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1995 ANNUAL REPORT

ZEBRA MUSSEL IMPACTS ON ENDANGERED UNIONIDS

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Zebra Mussel Impacts on Endangered Unionids

Because this project is jointly funded by Tennessee and Kentucky and much of the work is interrelated, all data collected in both states during both years has been consolidated in this report.

MUSSEL SAMPLING

Four sampling sites were established on the Tennessee River in 1993: TRM 18.3 (below Kentucky Dam), TRM 67.5 (near Paris Landing), TRM 109.3 (near mouth of the Duck River), and TRM 197.5 (near Diamond Island). At each site 20 quadrat (0.25 m^2) samples were collected in 1993 and 1994 by hand excavating the substrate to a depth of about 10 cm. All excavated material was placed into 6 mm mesh dive bags, brought to the surface and sieved. Except for some small (<10 mm) juvenile unionids, all mussels were measured and identified. In 1993, mussel densities ranged from 11.8 to 70.6 individuals/m^2 (Table 1). A total of 19 species were collected; species richness was greatest in the tailwaters of Kentucky Dam and Pickwick Dam. An additional 739 mussels, including one live Lampsilis abrupta, were collected from these sites during qualitative sampling in 1993 (Table 2). No zebra mussels were found in 1993. Mussel densities ranged from 6.8 to 75.2 individuals/m^2 in 1994 at the four sites (Table 3). One live zebra mussel, 5 mm long, was collected at TRM 67.5 in 1994. This individual was attached to a rock. One valve (19 mm long) of a dead zebra mussel was found at TRM 109.3 in 1994. In addition to mussels collected during quadrat sampling in 1994, we also collected a total of 4,816 mussels for transplanting to Shoal Creek and for holding at hatcheries and other facilities. We did not find any zebra mussels attached to these unionids; this further indicates the very low densities

of zebra mussels in the Tennessee River through September of 1994.

Duck River

Four sites were established on the Duck River and quantitatively sampled in 1994 and 1995. Each year,twenty-five quadrat samples were collected at each site. Based on previous work by TVA biologists, we did not expect to collect many unionids at the two sites upstream of Lillard Mill; these two sites were established primarily to determine if colonization of the Duck River by zebra mussels would occur by a potential introduction into Normandy Reservoir. Sixteen species, including the endangered Lemiox rimosus, were collected downstream of Lillard Mill in 1994 (Table 4). Unionid densities were similar between years (Tables 4 and 5). Four of the mussels collected in 1995 at DRM 195.9 were marked, indicating that they had been transplanted in 1988 (Table 5). The Lampsilis fasciola found at this site was a juvenile about 3 years old. Apparently, reproduction of the remanent mussel population is occurring in this section of the river. Although many of the mussels translocated in 1988 disappeared from the transplant site, presumably this was due to downstream displacement during high flows. A large scale effort to reestabliah mussels in this section of river should be considered if stable gravel bars can be located. No zebra mussels were found in either year.

Licking River

Four sites were selected on the Licking River and quantitatively sampled in 1994 and 1995. At each site, 25 quadrat (0.25 m^2) samples were collected. Twenty-four species of unionids were collected, with the greatest density and diversity occurring each year at the site near Butler, Pendleton Co. (Tables 6 and 7). The endangered Cyprogenia stegaria was collected at two sites in 1994 and one site in 1995. No zebra mussels were found at any site

in either year.

Green River

Five sites were established on the Green River and 25 to 38 quadrat samples were collected at each site. Densities of unionids ranged from 2.5 to 16.6 individuals per square meter (Table 8). Five Cyprogenia stegaria were collected near Munfordville. No zebra mussels were collected at any site.

EXPERIMENTAL HOLDING OF UNIONIDS

In 1994, four facilities were used to maintain captive populations of unionids. A total of 1,644 unionids of 20 species was collected and brought into captivity (Table 9). Unionids at the American Pearl Company facility at Birdsong, Laurel Hill Management Area, and at the Frankfort fish hatchery are being held in vertical cages suspended from floats. A gravel-sand mixture, 15-20 cm deep, was placed on the bottom of a concrete raceway at the Minor Clark hatchery and mussels were allowed to burrow at will. Mussel survival has been monitored on a monthly basis. Survival of most groups of mussels has been high (85 to 100%); however, unexplained high mortality occurred among some species at the Frankfort hatchery during the summer of 1994 (Table 10).

Because little is known about transporting mussels, including the amount of time they can be held out of water, we conducted two experiments with Fusconaia ebena. In each experiment, groups of 50 individuals were either packed in ice or simply placed in coolers and covered with wet burlap and held out of water for varying amounts of time and then transported to the Frankfort fish hatchery. Within one month, mortality of mussels packed on ice for 48 hours was extremely high (Table 11). In contrast, mortality was low for all groups of mussels that had been covered only with wet burlap.

Because of the threat of introducing zebra mussels into hatchery facilities, we have begun to evaluate conditions that would provide for high survival of unionids during a 30 day quarantine period. In June 1995, about 300 F. ebena were collected from Kentucky Lake and quarantined at Tennessee Tech University. These mussels were quarantined at varying densities and long-term survival is being monitored. Additional trials with varying densities and water sources are planned for 1995-1996.

Table 1. Numbers and species of unionids collected in quantitative samples at four sites on the Tennessee River in 1993.

	Site			
Species	TRM 18.3	TRM 67.5	TRM 109.3	TRM 197.5
Amblema plicata	24	19	3	2
Arcidens confragosus	1	--	--	--
Cyclonaias tuberculata	6	--	--	5
Ellipsaria lineolata	11	--	--	8
Elliptio crassidens	3	--	--	1
Elliptio dilatata	7	--	--	--
Fusconaia ebena	78	11	28	216
Fusconaia flava	4	5	1	--
Lasmigona complanata	1	--	--	--
Leptodea fragilis	9	1	--	6
Megalonaias nervosa	5	1	3	--
Obliquaria reflexa	10	10	15	25
Pleurobema cordatum	4	--	--	1
Potamilus alatus	5	9	6	1
Quadrula metanevra	1	--	--	5
Quadrula pustulosa	73	--	2	39
Quadrula quadrula	18	2	10	4
Truncilla donaciformis	7	--	29	37
Truncilla truncata	9	--	--	--
Unidentified juveniles	32	1	19	3
Total	308	59	116	353
Density (#/m^2)	61.6	11.8	23.2	70.6

Table 2. Numbers and species of unionids collected in qualitative sampling at four sites on the Tennessee River in 1993.

Species	Site			
	TRM 18.3	TRM 67.5	TRM 109.3	TRM 197.5
Amblema plicata	17	17	52	1
Arcidens confragosus	--	1	1	--
Cyclonaias tuberculata	6	--	--	13
Ellipsaria lineolata	3	--	2	7
Elliptio crassidens	--	--	--	1
Fusconaia ebena	28	13	42	30
Fusconaia flava	--	6	60	--
Lampsilis abrupta	--	--	--	1
Lampsilis teres	--	--	--	1
Leptodea fragilis	--	2	2	--
Ligumia recta	--	--	--	5
Megalonaias nervosa	1	8	22	--
Obliquaria reflexa	1	9	54	2
Pleurobema cordatum	2	--	--	2
Potamilus alatus	--	--	4	2
Pyganodon grandis	--	2	1	--
Quadrula cylindrica	--	--	--	1
Quadrula metanevra	2	--	--	17
Quadrula nodulata	--	24	12	--
Quadrula pustulosa	18	--	5	32
Quadrula quadrula	6	35	143	5
Tritogonia verrucosa	--	--	1	2
Truncilla donaciformis	--	--	15	--
Total	84	117	416	122

Table 3. Numbers and species of unionids collected in quantitative samples at four sites on the Tennessee River in 1994.

Species	Site			
	TRM 18.3	TRM 67.5	TRM 109.3	TRM 197.5
Amblema plicata	13	3	30	--
Arcidens confragosus	--	1	--	--
Cyclonaias tuberculata	10	--	--	9
Ellipsaria lineolata	10	--	1	14
Elliptio crassidens	--	--	--	1
Fusconaia ebena	49	2	17	236
Fusconaia flava	--	--	9	--
Leptodea fragilis	--	1	--	3
Ligumia recta	2	--	--	3
Megalonaias nervosa	--	1	4	--
Obliquaria reflexa	12	3	24	34
Pleurobema cordatum	9	--	--	--
Potamilus alatus	4	4	9	1
Quadrula nodulata	1	--	3	--
Quadrula metanevra	5	--	1	8
Quadrula pustulosa	46	3	4	56
Quadrula quadrula	9	--	13	2
Truncilla donaciformis	--	--	98	9
Truncilla truncata	6	--	--	--
Unidentified juveniles	2	16	29	--
Total	178	34	242	376
Density (#/m^2)	35.60	6.80	48.40	75.20

Table 4. Numbers and species of unionids collected in quantitative samples at four sites on the Duck River in 1994.

Species	Site			
	DRM 135.5	DRM 171.6	DRM 195.9	DRM 239.7
Amblema plicata	4	1	--	--
Cyclonaias tuberculata	4	1	--	--
Lampsilis fasciola	--	1	1	--
Lasmigona costata	--	1	--	--
Lemiox rimosus	--	1	--	--
Leptodea fragilis	3	--	--	--
Megalonaias nervosa	1	--	--	--
Obliquaria reflexa	6	--	--	--
Potamilus alatus	1	1	--	--
Ptychobranchus fasciolaris	1	--	--	--
Pyganodon grandis	--	1	--	--
Quadrula cylindrica	--	1	--	--
Quadrula pustulosa	6	1	--	--
Quadrula quadrula	2	--	--	--
Truncillia truncata	2	2	--	--
Tritogonia verrucosa	2	--	--	--
Unidentified juveniles	2	--	--	--
Total	34	11	1	0
Density (#/m^2)	5.44	1.76	0.16	0.00

Table 5. Numbers and species of unionids collected in quantitative samples at four sites on the Duck River in 1995.

	Site			
Species	DRM 135.5	DRM 171.6	DRM 195.9	DRM 239.7
Amblema plicata	3	2	--	--
Arcidens confragosus	1	--	--	--
Cyclonaias tuberculata	9	3	4	--
Elliptio dilatata	--	3	1	--
Lampsilis fasciola	--	--	1	--
Lasmigona costata	1	1	--	--
Megalonaias nervosa	1	1	1	--
Obliquaria reflexa	8	--	--	--
Potamilus alatus	1	--	--	--
Ptychobranchus fasciolaris	2	1	--	--
Quadrula pustulosa	3	1	--	--
Quadrula quadrula	2	--	--	--
Truncillia donaciformis	1	--	--	--
Truncillia truncata	2	--	--	--
Tritogonia verrucosa	2	--	--	--
Total	36	12	7	0
Density (#/m^2)	5.76	1.92	1.12	0.00

Table 6. Number and species of mussels collected in quantitative samples from four sites on the Licking River in 1994.

	Site*			
Species	24	43	91	164
Actinonaias ligamentina	72	12	7	15
Amblema plicata	9	2	--	24
Cyclonaias tuberculata	--	--	--	14
Cyprogenia stegaria	--	--	1	4
Elliptio dilatata	24	6	10	37
Fusconaia flava	4	3	1	1
Fusconaia subrotunda	2	--	--	--
Lampsilis cardium	--	--	--	3
Lampsilis siliquoidea	--	1	--	--
Lasmigona complanata	--	--	--	2
Lasmigona costata	--	--	6	15
Leptodea fragilis	--	--	1	3
Megalonaias nervosa	--	--	1	14
Obliquaria reflexa	--	--	--	1
Pleurobema coccineum	1	--	--	--
Potamilus alatus	--	--	1	4
Ptychobranchus fasciolaris	13	3	1	2
Quadrula metanevra	--	--	--	1
Quadrula nodulata	--	--	--	4
Quadrula pustulosa	2	2	--	19
Quadrula quadrula	5	--	--	--
Tritogonia verrucosa	1	--	--	1
Truncilla donaciformis	--	--	--	3
Truncilla truncata	--	--	1	4
Unidentified juveniles	--	--	--	1
Total	133	29	30	171
Density (#/m^2)	21.28	4.64	4.80	27.36

*Site numbers refer to sites in: Laudermilk, E.L. 1990. A survey of the unionids (Bivalvia: Unionidae) of the mainstream Licking River and selected tributaries below Cave Run Reservoir, Kentucky. M.S. Thesis, Eastern Kentucky University, Richmond.

Table 7. Number and species of mussels collected in quantitative samples from four sites on the Licking River in 1995.

Species	Site*			
	24	43	91	164
Actinonaias ligamentina	56	4	21	21
Amblema plicata	6	--	1	12
Cyclonaias tuberculata	1	--	--	10
Cyprogenia stegaria	--	--	--	4
Elliptio dilatata	23	2	17	32
Epioblasma triquetra	1	--	--	--
Fusconaia flava	--	--	--	--
Fusconaia subrotunda	2	--	--	--
Lampsilis cardium	--	--	2	--
Lampsilis siliquoidea	--	--	--	--
Lasmigona complanata	--	--	--	--
Lasmigona costata	--	--	17	13
Leptodea fragilis	--	--	--	1
Ligumia recta	--	--	--	2
Megalonaias nervosa	--	--	2	6
Obliquaria reflexa	--	--	--	4
Pleurobema coccineum	1	3	2	--
Potamilus alatus	--	--	1	--
Ptychobranchus fasciolaris	6	1	5	1
Quadrula metanevra	1	--	--	1
Quadrula nodulata	--	--	--	--
Quadrula pustulosa	2	--	1	8
Quadrula quadrula	2	--	--	1
Strophitus undulatus	1	--	--	--
Tritogonia verrucosa	--	--	--	--
Truncilla donaciformis	--	--	--	6
Truncilla truncata	--	--	1	--
Unidentified	--	--	1	2
Total	102	10	71	124
Density (#/m^2)	16.32	1.60	11.36	19.84

*Site numbers refer to sites in: Laudermilk, E.L. 1990. A survey of the unionids (Bivalvia: Unionidae) of the mainstream Licking River and selected tributaries below Cave Run Reservoir, Kentucky. M.S. Thesis, Eastern Kentucky University, Richmond.

Table 8. Numbers and species of mussels collected in quantitative samples from five sites on the Green River.

	Site				
Species	1	2	3	4	5
Actinonaias ligamentina	42	41	58	131	1
Amblema plicata	5	17	4	4	--
Cyclonaias tuberculata	--	2	1	3	--
Cyprogenia stegaria	--	--	5	--	--
Elliptio crassidens	--	1	--	1	1
Elliptio dilatata	8	--	1	5	--
Fusconaia flava	--	--	--	1	--
Lampsilis cardium	1	--	1	1	--
Lampsilis ovata	--	--	1	--	--
Megalonaias nervosa	--	--	--	3	3
Obliquaria reflexa	--	--	--	1	1
Pleurobema cordatum	--	--	--	--	3
Pleurobema spp.	--	--	5	3	--
Ptychobranchus faciolaris	5	1	1	1	--
Quadrula metanevra	--	--	--	2	--
Quadrula pustulosa	1	--	2	1	--
Truncillia truncata	--	2	2	1	7
Total	62	64	81	158	16
Number of Samples	36	25	36	38	25
Density (#/m^2)	6.89	10.24	9.00	16.63	2.56

Table 9. Numbers and source of unionids being held at four facilities in Tennessee and Kentucky.

		Numbers and Holding Facility			
Species	Source	Birdsong	Frankfort Hatchery	Minor Clark Hatchery	Laurel Hill Mgt. Area
Actinonaias ligamentina	Licking R., KY	50	50	50	--
Amblema plicata	Elkhorn Ck., KY	--	31	--	--
Cyclonaias tuberculata	Tenn. R., TN	101	--	--	--
Elliptio dilatata (1) (2)	Elkhorn Ck., KY Licking R., KY	-- 101	123 --	-- 104	-- --
Ellipsaria lineolata (1) (2)	Tenn. R., TN Cumberland R., TN	-- --	40 --	-- --	-- 14
Fusconaia ebena	Tenn. R., TN	50	400	--	--
Lampsilis cardium (1) (2)	Elkhorn Ck., KY Licking R., KY	-- --	1 --	-- 5	-- --
Lampsilis fasciola	Elkhorn Ck., KY	--	3	--	--
Lampsilis siliquoidea	Elkhorn Ck., KY	--	54	--	--
Lasmigona costata (1) (2)	Elkhorn Ck., KY Licking R., KY	-- 8	22 --	-- --	-- --
Megalonaias nervosa (1) (2)	Elkhorn Ck., KY Cumberland R., TN	-- --	2 --	-- --	-- 4
Pleurobema coccineum	Licking R., KY	13	--	27	--
Pleurobema cordatum	Cumberland R., TN	--	--	--	175
Potamilus alatus	Elkhorn Ck., KY	--	2	--	--
Ptychobranchus fasciolaris (1) (2)	Licking R., KY Cumberland R., TN	59 --	-- --	50 --	-- 1
Quadrula metanevra	Cumberland R., TN	--	--	--	5
Quadrula nodulata	Cumberland R., TN	--	--	--	1
Quadrula pustulosa	Cumberland R., TN	--	--	--	2
Quadrula quadrula	Cumberland R., TN	--	--	--	20
Tritogonia verrucosa	Licking R., KY	--	--	38	--
Totals		382	766	274	222

Table 10. Numbers, species, and survival of mussels held in captivity.

BIRDSONG (Embayment of Kentucky Lake)

SPECIES	N	SURVIVAL	MONTHS IN CAPTIVITY
Actinonaias ligamentina	50	90%	11
Cyclonaias tuberculata	101	99%	21
Elliptio dilatata	101	98%	11
Fusconaia ebena	50	100%	12
Lasmigona costata	8	100%	10
Pleurobema coccineum	13	85%	10
Ptychobranchus fasciolaris	59	85%	10

LAUREL HILL (Farm Pond)

SPECIES	N	SURVIVAL	MONTHS IN CAPTIVITY
Ellipsaria lineolata	14	100%	9
Megalonaias nervosa	4	50%	9
Pleurobema cordatum	175	99%	9
Ptychobranchus fasciolaris	1	100%	9
Quadrula metanevra	5	100%	9
Quadrula pustulosa	2	100%	9
Quadrula quadrula	20	90%	9

MINOR CLARK HATCHERY (Raceway)

SPECIES	N	SURVIVAL	MONTHS IN CAPTIVITY
Actinonaias ligamentina	50	98%	11
Elliptio dilatata	105	99%	11
Lampsilis cardium	5	100%	11
Pleurobema coccineum	27	100%	11
Ptychobranchus fasciolaris	50	98%	11
Trilogonia verrucosa	39	100%	11

FRANKFORT HATCHERY (Pond)

SPECIES		N	SURVIVAL	MONTHS IN CAPTIVITY
Amblema plicata		31	91%	10
Actinonaias ligamentina		40	42%	11
Elliptio dilatata	Group 1	103	12%	12
	Group 2	49	100%	9
Lampsilis siliquoidea	Group 1	11	55%	12
	Group 2	43	98%	10
Lasmigona costata	Group 1	9	23%	12
	Group 2	13	85%	10

Table 11. Percent mortality of Fusconaia ebena held out of water for various lengths of time and either packed on ice or covered with wet burlap. Each treatment group consisted of 50 individuals (Total = 400).

	Ice		
Time	Test #1	Test #2	Wet Burlap
9 h	6%	--	4%
24 h	4%	20%	2%
48 h	62%	86%	8%