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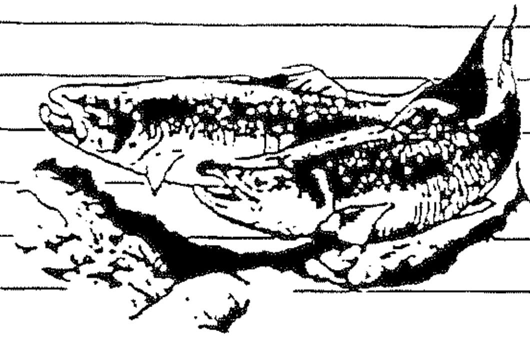
Research



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Unionid Mussels Survive Handling and Aerial Exposure in Fall and Spring Field Trials

Freshwater mussels are frequently collected and held out of water during field surveys, commercial clamming operations, and relocation studies. Generally, the tolerance of mussels to handling is considered relatively high and little attention is given to their condition and survival after replacement in the water. Factors affecting survival, such as water temperature, time out of water, and species sensitivity, have not been thoroughly investigated. Because of decreasing water temperatures, mussels may be slow to reposition and burrow when displaced in late fall, thereby increasing their susceptibility to predation and current transport. Conversely, displacement in spring and early summer may stress reproductively active individuals. Further, shell morphology may determine a mussel's ability to tolerate aerial exposure. For example, thick-shelled mussels with a tight valve closure may withstand aerial exposure longer than mussels with thin to moderately thick shells and a slightly gaping valve.

We evaluated the effects of handling and aerial exposure on the survival of freshwater mussels, and compared the migration and survival rates among mussels that were displaced in fall and in spring.

Mussels Were Held Out of Water As Long As Eight Hours

The study was conducted at an existing mussel bed in Pool 7 (river mile 713.2) of the upper Mississippi River. We collected four species of mussels within the study area, including threeridge, (*Amblema plicata plicata*) threehorn wartyback, *(Obliquaria reflexa)*, pocketbook *(Lampsilis ventricosa)*, pimpleback *(Quadrula pustulosa)*, and Wabash pigtoe (*Fusconaia flava)* and held them in submerged cages overnight. A 3×3-m grid of PVC pipe was used to mark nine 1-m^2 squares; three squares served as controls and resident mussels within the squares were left undisturbed. Six squares served as placement squares. All resident mussels in these squares were removed, counted, and identified to estimate natural density and mortality. Treatments were evaluated in triplicate (n = 25) for threeridge and threehorn wartyback only. Because of low availability, one replicate per treatment was used for pimpleback (n = 20) and Wabash pigtoe (n = 25). The treatments were 0-, 1-, 4- or 8-h air exposure. Mussels were marked with a dremel tool to identify each replicate and treatment and held out of water for the designated time. After treatment, mussels were placed in the appropriate grid square with the anterior one-fourth of the animal buried in the substrate. The spring study was conducted in early June 1992 and the fall study was conducted in October 1992. Water temperature did not vary appreciably (± 1°C) between the time of removal and replacement of mussels. Air temperature was measured hourly during aerial exposure. Air temperatures during each sampling period were 18–28°C in spring and 12–23°C in fall; water temperatures were 23°C in spring and 15.5°C in fall.

Mussels in the study grids were reexamined after 6 months. Recovery was defined as the number of marked mussels that were recaptured at 6 months divided by the number originally marked. The mortality of mussels in each treatment was estimated as number dead divided by total number of marked mussels and shells recovered; an adjusted mortality was estimated as number dead divided by total number of mussels originally marked. Natural mortality was estimated by comparing the number of shells taken from the control squares at the 6-month resurvey to the number of shells collected from the placement squares at the beginning of the trial. Migration between squares was estimated from the number of marked mussels found outside of their original placement square. Data were analyzed statistically by one-way analysis of variance (ANOVA) with PC-SAS.

Mussels Survive Extended Periods of Aerial Exposure in Moderate Temperatures

The overall percent recovery of marked mussels in spring and fall was more than 85% (Table 1). The only treatment with a significantly lower recovery rate was the 8-h exposure of threehorn wartyback during the spring study (38.7% recovery). The percent migration of mussels from their original placement squares was low. The highest percent migration (12.3%) was observed in threehorn wartyback in the spring study (Table 1).

The mortality of Wabash pigtoe and pimpleback mussels was low (0–22%) and showed no significant differences among treatments or between studies (Table 2). The mean mortality of threeridge and threehorn wartyback was also low; although not statistically significant, there was a notable increase in mortality in the 8-h treatment in spring (Table 2). The adjusted mean percent mortality, however, calculated with the original number of mussels marked, was significantly greater in the 8-h treatment of threehorn wartyback in spring (65.3%). This was the only group for which the initial and adjusted mortality were significantly different and the difference was attributed to the low recovery rate.

The water and air temperatures during our studies were relatively moderate. Mussels survived up to 4-h aerial exposure and replacement in water at these temperatures. The four species survived up to 4 h of aerial exposure equally well and there were no significant differences in mortality among the 0-, 1-, and 4-h treatments. However, we suspect that the low recovery of threehorn wartyback mussels in the 8-h treatment during spring was because of the death of the mussels and displacement of the shells downstream by water currents.

Although survival was lowest in the 8-h spring trial, we found no marked difference in survival between the fall and spring trials in aerial exposures of 4 h or more. A minimal period of aerial exposure is advisable, but it may be most important to schedule mussel collections during periods of minimal reproductive activity. In this study, we observed mussels prematurely releasing glochidia and sperm during aerial exposure, which indicated not only stress, but loss of reproductive effort for the year. Generally, mussels have lower food reserves and higher reproductive demands in spring than in fall. Handling mussels in fall, before cold temperatures ensue, would avoid disruption of spawning and glochidial release by many mussel species.

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Table 1. Recovery and migration of marked mussels 6 months after handling and exposure treatments.

	Percent recovery		Percent migration	
Species	Spring	Fall	Spring	Fall
Amblema plicata	97.7	93.6	2.0	0.4
Fusconaia flava	95.0	83.0	3.0	1.2
Quadrula pustulosa	91.3	60.0[a]	8.7	0
Obliquaria reflexa	81.3b[a]	90.3	12.3	2.2

[a] Recovery of mussels in the control group was 0%.
[b] Recovery of mussels in the 8-h treatment was significantly lower than in other treatment groups (38.7%; $P > 0.0003$).

Table 2. Percent mortality of mussels after handling and emersion.

Exposure duration (h)	Percent mortality							
	Spring study				Fall study			
	Amblema plicata	*Obliquaria reflexa*	*Fusconaia flava*	*Quadrula pustulosa*	*Amblema plicata*	*Obliquaria reflexa*	*Fusconaia flava*	*Quadrula pustulosa*
0	5.4	1.4	0	0	1.5	2.8	0	0
1	5.7	1.4	0	0	0	1.5	0	22
4	5.1	3.2	0	0	1.4	1.3	0	0
8	21.5	10.8	0	0	1.6	0	0	0