YMA

To: Dick Neves

RECEIVED
1991

Young-Morgan & Associates

One for Dr Hagan @ TVA
+ one for Dr Neves @ VPI

USFWS
ASHEVILLE, NC
4/9/91
BPC NAM
RGB JAR
RRC NC
JAF LR
VGH

Done 4/15/91 mc

21 March 1991

Bob Hatcher
Endangered Species
Tennessee Wildlife Resources Agency
Ellington Agricultural Center
P. O. Box 40747
Nashville, TN 37204

RE Report on TVA Birdwing Pearlymussel Transplant Site Survey Results

Dear Bob:

Young-Morgan & Associates (YMA) has recently completed its report summarizing the status of the Tennessee Valley Authority's transplanted *Lemiox rimosus (= Conradilla caelata)* populations. We have enclosed a copy of the report for your information.

If we can be of further service, please telephone.

Sincerely,

Young-Morgan & Associates

Don Hubbs, M.S.

Enclosure

cc Mr. David McKinney
Mr. Steve Parks

Consultants in the Environmental and Applied Earth Sciences

P.O. Box 164 · Franklin, Tennessee 37065 · 615-790-0000
P.O. Box 208 · Abingdon, Virginia 24210 · 703-676-3150

Lemiox rimosus

TRANSPLANT SITE SURVEY

Prepared for:

UPPER DUCK RIVER DEVELOPMENT AGENCY

Prepared by:

D. Hubbs, T. Hunt, and R.D. Kathman
Young-Morgan & Associates, Inc.
Abingdon, Virginia
Franklin, Tennessee

MARCH 1991

Young-Morgan & Associates
Consultants in the Environmental and Applied Earth Sciences

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Young-Morgan & Associates (YMA) was retained by the Upper Duck River Development Agency to monitor the TVA Lemiox rimosus (= Conradilla caelata) Transplant Sites established during TVA's Cumberlandian Mollusk Conservation Program (CMCP). Cumberlandian mussel fauna is composed of a group of species restricted to the Tennessee and Cumberland River Systems as they drain the Southern Appalachians and the Cumberland Plateau (Stansbery, 1972). Four thousand birdwing pearlymussels (Lemiox rimosus) were transplanted from the Duck River in 1982. One thousand individuals were placed in each of the following rivers: Duck, Buffalo, Nolichucky and North Fork Holston. After transplanting, TVA returned semiannually from 1983 to 1987 to quantitatively sample each site. In 1988, sites were sampled only during the fall season. YMA sampled each transplant site during the fall of 1989 and 1990. The following describes the methods utilized and results obtained during the 1990 survey, as well as a discussion and recommendation for future studies.

Forty 0.5 m^2 samples were collected at all transplant sites in 1989. However, following a detailed statistical analysis of the quantitative data from the 1979 TVA study, Green and Young (1990) determined a statistically valid sample size of 80 quadrats and a sampling area of 0.25 m^2. Therefore eighty 0.25 m^2 quadrats were sampled within the ~200 m^2 transplant site in 1990. Note that quadrat size and number is constant at each site, but total habitat

area available can differ among the four rivers.

TRANSPLANT SITE SURVEYS

Duck River

During the site visit in 1989, Steve Ahlstedt (TVA, Norris, TN) commented on the dramatic physical change of the transplant site. Areas which were originally shoals (0 - 2' water depth) in 1982 had water more than three feet deep, and the areas of deep water now were shallow. Transplanted Lemiox rimosus in shallow areas probably were scoured and relocated along with the substrata. Transplant site characteristics were relatively unchanged between 1989 and 1990.

Two L. rimosus were found within the transplant site resulting in an overall density of 0.1 individuals per square meter (Table 1). An additional 80 quadrats (~200 m^2 area) were sampled approximately 50 m downstream of the original transplant site. Two additional specimens were collected in the downstream quadrats for an estimated density of 0.1/m^2. Based upon the area sampled (~400 m^2) and the overall density (0.1/m^2), approximately 40 Lemiox rimosus still exist in the area sampled. One manhour was spent searching further downstream for evidence of further transport of transplanted individuals, but no additional live L. rimosus were recovered. No other live mussel species were found during this survey.

Buffalo River

During the visit to the Buffalo River transplant site in 1989, an apparent alteration of substrate was observed since 1982. Erosion of the streambanks had caused a tree, which is still present, to fall along the transplant site. This created a depositional zone of fine sediments and also reduced the channel width, resulting in higher velocities through the transplant site. Dry weather and low flows facilitated sampling efforts at the Buffalo River transplant site during 1990.

Quantitative sampling was the same as described for the Duck River site. The eighty quadrats sampled within the transplant site (~300 m^2 area) yielded no Lemiox rimosus (Table 1). One specimen, a gravid female, was collected in the additional 80 quadrats downstream of the site, resulting in a population estimate of 10 individuals near the transplant site. In addition to the 80 quadrats sampled downstream of the transplant site, approximately one manhour was spent searching the next downstream riffle (approximately 900 feet from the transplant site) for evidence of transport or movement. No L. rimosus were located during this search. Mussel specimens collected from this site in 1989 and 1990 showed evidence of rapid shell erosion typically associated with streams having a low buffering capacity, which could be a major limiting factor in the success of this transplant location. No other species of mussels were collected during the 1990 survey. Single specimens of Fusconaia barnesiana and Actinonaias pectorosa

were collected during 1989.

Nolichucky River

Steve Ahlstedt (personal communication) has indicated that heavy predation by muskrats, extensive siltation and substratum shifts have occurred at this site since 1982. In addition, during periods of drought (1985-1988), approximately one-third of the transplant site was dry and exposed. Due to these situations, he believed that the success of establishing a new population at this site would be limited. The transplant site is basically a riffle habitat with gravel and cobble substrate.

The same sampling methodology utilized for the Duck and Buffalo Rivers was applied to the Nolichucky transplant site. No specimens (in 20 m^2) were found within the transplant site (~125 m^2 area)(Table 1). One individual was recovered from 80 0.25 m^2 quadrat samples collected from immediately below the downstream end of the site (~200 m^2 area), resulting in a density of 0.05 individuals per square meter. The remaining population of Lemiox rimosus near the Nolichucky River transplant site is calculated to be 10 specimens. Other mussels collected during this survey were Amblema plicata, Cyclonaias tuberculata, Elliptio dilatata, Lampsilis ovata, Ptychobranchus fasciolaris and Quadrula pustulosa. It was noted that a bed of water willow was gradually overtaking this transplant site and eventually could cause a severe reduction in flow through the site.

North Fork Holston

Of all the transplant sites, the North Fork Holston River (NFHR) was believed to be the most likely site for a successful transplant (Steve Ahlstedt, personal communication). The basis for this opinion was due to the overall features of the site, including excellent water quality, relative lack of anthropogenic perturbations, and substrate stability and composition.

Eighty 0.25 m^2 quadrats were sampled within the transplant site (~380 m^2) and 80 immediately downstream (~200 m^2). Three L. rimosus were found within the transplant site and one outside, resulting in an overall estimated population size of 67 (Table 1). During qualitative sampling (~1 manhour) downstream of the site, no additional L. rimosus were collected. Results from the 1990 survey indicate that a greater than 50% reduction has occurred since 1989. This could be attributed to increased transport resulting from higher than normal flows during the spring of 1990. Other mussel species encountered during this survey include Amblema plicata, Lampsilis ovata, L. fasciola, Pleurobema oviforme and Villosa iris.

Raw data for the mussels collected at the four transplant sites are presented in Appendix A.

DISCUSSION

TVA quantitatively sampled the transplant areas in the spring and fall for six years (1983-1987), and in the fall for 1988. Their methodology consisted of randomly sampling 10 1.0 m^2 quadrats within the transplant area. When TVA began sampling downstream areas in 1986, sample numbers and location relative to the transplant sites varied from 0 to 33 and from just downstream to over 40 m downstream. Results of their surveys are shown in Figures 1-4. In 1988-89, YMA worked with Roger Green (University of Western Ontario, London, Ontario, Canada) to establish a sampling procedure which would ensure that the approximate size and number of areas would be sampled to best represent the population of mussels in each area sampled. Their conclusions, based on extensive statistical analyses, led to the methodologies used during the YMA surveys. Although two different methodologies (that of TVA and that of YMA) have been used to monitor the transplanted mussels, the resultant residing populations of L. rimosus in each transplant area are compared to provide an idea of what has occurred at each site since the original transplantation in 1982.

As seen in Figure 1a, the number of mussels per square meter within the Duck River site has steadily declined from 1985 to 1990. From 1983 to 1985 there was a general overall increase in the number observed, but even the highest density of 1.1/m^2 in the fall of 1985 was well below the original density of approximately 5/m^2. Figure 1b shows that density downstream of the site has remained

near 0.1 per square meter except for spring 1987 and fall 1989, when densities were 0.42/m^2 and 0.2/m^2, respectively. Of the 1000 transplanted in 1982 an estimated 20 still remain within the original area.

Analysis of the transplant data from the Buffalo (Figures 2a and 2b), Nolichucky (Figures 3a and 3b) and North Fork Holston (Figures 4a and 4b) indicated similar population trends. The density of L. rimosus within the Buffalo River site has varied among the years. There was a general decline (except Fall 1984) until the fall of 1987, at which time a twofold increase in numbers was observed from fall 1985 to fall 1987 (a fall 1986 survey was not conducted). The density has declined since 1987, with results from the 1990 survey indicating that no living specimens still remain within the transplant site itself. Densities downstream of the site have remained low (<0.275/m^2).

Figure 3a shows that the density within the Nolichucky River site has generally decreased from 2.2/m^2 in 1983 to 0/m^2 during the 1990 survey. Since none were found at the site and very few (0.05/m^2, or an estimated 10 individuals) downstream, it appears that either the mussels here did not survive within the site, did survive but were washed downstream of any sampling areas, or did not survive after being washed downstream.

The density of L. rimosus within the North Fork Holston site has gradually but steadily declined every year, except for a slight increase in the fall of 1986. The 1990 estimated density downstream of the site was ~0.05/m^2. Density estimates indicate

approximately 57 living specimens remain within the transplant area.

The fact that mussels have been collected downstream of each original site almost every year indicates that some movement has occurred. In the Duck River, for example, more mussels were found downstream than in the original site for 1989 and an equal number was found in each area for 1990. The exact numbers of mussels and distance downstream would be very difficult, if not impossible, to determine.

Estimation of population densities never exceeded 20-30 percent of the original density, even less than a year after transplantation, for the Duck, Buffalo and Nolichucky Rivers. The North Fork Holston River was the only site which appeared to have a stable L. rimosus population for the first few years after initial transplantation, but in 1985 even these mussels began to disappear until relatively few are left today. Since this site was the most similar to the original habitat in the Duck River (personal communication, Steve Ahlstedt), it would make sense that the mussels were able to survive the longest in this area compared with the other three sites. However, the continual decline in numbers of mussels since 1985 with no visible change in overall site characteristics may implicate factors such as food availability, predation, downstream movement, or a combination of these and other as yet unknown factors responsible for the survival of this species.

Regardless of the sampling technique, there has been a generally steady decline of numbers both within the transplant sites and the sampled areas downstream of the original transplant sites. This decline has several possible implications: (a) this species (L. rimosus) cannot be transplanted easily, (b) the specific sites chosen have characteristics not conducive to L. rimosus viability, (c) weather and climatic conditions have interfered or changed site characteristics from a favorable to a non-favorable environment, (d) mussels are alive (and possibly reproducing) but have been carried downstream where no sampling has occurred, (e) the host fish species are not present at the transplant sites, (f) this species is a selective feeder and the particular bacterial/algal food complex is not present, and/or (g) predation has eliminated most of the populations. The present data provide few clues as to whether these or other factors are involved in the obvious decline of the transplanted mussels.

RECOMMENDATIONS

Monitoring of the Buffalo and Nolichucky transplant sites should be discontinued. The low densities of L. rimosus at these sites (due at least in part to poor environmental/habitat) conditions suggest little success in establishing new populations of L. rimosus. We also feel that biennial surveys of the Duck River and North Fork Holston River would be adequate to assess the

population changes within these two sites and therefore recommend that the next survey be conducted in 1992.

Populations of the banded darter (Etheostoma zonale) (host fish of L. rimosus) should be monitored within selected transplant sites (Duck and North Fork Holston) during the spring (April - June). Banded darters would be collected from the transplant area with a backpack electrofisher and checked for presence of glochidia, then returned to the river. Timing of the sampling of host fish from the transplant sites would be determined by monitoring for presence of glochidia on banded darters collected from the Duck River at Lillard's Mill. This would provide current data revealing host fish availability and relative parasitism rates by glochidia (number of fish with glochidia vs. number without) from Lemiox rimosus.

One thousand uniquely marked L. rimosus from the Duck should be transplanted to the Clinch River at Kyles Ford. Five hundred transplanted mussels would be placed in permanently anchored substrate baskets, with the remaining 500 positioned in the substratum adjacent to the baskets. Kyles Ford represents an ideal location for transplantation in that it supports an abundant and diverse mussel fauna, it is known to have supported populations of L. rimosus in the past, and is a protected mussel sanctuary. Transplantation in this manner could enhance whatever population of L. rimosus exists at this location, as well as yield pertinent data with regard to the fate of transplanted mussels. After selecting a particular site for transplantation, a quantitative survey could

be conducted to determine the density of juvenile L. rimosus, if any, within the proposed site. This would allow for future documentation of recruitment through changes in density of juvenile L. rimosus within and adjacent to the transplant site.

LITERATURE CITED

Green, R.H. and Young, R.C. 1990. Sampling to detect rare species. Paper presented at the North American Benthological Society Conference, Blacksburg, Virginia, 23-25 May 1990.

Stansbery, D.H. 1972. A preliminary report on the naiad fauna of the Clinch River in the Southern Appalachian Mountains of Virginia and Tennessee (Mollusca: Bivalvia: Unionida). Bull. Am. Malacol. Union (1972): 20 - 22.

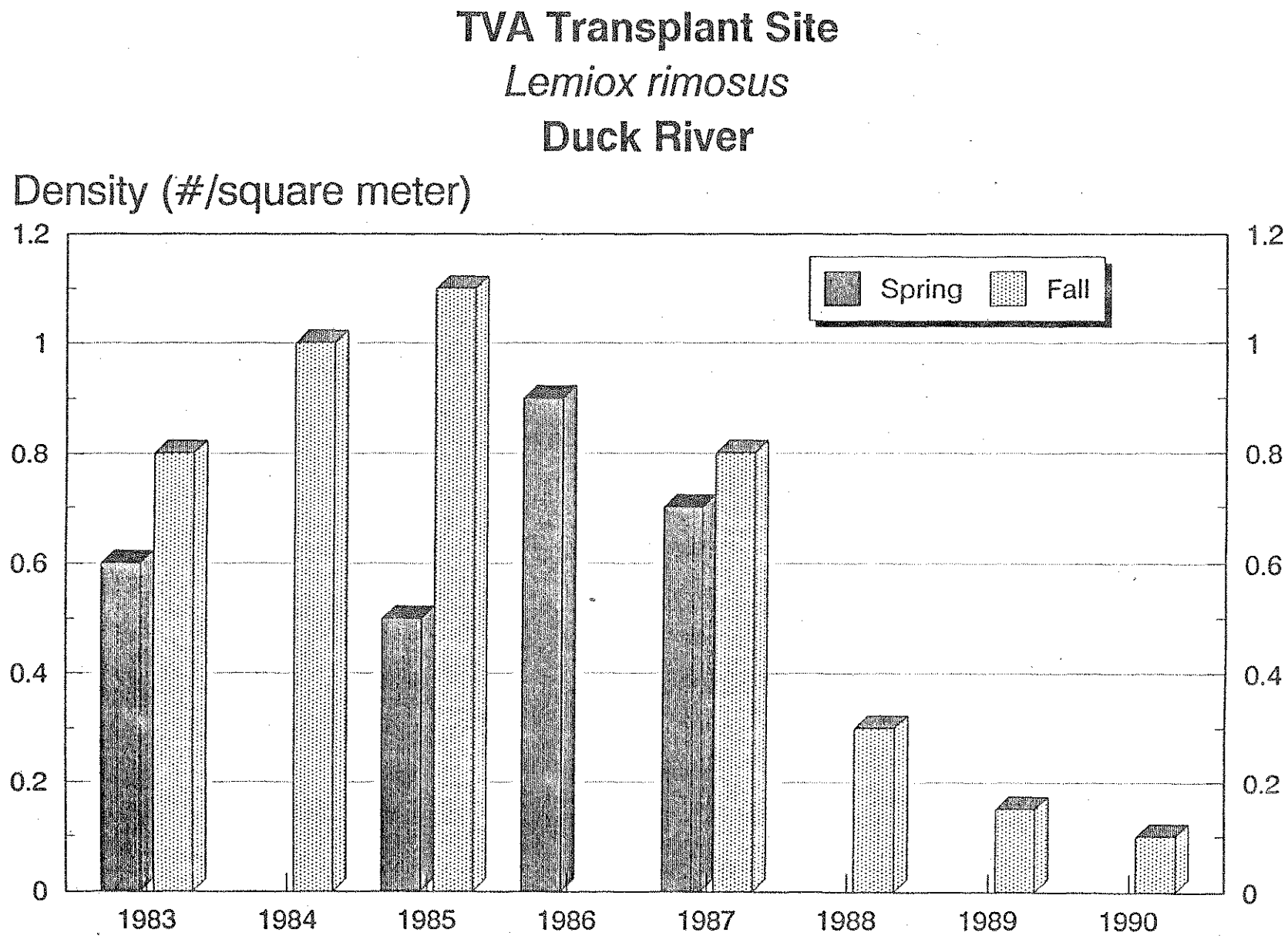

Figure 1a. Density of *Lemiox rimosus* within TVA Transplant Site (Original Density ~5/m^2).

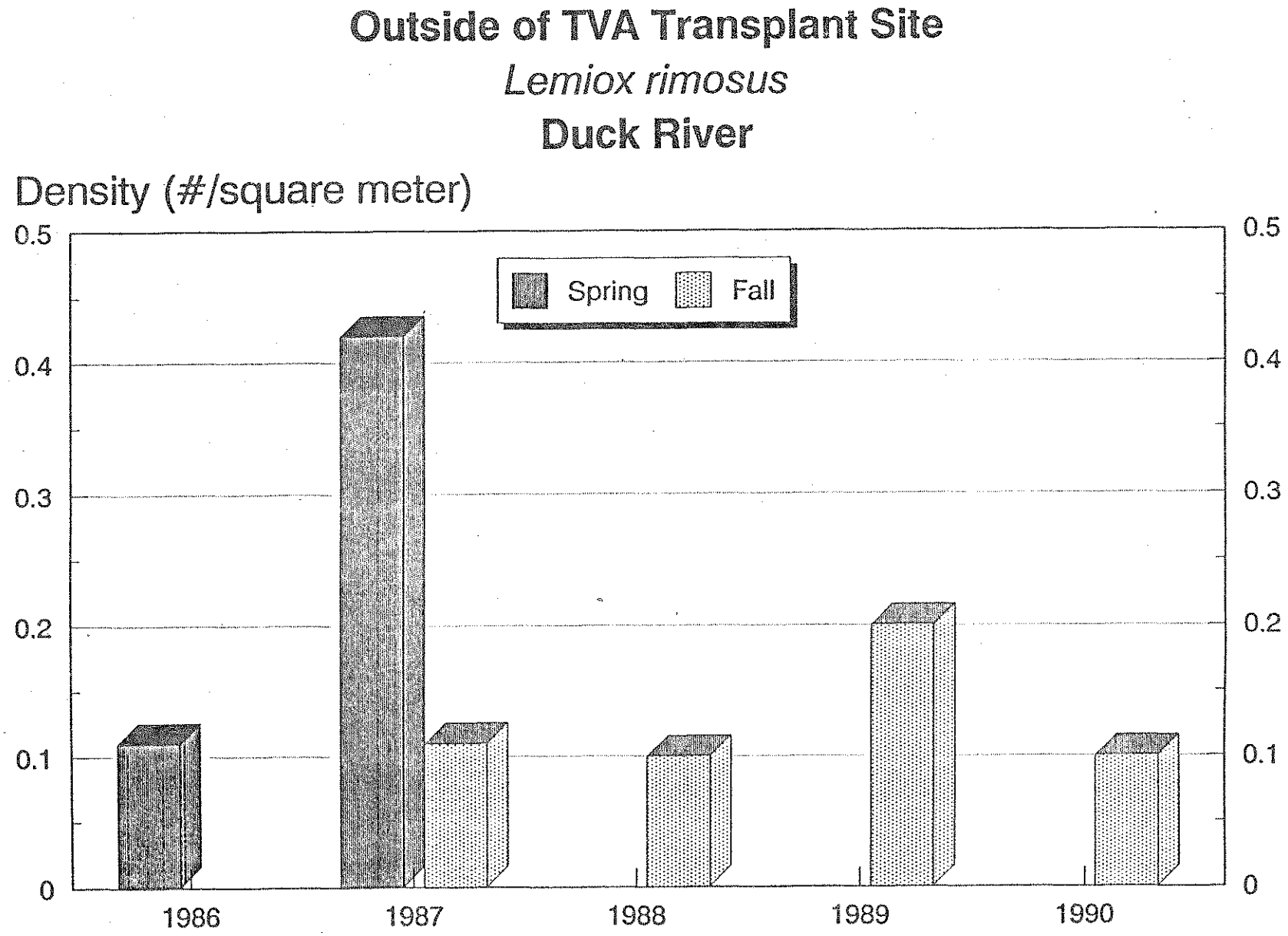

Figure 1b. Density of *Lemiox rimosus* outside TVA Transplant Site.

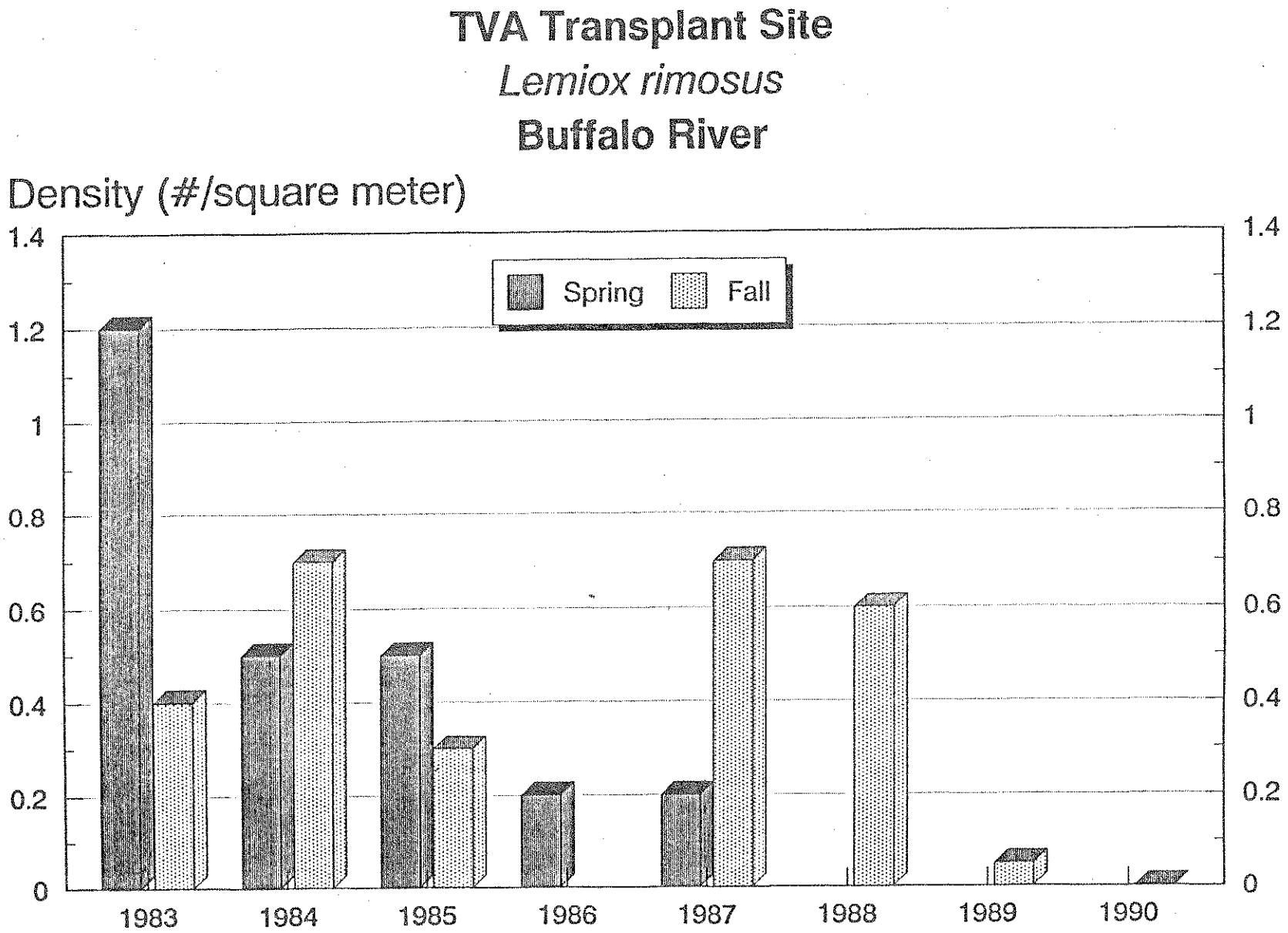

Figure 2a. Density of *Lemiox rimosus* within TVA Transplant Site (Original Density ~3/m^2).

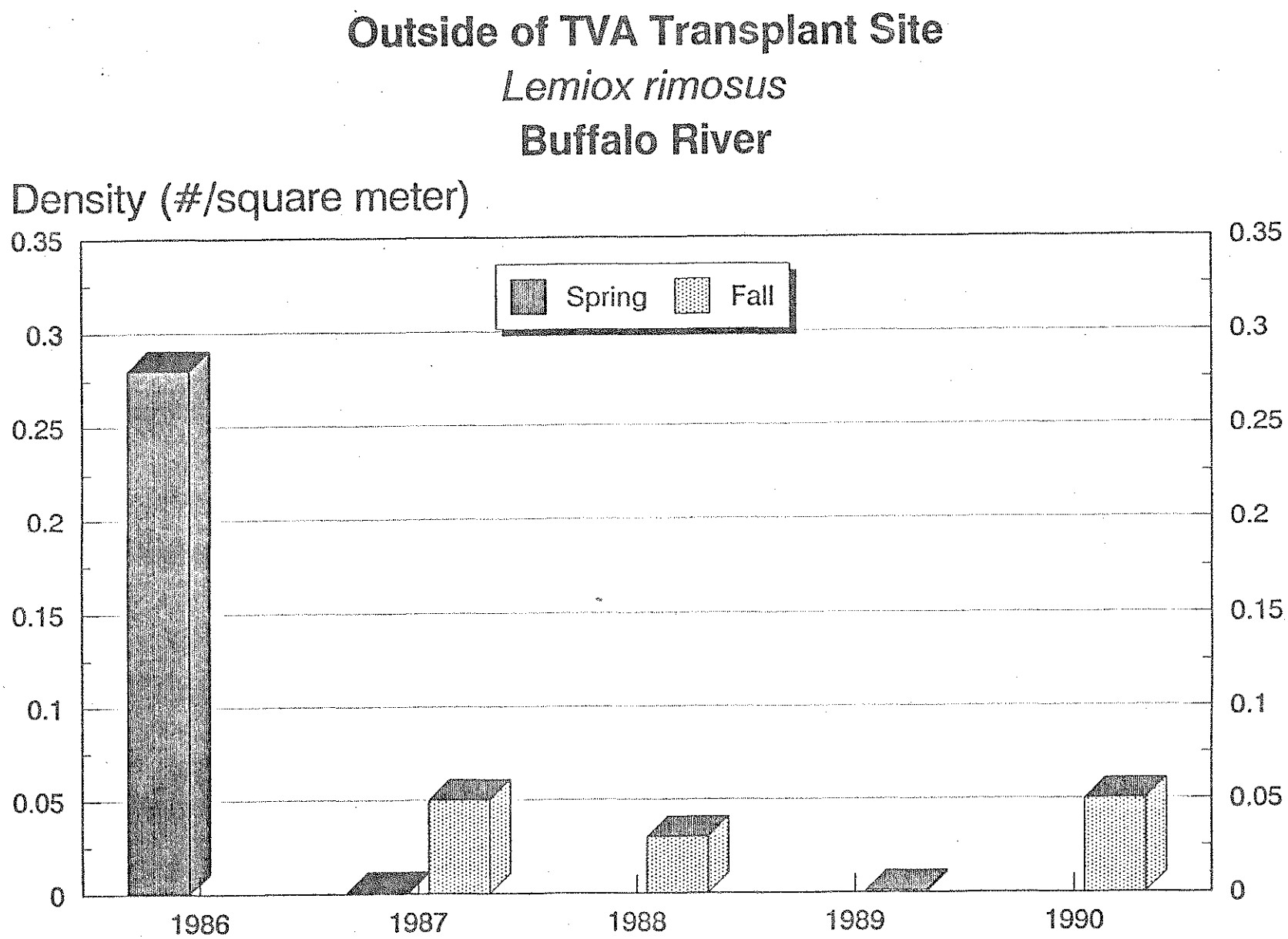

Figure 2b. Density of *Lemiox rimosus* outside TVA Transplant Site.

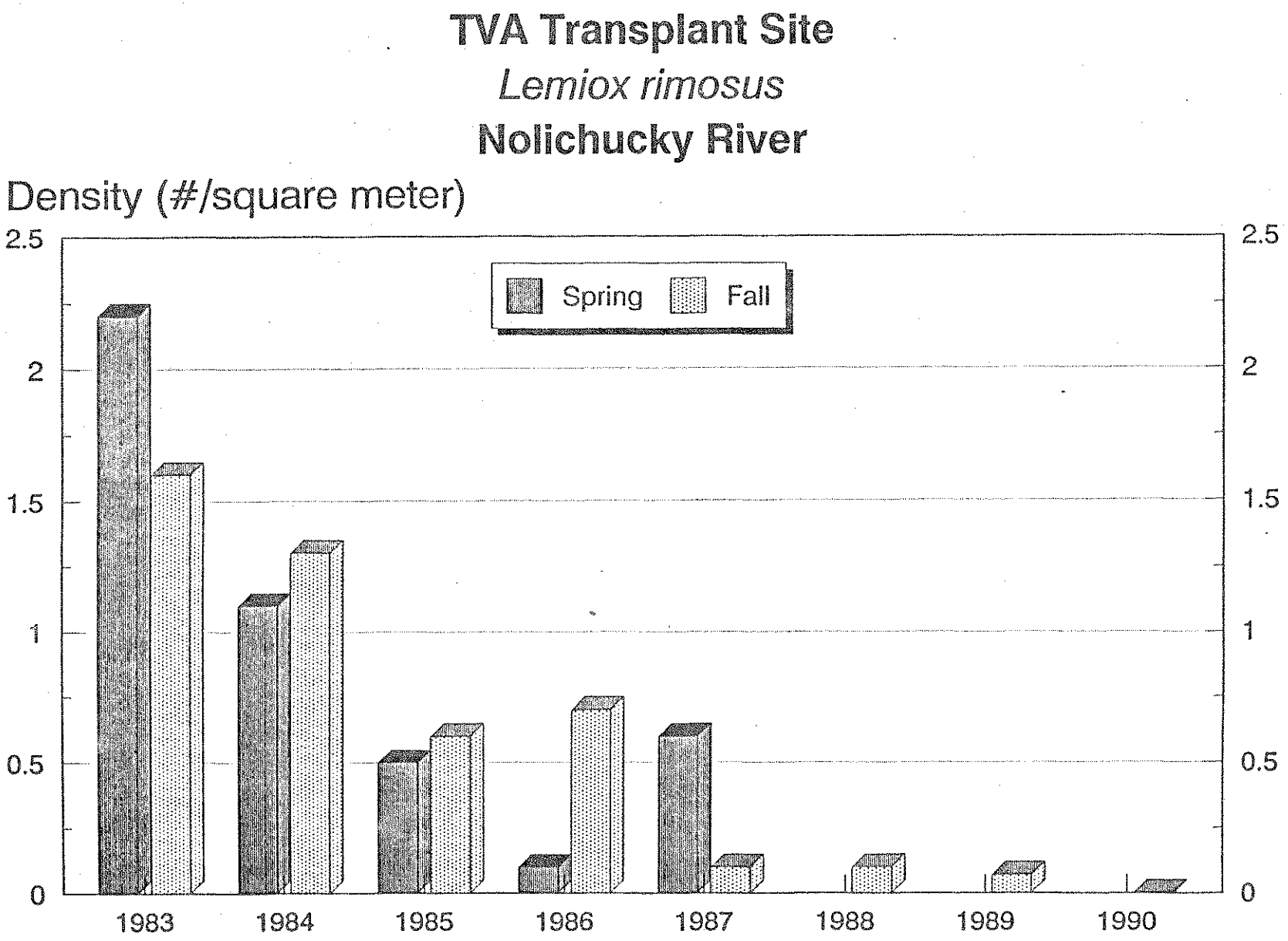

Figure 3a. Density of *Lemiox rimosus* within TVA Transplant Site (Original Density ~8/m^2).

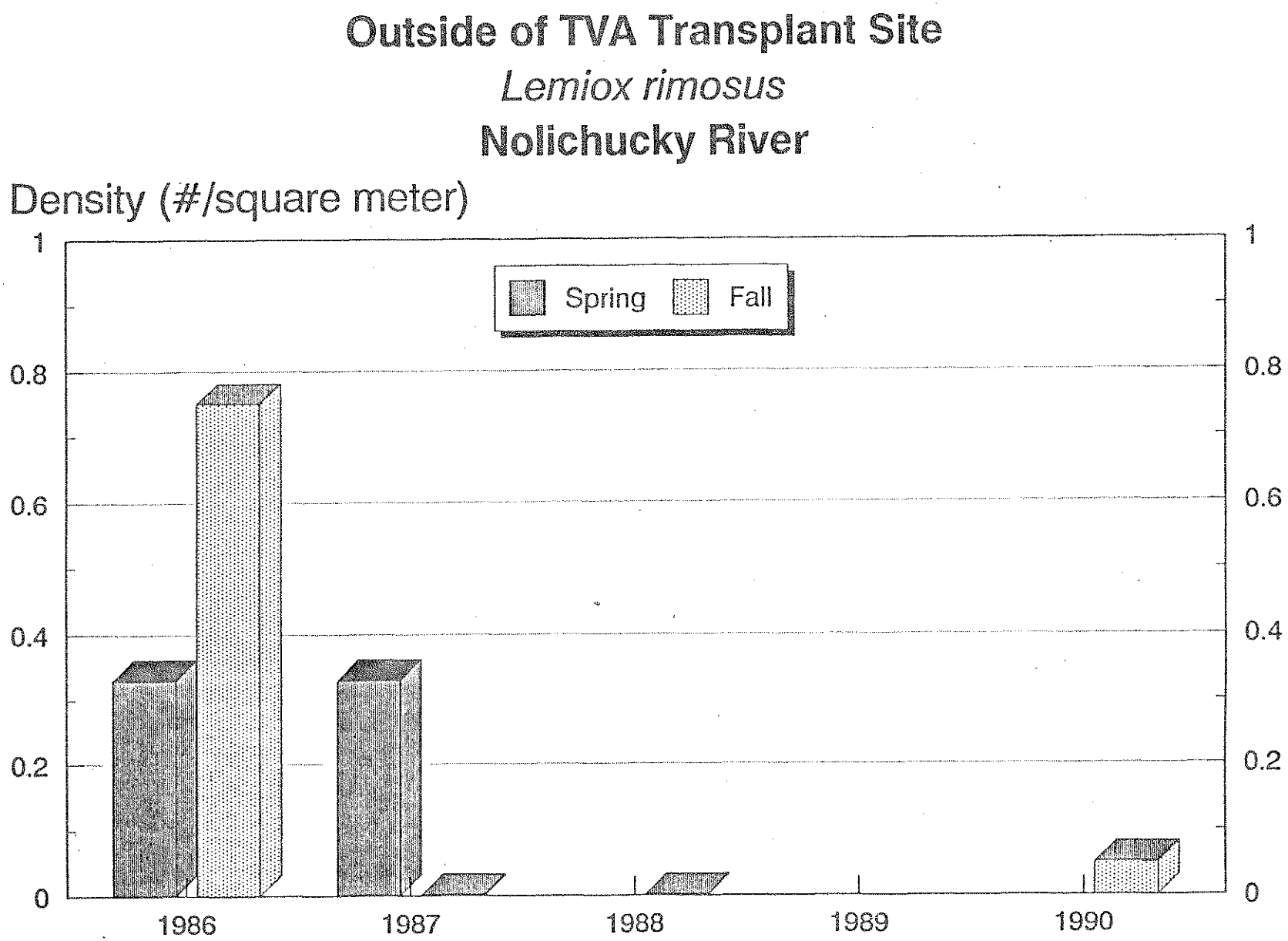

Figure 3b. Density of *Lemiox rimosus* outside TVA Transplant Site.

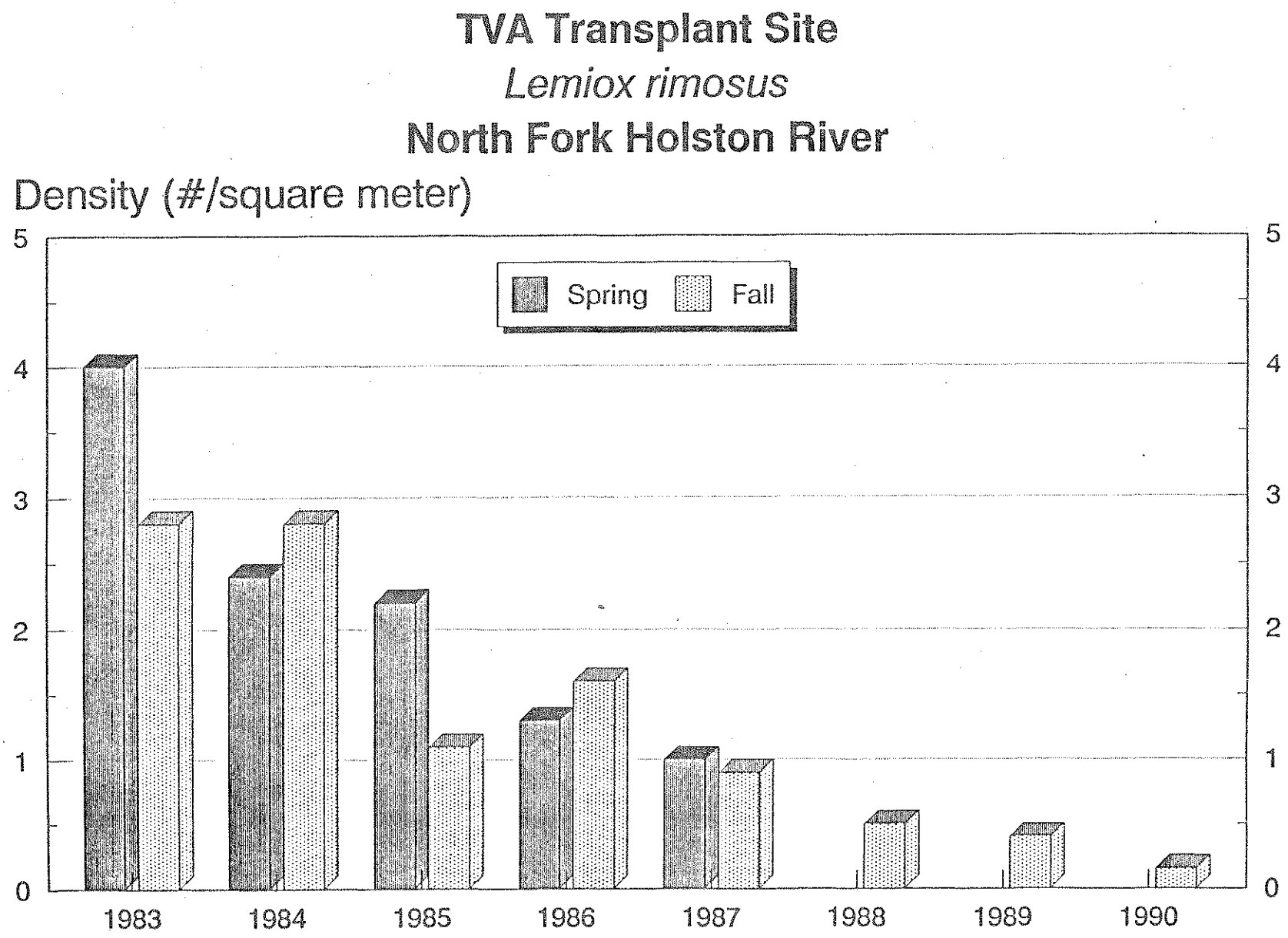

Figure 4a. Density of *Lemiox rimosus* within TVA Transplant Site (Original Density ~3/m^2).

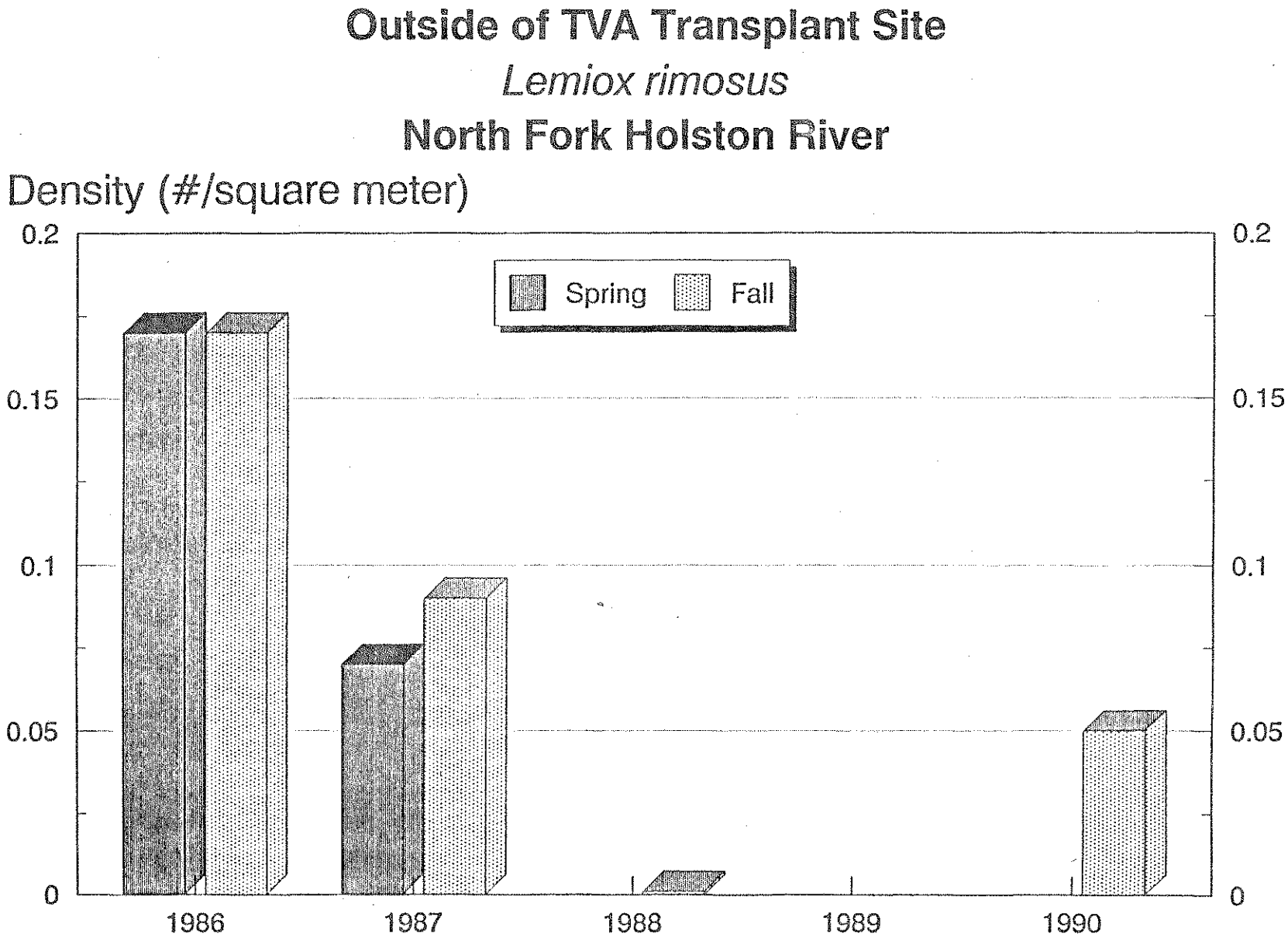

Figure 4b. Density of *Lemiox rimosus* outside TVA Transplant Site.

TABLE

Table 1. Comparison of results for 1989 and 1990 TVA *Lemiox rimosus* transplant site surveys.

River	Number Collected		Density (#/square meter)		Residing Population	
Within Transplant Area	1989[1]	1990[2]	1989	1990	1989	1990
Duck	3	2	0.15	0.10	30	20
Buffalo	1	0	0.05	0	15	0
Nolichucky	2	0	0.07	0	9	0
North Fork Holston	16	3	0.40[3]	0.15	152	57
Outside Transplant Area						
Duck	4	2	0.20	0.10	40	20
Buffalo	0	1	0	0.05	0	10
Nolichucky	N/A	1	-	0.05	-	10
North Fork Holston	N/A	1	-	0.05	-	10

[1] Based upon 40 0.5 square meter quadrats

[2] Based upon 80 0.25 square meter quadrats

[3] Based upon 80 0.5 square meter quadrats

APPENDIX A

Raw Data from Transplant Sites

River[1]	Mussel Species[2]	Length (mm)	Height (mm)	Width (mm)	Sex	Age (yrs)
Duck (A)	Lemiox rimosus	46	32	19	M	13+
	L. rimosus[3]	41	30	17	M	12+
Duck (B)	L. rimosus	36	25	18	F[4]	13+
	L. rimosus[3]	44	31	17	M	11?
Buffalo (A)						
Buffalo (B)	L. rimosus	39	28	20	F[5]	?[6]
Nolichucky (A)	Quadrula pustulosa					
Nolichucky (B)	L. rimosus	40	29	16	M	12
	Lampsilis ovata (2 specimens)					
	Cyclonaias tuberculata					
	Elliptio dilatata					
	Ptychobranchus fasciolaris					
	Amblema plicata					
North Fork Holston (A)	L. rimosus	40	32	18	M	11+
	L. rimosus	38	29	17	M	11+
	L. rimosus	39	28	17	M	11+
	Villosa iris (5 specimens)					
	Lampsilis ovata					
	Lampsilis fasciola					
	Amblema plicata					
North Fork Holston (B)	L. rimosus[3]	46	33	21	M	15+
	Pleurobema oviforme					
	Amblema plicata					
	Villosa iris (2 specimens)					

[1] (A) denotes area within the original site.
(B) denotes area downstream of original site.
[2] Measurements, sex and age taken for L. rimosus only.
[3] Collected by YMA in 1989 (Recapture).
[4] Non-gravid.
[5] Gravid.
[6] Too eroded to age.