigantea in their first year of growth are included even if they exceed 35 mm).

Table 9

Species Represented by Juvenile Specimens

	Loc. 2		Loc. 3		Loc. 4		Loc. 7	
Species	1990	1991	1990	1991	1990	1991	1990	1991
Amblema plicata	X	X	X	X	X	X	X	X
Megalonaias gigantea		X			X			X
Fusconaia flava			X		X		X	
Quadrula quadrula			X	X			X	
Quadrula pustulosa			X	X	X	X		
Quadrula metanevra			X					
Anodonta imbecillis			X	X	X		X	
Obliquaria reflexa		X	X					X
Plagiola lineolata			X					
Truncilla truncata	X	X	X	X	X	X	X	X
Truncilla donaciformis		X		X				
Proptera alata	X		X		X		X	X
Obovaria olivaria			X		X			
Leptodea fragilis	X	X	X		X			
Lampsilis ventricosa					X			
Total Species	4	6	12	6	10	3	6	5

More species occurred as juveniles at Locations 3, 4, and 7 in 1990 than in 1991 but fewer species were represented by juveniles at Location 2 in 1990 than in 1991. The greatest decrease was seen at Location 4, the Control Site.

I believe that the decrease at Locations 3, 4, and 7 was caused by the fact that 1990 collections were made in December but 1991 collections were made in September. Most mussel species begin free-living existence in the summer and are only 0.1 - 0.3 mm long at that stage. By September many of those species would still be nearly microscopic in size but by December all of them would be in the macroscopic range. The minor increase in juveniles at Location 2 may have occurred because the 1991 transect was shifted upstream by at least 50 feet to avoid a deep hole, and that location may have been slightly upstream from the area sampled in 1990 and in an area of somewhat greater mussel density and diversity.

E. Species Richness.

The numbers of specimens and the numbers of species found in the quantitative transects are given below together with the Shannon-Weaver Diversity indices and an evaluation of the statistical significance of increases or decreases in the values of these indices.

Table 10

Numbers of Specimens, Numbers of Species, and Diversity Measures at Quantitative Sites, 1990 and 1991.

Location	Specimens		Species		S-W Diversity		Signif.
	1990	1991	1990	1991	1990	1991	Diff.
2	71	390	9	23	1.247	2.09	yes
3	254	319	24	24	2.409	2.20	yes
4	262	399	22	26	1.792	1.85	no
7	175	261	17	17	1.446	1.32	no

The above results require discussion. As pointed out previously, the Shannon-Weaver Diversity index is sensitive to numbers of specimens and also to the extent of relative dominance of any single species (e.g. Amblema plicata). One is therefore tempted to suggest that the decreases in S-W Diversity which appear to have occurred at Location 3 between 1990 and 1991, and at location 7 from 1990 to 1991, are probably statistical artifacts. After all, the number of species found did not change from year to year at either location. Further, as stated previously, the area sampled in 1991 in Location 2 may have been a few meters upstream from the area sampled at that location in 1990, and that may account for the apparent increase in diversity.

In general, much larger numbers of specimens were collected

in each transect in 1991 than in 1990. I attribute this to the greater efficiency of the diver used in 1991. The 1991 diver has been a commercial mussel fisherman for many years whereas the 1990 divers have not been.

F. Growth in Amblema plicata.

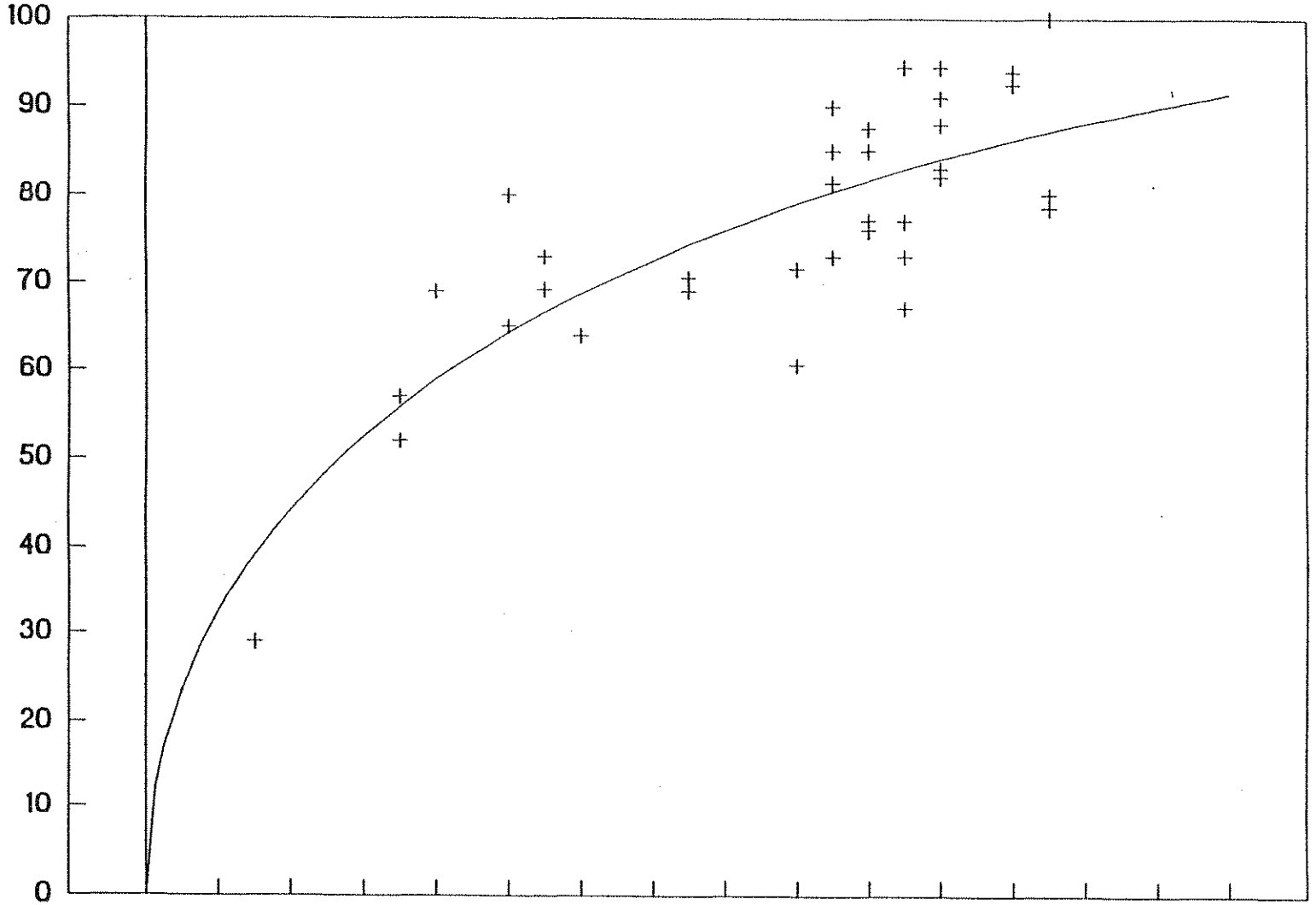
In Charts 1 - 8 growth curves have been fitted to the age and length data by the method of least mean squares. The quantitative surveys provided many specimens of A. plicata so it was possible to measure and age specimens of many size groups. The qualitative stations provided much fewer specimens, however, so small and middle-sized size groups were poorly represented.

Charts 1 to 8 demonstrate that the rates of growth of A. plicata in the six survey locations are remarkably similar. In order to establish a basis for comparison the data sets were also analyzed statistically, however. The results are given in Table 11 and are explained in the footnote therein.

The following points may help the non-statistician in interpreting Table 11. The Model Utility F Statistic in each case is considered very high, indicating that the data fit the equation very well. The values for R Squared show how much of the variation is explained by the equation (= model). The values for the coefficient of $X^{1/2}$ are also high indicating that $X^{1/2}$ is an important term in the equation. The values for Coefficient

Location: 2 Station: 2573 Amblema plicata

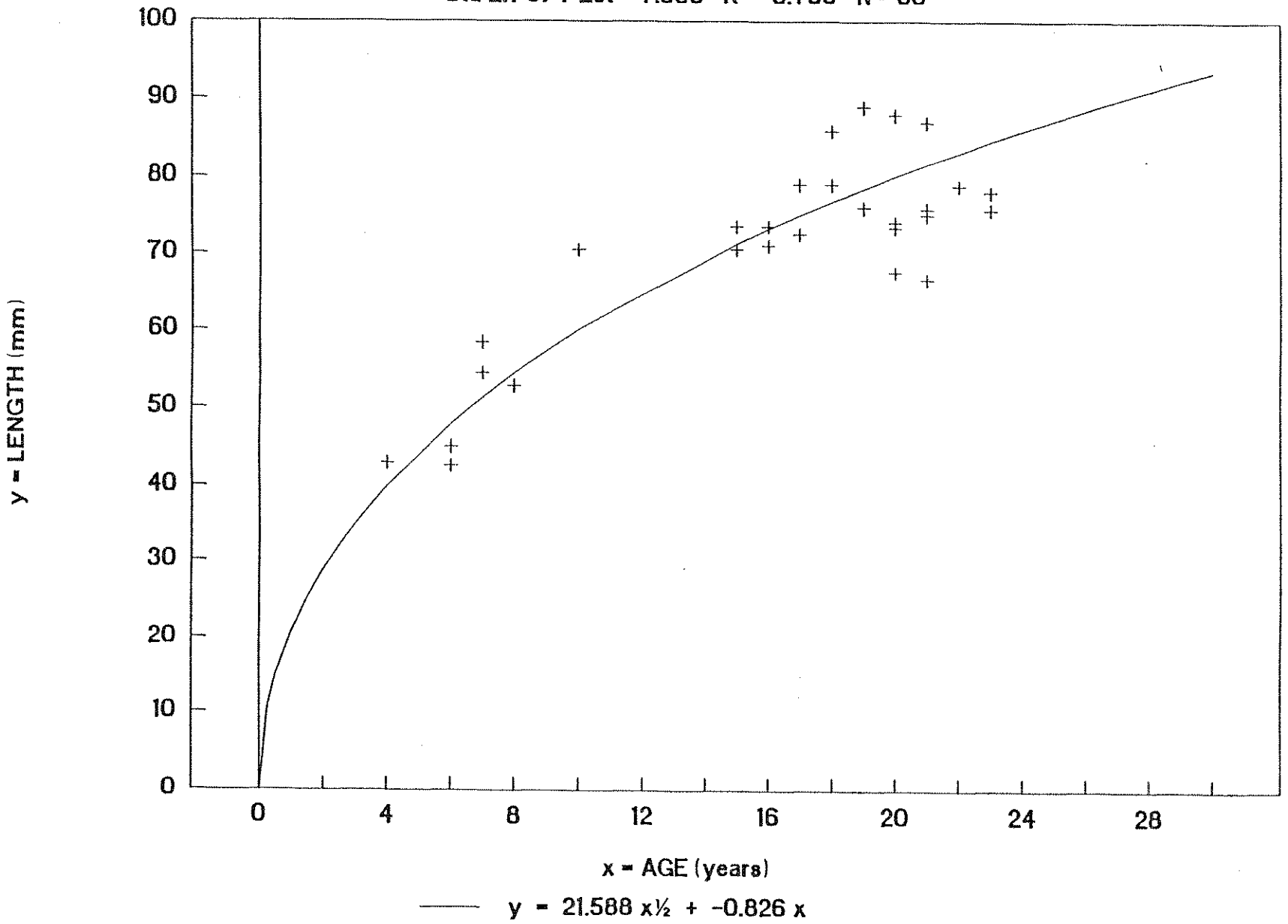
Std Err of Y Est = 8.420 R^2 = 0.657 N = 35



y = 25.245 x½ + -1.561 x

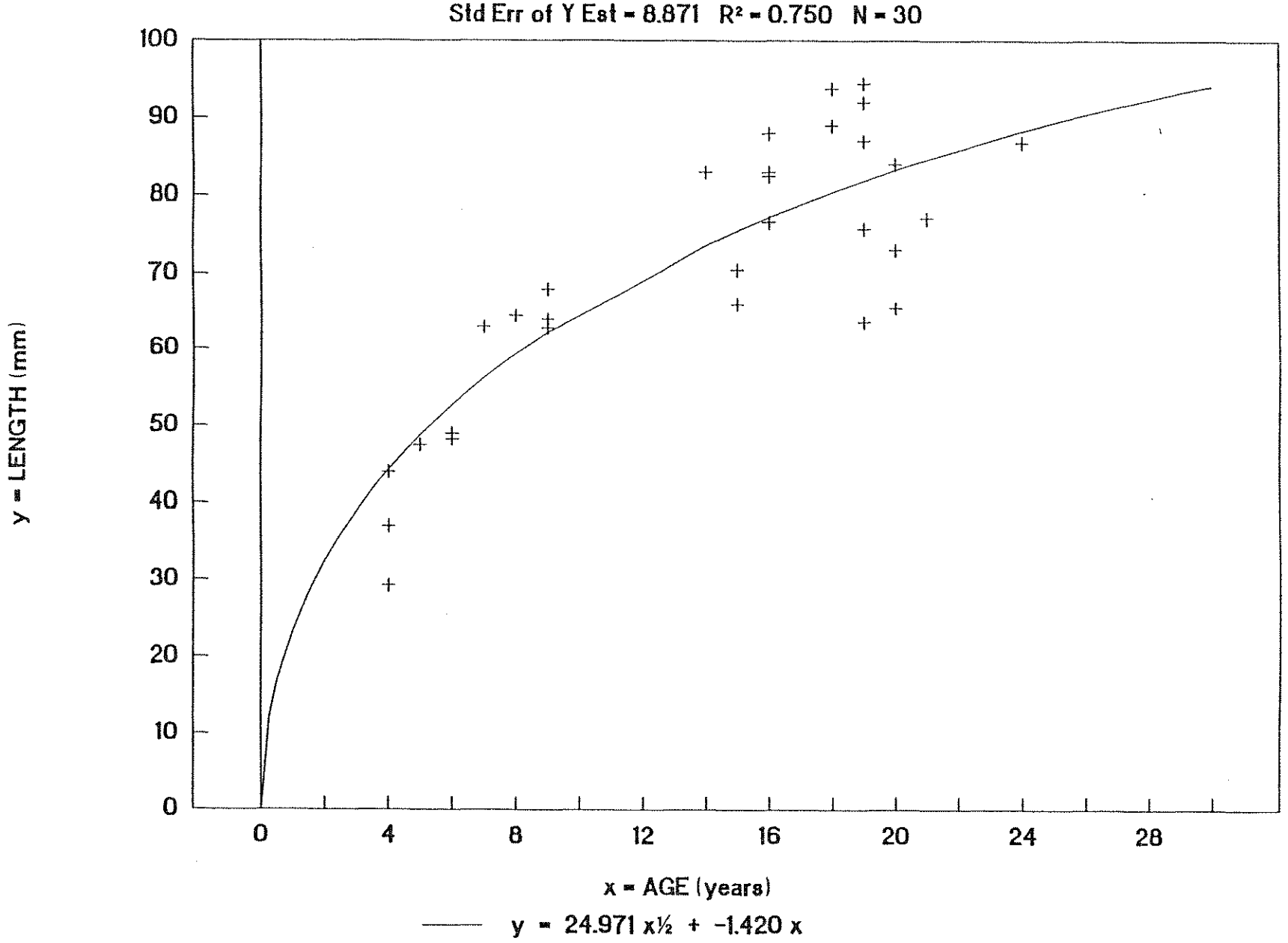
Location: 3 Station: 2572 Amblema plicata

Std Err of Y Est = 7.603 R^2 = 0.759 N = 30

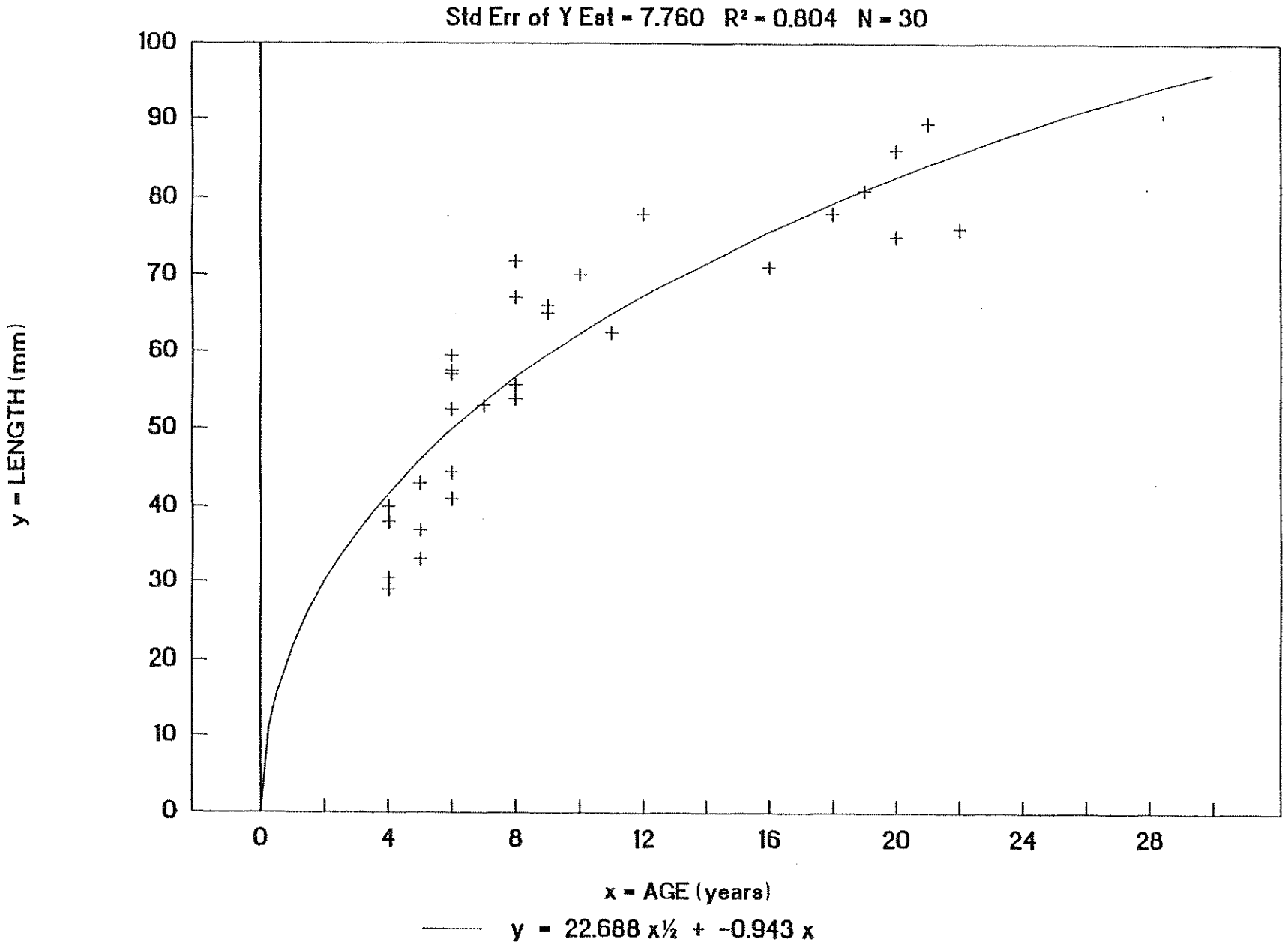


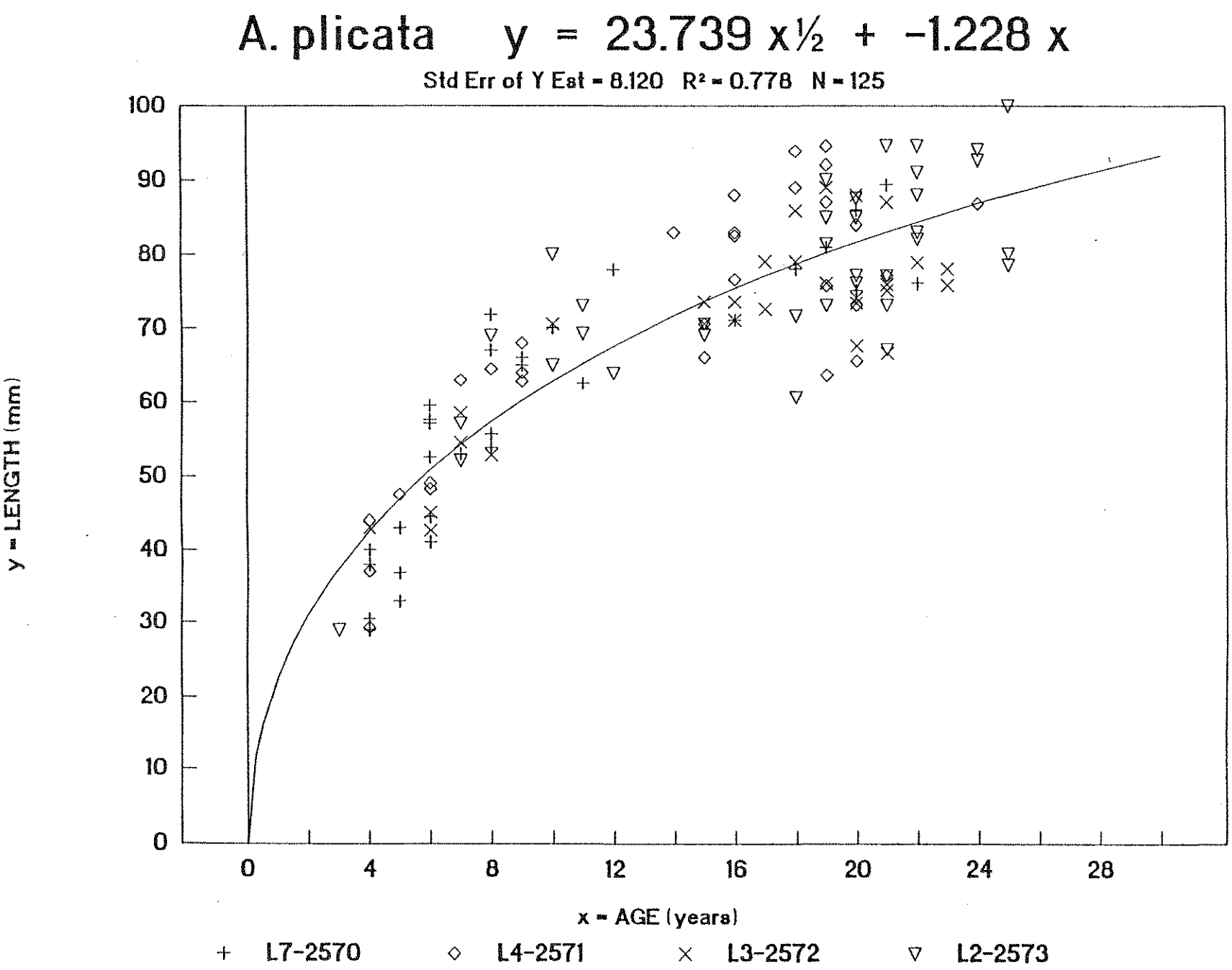
y = 21.588 x½ + -0.826 x

Location: 4 Station: 2571 Amblema plicata

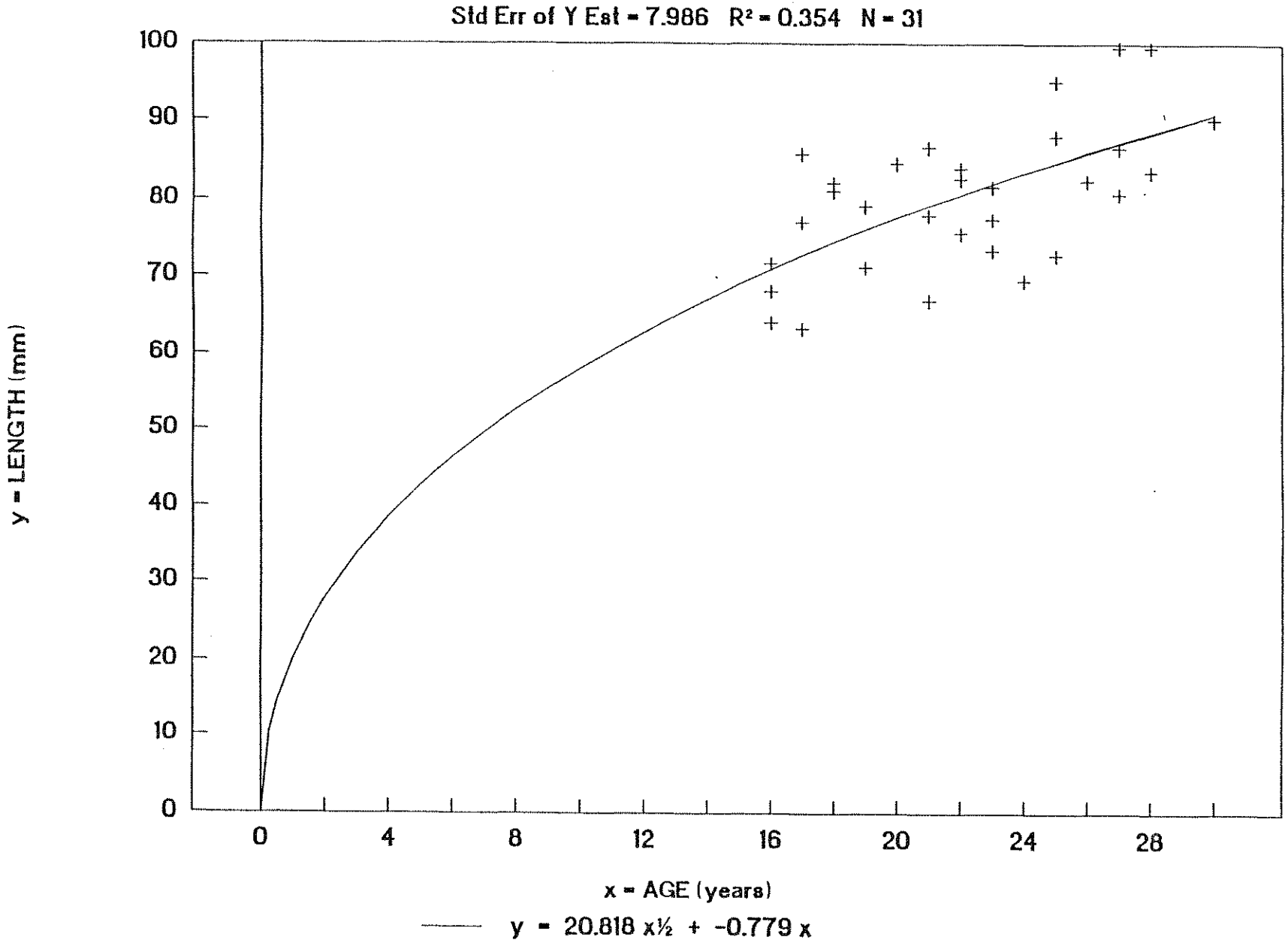


Location: 7 Station: 2570 Amblema plicata

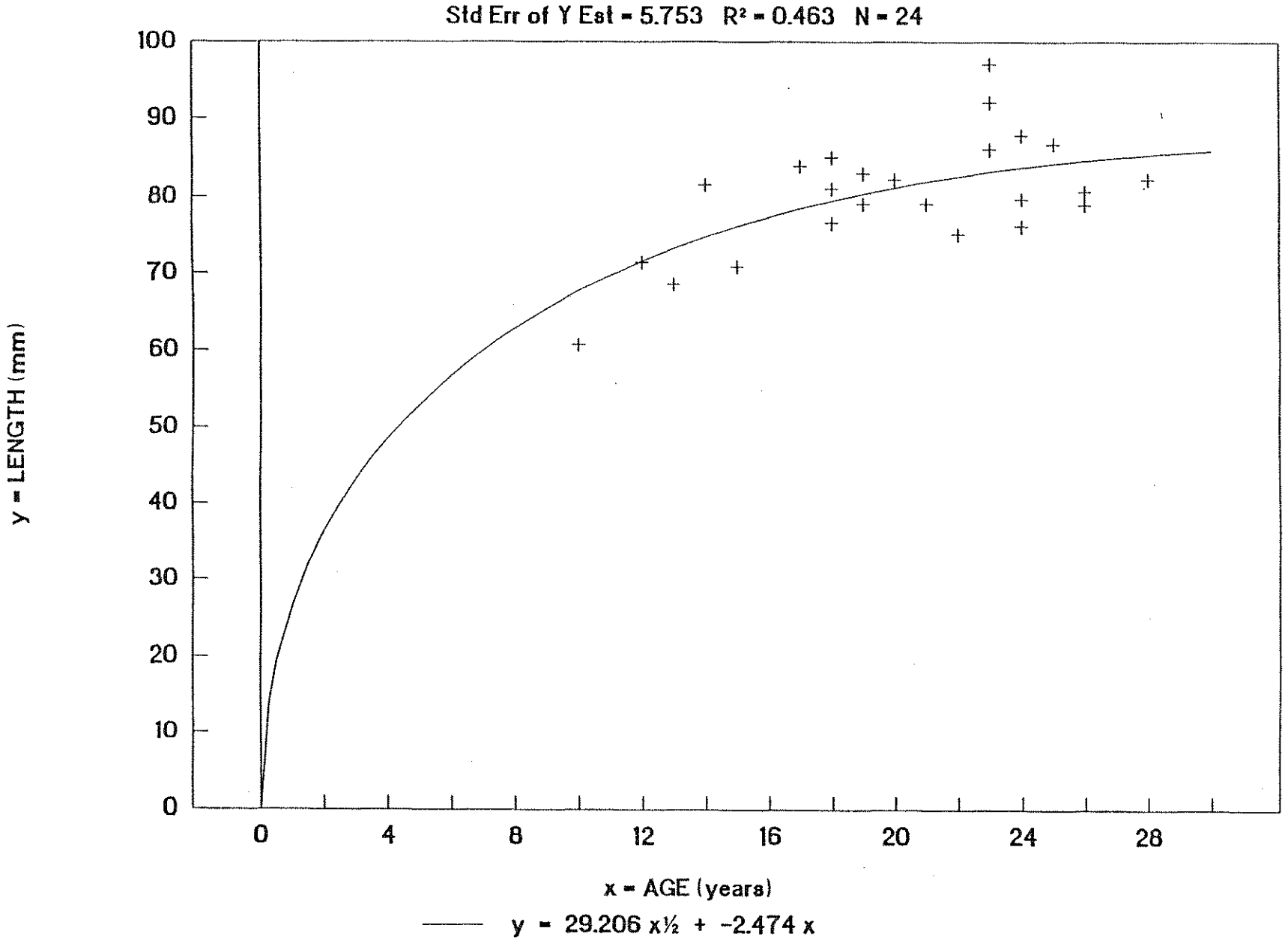



A. plicata y = 23.739 x½ + -1.228 x
Std Err of Y Est = 8.120 R² = 0.778 N = 125
y = LENGTH (mm)
100
90
80
70
60
50
40
30
20
10
0
0
4
8
12
16
20
24
28
x = AGE (years)
+ L7-2570
◇ L4-2571
× L3-2572
▽ L2-2573

Main Channel Station: 2576 Amblema plicata

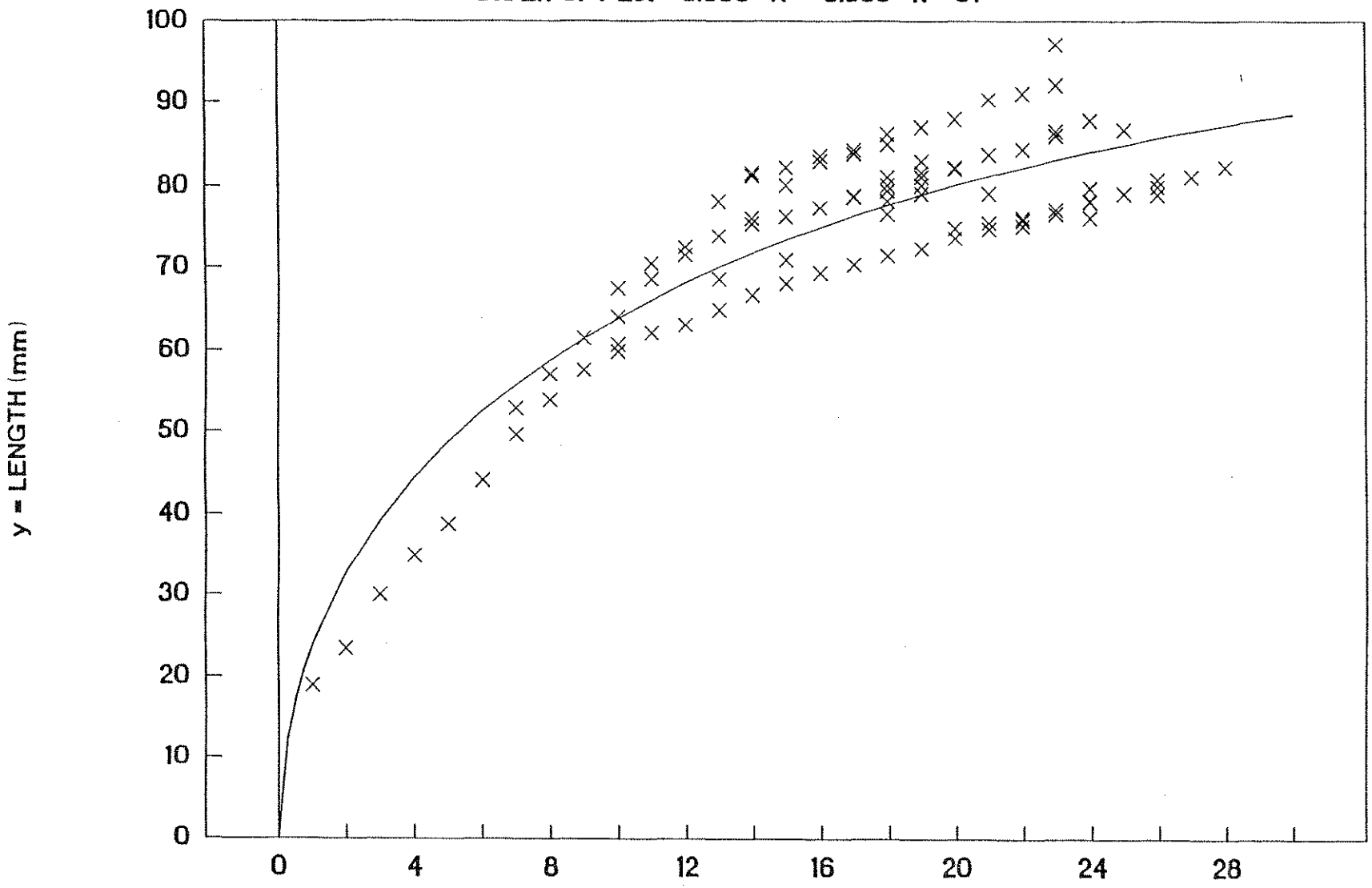


Main Channel Station: 2578 Amblema plicata



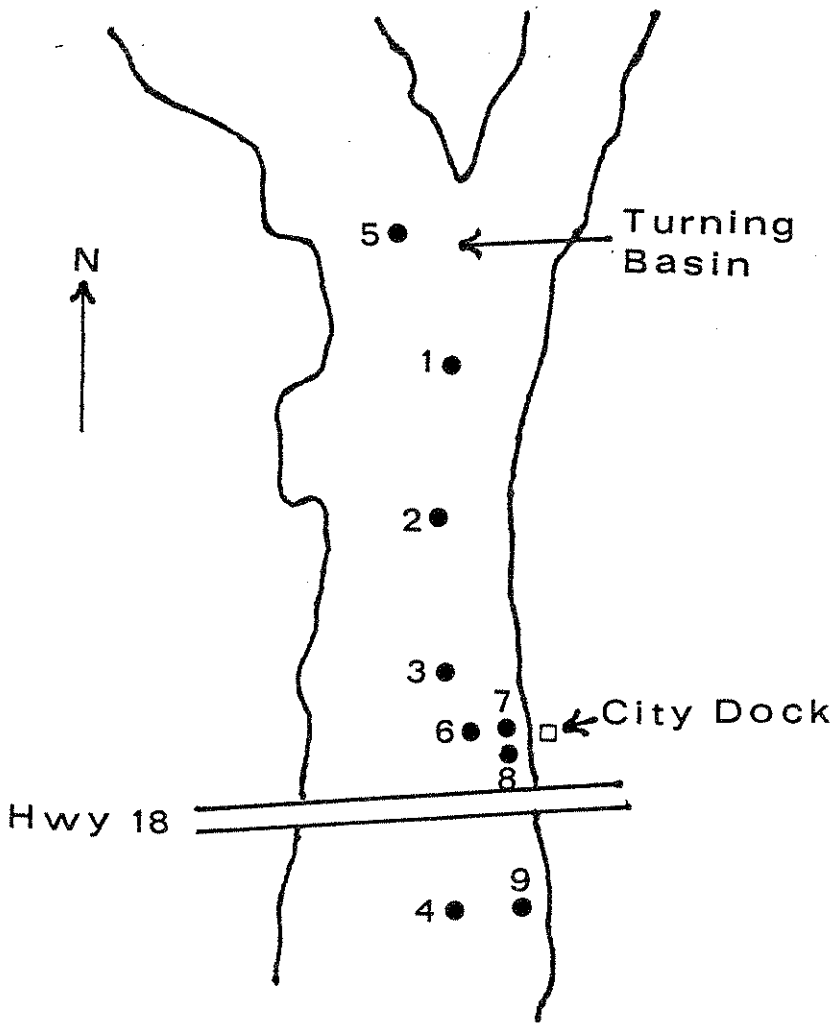
Main Channel Station: 2578 Amblema plicata

Std Err of Y Est = 5.809 R^2 = 0.833 N = 97



Multiple age,len pairs on 8 of 24 indiv

y = 25.630 x½ + -1.730 x


N
5
Turning
Basin
1
2
3
7
6
City Dock
8
Hwy 18
9
4

Prairie du Chien (Wisconsin) Mussel Survey Mississippi River
Ecosearch,Inc. Statistical Comparison of Quant Samples of 0.25 m2
COMPARING
Date 1: Dec 9, 1990 n 1 = 30 quadrats/sample
Station No. 2531 Location 7: Off city dock, 150' off conveyor
A Z-shaped transect with 30 randomized sampling points
WITH
Date 2: Sept 23, 1991 n 2 = 30 quadrats/sample
Station No. 2570 Location 7: 50-100' off City Dock, 100'below to 100' above dock.
Depth 14-16', soft mud Z transect of 30 samples.

* S Significant ; ns not sig
\+ Increase ; - Decrease
v variances are sig diff
t crit = 2.00 ; alpha = 0.05, two-tailed

	ABUNDANCE (x = count / quadrat)							LOG TRANSFORMED (z = Ln(x+1))					
Genus species	Tot 1 Tot 2	Mean 1 Mean 2	^s 1 ^s 2	t test 2-1		Signif-icance*		t test 2-1		Mean 1 Mean 2	^s 1 ^s 2
Amblema plicata	114 185	3.80 6.17	3.46 6.72	1.71	v	ns	+ ns	1.40		1.307 1.622	0.869 0.866
Megalonaias gigantea	18 12	0.60 0.40	1.00 0.81	-0.85		ns	- ns	-0.65		0.304 0.225	0.503 0.434
Obovaria olivaria	2 -	0.07 -	0.25 -	-1.44		ns	- ns	-1.00		0.023 -	0.127 -
Truncilla truncata	8 10	0.27 0.33	0.45 0.55	0.52		ns	+ ns	0.71		0.162 0.221	0.298 0.351
T. donaciformis	- -	- -	- -	-				-		- -	- -
Quadrula quadrula	9 3	0.30 0.10	0.65 0.31	-1.52	v	ns	- ns	v -1.39		0.179 0.069	0.376 0.211
Q. pustulosa	2 3	0.07 0.10	0.25 0.40	0.38	v	ns	+ ns	0.25		0.046 0.060	0.176 0.233
Q. metanevra	- 2	- 0.07	- 0.25	1.44		ns	+ ns	1.44		- 0.046	- 0.176
Q. nodulata	1 -	0.03 -	0.18 -	-1.00		ns	- ns	-1.00		0.023 -	0.127 -
Fusconaia flava	6 9	0.20 0.30	0.41 0.60	0.76		ns	+ ns	0.60		0.139 0.189	0.282 0.359
Elliptio dilatata	2 2	0.07 0.07	0.25 0.25	-		ns	ns	-		0.046 0.046	0.176 0.176
Leptodea fragilis	2 3	0.07 0.10	0.37 0.40	0.34		ns	+ ns	0.41		0.037 0.060	0.201 0.233
Proptera alata	1 7	0.03 0.23	0.18 0.50	2.04	v	S	+ S	v 2.07		0.023 0.152	0.127 0.317
Lampsilis o. ventricosa	1 2	0.03 0.07	0.18 0.25	0.58		ns	+ ns	0.58		0.023 0.046	0.127 0.176
L. higginsi	- 1	- 0.03	- 0.18	1.00		ns	+ ns	1.00		- 0.023	- 0.127
L. radiata siliquoidea	- -	- -	- -	-				-		- -	- -
Plagiola lineolata	- -	- -	- -	-				-		- -	- -
Obliquaria reflexa	3 14	0.10 0.47	0.31 0.57	3.10	v	S	+ S	v 3.13		0.069 0.314	0.211 0.372
Anodonta grandis	1 1	0.03 0.03	0.18 0.18	-		ns	ns	-		0.023 0.023	0.127 0.127
Anodonta imbecillus	2 3	0.07 0.10	0.25 0.31	0.46		ns	+ ns	0.46		0.046 0.069	0.176 0.211
Pleurobema cordata	- -	- -	- -	-				-		- -	- -
Ligumia recta	2 2	0.07 0.07	0.25 0.25	-		ns	ns	-		0.046 0.046	0.176 0.176
Lasmigona complanata	1 2	0.03 0.07	0.18 0.25	0.58		ns	+ ns	0.58		0.023 0.046	0.127 0.176
Arcidens confragosus	- -	- -	- -	-				-		- -	- -
Actinonaias carinata	- -	- -	- -	-				-		- -	- -
Strophitus undulatus	- -	- -	- -	-				-		- -	- -
ALL ORGANISMS	175 261	5.83 8.70	5.05 7.89	1.68	v	ns	+ ns	1.93		1.572 2.009	0.976 0.762
LESS COMMERCIALS (-A.plicata,M.gigantea)	43 64	1.43 2.13	1.45 1.61	1.77		ns	+ S	2.16		0.674 1.004	0.627 0.554
SPECIES PRESENT / 0.25 m2 QUADRAT	71 91	2.37 3.03	1.71 1.54	1.58		ns	+ S	2.07		1.022 1.313	0.636 0.435

DIVERSITY INDICIES	N	Spe Div	^s	t test	Significance*
All Species (Using natural logs)	175 261	1.45 1.32	1.51 1.57	-1.08	ns -
Less Commercials (-A.plicata,M.gigantea)	43 64	2.39 2.39	0.79 0.78	-0.05	ns -

(The Shannon-Weaver Index can be considered a type of mean.)

Prairie du Chien (Wisconsin) Mussel Survey Mississippi River * S Significant ; ns not sig
Ecosearch,Inc. Statistical Comparison of Quant Samples of 0.25 m2 + Increase ; - Decrease
COMPARING v variances are sig diff
Date 1: Dec 9, 1990 n 1 = 30 quadrats/sample t crit = 2.00 ; alpha = 0.05,
Station No. 2530 Location 4: Between red & green bouys below hwy bridge. two-tailed
A Z-shaped pattern laid out with 70 m of rope, with 30 randomized sampling points
WITH
Date 2: Sept 24, 1991 n 2 = 30 quadrats/sample
Station No. 2571 Location 4: Between channel marker bouys
Depth 14', shell, gravel, cinders just below hwy 18 bridge.

	ABUNDANCE (x = count / quadrat)								LOG TRANSFORMED (z = Ln(x+1))				
Genus species	Tot 1 Tot 2	Mean 1 Mean 2	^s 1 ^s 2	t test 2-1		Signif- icance*				t test 2-1	Mean 1 Mean 2	^s 1 ^s 2	
Amblema plicata	151 227	5.03 7.57	2.88 4.31	2.67		S	+	S		2.74	1.666 2.034	0.553 0.485	
Megalonaias gigantea	24 22	0.80 0.73	1.27 0.98	-0.23		ns	-	ns		-0.03	0.418 0.414	0.549 0.512	
Obovaria olivaria	6 15	0.20 0.50	0.48 0.73	1.87		ns	+	ns		1.87	0.129 0.308	0.301 0.429	
Truncilla truncata	14 29	0.47 0.97	0.63 1.10	2.16	v	S	+	ns		1.94	0.304 0.537	0.391 0.530	
T. donaciformis	1 1	0.03 0.03	0.18 0.18	-		ns		ns		-	0.023 0.023	0.127 0.127	
Quadrula quadrula	6 16	0.20 0.53	0.41 0.78	2.08	v	S	+	ns	v	1.90	0.139 0.322	0.282 0.448	
Q. pustulosa	3 12	0.10 0.40	0.31 0.62	2.37	v	S	+	S	v	2.36	0.069 0.258	0.211 0.383	
Q. metanevra	3 4	0.10 0.13	0.31 0.35	0.40		ns	+	ns		0.40	0.069 0.092	0.211 0.240	
Q. nodulata	1 2	0.03 0.07	0.18 0.25	0.58		ns	+	ns		0.58	0.023 0.046	0.127 0.176	
Fusconaia flava	8 4	0.27 0.13	0.45 0.35	-1.29		ns	-	ns		-1.29	0.185 0.092	0.312 0.240	
Elliptio dilatata	5 4	0.17 0.13	0.46 0.35	-0.32		ns	-	ns		-0.20	0.106 0.092	0.282 0.240	
Leptodea fragilis	8 16	0.27 0.53	0.52 0.68	1.70		ns	+	ns		1.72	0.175 0.341	0.331 0.413	
Proptera alata	3 13	0.10 0.43	0.31 0.57	2.83	v	S	+	S	v	2.85	0.069 0.291	0.211 0.369	
Lampsilis o. ventricosa	12 7	0.40 0.23	0.56 0.50	-1.21		ns	-	ns		-1.31	0.268 0.152	0.365 0.317	
L. higginsi	3 5	0.10 0.17	0.31 0.38	0.75		ns	+	ns		0.75	0.069 0.116	0.211 0.263	
L. radiata siliquoidea	- 1	- 0.03	- 0.18	1.00		ns	+	ns		1.00	- 0.023	- 0.127	
Plagiola lineolata	- 1	- 0.03	- 0.18	1.00		ns	+	ns		1.00	- 0.023	- 0.127	
Obliquaria reflexa	2 3	0.07 0.10	0.25 0.31	0.46		ns	+	ns		0.46	0.046 0.069	0.176 0.211	
Anodonta grandis	1	0.03	0.18	-		ns		ns		-	0.023	0.127	
vs Carunculina parva	1	0.03	0.18								0.023	0.127	
Anodonta imbecillus	1 2	0.03 0.07	0.18 0.25	0.58		ns	+	ns		0.58	0.023 0.046	0.127 0.176	
Pleurobema cordata	1	0.03	0.18	-		ns		ns		-	0.023	0.127	
vs Actinon. ellipsiform	1	0.03	0.18								0.023	0.127	
Ligumia recta	5 7	0.17 0.23	0.38 0.50	0.58		ns	+	ns		0.49	0.116 0.152	0.263 0.317	
Lasmigona complanata	- 1	- 0.03	- 0.18	1.00		ns	+	ns		1.00	- 0.023	- 0.127	
Arcidens confragosus	3 1	0.10 0.03	0.31 0.18	-1.03	v	ns	-	ns	v	-1.03	0.069 0.023	0.211 0.127	
Actinonaias carinata	- 1	- 0.03	- 0.18	1.00		ns	+	ns		1.00	- 0.023	- 0.127	
Strophitus undulatus	1 3	0.03 0.10	0.18 0.40	0.83	v	ns	+	ns	v	0.76	0.023 0.060	0.127 0.233	
ALL ORGANISMS	262 399	8.73 13.30	3.58 4.92	4.11		S	+	S		4.12	2.210 2.600	0.375 0.357	
LESS COMMERCIALS (-A.plicata,M.gigantea)	87 150	2.90 5.00	1.95 2.53	3.60		S	+	S		3.71	1.221 1.705	0.572 0.427	
SPECIES PRESENT / 0.25 m2 QUADRAT	124 163	4.13 5.43	1.68 1.98	2.75		S	+	S		2.78	1.585 1.815	0.325 0.315	

DIVERSITY INDICIES	N	Spe Div	^s	t test	Significance*	
All Species (Using natural logs)	262 399	1.79 1.85	1.56 1.59	0.59	ns	+
Less Commercials (-A.plicata,M.gigantea)	87 150	2.68 2.67	0.73 0.89	-0.09	ns	-

(The Shannon-Weaver Index can be considered a type of mean.)

in which A = age in years, X is a constant, and L = length in mm. The value of X which I originally used was 20. This predicts a length of 20 mm at 1 year of age, 40 mm at 4 years, 60 mm at 9 years, 80 mm at 16 years, and 100 mm at 25 years, which is approximately what one finds. Variations in this basic equation apply to individual population samples, however, and these have been calculated, with confidence limits, and appear on the charts.

4. DISCUSSION

The data on which the following discussions are based are presented on previous pages in Tables 1 through 5, in Table 6A - 6D on following pages, and in Addendum #1 to June, 1990 Environmental Impact Report of the City of Prairie du Chien and Didion, Inc. Relative to Continued Operation of Didion Grain Loading Converor at the City's Municipal Harbor, dated December, 1990. The subheadings for the discussions follow the "Research Criteria" specified in the 1991 Monitoring Plan, as amended (see Appendix).

Mississippi River
Ecosearch, Inc.

Prairie du Chien Mussel Survey
Age-Length of Amblema plicata

Wisconsin
Sept. 23-25, 1991

Location	7		4		3		2		Main Chan		Main Chan		Main Chan			
Station	2570		2571		2572		2573		2576		2578		2578			
	N = 30		N = 30		N = 30		N = 35		N = 31		N = 24		Multiple Measurements on 8 of 24			
Index	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length
1	4	29.0	4	29.3	4	43.0	3	29.0	16	64.0	10	60.7	1	19.0	18	71.3
2	4	30.5	4	37.0	6	42.6	7	52.0	16	68.0	12	71.4	2	23.5	18	76.5
3	4	38.0	4	44.0	6	45.0	7	57.0	16	71.5	13	68.5	3	30.0	18	78.1
4	4	40.0	5	47.5	7	54.5	8	69.0	17	63.2	14	81.5	4	34.9	18	79.3
5	5	33.0	6	48.2	7	58.4	10	65.0	17	76.9	15	70.8	5	38.7	18	80.0
6	5	36.8	6	49.0	8	52.8	10	80.0	17	85.7	17	83.9	6	44.0	18	81.0
7	5	43.0	7	63.0	10	70.5	11	69.2	18	81.0	18	76.5	7	49.5	18	85.0
8	6	41.0	8	64.5	15	70.5	11	73.0	18	82.0	18	81.0	7	52.8	18	86.2
9	6	44.4	9	62.8	15	73.5	12	63.9	19	71.0	18	85.0	8	53.8	19	72.2
10	6	52.5	9	64.0	16	71.0	15	69.0	19	79.0	19	79.0	8	57.0	19	79.0
11	6	57.0	9	68.0	16	73.5	15	70.5	20	84.5	19	83.0	9	57.5	19	80.0
12	6	57.5	14	83.0	17	72.5	18	60.5	21	66.8	20	82.2	9	61.4	19	81.0
13	6	59.5	15	66.0	17	79.0	18	71.6	21	77.8	21	79.0	10	59.8	19	81.6
14	7	53.0	15	70.5	18	79.0	19	73.0	21	86.5	22	75.0	10	60.7	19	83.0
15	8	53.8	16	76.5	18	85.9	19	81.4	22	75.5	23	86.0	10	64.0	19	87.0
16	8	55.6	16	82.5	19	76.0	19	85.0	22	82.5	23	92.0	10	67.4	20	73.5
17	8	67.0	16	83.0	19	89.0	19	90.0	22	83.9	23	97.0	11	62.0	20	74.7
18	8	71.8	16	88.0	20	67.5	20	76.0	23	73.2	24	76.0	11	68.5	20	82.0
19	9	65.0	18	89.0	20	73.3	20	77.1	23	77.3	24	79.6	11	70.4	20	82.0
20	9	66.0	18	93.8	20	74.0	20	85.0	23	81.5	24	87.8	12	63.0	20	82.2
21	10	70.0	19	63.6	20	88.0	20	87.5	24	69.3	25	86.7	12	71.4	20	88.0
22	11	62.5	19	75.7	21	66.5	21	67.0	25	72.6	26	78.8	12	72.4	21	74.6
23	12	77.9	19	87.0	21	75.0	21	73.0	25	87.9	26	80.6	13	64.8	21	75.4
24	16	71.0	19	92.0	21	75.8	21	77.0	25	95.0	28	82.2	13	68.5	21	79.0
25	18	78.0	19	94.5	21	87.0	21	94.5	26	82.3			13	73.8	21	83.7
26	19	80.9	20	65.5	22	78.8	22	82.0	27	80.6			13	78.1	21	83.7
27	20	75.0	20	73.0	23	75.7	22	83.0	27	86.4			14	66.6	21	90.3
28	20	86.0	20	84.0	23	78.0	22	88.0	27	102.3			14	75.3	22	75.0
29	21	89.4	21	77.0	27	107.0	22	91.0	28	83.4			14	76.0	22	75.7
30	22	76.0	24	86.8	30	103.0	22	94.5	28	103.0			14	81.2	22	76.0
31							24	92.6	30	90.0			14	81.5	22	84.4
32							24	94.0					15	67.9	22	84.4
33							25	78.5					15	70.8	22	91.0
34							25	80.0					15	76.2	23	76.5
35							25	100.0					15	80.0	23	77.0
36													15	82.2	23	86.0
37													16	69.2	23	86.5
38													16	77.3	23	92.0
39													16	83.0	23	97.0
40													16	83.6	24	76.0
41													17	70.2	24	78.0
42													17	78.6	24	78.1
43													17	78.7	24	79.6
44													17	83.9	24	87.8
45													17	84.3	25	79.0
46															25	79.0
47															25	86.7
48															26	78.8
49															26	79.8
50															26	80.6
51															27	81.0
52															28	82.2

Prairie du Chien (Wisconsin) Mussel Survey Mississippi River
Ecosearch, Inc. Statistical Comparison of Quantitative Samples of 0.25 m2

COMPARING
Date 1: Dec 10, 1990 n 1 = 30 quadrats/sample
Station No. 2533 Location 2

* S Significant ; ns not sig
\+ Increase ; - Decrease
v variances are sig diff
t crit = 2.00 ; alpha = 0.05, two-tailed

WITH
Date 2: Sept 25, 1991 n 2 = 30 quadrats/sample
Station No. 2573 Location 2: Just above bouy #2, just inside it (inside the channel).
Depth 16', muddy sand

	ABUNDANCE (x = count / quadrat)								LOG TRANSFORMED (z = Ln(x+1))		
Genus species	Tot 1 Tot 2	Mean 1 Mean 2	^s 1 ^s 2	t test 2-1		Significance*			t test 2-1	Mean 1 Mean 2	^s 1 ^s 2
Amblema plicata	46 172	1.53 5.73	1.76 2.94	6.73	v	S	+	S	7.74	0.735 1.814	0.618 0.449
Megalonaias gigantea	10 55	0.33 1.83	0.66 1.37	5.41	v	S	+	S	5.78	0.202 0.910	0.386 0.550
Obovaria olivaria	1 5	0.03 0.17	0.18 0.46	1.47	v	ns	+	ns	v 1.47	0.023 0.106	0.127 0.282
Truncilla truncata	2 26	0.07 0.87	0.25 0.90	4.69	v	S	+	S	v 5.12	0.046 0.516	0.176 0.471
T. donaciformis	- 3	- 0.10	- 0.40	1.36		ns	+	ns	1.40	- 0.060	- 0.233
Quadrula quadrula	- 19	- 0.63	- 0.76	4.54		S	+	S	4.80	- 0.391	- 0.446
Q. pustulosa	- 16	- 0.53	- 0.82	3.57		S	+	S	3.87	- 0.318	- 0.450
Q. metanevra	- 1	- 0.03	- 0.18	1.00		ns	+	ns	1.00	- 0.023	- 0.127
Q. nodulata	- -	- -	- -	-					-	- -	- -
Fusconaia flava	5 17	0.17 0.57	0.38 0.77	2.54	v	S	+	S	v 2.54	0.116 0.350	0.263 0.434
Elliptio dilatata	- 1	- 0.03	- 0.18	1.00		ns	+	ns	1.00	- 0.023	- 0.127
Leptodea fragilis	1 18	0.03 0.60	0.18 0.93	3.27	v	S	+	S	v 3.32	0.023 0.335	0.127 0.499
Proptera alata	4 14	0.13 0.47	0.35 0.63	2.54	v	S	+	S	v 2.53	0.092 0.304	0.240 0.391
Lampsilis o. ventricosa	1 8	0.03 0.27	0.18 0.52	2.32	v	S	+	S	v 2.35	0.023 0.175	0.127 0.331
L. higginsi	- 2	- 0.07	- 0.37	1.00		ns	+	ns	1.00	- 0.037	- 0.201
L. radiata siliquoidea	- 1	- 0.03	- 0.18	1.00		ns	+	ns	1.00	- 0.023	- 0.127
Plagiola lineolata	- -	- -	- -	-					-	- -	- -
Obliquaria reflexa	- 9	- 0.30	- 0.47	3.53		S	+	S	3.53	- 0.208	- 0.323
Anodonta grandis	- 1	- 0.03	- 0.18	1.00		ns	+	ns	1.00	- 0.023	- 0.127
Anodonta imbecillus	- 2	- 0.07	- 0.37	1.00		ns	+	ns	1.00	- 0.037	- 0.201
Proptera laevissima	- 1	- 0.03	- 0.18	1.00		ns	+	ns	1.00	- 0.023	- 0.127
Ligumia recta	1 9	0.03 0.30	0.18 0.47	2.92	v	S	+	S	v 2.92	0.023 0.208	0.127 0.323
Lasmigona complanata	- 3	- 0.10	- 0.55	1.00		ns	+	ns	1.00	- 0.046	- 0.253
Arcidens confragosus	- 5	- 0.17	- 0.38	2.41		S	+	S	2.41	- 0.116	- 0.263
Actinonaias carinata	- 2	- 0.07	- 0.25	1.44		ns	+	ns	1.44	- 0.046	- 0.176
Strophitus undulatus	- -	- -	- -	-					-	- -	- -
ALL ORGANISMS	71 390	2.37 13.00	1.96 3.12	15.82	v	S	+	S	v 12.43	1.027 2.612	0.654 0.245
LESS COMMERCIALS (-A.plicata,M.gigantea)	15 163	0.50 5.43	0.73 2.50	10.37	v	S	+	S	13.86	0.308 1.788	0.429 0.397
SPECIES PRESENT / 0.25 m2 QUADRAT	43 178	1.43 5.93	1.10 1.76	11.86	v	S	+	S	v 11.32	0.782 1.907	0.487 0.243

DIVERSITY INDICIES	N	Spe Div	^s	t test	Significance*	
All Species (Using natural logs)	71 390	1.25 2.09	1.21 1.33	5.71	S	+
Less Commercials (-A.plicata,M.gigantea)	15 163	1.71 2.61	0.69 0.78	3.79	S	+

(The Shannon-Weaver Index can be considered a type of mean.)

Prairie du Chien (Wisconsin) Mussel Survey Mississippi River
Ecosearch, Inc. Statistical Comparison of Quantitative Samples of 0.25 m2

COMPARING
Date 1: Dec 10, 1990 n 1 = 30 quadrats/sample
Station No. 2532 Location 3

* S Significant ; ns not sig
\+ Increase ; - Decrease
v variances are sig diff
t crit = 2.00 ; alpha = 0.05, two-tailed

WITH
Date 2: Sept 24, 1991 n 2 = 30 quadrats/sample
Station No. 2572 Location 3: In channel near 3rd bouy below turning basin, off city dock. Z-transect
Depth 16', shell,gravel,sand

	ABUNDANCE (x = count / quadrat)								LOG TRANSFORMED (z = Ln(x+1))			
Genus species	Tot 1 Tot 2	Mean 1 Mean 2	^s 1 ^s 2	t test 2-1		Signif-icance*			t test 2-1		Mean 1 Mean 2	^s 1 ^s 2
Amblema plicata	76 130	2.53 4.33	1.91 3.15	2.67	v	S	+	S	2.60		1.111 1.510	0.579 0.609
Megalonaias gigantea	40 41	1.33 1.37	1.35 1.16	0.10		ns	+	ns	0.29		0.697 0.737	0.557 0.522
Obovaria olivaria	11 5	0.37 0.17	0.61 0.38	-1.52	v	ns	-	ns	-1.42		0.235 0.116	0.377 0.263
Truncilla truncata	37 26	1.23 0.87	1.38 0.90	-1.22		ns	-	ns	-0.81		0.634 0.524	0.588 0.452
T. donaciformis	1 3	0.03 0.10	0.18 0.31	1.03	v	ns	+	ns	v	1.03	0.023 0.069	0.127 0.211
Quadrula quadrula	11 8	0.37 0.27	0.56 0.52	-0.72		ns	-	ns	-0.78		0.245 0.175	0.359 0.331
Q. pustulosa	8 26	0.27 0.87	0.52 1.04	2.82	v	S	+	S	2.94		0.175 0.497	0.331 0.499
Q. metanevra	8 1	0.27 0.03	0.58 0.18	-2.09	v	S	-	S	v	-2.11	0.166 0.023	0.348 0.127
Q. nodulata	1 3	0.03 0.10	0.18 0.31	1.03	v	ns	+	ns	v	1.03	0.023 0.069	0.127 0.211
Fusconaia flava	10 4	0.33 0.13	0.61 0.35	-1.57	v	ns	-	ns	-1.49		0.212 0.092	0.369 0.240
Elliptio dilatata	3 2	0.10 0.07	0.31 0.25	-0.46		ns	-	ns	-0.46		0.069 0.046	0.211 0.176
Leptodea fragilis	4 23	0.13 0.77	0.35 0.90	3.61	v	S	+	S	v	3.76	0.092 0.456	0.240 0.473
Proptera alata	4 10	0.13 0.33	0.35 0.55	1.69	v	ns	+	ns	1.66		0.092 0.221	0.240 0.351
Lampsilis o. ventricosa	7 5	0.23 0.17	0.50 0.38	-0.58		ns	-	ns	-0.49		0.152 0.116	0.317 0.263
L. higginsi	4 3	0.13 0.10	0.35 0.31	-0.40		ns	-	ns	-0.40		0.092 0.069	0.240 0.211
L. radiata siliquoidea	2 1	0.07 0.03	0.25 0.18	-0.58		ns	-	ns	-0.58		0.046 0.023	0.176 0.127
Plagiola lineolata	1 3	0.03 0.10	0.18 0.31	1.03	v	ns	+	ns	v	1.03	0.023 0.069	0.127 0.211
Obliquaria reflexa	3 4	0.10 0.13	0.31 0.35	0.40		ns	+	ns	0.40		0.069 0.092	0.211 0.240
Anodonta grandis	2 1	0.07 0.03	0.25 0.18	-0.58		ns	-	ns	-0.58		0.046 0.023	0.176 0.127
Anodonta imbecillus	2 5	0.07 0.17	0.25 0.46	1.04	v	ns	+	ns	v	0.98	0.046 0.106	0.176 0.282
Pleurobema cordata	- -	- -	- -	-					-		- -	- -
Ligumia recta	11 4	0.37 0.13	0.61 0.35	-1.81	v	ns	-	ns	v	-1.75	0.235 0.092	0.377 0.240
Lasmigona complanata	2 1	0.07 0.03	0.25 0.18	-0.58		ns	-	ns	-0.58		0.046 0.023	0.176 0.127
Arcidens confragosus	3 4	0.10 0.13	0.31 0.43	0.34		ns	+	ns	0.22		0.069 0.083	0.211 0.260
Actinonaias carinata	- -	- -	- -	-					-		- -	- -
Strophitus undulatus	3 6	0.10 0.20	0.31 0.66	0.75	v	ns	+	ns	v	0.51	0.069 0.106	0.211 0.336
ALL ORGANISMS	254 319	8.47 10.63	3.88 5.39	1.79		ns	+	ns	1.41		2.168 2.338	0.409 0.516
LESS COMMERCIALS (-A.plicata,M.gigantea)	138 148	4.60 4.93	2.21 3.49	0.44	v	ns	+	ns	-0.21		1.639 1.611	0.432 0.610
SPECIES PRESENT / 0.25 m2 QUADRAT	156 168	5.20 5.60	1.75 2.39	0.74		ns	+	ns	0.37		1.786 1.818	0.283 0.391

DIVERSITY INDICIES	N	Spe Div	^s	t test	Significance*	
All Species (Using natural logs)	254 319	2.41 2.20	1.17 1.32	-2.23	S	-
Less Commercials (-A.plicata,M.gigantea)	138 148	2.62 2.61	0.97 0.94	-0.08	ns	-

(The Shannon-Weaver Index can be considered a type of mean.)

Prairie du Chien (Wisconsin) Mussel Survey — Mississippi River
Ecosearch, Inc. — Quantitative Samples of 0.25 m2 — Sept 25, 1991

Station No. 2573 Location 2: Just above buoy #2, just inside it
Depth 16', muddy sand (inside the channel).

Genus species	Abundance Total	Juv	Mean	s^	95% CI LL	UL	Replicate Samples: n = 30, df = 29 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		J %	Mean*	s^*	LL*	UL*	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Amblema plicata	172	9	5.7	2.9	4.6	6.8	7	7	7	3	8	5	4	2	7	5	6	3	4	10	6
		5 %	5.1	0.6	4.2	6.3	4	2	4	5	6	3	10	14	9	5	6	3	5	11	1
Megalonaias gigantea	55	1	1.8	1.4	1.3	2.3	.	1	2	2	2	1	.	3	.	2	2	1	4	2	1
		2 %	1.5	0.7	1.0	2.1	2	1	1	.	.	2	3	.	2	4	5	3	2	4	3
Obovaria olivaria	5		0.2	0.5	-0.0	0.3	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
			0.1	0.3	0.0	0.2	.	2	.	.	.	1	.	.	.	.	.	.	.	.	.
Truncilla truncata	26	6	0.9	0.9	0.5	1.2	.	1	2	1	2	1	1	.	1	.	1	2	3	.	1
		23 %	0.7	0.6	0.4	1.0	1	1	.	3	1	2	.	.	.	.	.	1	1	.	.
T. donaciformis	3	2	0.1	0.4	-0.1	0.3	.	2	.	.	.	.	.	.	.	1	.	.	.	.	.
		67 %	0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Quadrula quadrula	19		0.6	0.8	0.3	0.9	.	.	.	1	.	1	.	2	1	1	.	.	2	1	
			0.5	0.6	0.3	0.7	.	.	2	.	2	1	1	.	.	.	2	1	1	.	.
Q. pustulosa	16		0.5	0.8	0.2	0.8	.	1	1	3	1	.	.	.	2	.	2	2	.	1	.
			0.4	0.6	0.2	0.6	1	.	.	.	.	.	1	1	.	.	.	.	.	.	.
Q. metanevra	1		0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
			0.0	0.1	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fusconaia flava	17		0.6	0.8	0.3	0.9	1	1	1	.	.	.	3	.	.	1	1	2	1	.	.
			0.4	0.5	0.2	0.7	.	1	.	.	1	1	1	.	.	.	.	.	2	.	.
Elliptio dilatata	1		0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			0.0	0.1	-0.0	0.1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Leptodea fragilis	18	1	0.6	0.9	0.3	0.9	.	.	.	.	.	.	3	2	1	2	.	.	.	1	.
		6 %	0.4	0.6	0.2	0.7	2	.	2	.	.	2	2	.	.	.	.	.	1	.	.
Proptera alata	14		0.5	0.6	0.2	0.7	.	1	.	1	.	.	1	.	.	.	.	2	1	.	1
			0.4	0.5	0.2	0.6	1	.	.	1	2	.	.	.	.	.	1	1	1	.	.
Lampsilis o. ventricosa	8		0.3	0.5	0.1	0.5	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
			0.2	0.4	0.1	0.3	.	.	1	1	.	.	.	1	.	.	2	1	.	.	1
L. higginsi	2		0.1	0.4	-0.1	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
L. radiata siliquoidea	1		0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			0.0	0.1	-0.0	0.1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Obliquaria reflexa	9	1	0.3	0.5	0.1	0.5	1	.	1	.	.	.	1	.	.	.	.	.	.	.	.
		11 %	0.2	0.4	0.1	0.4	1	.	.	1	.	1	.	.	.	1	.	.	1	1	.
Anodonta grandis	1		0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			0.0	0.1	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Anodonta imbecillus	2		0.1	0.4	-0.1	0.2	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Proptera laevissima	1		0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
			0.0	0.1	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ligumia recta	9		0.3	0.5	0.1	0.5	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.
			0.2	0.4	0.1	0.4	1	1	.	.	.	1	.	1	.	.	.	1	.	1	.
Lasmigona complanata	3		0.1	0.5	-0.1	0.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			0.0	0.3	-0.0	0.2	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.
Arcidens confragosus	5		0.2	0.4	0.0	0.3	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.
			0.1	0.3	0.0	0.2	.	.	.	1	.	1	.	.	.	.	.	.	1	.	.
Actinonaias carinata	2		0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.
ALL ORGANISMS	390	20	13.0	3.1	11.8	14.2	10	14	15	11	13	8	15	8	17	13	13	13	13	16	13
		5 %	12.6	0.3	11.4	13.9	13	8	10	12	12	16	18	18	15	11	16	11	15	17	6
LESS COMMERCIALS	163	10	5.4	2.5	4.5	6.4	3	6	6	6	3	2	11	3	10	6	5	9	5	4	6
(-A.plicata,M.gigantea)		6 %	5.0	0.5	4.2	5.9	7	5	5	7	6	11	5	4	4	2	5	5	8	2	2
SPECIES PRESENT /	178		5.9	1.8	5.3	6.6	4	7	7	6	4	4	8	4	8	7	6	7	5	5	7
0.25 m2 QUADRAT			5.7	0.3	5.1	6.4	8	6	5	6	5	11	6	5	4	4	5	7	9	4	4

TOTALS: 23 Species — 390 Organisms — 20 Juv — 5.1 % Juv %

DIVERSITY:	Species Div	Max Div	Evenness
All Species	2.092	3.135	0.6672
(Excluding Commercials)	(2.608)	(3.045)	(0.8566)

[Shannon-Weaver using natural logs]

Station No. 2573 Location 2: Just above buoy #2, just inside it
Depth 16', muddy sand (inside the channel).

Prairie du Chien (Wisconsin) Mussel Survey — Mississippi River
Ecosearch, Inc. — Quantitative Samples of 0.25 m2 — Sept 24, 1991

Station No. 2572 Location 3: In channel near 3rd buoy below turning basin, off city dock. Z-transect
Depth 16', shell,gravel,sand

Genus species	Abundance Total	Juv	Mean	s^	95% CI LL	UL	Replicate Samples: n = 30, df = 29 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		J %	Mean*	s^*	LL*	UL*	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Amblema plicata	130	10	4.3	3.2	3.2	5.5	.	6	12	2	2	4	4	5	3	3	3	6	2	4	10
		8 %	3.5	0.8	2.6	4.7	14	5	4	7	3	5	4	2	2	6	3	5	1	3	.
Megalonaias gigantea	41		1.4	1.2	0.9	1.8	1	2	2	2	2	2	2	3	1	.	2	2	1	1	1
			1.1	0.7	0.7	1.5	1	1	3	4	.	.	.	.	.	.	.	2	4	1	1
Obovaria olivaria	5		0.2	0.4	0.0	0.3	.	.	1	.	.	.	.	.	.	1	.	1	.	1	.
			0.1	0.3	0.0	0.2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Truncilla truncata	26	2	0.9	0.9	0.5	1.2	1	1	2	1	2	1	.	.	.	.	.	4	1	1	.
		8 %	0.7	0.6	0.4	1.0	1	1	.	1	.	2	1	.	.	1	.	1	1	2	1
T. donaciformis	3	2	0.1	0.3	-0.0	0.2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
		67 %	0.1	0.2	-0.0	0.2	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.
Quadrula quadrula	8	1	0.3	0.5	0.1	0.5	.	.	.	1	.	.	.	1	.	.	.	.	2	1	.
		13 %	0.2	0.4	0.1	0.3	1	.	.	1	.	.	.	.	.	.	.	.	.	1	.
Q. pustulosa	26	2	0.9	1.0	0.5	1.3	.	.	1	4	3	.	2	3	1	1	.	1	1	1	.
		8 %	0.6	0.6	0.4	1.0	1	1	.	.	.	1	.	.	.	1	.	.	1	2	1
Q. metanevra	1		0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
			0.0	0.1	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Q. nodulata	3		0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			0.1	0.2	-0.0	0.2	.	.	1	.	.	.	.	.	.	.	1	.	.	1	.
Fusconaia flava	4		0.1	0.3	0.0	0.3	.	1	1	.	.	.	.	.	.	.	.	.	.	1	.
			0.1	0.3	0.0	0.2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Elliptio dilatata	2		0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leptodea fragilis	23		0.8	0.9	0.4	1.1	1	1	1	2	2	.	1	1	.	1	.	2	1	3	.
			0.6	0.6	0.3	0.9	.	.	.	1	.	1	.	1	.	.	.	.	1	3	.
Proptera alata	10		0.3	0.5	0.1	0.5	.	.	.	.	1	.	.	.	.	.	1	1	1	.	.
			0.2	0.4	0.1	0.4	.	.	.	1	1	.	1	.	.	.	1	.	.	2	.
Lampsilis o. ventricosa	5		0.2	0.4	0.0	0.3	.	.	.	.	1	.	1	1	.	.	.	1	.	.	.
			0.1	0.3	0.0	0.2	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
L. higginsi	3		0.1	0.3	-0.0	0.2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
			0.1	0.2	-0.0	0.2	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.
L. radiata siliquoidea	1		0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			0.0	0.1	-0.0	0.1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Plagiola lineolata	3		0.1	0.3	-0.0	0.2	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.
			0.1	0.2	-0.0	0.2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Obliquaria reflexa	4		0.1	0.3	0.0	0.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
			0.1	0.3	0.0	0.2	.	.	.	1	.	.	1	.	.	.	.	.	1	.	.
Anodonta grandis	1		0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
			0.0	0.1	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anodonta imbecillus	5	2	0.2	0.5	-0.0	0.3	.	.	1	1	.	1	.	.	.	.	.	.	.	2	.
		40 %	0.1	0.3	0.0	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ligumia recta	4		0.1	0.3	0.0	0.3	.	1	.	.	.	.	.	.	1	.	.	1	.	.	.
			0.1	0.3	0.0	0.2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Lasmigona complanata	1		0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			0.0	0.1	-0.0	0.1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arcidens confragosus	4		0.1	0.4	-0.0	0.3	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.
			0.1	0.3	-0.0	0.2	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.
Strophitus undulatus	6		0.2	0.7	-0.0	0.4	.	.	3	2	.	.	.	.	1	.	.	.	.	.	.
			0.1	0.4	-0.0	0.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ALL ORGANISMS	319	19	10.6	5.4	8.6	12.6	3	12	25	16	13	11	10	14	7	7	6	19	12	15	13
		6 %	9.4	0.7	7.5	11.6	19	10	9	17	5	10	8	4	2	8	7	9	9	16	3
LESS COMMERCIALS	148	9	4.9	3.5	3.6	6.2	2	4	11	12	9	5	4	6	3	4	1	11	9	10	2
(-A.plicata,M.gigantea)		6 %	4.0	0.8	3.0	5.3	4	4	2	6	2	5	4	2	.	2	4	2	4	12	2
SPECIES PRESENT /	168		5.6	2.4	4.7	6.5	3	6	10	9	7	6	5	6	5	5	3	9	10	9	4
0.25 m2 QUADRAT			5.2	0.5	4.3	6.1	6	6	4	8	3	5	5	3	1	3	5	4	6	9	3

TOTALS: 24 Species — 319 Organisms — 19 Juv — 6.0 % Juv %

DIVERSITY:	Species Div	Max Div	Evenness
All Species	2.198	3.178	0.6917
(Excluding Commercials)	(2.613)	(3.091)	(0.8454)

[Shannon-Weaver using natural logs]

Station No. 2572 Location 3: In channel near 3rd buoy below turning basin, off city dock. Z-transect
Depth 16', shell,gravel,sand

Prairie du Chien (Wisconsin) Mussel Survey — Mississippi River
Ecosearch, Inc. — Quantitative Samples of 0.25 m2 — Sept 24, 1991

Station No. 2571 — Location 4: Between channel marker buoys just below hwy 18 bridge.
Depth 14', shell, gravel, cinders

Genus species	Abundance Total	Juv	Juv %	Mean*	s^*	95% CI LL*	95% CI UL*	Replicate Samples: n = 30, df = 29 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
								16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Amblema plicata	227	17	7 %	7.6	4.3	6.0	9.2	18	3	4	9	17	6	18	12	4	6	5	6	10	2	4
				6.6	0.6	5.4	8.2	11	8	8	5	7	6	2	3	7	6	7	11	10	7	5
Megalonaias gigantea	22			0.7	1.0	0.4	1.1	.	1	2	.	.	.	.	1	.	2	2	.	1	1	.
				0.5	0.7	0.2	0.8	.	3	.	2	.	.	.	.	.	.	1	2	1	3	.
Obovaria olivaria	15			0.5	0.7	0.2	0.8	.	2	1	.	.	.	.	.	.	1	1	1	.	1	.
				0.4	0.5	0.2	0.6	.	2	.	.	1	.	2	.	2	.	1	.	.	.	.
Truncilla truncata	29	4	14 %	1.0	1.1	0.6	1.4	.	1	.	.	1	.	.	1	.	1	2	2	2	3	.
				0.7	0.7	0.4	1.1	3	1	.	1	.	1	1	.	2	.	4	2	.	.	1
T. donaciformis	1			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
				0.0	0.1	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Quadrula quadrula	16			0.5	0.8	0.2	0.8	.	.	1	.	.	.	2	.	2	2	.	1	2	.	.
				0.4	0.6	0.2	0.6	.	1	.	.	.	.	.	.	.	.	1	1	1	.	2
Q. pustulosa	12	1	8 %	0.4	0.6	0.2	0.6	.	.	.	.	.	.	1	.	.	.	1	.	1	.	.
				0.3	0.5	0.1	0.5	1	1	2	.	1	.	.	.	.	1	.	2	.	.	1
Q. metanevra	4			0.1	0.3	0.0	0.3	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
				0.1	0.3	0.0	0.2	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.
Q. nodulata	2			0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
				0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Fusconaia flava	4			0.1	0.3	0.0	0.3	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.
				0.1	0.3	0.0	0.2	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.
Elliptio dilatata	4			0.1	0.3	0.0	0.3	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
				0.1	0.3	0.0	0.2	.	.	.	.	.	1	1	.	.	.	1	.	.	.	.
Leptodea fragilis	16			0.5	0.7	0.3	0.8	.	.	1	.	.	1	.	.	.	.	2	1	1	.	2
				0.4	0.5	0.2	0.6	1	2	.	.	.	.	1	1	.	1	1	.	1	.	.
Proptera alata	13			0.4	0.6	0.2	0.6	.	.	.	1	.	1	.	.	1	.	1	2	.	.	.
				0.3	0.4	0.2	0.5	1	.	1	.	.	.	1	1	1	.	.	.	1	1	.
Lampsilis o. ventricosa	7			0.2	0.5	0.0	0.4	1	.	.	.	1	.	.	2	.	.	.	1	.	.	.
				0.2	0.4	0.0	0.3	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.
L. higginsi	5			0.2	0.4	0.0	0.3	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.
				0.1	0.3	0.0	0.2	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.
L. radiata siliquoidea	1			0.0	0.2	-0.0	0.1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
				0.0	0.1	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plagiola lineolata	1			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
				0.0	0.1	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Obliquaria reflexa	3			0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.
				0.1	0.2	-0.0	0.2	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Carunculina parva	1			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
				0.0	0.1	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anodonta imbecillus	2			0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
				0.0	0.2	-0.0	0.1	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.
Ligumia recta	7			0.2	0.5	0.0	0.4	1	2	.	.	.	.	.	1	.	.	.	.	.	.	.
				0.2	0.4	0.0	0.3	.	.	1	.	.	.	1	.	.	1	.	.	.	.	.
Lasmigona complanata	1			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
				0.0	0.1	-0.0	0.1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arcidens confragosus	1			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
				0.0	0.1	-0.0	0.1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Actinonaias carinata	1			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
				0.0	0.1	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
A. ellipsiformis	1			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
				0.0	0.1	-0.0	0.1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Strophitus undulatus	3			0.1	0.4	-0.1	0.3	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
				0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
ALL ORGANISMS	399	22	6 %	13.3	4.9	11.5	15.1	20	9	10	12	21	8	23	18	9	12	16	15	19	7	6
				12.5	0.4	10.8	14.4	19	18	14	9	10	8	10	6	15	12	19	19	14	12	9
LESS COMMERCIALS (-A.plicata,M.gigantea)	150	5	3 %	5.0	2.5	4.1	5.9	2	5	4	3	4	2	5	5	5	4	9	9	8	4	2
				4.5	0.5	3.7	5.5	8	7	6	2	3	2	8	3	8	6	11	6	3	2	4
SPECIES PRESENT / 0.25 m2 QUADRAT	163			5.4	2.0	4.7	6.2	3	5	6	3	5	3	5	6	5	5	9	8	8	4	2
				5.1	0.4	4.5	5.9	7	7	6	4	4	3	8	4	7	7	10	6	5	4	4

TOTALS: 26 Species — 399 Organisms — 22 Juv — 5.5 % Juv %

DIVERSITY: [Shannon-Weaver using natural logs]

	Species Div	Max Div	Evenness
All Species	1.851	3.258	0.5682
(Excluding Commercials)	(2.668)	(3.178)	(0.8394)

Station No. 2571 — Location 4: Between channel marker buoys just below hwy 18 bridge.
Depth 14', shell, gravel, cinders

Prairie du Chien (Wisconsin) Mussel Survey — Mississippi River
Ecosearch, Inc. — Quantitative Samples of 0.25 m2 — Sept 23, 1991

Station No. 2570 Location 7: 50-100' off City Dock, 100'below to 100' above dock.
Depth 14-16', soft mud — Z transect of 30 samples.

Genus species	Abundance Total	Juv	Mean	s^	95% CI LL	UL	Replicate Samples: n = 30, df = 29 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		J %	Mean*	s^*	LL*	UL*	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Amblema plicata	185	12	6.2	6.7	3.7	8.7	33	17	15	2	11	.	.	4	2	3	10	5	6	2	1
		6 %	4.1	1.4	2.7	6.0	.	2	1	4	3	11	5	3	3	2	7	9	10	8	6
Megalonaias gigantea	12	1	0.4	0.8	0.1	0.7	2	.	.	1	3	.	.	.	2	.	2	1	.	1	.
		8 %	0.3	0.5	0.1	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Truncilla truncata	10	3	0.3	0.5	0.1	0.5	2	.	1	.	.	1	.	1	1	1	.	.	.	1	.
		30 %	0.2	0.4	0.1	0.4	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Quadrula quadrula	3		0.1	0.3	-0.0	0.2	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.
			0.1	0.2	-0.0	0.2	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Q. pustulosa	3		0.1	0.4	-0.1	0.3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Q. metanevra	2		0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.
Fusconaia flava	9		0.3	0.6	0.1	0.5	1	.	1	.	.	.	.	.	.	1	.	2	.	.	.
			0.2	0.4	0.1	0.4	.	.	.	.	2	.	.	.	1	.	.	.	.	.	1
Elliptio dilatata	2		0.1	0.3	-0.0	0.2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Leptodea fragilis	3		0.1	0.4	-0.1	0.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.
Proptera alata	7	1	0.2	0.5	0.0	0.4	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.
		14 %	0.2	0.4	0.0	0.3	.	.	.	.	.	1	.	1	.	.	.	2	.	.	.
Lampsilis o. ventricosa	2		0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
			0.0	0.2	-0.0	0.1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
L. higginsi	1		0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
			0.0	0.1	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Obliquaria reflexa	14	2	0.5	0.6	0.3	0.7	1	1	.	.	.	1	.	.	2	1	.	.	.	1	1
		14 %	0.4	0.5	0.2	0.6	.	1	.	1	.	.	1	.	1	.	.	1	1	.	.
Anodonta grandis	1		0.0	0.2	-0.0	0.1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
			0.0	0.1	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anodonta imbecillus	3		0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
			0.1	0.2	-0.0	0.2	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
Ligumia recta	2		0.1	0.3	-0.0	0.2	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
			0.0	0.2	-0.0	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Lasmigona complanata	2		0.1	0.3	-0.0	0.2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
			0.0	0.2	-0.0	0.1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
ALL ORGANISMS	261	19	8.7	7.9	5.8	11.6	41	19	19	5	15	3	.	5	8	7	12	11	6	5	2
		7 %	6.5	1.1	4.6	8.9	1	3	2	6	5	13	6	6	6	2	8	14	13	9	9
LESS COMMERCIALS	64	6	2.1	1.6	1.5	2.7	6	2	4	2	1	3	.	1	4	4	.	5	.	2	1
(-A.plicata,M.gigantea)		9 %	1.7	0.7	1.2	2.4	1	1	1	2	2	2	1	3	3	.	1	5	3	1	3
SPECIES PRESENT /	91		3.0	1.5	2.5	3.6	6	3	5	4	3	3	.	2	5	5	2	6	1	4	2
0.25 m2 QUADRAT			2.7	0.5	2.2	3.4	1	2	2	3	2	3	2	4	4	1	2	5	3	2	4

TOTALS: 17 Species — 261 Organisms — 19 Juv — 7.3 % Juv %

DIVERSITY:	Species Div	Max Div	Evenness
All Species	1.315	2.833	0.4642
(Excluding Commercials)	(2.386)	(2.708)	(0.8810)

[Shannon-Weaver using natural logs]

Station No. 2570 Location 7: 50-100' off City Dock, 100'below to 100' above dock.
Depth 14-16', soft mud — Z transect of 30 samples.

without any growth annuli have also been recorded as juveniles.

In Tables 3 and 4 the numbers of specimens exhibiting any irregularities have been recorded as damaged whether or not that damage is attributable to barges. Brief characterizations of these irregularities are given in footnotes. It should also be mentioned that the gravidity data reported in Table 3 was obtained by examination of numerous (but not all) of the adult specimens of those species which are believed, under normal circumstances, to be gravid in or about late September in this region. This group consists of all species in the Subfamilies Anodontinae and Lampsilini and one species in the Subfamily Elliptioninse, viz. Megalonaias gigantea. The reason that not all specimens of those groups were checked for gravidity is that this determination involves forcing the live mussel partly open, a procedure which often damages the shell and which may even kill the animal by causing one of its adductor muscles to become detached from the shell. In Table 3 the species examined for gravidity are listed along with notations showing whether both males and females, or females alone, were examined (this depended on whether or not the sexes are clearly distinguishable by their shells), the numbers of specimens examined, and the number found to be gravid.

The growth and age measurements are shown on Charts 1-6. In general a parabolic relationship between age and length seems to exist conforming approximately to the following simple equation:

$$\sqrt{A} \times X = L$$

Mississippi River Ecosearch, Inc.	Prairie du Chien Mussel Survey Age-Length of **Amblema plicata**					Wisconsin Sept. 1991	
Location:	7	4	3	2	7,4,3,2	Main Ch	Main Ch
Station:	2570	2571	2572	2573	Combined	2576	2578
Model Utility F-stat	114.5210	84.0900	88.2476	63.1698	431.0318	15.8911	18.9905
Std Err of Y Est	7.7603	8.8705	7.6032	8.4201	8.1198	7.9862	5.7530
R Squared	0.8035	0.7502	0.7591	0.6569	0.7780	0.3540	0.4633
No. of Observations	30	30	30	35	125	31	24
Degrees of Freedom	28	28	28	33	123	29	22
Coefficient of x½	22.6879	24.9714	21.5878	25.2448	23.7387	20.8177	29.2063
Std Err of Coef.	1.7914	2.5537	2.2205	2.5607	1.0478	3.4413	2.4190
Model Utility t-ratio	12.6647	9.7785	9.7218	9.8586	22.6560	6.0493	12.0736
95% Conf Inv: Lower Limit	19.0183	19.7404	17.0392	20.0151	21.6599	13.7795	24.1895
Upper Limit	26.3574	30.2024	26.1364	30.4745	25.8175	27.8560	34.2230
Coefficient of x	-0.9425	-1.4199	-0.8257	-1.5608	-1.2277	-0.7790	-2.4736
Std Err of Coef.	0.4940	0.6290	0.5052	0.5785	0.2485	0.7212	0.5254
Model Utility t-ratio	-1.9079	-2.2575	-1.6345	-2.6982	-4.9413	-1.0801	-4.7081
Critical value of t (±)	-2.0484	-2.0484	-2.0484	-2.0423	-1.9840	-2.0452	-2.0739
95% Conf Inv: Lower Limit	-1.9545	-2.7083	-1.8606	-2.7422	-1.7207	-2.2541	-3.5632
Upper Limit	0.0694	-0.1315	0.2091	-0.3794	-0.7348	0.6961	-1.3840

The LENGTH (y) of *Amblema plicata* is predicted from the AGE (x) by the relation

$$y = \text{Coeff}_1\, x^{1/2} + \text{Coeff}_2\, x$$

where $x^{1/2}$ denotes the square root of x or $\sqrt{x}$. The coefficients were calculated using the / Data Regression procedure of Lotus-123. The quantities shown in **boldface** in the table are calculated automatically by the regression procedure. The other table entries are obtained from them. The "Model Utility F-stat" is predicted from **R Squared**, the **No. of Observations**, and the **Degrees of Freedom**. Comparison with critical values of F around 7.64 ($\alpha = 0.01$ level) leads to a convincing rejection of the null hypothesis that the model is not useful. The large values of F reflect the fact that R^2 is over 65% for much of the data. Each of the two Coefficients has a "Model Utility t-ratio" which is simply the Coefficient divided by the Standard Error of the Coefficient. The "t-ratio" tests the null hypothesis that the coefficient is zero. Since critical values of t at the $\alpha = 0.01$ level, df $\geq$ 28, are around 2.8 or less, the coefficients of $x^{1/2}$ all yield t-ratios which strongly reject the claim that the coefficient is zero. The coefficient of the linear x term appears less essential. Its t-ratio can be compared directly to an $\alpha = 0.05$, two-tailed, (negative) critical value for the stated df that appears on the next line. We reject the null hypothesis of the Coefficient of x being zero for Stations 2571, 2573, 2578, and the combination of 2570-73. We fail to reject for stations 2570, 2572, and 2576. Perhaps the most important values that appear in the table are the 95% Confidence Intervals calculated for both coefficients. These are calculated by adding to or subtracting from the coefficient, the product of the standard error times the critical value of t. Generally these intervals overlap greatly. All but one of the coefficients of the first four stations fall within each others confidence interval **and** the combined confidence interval. The fitted curves are **not significantly different** for the first four stations. The possible differences at the two main river channel stations may be due to a shortage of low age individuals in the samples from those stations.

of X are fairly low, however, indicating that that term is not particularly important. Comparisons between the curves are made by comparing the values for coefficients of $X^{1/2}$ in one Station with that from another Station to determine if the value from one falls within the confidence limits (of 95%) of the other. If they do then the two coefficients of $X^{1/2}$, and the curves themselves, are considered not to be significantly different.

It can be seen that the R^2 values are relatively high for Stations 2570 - 2573 but are rather low for Stations 2576 & 2577. The latter low values are believed to be attributable to the absence of small and medium-sized specimens in those samples.

Note that in adult specimens the mean distances between annuli are very small whereas in young specimens they are relatively large. Possible growth rate reductions caused by barges, if any, should therefore be tested by using small specimens, i.e. those in the 30 - 50 mm size range (ca 3 - 7 years old). Annual increments would be about 5 mm in such specimens. Even then, however, because of the wide variation in growth rates between individuals of the same age, many individuals from each site would need to be measured and aged to enable statistically significant differences to be revealed.

5. CONCLUSIONS

The data from quantitative surveys at four East Channel

locations in 1991 were compared with the data obtained in 1990. The results as they relate to specified parameters were then compared with threshold values for quantitative changes in those parameters which, if they had been met or exceeded, would have triggered reconsultation with regulatory agencies. Data from qualitative surveys in the Main River Channel were also examined. The conclusions are elaborated below.

A. Damaged Mussels.

No damaged mussels were seen in the East Channel whose damage could reasonably be considered to have been caused by other than brailing activities. Further, the control location (Location 4) showed a higher frequency of damaged specimens than the test locations. Brail damage is also evident in the qualitative samples from the Main River Channel.

Clearly no jeopardy involving physical damage to the shells of live mussels exists from Didion barge traffic. .

B. Presence of <u>Lampsilis higginsi</u>.

When 1990 and 1991 results are compared, minor changes in the numbers of <u>L. higginsi</u> appear in the data from all test sites and from the control site. The proportion of <u>L. higginsi</u> in the totality of the mussel samples from the test sites decreased from 0.80% to 0.62%, and increased in the control site

from 1.14% to 1.25%. The numbers involved are so small, however, that none of the changes are statistically significant.

A reduction of 50% or more in L. higginsi is the trigger criterion for reconsultation. That was not met.

C. Mussel Densities : All Species Exclusive of Three-Ridge and Washboard.

The mean density of all mussels in the quadrats, exclusive of A. plicata and M. gigantea, significantly increased at Locations 2, 4, and 7, and decreased non-significantly at Location 3.

The threshold change for this criterion which triggers reconsultation is a decrease of 20%. Since three of the locations showed statistically significant increases, and one (Location 3) showed no significant change, that threshold value was not met.

D. Recruitment.

Decreases in the number of species represented by juveniles occurred at all sites but were most pronounced at Location 4, the control site, where the number of species as juveniles decreased from 10 to 3.

It has already been pointed out that since the 1990 collections were made in December, and the 1991 collections in September, the number of species represented by current year

cohorts of greater-than-microscopic size would be expected to be much smaller in 1991 than in 1990. Further, since the greatest proportionate decrease occurred in the control site, barge traffic cannot be implicated in this general apparent decline.

Although a decline of 10% in the number of species represented by juveniles is sufficient to trigger reconsultation, for the reasons given above, I believe that the apparent decline in species represented by juveniles is not a true decline. Further, even the apparent decline is not attributable to barges. In my opinion reconsultation is therefore unwarrented based on this parameter.

I recommend that subsequent studies to assess recruitment be conducted in November of each year. This is late enough to enable current-year juveniles to have achieved reasonable macroscopic size and early enough to make it unlikely that the weather will impede the efficiency of the monitoring program.

E. Species Richness.

The total numbers of species found increased or remained the same at all sites in 1990 and 1991. Shannon-Weaver diversity indices were significantly greater at Location 2 in 1991, significantly less at Location 3, and not significantly different at Locations 4 or 7. Greater efficiency of the diver in 1991 is believed to have been the principle cause of those differences.

The critical level for this parameter which would trigger

reconsultation is a reduction of 20%. Since there is no reduction at all in species richness, that trigger level obviously is not met.

F. Growth of Amblema plicata.

As stated previously all six of the curves are visually very similar. Station 2578 did produce a $X^{1/2}$ coefficient which was not within the confidence limits for that statistic at other stations, however, but was greater. This indicates that the rate of growth at that station, which is in the shipping channel of the Main Channel, appears to be somewhat greater than at other Stations. I believe that this can be accounted for by the fact that the substrate at Station 2578 was of hard sand, indicating that the area may be subject to stronger constant current than other Stations, and that the food supply there may be greater.

Although these results are useful and interesting, they indicate that no dimunition of growth rates are attributable to Didion Barge traffic, so no reconsultation with reglatory agencies is called for.

The overall conclusion from the 1991 surveys is that no basis has been indicated to exist for concluding that Didion barge traffic has negatively impacted freshwater mussels in general, or Lampsilis higginsi in particular, in the East Channel of the Mississippi River.

A SAMPLING PLAN FOR MONITORING THE POSSIBLE EFFECTS OF DIDION BARGE TRAFFIC ON THE FRESHWATER MUSSELS OF THE EAST CHANNEL OF THE MISSISSIPPI RIVER AT PRAIRIE DU CHIEN, WISCONSIN

Arthur H. Clarke, ECOSEARCH, Inc.

September 19, 1991

1. INTRODUCTION

During 1990, with the assistance of the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and the Wisconsin Department of Natural Resources, and after much preliminary sampling and discussion, a plan was developed for monitoring the possible biological effects of barge traffic by barges used by Didion Inc. to ship grain from the port of Prairie du Chien in the East Channel of the Mississippi River. All parties were concerned that barges might have a negative impact of a federally-listed endangered species which occurs there, viz. Lampsilis higginsi (Lea, 1857)(Mollusca: Unionidae).

The final monitoring plan which was adopted called for assessing the possible acute (i.e. immediate) effects of these barges on all freshwater mussels in the area and also for assessing the possible chronic (i.e. long-term) effects. Divers were to be used for gathering the specimens and a malacologist was to examine the specimens and to record the required data. A set of sampling stations was designated and a series of qualitative and quantitative parameters was specified which, after measurement, would allow acute and chronic effects to be recognized and assessed. Details are presented below.

2. MATERIALS AND METHODS

A. MONITORING SITES

Early in 1990 a series of sites designated as locations 1, 2, 3, 4, and 5 was sampled, but after preliminary results were obtained it was decided that use of some of those test sites should be abandoned and that some new sites, designated as locations 6, 7, 8, and 9 should be added. All of these locations are shown on Map 1. After further testing and discussion a plan

for the 1990 fall sampling program was completed. The sites to be sampled for acute effects were locations 3, 4, 7, and 9 and those to be sampled for chronic effects were locations 3, 4, 7, and 8.

During the 1990 fall sampling program, however, the divers found that Location 8 had a substrate of deep mud and was virtually barren of mussels. In addition, Location 9 also had a mud substrate, a sparse mussel fauna, and was much shallower than the other test sites, all of which had substrates of gravel. It was obvious that these sites were unsuitable and we therefore elected to sample Location 2 for both acute and chronic effects instead of using Locations 9 and 8 for these purposes. Location 2 had 2 advantages, viz. (1) it is the shallowest area in the East Channel which is traversed by Didion barges and therefore the one which would most likely be affected by barge traffic in the shipping channel, and (2) there is already a substantial body of data already existed about mussel communities at Location 2, thus enabling possible changes to be recognized promptly.

In view of the fact that extensive background data now exist about mussel communities at locations 2, 3, 4, and 7, we will continue monitoring those locations for acute and chronic effects of barges in 1991. If time permits, we also propose to monitor two new sites in the West Channel of the Mississippi River in the vicinity of (but sufficiently distant so as not to interfere with) two sites now being studied by Dr. A. C. Miller (ACOE, WES).

The geographical positions of the numbered locations of interest here are described below.

Location 2. This is east of, and close to, the second channel marker bouy below (south of) the Turning Basin in the East Channel, or about halfway between the Turning Basin and the City Dock. This is a test site in the shipping channel.

Location 3. This is east of, and close to, the third bouy below the Turning Basin. It is offshore from, and a little north of, the City Dock. This is another test site in the shipping channel.

Location 4. This is between the first two channel marker bouys just south of Highway 18 bridge. It is a control site in the river channel but not subject to barge traffic.

Location 7. This is the area in front of the City Dock and is defined as the area extending from 50 feet to 100 feet west of the dock and from 100 feet north of the dock to 100 feet below the dock. It is a test site designed to monitor the effects of terminalling activities at the dock.

Location 8. This is located just downstream from Location

7 extending from 100 to 300 feet below the city dock. It was planned that use of this location would allow the assessment of possible downstream effects of turbidity generated at Location 7. As discussed above, however, it was found to be almost barren of mussels.

Location 9 This was located east of Location 4 but between two wing dams. It was designed as a control site for Location 8, but as pointed out above, it was only 4 or 5 feet deep and had a sparse mussel fauna.

B. MONITORING PROCEDURES

Acute effects are normally assessed using non-quantitative methods but assessment of chronic effects requires quantitative procedures. In order to reduce damage to the mussel bed both acute and chronic effects will be assessed using the same specimens, however. Since about 100 specimens are needed to assess acute effects at each station, if substantially fewer than 100 specimens are obtained at a station using quantitative methods, additional specimens will be collected using non-quantitative procedures.

At each sampling location a 70-meter rope, with 30 randomized points marked by inserted chain links, will be laid out on the bottom in a Z-shaped pattern and weighted down with concrete blocks. Samples will be taken by a diver, one at each pre-selected point, using a Surber Sampler. The Surber Sampler will have a square frame 19.7 inches long and wide (area 0.25m) and a square basket attached to the downstream end which is also 19.7 inches long and wide, and about 10 inches high. The basket will be covered on all sides with mesh having 1/8-inch openings and will be open only on the side facing the upstream rectangle. The diver will excavate all substrate within the frame at each sample locus down to a depth of 6 inches and will place all of the material in the basket. As each sample is taken the sampler will be raised to the boat and another sampler, containing tabulated mussels to be replaced, will be lowered.

In the boat the contents of each sampler will be screened and sorted and all live mussels will be identified to species, checked for shell damage, checked for gravidity where appropriate, counted, and the number of specimens 35 mm long or less will be noted.

It is proposed that, because of the heavy fishing pressure for commercial mussels in the area and the resulting fact that large sized mussels will have been selectively removed thus creating unnatural size-group distributions, that the traditional, time-consuming task of measuring every mussel be omitted. Those measurements are not of use anyway in assessing the parameters requiring investigation in this program. We will, however, carry out the necessary measurements to properly assess

the rate of growth of Amblema plicata in the East Channel, as requested by the U.S. Fish & Wildlife Service.

3. RESULTS

The results of the survey will be analyzed in such a way that the following parameters are addressed. "Trigger criteria", i.e. parameter values which have been considered serious enough to require reconsultation with regulatory agencies, are also specified.

A. DAMAGED MUSSELS. A damage rate considered significant by regulatory agencies will be specified.

B. PRESENCE OF Lampsilis higginsi. A reduction of 50% or more, based on similar total numbers of specimens, will be considered significant.

C. DENSITIES. Densities of all species exclusive of the three-ridge and the washboard will be calculated. Changes of 20# or more will be considered significant.

D. RECRUITMENT. The numbers of juvenile specimens (35 mm long or less) of all species will be assessed. A reduction of 10% in the number of species previously found as juveniles will be considered significant.

E. SPECIES RICHNESS. Major changes in species composition will be looked for. A reduction of 20%, based on samples containing similar numbers of specimens, will be considered significant.

E. CONDITION. Meat-to-shell ratios (both dry and wet) of 10 adult specimens of the three-ridge mussel will be collected and sent to the Waterways Experiment Station for determination. A reduction of 25% in the year-to-year level (in mussels collected about the same time of year) will be considered significant.

4. CONCLUSIONS

All of the data will be entered directly on standard data sheets. After all of the data have been gathered the data sheets will be given to our statician, Dr. J.C Loter of Corpus Christi State University, for statistical analysis and the writer, A.H. Clarke will write a report. The report will be sent promptly to all appropriate regulatory agencies for review and response.

NOTE SUBSEQUENTLY ADDED: This Sampling Plan was verbally accepted by Mr. Robert Whiting of the Army Corps of Engineers and, with one modification, by Mr. Ronald Refsnider of the Fish and Wildlife Service. The FWS addition concerned the need for length measurements (at each of the last 6 annuli) and age determinations for about 30 Amblema plicata from each site.