

TRANSLOCATION OF FRESHWATER MUSSELS (BIVALVIA: UNIOINIDAE) FROM THE FORMER PLAINWELL IMPOUNDMENT AREA ON THE KALAMAZOO RIVER, MICHIGAN

Report to the U.S. Fish and Wildlife Service,

Region 3,

East Lansing Field Office

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INTRODUCTION/BACKGROUND

In 2008, a Time Critical Removal Action (TCRA) was conducted to remove Polychlorinated biphenyls (PCBs) in the Kalamazoo River within the former impoundment area of the Plainwell dam. As part of the removal action the flow of the river was diverted from the spillway channel to the former power house channel. This diversion made the river free-flowing in its historical channel, and stopped flows over the remaining concrete spillway structure of the former Plainwell dam (Figures 1, 2, 3).

In 2000 and 2001, a mussel bed approximately 200 feet downstream from the concrete structure of the former Plainwell dam was found on the spillway channel side (Mulcrone and Mehne, 2001). A majority of the mussel community was composed of mucklets, *Actinonaias ligamentina*. This population as well as the white heelsplitter, *Lasmigona complanata*, were considered to be reproducing since individuals less than 3 years old were present. *Actinonaias ligamentina* and *L. complanata* are usually found in larger rivers, and *A. ligamentina* usually requires a gravelly habitat with flowing water (Parmalee, 1967; van der Schalie, 1938; Watters et al, 2009). *Lasmigona complanata* can be found in more sluggish waters. Because the river flow immediately downstream from the former spillway of the Plainwell dam was halted when TCRA work was complete, the area began to silt in and was no longer suitable for riverine mussels.

The Michigan Department of Natural Resources (MDNR) and U. S. Fish and Wildlife Service (USFWS) decided to relocate the mussels to a more suitable habitat. This report records the relocation activities from June 18 to September 11, 2009, for the mussel bed below the former Plainwell dam.

METHODS

Five visits (June 18, June 25, July 17, August 21 and September 11) were made below the former Plainwell dam to search for and translocate mussels upstream. Mussels were removed from the area by snorkeling, searching by hand or using nets to scoop the substrate (where areas were too deep or too silty to dig) (Figure 4). Time spent on searching per person hour was noted to evaluate the catch per unit effort.

Mussels were placed in mesh bags and kept in water until identified and counted. Mussels were marked with an "x" using a small, battery operated drill to distinguish translocated mussels from resident mussels upstream in future follow-up surveys. Bags with mussels were kept within the river until time of transportation, where they were placed in containers and kept wet (Figure 5). Time of transport from downstream to upstream site was less than 15 minutes. Mussels were placed in the river at the translocation site anterior side down.

Mussels were placed approximately 1 mile upstream, about 100 to 500 feet downstream of the U.S. 131 bridge (Figures 6 and 7). This particular area was picked for translocation because 1) the hydrology is considered to be stable following TCRA work since it is at the upstream limit of the influence of the former Plainwell dam (pers comm. MDNRE, ARCADIS Engineering) and 2) live mussels of the same species composition were found in the area. Previous studies (Mulcrone and Mehne, 2001) found

reproducing populations in this area (Figure 8). The stretch of river downstream of the selected translocation site was not suitable because the TCRA project and dam removal decreased the stability of sediments. Sediment erosion is expected to occur at the formerly impounded section as the river adjusts to a free-flowing state. Gravelly areas below the former impoundment structure were not selected for translocation because they did not have live mussels.

GPS readings were taken at translocation sites at both the collection area and the translocation areas (Figure 1).

During the first visit, approximately 280 mussels lengths were measured and growth rings were counted for aging. Ages and measurements were used to give a demographic overview of the population and to note recruitment. Rings are assumed to be annual markers of growth, however, this aging method is fairly crude and growth rings on some species are particularly difficult to distinguish. On subsequent visits, ages were not estimated although mussels four years or younger were noted.

Collections included live and dead mussels so that mortality rates could be determined. Mussel shells are often found within beds as a result of natural mortality. Mussels were classified as “fresh dead”, when tissue remained within the mussel shell (Figures 9 and 10) or “recent dead” when no tissue remained, but the pearly nacre was still present and shiny. These shells were removed from the area where mussels were being retrieved so they would not be re-counted in subsequent removals. Other shells of different species that were not fresh or recently dead were noted.

Shells were collected for deposition into the University of Michigan Museum of Zoology’s Mollusk Division collection.

RESULTS

A total of 1554 mussels were removed from the area below the former Plainwell dam and translocated upstream (Table 1). Seven species were moved, with the mucket, *Actinonaias ligamentina* making up 87% of the total. The white heelsplitter, *Lasmigona complanata*, was 10% of the fauna and the pocketbook, *Lampsilis cardium*, approximately 2.8%. The rest of the species (cylindrical paper shell, *Anodontoides ferrusianus*, fat mucket, *Lampsilis siliquoidea*, fluted shell, *Lasmigona costata*, and creeper, *Strophitus undulatus*) were each less than 1% of the total.

Forty-seven person hours were spent searching for the mussels, ranging from 15 (first visit) to 5 (last visit) person-hours (Table 2). Catch per unit effort declined from 40 to 11 mussels per hour searching from June 15 to July 25. The rates increased slightly over the next two visits (August 21 and September 11). The increase was likely due to lower water levels (Figure 11) that made collection easier.

Mussel mortality was recorded on the first (June 18) and last (September 11) visits. Fifty-three mussels were recorded as fresh dead and 71 mussels were recent dead on June 18 (Table 3; Figures 12 and 13). The fresh and recent dead mussels together made up 13.8% of the population removed from the substrate. Total fresh dead collected the first day on the last day made up 6.8% percent of the mussels

retrieved. A majority of the fresh dead mussels were *A. ligamentina*. No live *A. marginata* or *L. siliquoidea* were found in the collection area, however one of each of these species was found dead with tissue present.

Fewer mussels were collected on September 11 than June 18, but approximately 7.7% of the mussels collected were fresh dead. On September 11, the fresh and recent dead mussels together made up 34.4% of the population removed from the substrate as opposed to 13.89% on June 18. Again, the majority of fresh dead mussels were *A. ligamentina*.

Age was plotted against length to get a rough demographic estimate of the age classes present for the two most common species, *A. ligamentina* and *L. complanata* (Tables 4 and 5). Ages and numbers are presented as natural breaks interpreted by Mehne and Associates. The estimated average age of *A. ligamentina* was 7.8 years and ranged from four to 11 years. The estimated average age of *L. complanata* was 6.4 years, ranging from two to 10 years. Ages of *Lampsilis cardium* were noted from 4 to 10 years.

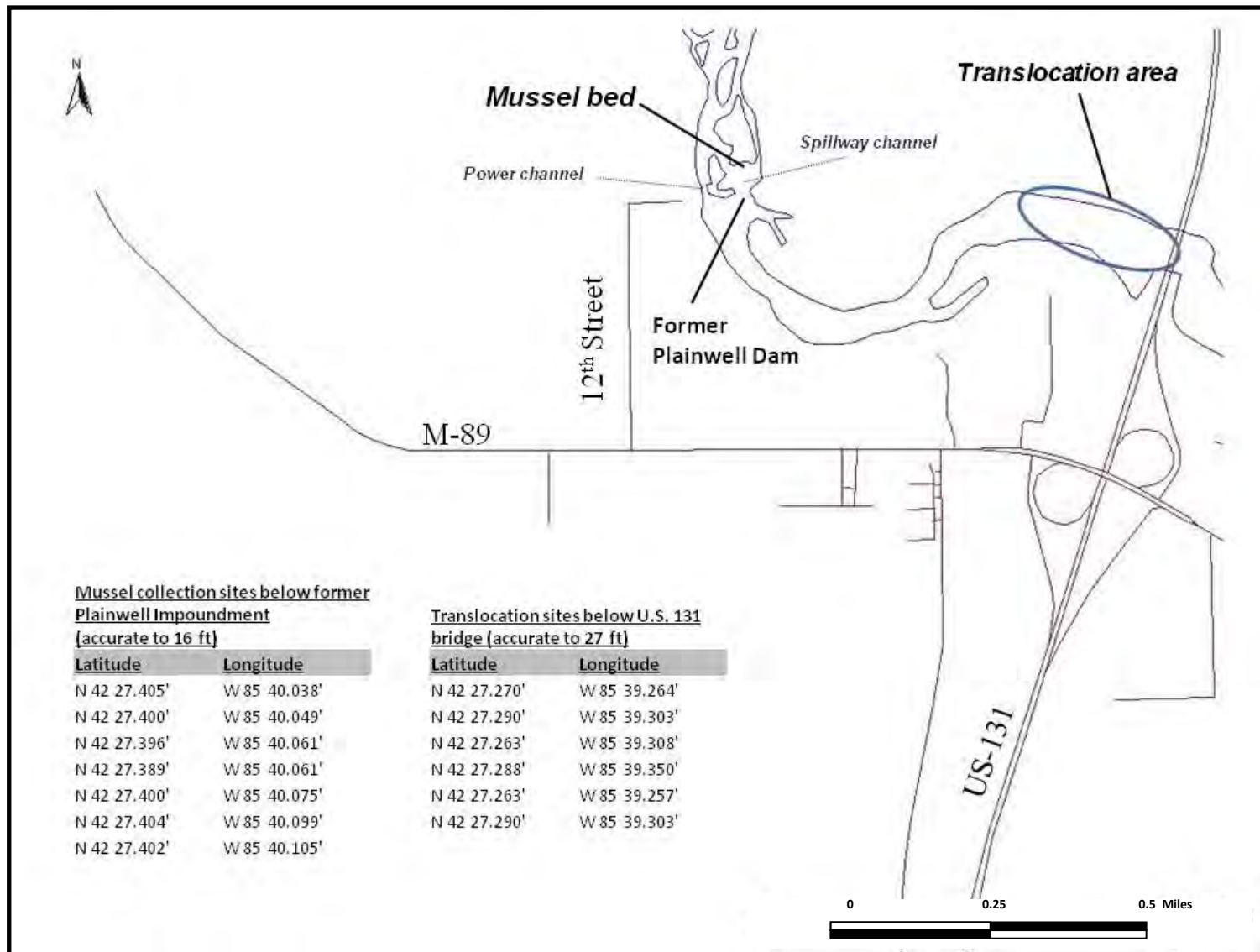


Figure 1. Map showing the collection and translocation areas

Table 1. Live mussels translocated from below the former Plainwell Dam

<u>Species</u>	<u>Number of mussels per date</u>					<u>Total</u>
	<u>6/18/2009</u>	<u>6/25/2009</u>	<u>7/17/2009</u>	<u>8/21/2009</u>	<u>9/11/2009</u>	
Mucket, <i>Actinonaias ligamentina</i>	684	417	71	82	89	1343
Cylindrical papershell, <i>Anodontoides ferruscianus</i>	0	1	0	0	1	2
Pocketbook, <i>Lampsilis cardium</i>	24	12	2	3	3	44
Fat mucket, <i>Lampsilis siliquoidea</i>	0	1	0	0	0	1
White heelsplitter, <i>Lasmigona complanata</i>	65	48	15	14	14	156
Fluted shell, <i>Lasmigona costata</i>	2	2	1	2	0	7
Creeper, <i>Strophitus undulates</i>	0	0	0	0	1	1
Total	775	481	89	101	108	1554

Table 2. Catch per unit effort of collection

<u>Date</u>	<u>Person</u>	<u>No.</u>	<u>Mussels</u>
	<u>hours</u>	<u>mussels</u>	<u>collected</u>
	<u>searched</u>	<u>collected</u>	<u>per hour</u>
			<u>searched</u>
June 18	15	776	52
June 25	12	481	40
July 17	8	89	11
August 21	7	101	14
September 11	5	108	21
Total	47	1554	33

Table 3. Fresh and recent dead mussels found below the former Plainwell Dam

Species	June 18						September 11					
	Fresh dead	Recent dead	TOTAL DEAD	TOTAL LIVE AND DEAD MUSSELS	Per cent fresh dead	Per cent total dead	Fresh dead	Recent dead	TOTAL DEAD	TOTAL LIVE AND DEAD MUSSELS	Per cent fresh dead	Per cent total dead
Mucket, <i>Actinonaias ligamentina</i>	48	64	112	796	6.6	14.1	8	109	117	206	8.2	57
Elktoe, <i>Alasmidonta marginata</i> *	1	1	2	2	100	100	0	0	0	0	0	0
Pocketbook, <i>Lampsilis cardium</i>	2	2	4	28	7.7	14.3	0	7	7	31	0	23
Fat mucket, <i>Lampsilis siliquioidea</i> **	1	1	2	2	100	100	0	0	0	0	0	0
White heelsplitter, <i>Lasmigona complanata</i>	0	2	2	67	0	3	1	2	3	5	25	60
Fluted shell, <i>Lasmigona costata</i>	1	1	2	4	50	50	0	0	0	0	0	0
TOTAL	53	71	124	899	6.8	13.8	9	118	127	242	7.7	34.4

* no live *A. marginata* were found

** only one live *L. siliquioidea* was found

Table 4. Estimated age structure of *A. ligamentina*

Size (mm)	Number	Age estimate (years)
80-89	3	4
90-99	12	5 to 6
100-109	37	6
110-119	72	8
120-129	70	9 to 10
130-139	14	>10

Table 5. Estimated age structure of *L. complanata*

Size (mm)	Number	Age estimate (years)
56-91	8	3 to 6
92-114	16	5 to 8
115-126	20	5 to 9
127-144	13	8 to 9
145-159	2	10

DISCUSSION AND CONCLUSIONS

A total of 1554 mussels of seven species were translocated approximately 1 mile upstream of the former Plainwell impoundment. The mucket, *Actinonaias ligamentina*, was the most common, making up 87% of the population. The white heelsplitter, *Lasmigona complanata*, was the next most common species, making up 10% of the population.

The demographics of the bed below the former Plainwell impoundment indicate the population had been reproducing. Since juvenile mussels are difficult to find (Mulcrone, 2004) mussels under 3 years were used to indicate recent reproduction. Recruitment within two (*L. complanata*) and four (*A. ligamentina*) years was indicated for the two most common species.

The entire mussel bed below the former dam may not have been removed, but catch per unit effort steadily decreased over each visit. Live mussels retrieved on the last three visits were fairly consistent, ranging from 89 to 108.

Translocation likely reduced the mortality for a large amount of the mussel bed below the dam. The numbers of fresh and recent dead mussels made up 13.8% and 34.4% of the mussels taken from the area on the first and last collection days, respectively. The total amount of mortality recorded was underestimated, since fresh dead mussels were observed, but not thoroughly counted on the second and third visits. The amount of recent dead shells that had no tissue but an iridescent nacre also indicated recent mortality. After tissue decomposition, the length of time of death is difficult to distinguish since shell condition is affected by water chemistry (Strayer and Malcom, 2007). However, the large numbers (117) of recent dead shells on the last day of collection seem to indicate many individuals had died within this area. Tissues had likely decomposed in the warmer waters in previous weeks.

While death rates of mussels in the wild have not been thoroughly evaluated in the literature, it is rare to find many dead mussels with tissue still present (R. Mulcrone, personal observation). Mussels were likely dying due to extended periods of anoxia. Adult mussels can survive when dissolved oxygen levels are as low as 1 mg/L, but this concentration level is generally lethal after two weeks. Low oxygen levels are lethal to juvenile mussels for shorter periods of time (Strayer, 2008). Visits to the area below the former Plainwell dam were made over a 12 week period in the warmest months of the year. The progression and prolonged anoxic conditions were likely the cause of much of the fresh and recent dead mortalities observed for adults. The anterior side of the shells, which usually are found within the substrate, had black coloration and the water was fairly stagnant.

Anoxic conditions were mostly lethal to *A. ligamentina*, which is usually found in large rivers with gravel and sand beds (Parmalee, 1967; van der Schalie, 1938; Watters et al, 2009). *Lasmigona complanata* has been recorded to tolerate conditions in sluggish water with finer substrates (van der Schalie, 1938; Strayer, 1981; Watters et al., 2009). One *Alasmidonta marginata*, a state listed Special Concern species, was found dead with tissue present.

Mussels will move in response to lowered water levels and exposed, but their movement is random (Samad and Stanley, 1986). While mussels were seen moving in the area below the former Plainwell dam (R. Mulcrone, personal observation), they would not have been able to maneuver to free flowing water (Figures 14 and 15).

Previous studies (Cope and Waller, 1995 and Newton et al. 2001) have recorded mortalities associated with relocating mussels. Because the mussels were being relocated to an area within the same watershed and within a short time of collection, the amount of mortality should be reduced.

Habitat where the mussels were translocated was gravel with sand. ARCADIS and the MDNRE regarded this area to be a more stable part of the post-TCRA river bed. Because the translocation was within the same watershed and was approximately 1 mile upstream, host fish populations are likely similar to the downstream impoundment area and would be suitable for recruitment. The occurrence of 2 year old *A. ligamentina* in the translocation area supported that this area is suitable for mussel recruitment.

The translocation area will be revisited next summer and marked mussels will be counted and evaluated for mortality. Although recovery of mussels with marked shells is generally lower than mussels with metal pit tags (Kurth, et al., 2007) the area is fairly shallow and accessible, likely making recapture easier. Previous studies in larger rivers have found mussel migration from translocated areas were fairly low (5%) (Waller et al, 1993). GPS readings should help a team retrieve the translocated population.

Follow-up visits up to five years post-translocation have been suggested to evaluate if the translocation is successful (Cope and Waller, 1995). Although recruitment has already been noted in this area, the stability of the habitat post-TCRA should also be monitored.

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Figure 2. Plainwell impoundment prior to TCRA work



Figure 3. Former Plainwell impoundment
(June 18, 2009)



Figure 4. MDEQ and Mehne and Associates removing mussels from the downstream area of the former Plainwell impoundment (June 18)



Figure 5. Mussels prior to transport upstream (June 18)



Figure 6. MDNR and Mehne and Associates placing mussels in upstream translocation area (June 18)



Figure 7. Upstream translocation area (July 16)



Figure 8. Younger *Actinonaias ligamentina*, showing recruitment in translocation area (July 16)



Figures 9 (left) and 10 (right). Fresh dead mussels showing tissue remaining within the shell (Sept. 11)



Figure 11 (left). Fresh and recent dead mussels collected (June 18)

Figure 12 (right). Fresh dead mussels showing tissue still in shell (June 18)



Figure 13. View looking upstream at former Plainwell dam structure (September 11)

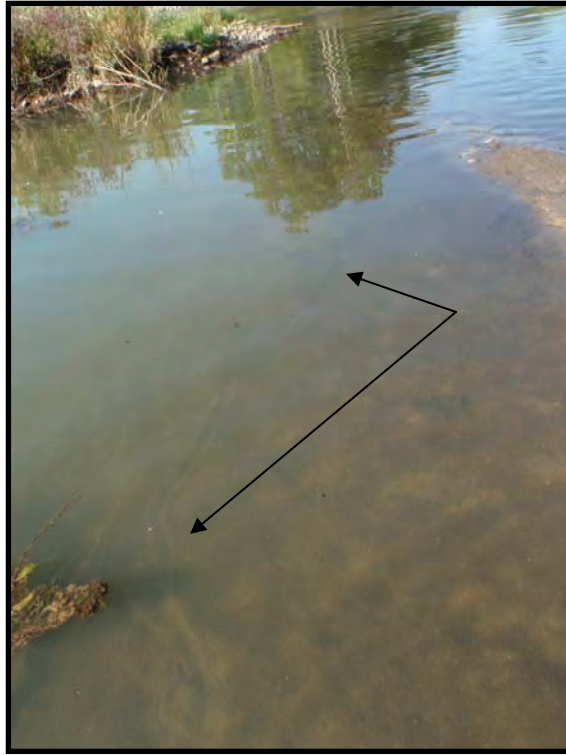


Figure 14. Arrows pointing to mussel trail, showing movement



Figure 15. Area (circle) where mussel was moving, below former Plainwell dam (September 11)