

QUANTITATIVE MUSSEL SURVEY IN POOL 24  
OF THE UPPER MISSISSIPPI RIVER  
AT MRM 300 DURING FALL, 1994.

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APPROVED:

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Date

## EXECUTIVE SUMMARY

A quantitative mussel dive survey was conducted in October of 1994 at Mississippi River Mile (MRM) 300 below Lock and Dam 22 on Pool 24 in Ralls County, Missouri. Our purpose was to determine if there were any changes in the mussel community since a similar survey was conducted in 1988. The impending spread of the zebra mussel in the Mississippi River also played a role in prompting a survey at this time. It is likely that this was the last survey to be conducted at this site before the characteristic zebra mussel population explosion occurs.

The sample site was located in a main channel border area where substrates consisted primarily of sand, gravel, and rock with some finer sediments located near the shoreline.

A total of 17 native mussel species were found at this site in 1994 compared to 19 species in 1988. Missing in 1994 were the giant floater and the yellow sandshell. We collected 233 zebra mussels in 1994, our first official documentation of their occurrence at this site.

Native mussel density increased from  $25/m^2$  in 1988 to  $34/m^2$  in 1994. Overall mussel density, including zebra mussels, was  $40/m^2$ . The most notable increases in density from 1988 to 1994 were exhibited by threehorn wartyback ( $3.7$  to  $9.3/m^2$ ), the threeridge ( $1.5$  to  $8.0/m^2$ ), and the zebra mussel ( $0$  to  $6.6/m^2$ ). Of the remaining 17 species encountered in 1988, eight exhibited slight increases in density while nine showed slight decreases. The most notable decreases in density from 1988 to 1994 were exhibited by the washboard ( $1.5$  to  $0.4/m^2$ ) and fawnsfoot ( $2.8$  to  $0.2/m^2$ ).

The mean age of selected living mussels ranged from 3 for the fawnsfoot to 13 for the washboard. Recruitment of juvenile mussels of all species was very low, including the commercially important washboard and threeridge mussels. We collected no washboards less than six years old, and only three were less than eleven years old. We collected only seven threeridges less than five years old (2%).

Despite sanctuary protection, the number and proportion of commercially harvestable washboards at this site has declined considerably. In our 1988 collections, 88% (N=42) of washboards were of legal height (4 inches), compared to 62% (N=8) in 1994. The proportion of threeridge mussels reaching the 2.75-inch height requirement also decreased from 81% (N=42) in 1988 to 18% (N=54) in 1994.

Substantial differences in the densities of other mollusks were also observed. The density of silty hornsnails increased from 4.6/m<sup>2</sup> in 1988 to 19.2/m<sup>2</sup> in 1994. Ninety percent of silty hornsnails collected in 1994 were fresh dead. The density of fingernail and asian clams also increased from 1.8 to 11.9/m<sup>2</sup>, 93% of which were fresh dead fingernail clams.

Recommendations based upon these findings include:

- 1) denial of Central Stone Company's request for a permit to place a floating dock in this area;
- 2) placement of mooring buoys, as planned by the Corps of Engineers, in order to minimize the effects of barge traffic on sanctuary mussels;
- 3) execution of another quantitative dive survey in 1999; and
- 4) maintenance of this area as a mussel sanctuary.

## INTRODUCTION

A quantitative mussel dive survey was conducted in October, 1994 to assess the condition of a mussel community at Mississippi River Mile 300, below Lock and Dam 22. This report documents the results of that survey and compares the results to those of a similar survey conducted at this site in 1988.

## BACKGROUND

Mussel shells have been commercially important over the course of the last century. From the late 1800's to the late 1930's mussel shells were being used to make "pearl" buttons. The industry collapsed with the use of plastic to make buttons. By the 1960's mussel shells were being used to "seed" cultured pearls, and that remains a market for the shells today. In recent years however, a surplus of shell caused the market price to drop. Subsequently, the number of licensed shellers in Missouri fell to an all time low of one in 1994. As the surplus disappeared and prices rose the number of commercial musselers also rose. There were ten commercial musseler permits and five helper permits issued in Missouri in 1995, along with one mussel shell buyers permit.

In 1988, the sample site was selected for observation after a preliminary brailling survey showed that a diverse mussel community existed there (Koch, 1990). After completing the dive survey, Koch recommended that this area become a mussel sanctuary. In 1989 the area between the head of Gilbert Island (MRM 298.2) and Lock and Dam #22 (MRM 301.2) was designated a sanctuary. Mussels in this area are protected from all commercial mussel harvest.

During the 1988 survey, a total of 19 mussel species were recorded. All of these were typical of the pool and of the main channel border or open river habitats. Seven species had a density of at least one per square meter. They were the deertoe, butterfly, threehorn wartyback, fawnsfoot, washboard, threeridge, and fragile papershell. The density of all species combined was  $25/m^2$ .

Koch noted that there were very few "mid-sized" individuals of several species, including the commercially important washboard and threeridge. The size distribution consisted of some very young and many old, mature individuals.

During 1993, the Mississippi River reached record water levels due to heavy rainfall throughout the river basin. The river was above flood stage at the survey site from April through September.

Another dive survey was conducted within our sample site between September 14 and 16, 1994 by Ecological Specialists, Inc. (Dunn, 1994). ESI was hired by the Central Stone Company of Hannibal, Missouri to survey the mussel community along their property on the Mississippi River. Central Stone has applied for a permit to place a floating barge along their property to be used for loading and unloading material. Central Stone prefers to place the dock in the middle of the sample site. The last correspondence regarding this permit occurred on September 12, 1995. Issuance of the permit has been delayed until further information can be collected from ESI.

ESI found a total mussel density of 27/m<sup>2</sup>. Individuals less than five years old were present for most species. ESI encountered 17 species during quantitative sampling and 24 species during qualitative sampling. The threehorn wartyback, threeridge, butterfly, deertoe, washboard, and mapleleaf comprised 87% of mussels in each sample type.

#### METHODS

This site was selected for sampling in 1994 primarily because we were interested in documenting any trends in mussel community composition in the refuge site over time.

The sample site is located on Pool 24 at Mississippi River Mile (MRM) 300.0, approximately one mile downstream of Lock and Dam #22 at Saverton, on the Missouri side of the navigation channel (Figure 1). The site is situated between the navigation channel and ten meters from the "normal" shoreline along the open river. Substrate consisted mainly of sand, gravel, and rock, with some finer sediment nearer the shoreline. The total sample area was 48,000 square meters, delineated by an area 800 meters in length and 60 meters wide. Samples were collected during October 17-19, 1994.

There were four additional sets of samples taken from outside the sample area. Two of these sites were approximately fifty meters upstream from the sample area, and two were approximately 300 meters downstream. The results of these samples are recorded separately and are not included in sample area statistics.

The sample area was subdivided into 100 meter by 60 meter sections. These sections were then further divided into 20 meter by 10 meter sampling units. A total of 50 units were randomly chosen for sampling. Floating ropes (two 70 meters long and marked with floating jugs at 10, 30, 50, and 70 meters, and two 100 meters long marked with floating jugs at intervals of 10 meters) were used to delineate sampling unit boundaries. The 70 meter lines were anchored at the shoreline, then stretched out into the river channel. This line was then tied to a large

floating jug which was held in place by a concrete block. Once the first 70 meter line was set, the 100 meter line was tied to it at its outermost end and allowed to trail downstream. The second 70 meter line was then set at the downstream end of the 100 meter line and the two were tied to another floating jug and block set. Units were then sampled based on location of floating jugs.

Samples from units 1 and 13 of Section 1 were collected using a modified gold mining suction dredge. Complications with the dredge forced a change in sampling techniques to one that the diver had used previously. This system entailed using a series of buckets with lids sent to the river bottom. Once the diver and first bucket were on the bottom, a 1/4 meter square quadrat frame was placed on the river bottom. All rock, sand, sediment, and shells were scooped into the bucket down to a depth of six inches. A second bucket was then sent down to the diver and the first bucket was pulled to the surface. At this point, the diver would move the quadrat to another location within the sampling unit while the boat crews processed the first sample. Processing entailed emptying the contents of the bucket onto a sieve containing openings 2.0 millimeters in size. Large pieces of substrate were inspected for zebra mussels (Dreissena polymorpha) then discarded. After sediment was washed from the sample, the remaining substrate and shells were placed into Ziploc bags, labeled, and later placed in a freezer for storage. A total of three samples were collected from each sampling unit.

Some sample units possessed unusual characteristics. Three units occurred in water too swift to sample. They are not included in any density figures. A rock bar had also developed at the mouth of Fools Creek since the 1988 sample. Four units fell within this rock bar and were above water level during the 1994 survey. These samples were included in population statistics because the zero densities reflect real changes in site conditions.

River stages were recorded from the tailwater area at Lock and Dam #22. River stage averaged 4.2 during six early June sample dates in 1988 and 6.6 during three mid October sample dates in 1994.

Final processing of samples was completed in January, 1995. Each individual sample was thawed and the contents were poured into a metal tray. Mussels, snails, and clams were then separated from the substrate. Only fresh and fresh dead shells were retained. "Relic" and single valve shells were not included in sampling results. Organisms were then cleaned and identified. Height and length measurements to the nearest millimeter were recorded for all mussels except zebra mussels. Mussels were aged by determining and counting external growth rests. Mussel names used in this report follow the Illinois Natural History Survey Manual #5, "Field Guide to Freshwater Mussels of the Midwest" by K. S. Cummings and C. A. Mayer, 1992.

## RESULTS AND DISCUSSION

### Native Mussel Species Richness

We collected a total of 17 native species in 1994, two fewer than in 1988 (Table 1). No giant floaters or yellow sandshells were collected in 1994. All other species collected were identical between years and typical for this pool and habitat. No federally or Missouri rare, threatened, or endangered mussels were collected. One species on the Missouri Watch List, the hickorynut, did occur in the samples.

No new species were collected from any of the samples taken from outside the sample area. In the samples taken from 50 meters upstream from the survey site, only seven species of mussels were collected. Fourteen species were collected from sampling units located 300 meters downstream of the survey site.

### Native Mussel Density

The top 10 native species encountered in 1994 and 1988 were almost identical (Table 1). Ten species increased in density since the 1988 sample. The most notable increases from 1988 to 1994 occurred for the threehorn wartyback (3.7 to 9.3/m<sup>2</sup>), threeridge (1.5 to 8.0/m<sup>2</sup>), pimpleback (0.8 to 1.7/m<sup>2</sup>), and the mapleleaf (0.8 to 1.9/m<sup>2</sup>). Although all other density increases were less than 0.15/m<sup>2</sup>, the wartyback and black sandshell increased by substantial percentages. The hickorynut occurred at 0.6/m<sup>2</sup>, up from 0.5/m<sup>2</sup> in 1988.

Of the nine species experiencing declines in density from 1988 to 1994, the most notable were the washboard (1.5 to 0.4/m<sup>2</sup>) and the fawnsfoot (2.8 to 0.2/m<sup>2</sup>). Since sampling techniques differed between the two sample years, it is possible that the dredge used during the 1988 survey was more effective at collecting the small fawnsfoot mussels. However, other signs, such as a decrease of 20% in the proportion of live fawnsfoot mussels suggests the possibility of a declining fawnsfoot population.

Twelve of 13 washboards (92%) collected in 1994 would have been legal to harvest. Forty-two of 48 washboards (88%) collected in 1988 were of legal size (4 inches). The other commercially important species, the threeridge, increased in density, but the proportion of legally harvestable threeridges (> 2.75 inches) declined dramatically. Forty-two of 52 (81%) were harvestable in 1988, but only 54 of 300 (18%) threeridges were harvestable in 1994. It is unclear why densities of these two species are moving in opposite directions. As Koch had mentioned in his 1990 report, it is possible that washboards reach sexual maturity at a later age and may have been harvested to the point where many years may be necessary to rebuild the population. It is possible

that since the threeridge is a smaller species, it may reproduce at an earlier age and has responded more quickly than the washboard to the cessation of commercial harvest in this reach of Pool 24. The fact that 89% of threeridges collected in 1994 were five to eight years old supports this notion. All of these specimens would have either been too small to harvest or yet unborn at the time this area became a mussel sanctuary.

Despite decreases in densities of almost half of the species present, total native mussel density increased from 24.7/m<sup>2</sup> to 33.5/m<sup>2</sup>. Densities varied greatly between sampling units. Densities of zero or near zero occurred frequently near the mouth of Fools Creek. Several of the sampling units were above or just below the normal water line due to the development of a large rock bar. Many of the samples directly below the rock bar also exhibited low mussel densities. We believe that the rock bar formed because of timber clearing and channel disturbances on property adjacent to the sanctuary and along Fools Creek. Aerial photos (Figures 2 and 3) document the timber clearing and the creation of the rock bar at the creek mouth. Additional clearing completed after the 1990 photo (Figure 2) occurred along the Mississippi River and the lower portion of Fools Creek and may have further increased the amount of bedload being deposited on the rock bar.

There were considerable differences in substrate composition among sampling units. Samples collected from above the mouth of Fools Creek consisted of mostly sand and pea gravel substrates. Several of these sites had bedrock substrates; in such places mussels were found in loose sand that settled into cracks of the bedrock. Samples collected from downstream of Fools Creek consisted of cobble, gravel, and pea gravel. Sampling units located immediately downstream of Fools Creek consisted mainly of larger pieces of cobble and gravel.

#### Native Mussel Age Structure

Most mussels were alive when collected (Table 1). The proportion of living mussels declined somewhat from 1988 to 1994 for all but one of the ten most abundant species. The decline in proportion of living mussels was especially alarming for the fawnsfoot (20%) and hickorynut (15%).

Mean ages for all but three of the ten most abundant species declined from 1988 to 1994 (Table 1). This could partially be attributable to using different age interpreters in 1988 and 1994. Since aging by counting external growth rests is very subjective, it is quite possible that the age interpretations reflect different aging styles and perceptions of the occurrence or absence of growth rests. However, some mean age differences between 1988 and 1994 were too large to attribute to interpreter



variation. As an example, mean ages for threeridges and mapleleaves fell by ten years each; and the mean age of washboards decreased by nine years (Table 1).

Few young specimens were collected of any species. Five of ten selected species demonstrated age clusters that included 68% to 94% of their total population (Table 2), suggesting sporadic recruitment in some species.

#### Zebra Mussels

\* No zebra mussels were collected in the 1988 survey. They were found in the 1994 survey at a density of  $6.6/m^2$ . Zebra mussel density ranked third among all mussel species. Zebra mussels were not kept for measurements, but selected specimens were aged at the work site. Ages ranged from zero to four years old.

#### Snails and Clams

Asian clams, fingernail clams, and three species of snails were collected in both the 1988 and 1994 samples (Table 3). The density and proportion of living versus dead snails declined for all three species. Density of fresh dead silty hornsnails increased from  $0.9/m^2$  in 1988 to  $17.4/m^2$  in 1994, and 90% of all silty hornsnails collected in 1994 were fresh dead. The proportion of live olive mysterysnails varied little between sample years.

The total density of fingernail and asian clams decreased from 3.7 to  $0.5/m^2$ . The density of fresh dead fingernail clams was  $11.1/m^2$ , comprising 95% of all fingernail clams collected (Table 3).

## CONCLUSIONS AND RECOMMENDATIONS

We can make no sweeping generalizations concerning the overall health of the sanctuary's mussel community. However, we made some important observations which are cause for concern: 1) Native species richness has declined; 2) There has been a substantial shift from older to younger individuals for at least three species; 3) There is little evidence of recent reproduction for several species; 4) There has been an increase in the proportion of fresh dead shell for many species. We do not know the extent to which natural events, including the Flood of 1993, and human intervention have caused these changes. It seems likely that many of the negative changes occurred as a result of habitat degradation. The portion of the sample site located above Fools Creek had a substrate consisting mostly of sand. We believe the U. S. Army Corps of Engineers uses the beach located above this site as a dredge spoil deposition area, and it seems that much of this sand is washed downstream onto the sample site.

At the mouth of Fools Creek and immediately downstream, many of the mussels were either covered by large cobble and gravel or were forced to other locations due to the development of the rock bar. Samples collected farthest from the rock bar, at the lower end of the sample area, contained a greater density and diversity of mussels and contained less large rock than those samples collected close to the rock bar.

The increased disturbance created by barge traffic is also believed to affect the mussels in this bed. Many barges wait to pass through Lock 22 by running aground within the sanctuary. (Note Figure 2, which shows a barge that has run aground at the lower end of the sample site). The prop wash created by these barges attempting to remain in place may make it difficult for mussels to feed, breed, and exist. It is possible that many of the resident mussels, especially the smaller ones, are either displaced or covered by debris and are unable to recover from this stress.

Allowing Central Stone Company to place their floating loading dock will likely only aggravate the condition created by barge traffic, because two to four barges will be filled daily at a distance of only 15 meters from the bank in the middle of the mussel bed. Once a barge is filled a tow boat will have to remove the filled barge and place an empty one in its place. This activity will result in an almost continual disturbance of the mussel bed. For these reasons I recommend that Central Stone Company be denied their request for a permit to place the floating dock in this area. If permit denial is not an option, requesting Central Stone to provide annual monitoring would be important. If it is learned that mussel populations continue to decline due to this operation, then the permit should be reviewed and either altered or revoked.

The U. S. Army Corps of Engineers approved the purchase and placement of several mooring buoys to be used by barges waiting to pass through Lock 22. Unfortunately, these buoys have not yet been placed so that they may be used by barges. The Corps of Engineers should be encouraged to purchase and/or place these mooring buoys so that the effects of barge traffic on the mussel bed can be minimized.

The impending encroachment of the zebra mussel is likely to aid in the extirpation of many of the beleaguered native species below Lock and Dam 22. As of summer, 1995, the characteristic zebra mussel population explosion had not occurred. However, zebra mussels have been increasing in number according to reports of Mississippi River users. Another dive survey should be conducted at this site no later than fall 1999 in order to assess the effects of the zebra mussel invasion and Central Stone's floating dock if a permit is issued.

Finally, this area should remain a mussel sanctuary. This area is monitored by both the Missouri Department of Conservation and the U. S. Army Corps of Engineers. This mussel community is being monitored to assess the impacts of mussel harvest, the use of the area as a sanctuary, and the effect of barge traffic on mussels. This area and the mussels themselves also provide a river quality indicator that could be invaluable in future research.

Further reasons to maintain this area as a sanctuary are related to the zebra mussel invasion. Zebra mussels may force some species into localized extirpation. Maximizing mussel densities in this sanctuary may facilitate future efforts to recolonize the Mississippi River and other Missouri streams by using sanctuary broodstock.

**Table 1.** Mean density of all mussel species, and mean age and percent live of ten selected species at MRM 300.0 in 1988 and 1994.

Species	Mean Density		Mean Age		Percent Live	
	1988	1994	1988	1994	1988	1994
Deertoe	7.22	6.41	3	4	96	92
Butterfly	3.71	3.86	11	5	100	96
Threehorn Wartyback	3.68	9.30	9	5	99	95
Fawnsfoot	2.75	0.23	3	3	93	73
Washboard	1.52	0.36	22	13	100	100
Threeridge	1.54	8.00	17	7	100	94
Fragile Papershell	0.99	0.26	3	4	88	82
Pimpleback	0.75	1.65	10	6	100	95
Mapleleaf	0.75	1.92	17	7	100	96
Hickorynut	0.54	0.62	6	7	100	85
Pink Heelsplitter	0.42	0.03				
Wabash Pigtoe	0.21	0.28				
Pocketbook	0.21	0.23				
Monkeyface	0.12	0.09				
Giant Floater	0.09	0				
Pink Papershell	0.05	0.03				
Yellow Sandshell	0.05	0				
Wartyback	0.04	0.14				
Black Sandshell	0.04	0.11				
Zebra Mussel	0	6.55				
Total (all species) / meter <sup>2</sup>	24.68	40.07				
Total for native species only	24.68	33.52				

**Table 2.** Minimum and maximum ages of ten selected native mussel species occurring at MRM 300, 1994.

Species	Minimum Age	Maximum Age	Age Distribution
Threehorn Wartyback	1	19	94% between ages 3 and 7
Threeridge	1	16	89% between ages 5 and 8, 50% are age 7
Deertoe	1	8	86% between ages 3 and 6
Butterfly	2	12	90% between ages 3 and 7
Mapleleaf	1	15	68% between ages 4 and 7
Pimpleback	3	11	ages dispersed throughout sample
Hickorynut	3	21	only one over 12 years old
Washboard	6	19	ages dispersed throughout sample
Fragile Papershell	1	8	ages dispersed throughout sample
Fawnsfoot	1	5	ages dispersed throughout sample

**Table 3.** Mean density and proportion of live and fresh-dead snails, clams, and zebra mussels found at MRM 300.0 in 1988 and 1994.

<u>Species</u>	<u>1988</u>		<u>1994</u>	
	(49 units, 98 samples)		(47 units, 141 samples)	
	<u>Live</u> No./m <sup>2</sup>	<u>Fresh Dead</u> No./m <sup>2</sup>	<u>Live</u> No./m <sup>2</sup>	<u>Fresh Dead</u> No./m <sup>2</sup>
Silty Hornsnail <u>Pluerocestera canaliculata</u>	3.7 (81)	0.9 (19)	1.8 (10)	17.4 (90)
Olive Mysterysnail <u>Viviparus subpurpureus</u>	1.2 (58)	0.9 (42)	0.8 (48)	0.9 (52)
Pointed Campeloma <u>Campeloma decisum</u>	0.1 (100)	0 (0)	0 (0)	0.03 (100)
Zebra Mussels <u>Dreissena polymorpha</u>	0 (0)	0 (0)	6.6 (99)	0.06 (1)
Asian Clam <u>Corbicula fluminea</u>	Information not available.		0.3 (50)	0.3 (50)
Fingernail Clams Family Sphaeriidae	Information not available.		0.2 (5)	11.1 (95)

Density for all snail species combined (live only) was 5.0/m<sup>2</sup> in 1988 and 2.6/m<sup>2</sup> in 1994.  
 Density for all clam species combined (live only) was 3.7/m<sup>2</sup> in 1988 and 0.5/m<sup>2</sup> in 1994.

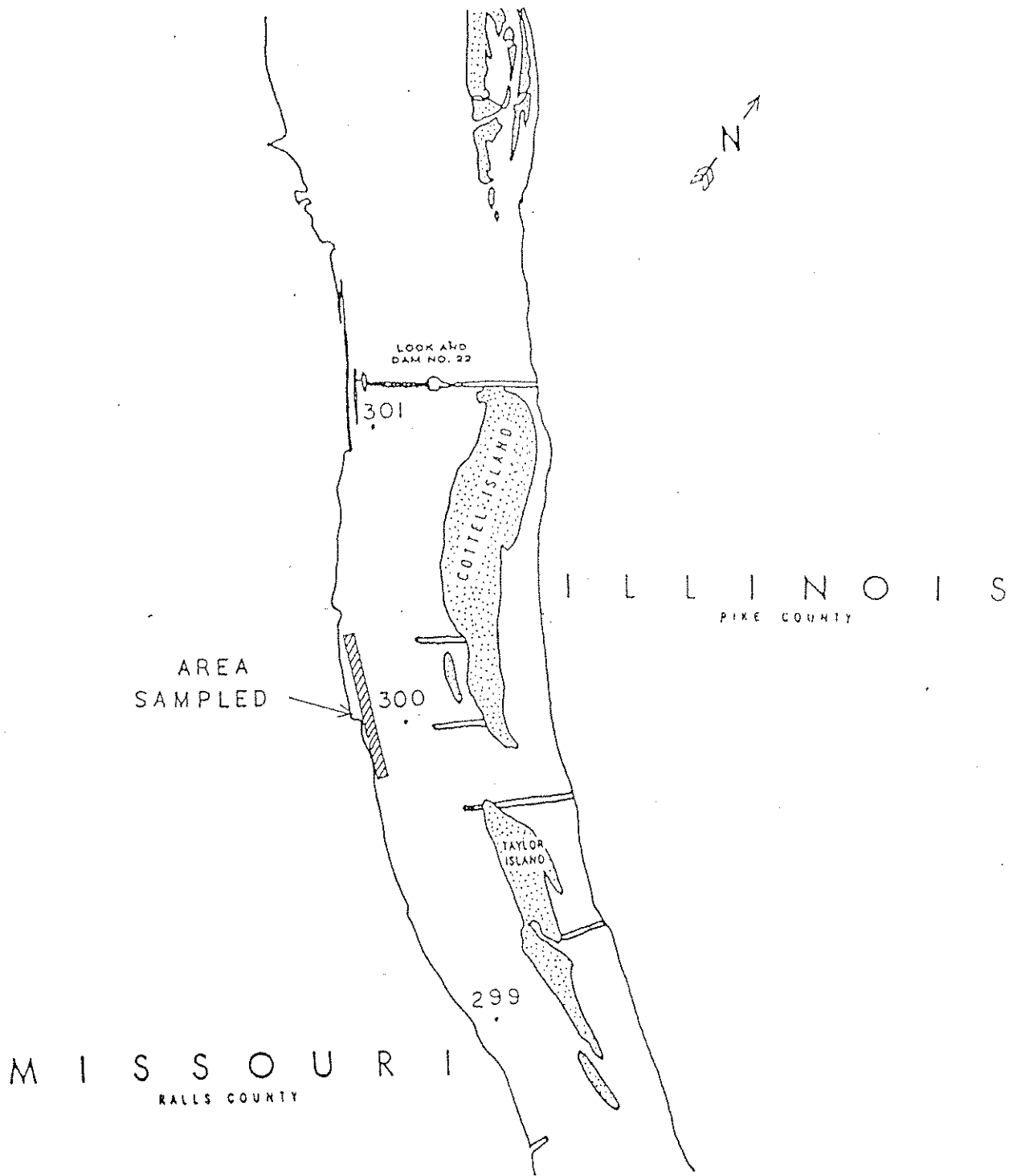
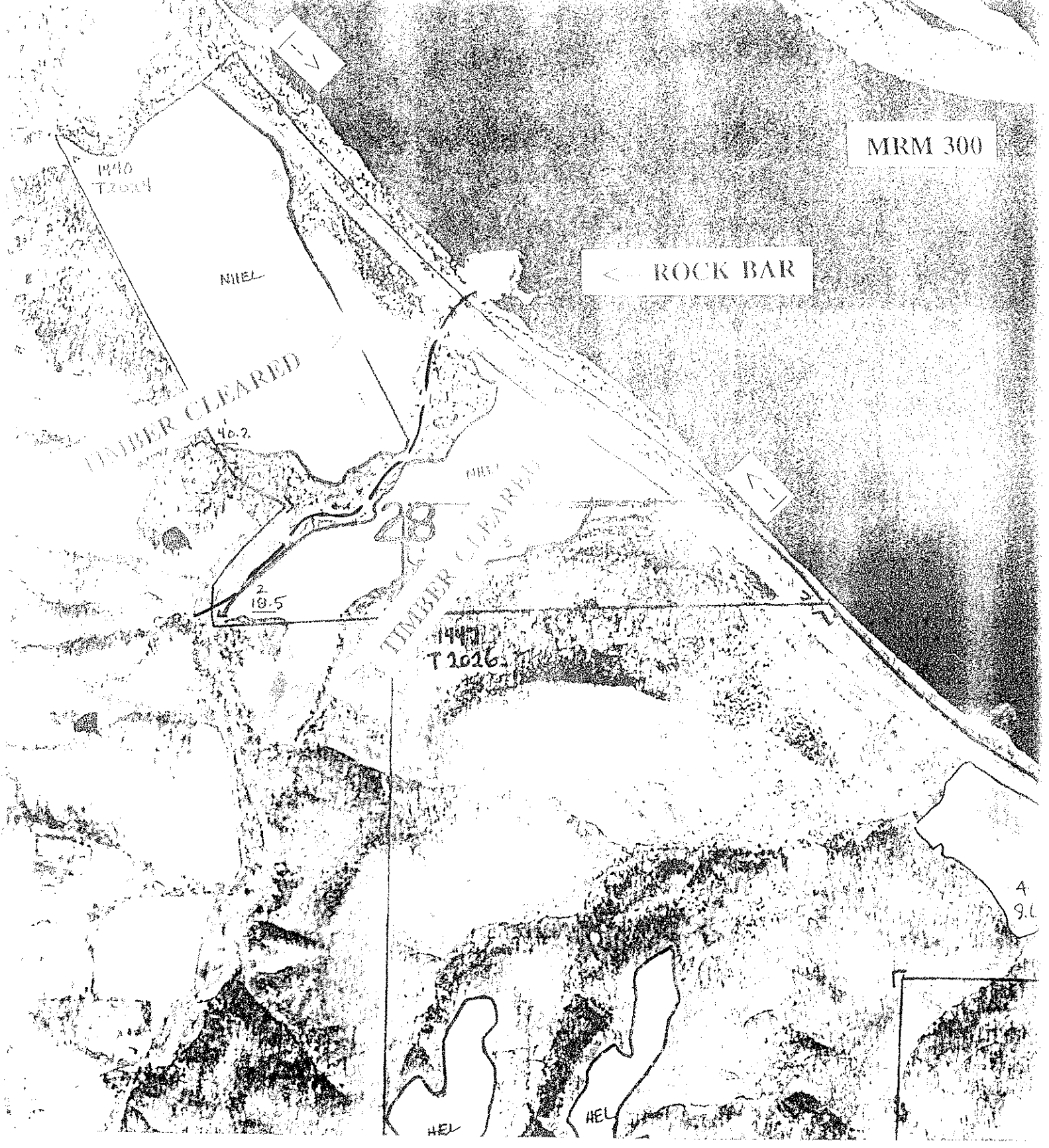


Figure 1. Approximate area sampled at Mississippi River Mile (MRM) 300 during May and June, 1988 and October, 1994.

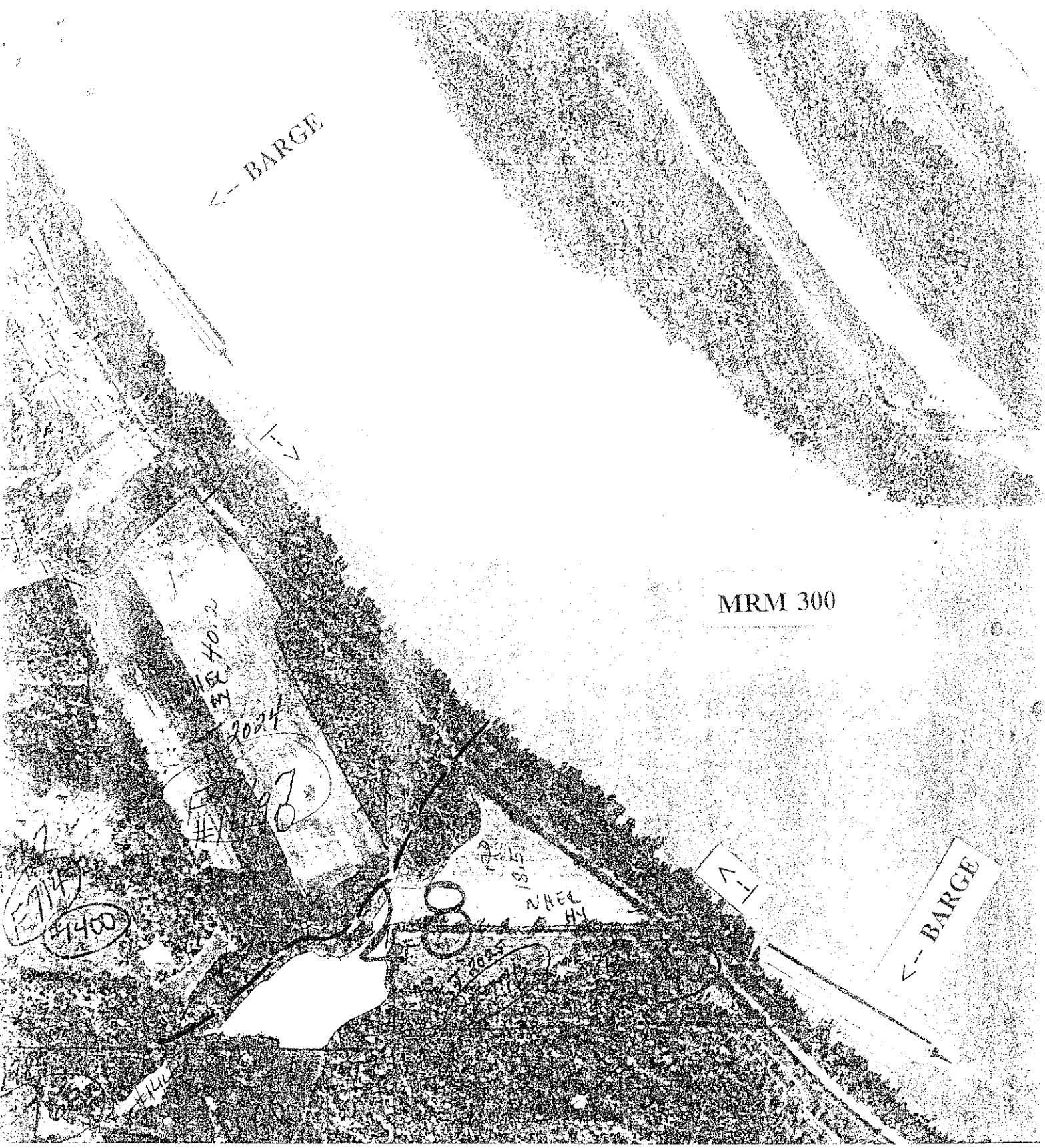


Approximate Area Sampled - |-->

Fools Creek - \_\_\_\_\_

Figure 2. Aerial photo of approximate area sampled at MRM 300. Ralls County Natural Resource Conservation Service photo taken in 1990.





Approximate Area Sampled - |-->

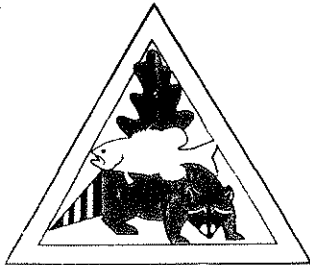
Fools Creek - \_\_\_\_\_

Figure 3. Aerial photo of approximate area sampled at MRM 300. Ralls County Natural Resource Conservation Service photo taken in 1980.

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1995



# MISSOURI DEPARTMENT OF CONSERVATION

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December 15, 1995

Dear Colleague:

Because of your involvement with the UMRCC Mussel Ad Hoc Committee, or your known interest in mussel resources, I thought you might be interested in results presented by Travis Moore in the enclosed report of our 1994 quantitative dive survey of mussels in a sanctuary area of Pool 24 on the Upper Mississippi River. The mussel community at this site has not changed dramatically since it was surveyed in 1988. However, we are concerned about decreases in density of washboard and fawnsfoot mussels, generally low recruitment of most species, and the recent appearance of zebra mussels.

I apologize if I have omitted from the distribution list anyone who may find this information useful, and I trust that those of you who receive the report will share a copy with such colleagues. Please call Travis Moore at 314-248-2530 if you have any questions about our methods or results.

Dave Neuswanger  
Fisheries District Supervisor

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