COPE

Triannual Unionid Report

Report No. 5

September 1994

A forum for the informal exchange of information
on the status of
North American unionid research, management, and conservation

Compiled by

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NOTE: The intent of this report is to expedite the exchange of information in an informal format. Report submissions were solicited from individuals and agencies involved in unionid conservation. The submissions were not edited. They were copied as received and assembled into the report.

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The federally endangered catspaw (*Epioblasma obliquata obliquata*) in Killbuck Creek Ohio.

On 1 September 1994 two living and four freshly dead shells of the catspaw (*Epioblasma obliquata obliquata*), also known as the purple catspaw, were found in Killbuck Creek downstream of Blissfield, Clark Township, Coshocton County, Ohio. On 6 September 1994 an additional 13 living specimens and 19 freshly dead shells were collected upstream of the town of Blissfield. Killbuck Creek is a tributary of the Walhonding River where a single dead specimen of the catspaw was found in 1991. This represents the single largest population known of this very rare species and is, perhaps, the only population that currently supports breeding individuals. Individuals of this population represented a number of different age classes and gravid females were found at the surface of the substrate. These females may have been displaying for a host, although this was not observed. Work is ongoing to determine the status of this species in the creek and to determine the composition of the unionid fauna of this stream.

The federally endangered clubshell (*Pleurobema clava*) and two Category 2 species (*Toxolasma lividus* and *Villosa fabalis*) found in the Blanchard River in northwestern Ohio.

Three species of rare Unionidae were collected from the Blanchard River near the U.S. Route 30 bridge in Hancock County, Ohio. A single dead shell of the clubshell, *Pleurobema clava*, was found upstream of the existing bridge at this site, and four dead shells of the purple lilliput, *Toxolasma lividus*, were found downstream of this bridge. Also collected were 29 living and 32 freshly dead shells of the rayed bean, *Villosa fabalis*. This species was found both upstream and downstream of the bridge. This represents the largest population of *V. fabalis* in the state and suggests that if habitat is suitable for that species, then the others still may be extant in this reach of stream and may be found with additional effort. Currently a stream clearing operation (the removal of sand bars and log-jams from a 98 mile reach of stream) threatens these populations. Additional survey work will be scheduled to determine the current population status of these species in this river. These data are being made available to local Department of Natural Resource and U.S. Fish and Wildlife Service personnel.

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Endangered Mussels in Commercial Harvest Survey: During the 1994 commercial harvester survey, I have collected five orange-foot pimpleback *(Plethobasus cooperianus)* from the boats of musselers. Four of these mussels were taken in Hardin Co., TN, they were ≤ 13 years old, two of which were gravid with pale orange glochidia. One specimen was taken in Perry Co., Tn, this specimen was approximately 17 years old. All five specimens were returned live to TWRA mussel sanctuaries. Commercial musselers were advised to check any mussels resembling *Cyclonaias tuberculata or Quadrula pustulosa* for orange soft parts and to return them to the river. I also advised the TWRA to remove these to similar species from the list of legally harvestable mussels to avoid future unintentional harvest of *P. cooperianus*.

The four individuals taken in Hardin Co. offer substantial evidence to recent recruitment of this species in the Pickwick tailwater from above Diamond Island to below Wolf Island (Tennessee River miles 201 - 190). The removal of 20 individuals of this species from the Pickwick Mussel Sanctuary by the Tennessee Valley Authority during 1993 may have substantially reduced the parent population upstream of the locations where these young mussels were collected.

Future activities in this stretch of the Tennessee, below Pickwick Dam should be evaluated in a new light considering this evidence of recent reproduction of what was thought to be a terminal species. Special consideration should be given to prevent any dredge of fill activities around Diamond or Wolf islands.

Zebra Mussel: The zebra mussel continues to be reported through out Tennessee and Cumberland rivers by commercial musselers working the lower stretches of both systems. Number of sightings are up slightly and likely correspond to a larger number of barges carrying populations into Tennessee's rivers. One "population" was discovered by a commercial diver at the mouth of Sangravel Harbor (TRM 100.4, Humphreys Co., TN) in an area adjacent to two mooring cells. This population resulted from individuals dropping of coal barges after the barges had been unloaded at TVA's New Johnsonville Plant and parked at the cells. TVA's river assessment team (RAT) was notified and subsequent sampling produced a density estimate of approximately 10 zebra mussels per square meter. TWRA will continue to monitor this "population" through the coming season to determine if it is expanding.

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An Initial Survey of the Unionid Mollusks of the Loup River System in Nebraska

The Loup River is a major tributary to the Platte River in Nebraska. Draining over 39,000 km^2, it contributes almost half of the total volume of the Platte River at Ashland, Nebraska near the later's confluence with the Missouri River (Bentall, 1982). The sole previous published reference on the unionids of this system is that of Aughey (1877) who conducted some field work within the Loup basin. With the possible exception of *Fusconaia flava* which he reported as occurring in "all the Nebraska rivers", there is no indication that unionids were collected in the Loup basin at that time.

In 1980 and 1981, an initial survey of the area was undertaken in conjunction with a continuing project to document the unionid distributions of Nebraska. A total of 31 sites were collected, and bivalves were recovered at 15 of these sites. Seven taxa were collected from the Loup system. All represent new records for this system and with the exception of *Uniomerus tetralasmus*, all were live records. The species recovered and their geographic frequency is depicted in the table below.

Taxa	Species Frequency: Sites Present	Species Frequency: As a % of Total Sites
Anodontoides ferussacianus (Lea, 1834)	8	26%
Lasmigona complanata (Barnes, 1823)	4	13
Potamilus ohiensis (Rafinesque, 1820)	1	3
Pygonodon g. grandis (Say, 1829)	9	29
Quadrula quadrula (Rafinesque, 1820)	3	10
Uniomerus tetralasmus (Say, 1830)	1	3
Utterbackia imbecillis (Say, 1829)	2	6

The main channels of Loup basin rivers are characterized by a shifting sand substrate, and live bivalves were uniformly absent from these habitats. Living unionids were obtained from backwater areas of Loup basin rivers, and from creeks, lakes, and canals in the region. In addition, live specimens were collected from stable sand substrates in the main channel of the Cedar River immediately below Ericson dam.

Further work in the Loup basin is planned, and it is possible that additional taxa will be added to the current species list as work proceeds.

Aughey, Samuel. 1877. Catalogue of the land and freshwater shells of Nebraska. *Bulletin of the U. S. Geological and Geographical Survey of the Territories* 3(3): 697-704.

Bentall, Ray. 1982. Nebraska's Platte River a graphic analysis of flows. *Nebraska Water Survey Paper 53*. Conservation and Survey Division, Institute of Agricultural and Natural Resources, The University of Nebraska-Lincoln. 47 pp.

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ATLAS OF THE FRESHWATER PEARLY MUSSELS (UNIONOIDA) OF NEW YORK.

In 1895, W.B. Marshall published a summary of the known distribution of the pearly mussels of New York. We are working on an atlas of the current distribution and status of these animals in New York, which will include spot maps, identification keys, illustrations, and a discussion of the origins of the fauna and recent changes in mussel distribution caused by human activities. New York formerly contained about 50 species of pearly mussels. Since Marshall's time, human activities have eliminated many populations of pearly mussels, and 10-12 species probably are now extirpated from the state. Several additional species are on the verge of being eliminated from New York, and many places that once had rich mussel communities now support few or no mussels. The state can be divided into three broad zoogeographic provinces according to their mussel faunas: i) the Susquehanna and Delaware River basins, which contain species that originated on the Atlantic Slope; (ii) the basins of the Allegheny River, Lake Erie, the Niagara River, and Lake Ontario east to Rochester, which are dominated by species that came from the Ohio River basin; and (iii) the Hudson River, Lake Champlain, St. Lawrence River, and eastern Lake Ontario basins, which contain varying mixes of the two faunas.

We are eager to hear about any unpublished records of these animals in New York.

Author Terry Balding

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Report: Completion of a qualitative unionid survey, begun in 1989, of the Chippewa River near Winter, Wisconsin downstream to Eau Claire, Wisconsin. I plan to submit this for publication in March 1995.

Zebra Mussel Infestation of Ohio River Unionidae
Rivermile 395 to 397

Patricia Morrison, Mitch Ellis, and Janet Butler. Ohio River Islands National Wildlife Refuge, P. O. Box 1811, Parkersburg, West Virginia 26102-1811, Phone (304) 422-0752, FAX (304) 422-0754.

Refuge staff began conducting baseline inventories of freshwater mussels inhabiting the waters around the two Manchester Islands in Lewis County, KY. On August 18-19, 1994, the authors began reconnaissance level sampling by handpicking shorelines and brailling. A total of 86 live individuals were collected, representing 11 species of unionids. Twenty-seven, or 31.4%, had zebra mussels attached to their shells (minimum=1, maximum=9). The zebra mussels ranged in size from 9 mm to 25 mm in length. The authors will return this fall to conduct more intensive qualitative and quantitative sampling by SCUBA.

The species found, in order of relative abundance, were:

Obliquaria reflexa
Quadrula pustulosa
Quadrula nodulata
Amblema plicata
Quadrula quadrula
Quadrula metanevra
Potamilus alatus
Fusconaia ebena
Fusconaia flava
Lampsilis teres
Pleurobema cordatum

Margaret Mulvey, University of Georgia, Savannah River Ecology Laboratory, P. O. Drawer E, Aiken South Carolina 29802 Phone: (803) 725-2472, FAX: (803) 725-3309, e-mail: Mulvey@SREL.EDU

The document below is available for distribution and will be mailed to interested individuals at no cost. Please direct requests to the address above.

The report describes genetic and morphological characteristics of *Elliptio* species occurring on the Savannah River Site in South Carolina. The "Mill Creek *Elliptio*" described by Britton and Fuller in 1979 (NERP-3) is designated *Elliptio hepatica*.

Davis, G. M. and M. Mulvey. 1993. Species Status of Mill Creek *Elliptio*. SRO-NERP-22. pp. 58.

Marian E. Havlik, Malacological Consultants, 1603 Mississippi Street, La Crosse, Wisconsin 54601-4969. Phone/FAX: 608-782-7958.

ARE UNIONID TRANSLOCATIONS A VIABLE MITIGATION TECHNIQUE? THE WOLF RIVER, WISCONSIN, EXPERIENCE: PART 3, AUGUST 1994.

As reported, May 1994 Triannual Unionid Rept., in August 1992, 8120 marked unionids (14 taxa) were translocated from the County A bridge, Wolf River, N of Shawano, WI. At the 461 m^2 translocation site, pre-project mean densities from 10 - 1.0 m^2 were 20.7/m^2. Post-project, densities were increased by 85%. Unionids were out of water 15 minutes to identify and mark, then stored in mesh bags below the river surface, before translocation the same day.

The numbers for the 1993 follow-up differ slightly from those reported previously because I have excluded data from a special, high density quadrat. The 1993 study (funded by Malacological Consultants) recovered 373 living mussels from 6 - 1.0 m^2 quadrats (mean density 62.17/m^2). We found a one year post-translocation survival rate of 98.36% among 120 living plus 2 dead marked mussels (marked mussel density of 20.3/m^2 confirmed we nearly doubled original density). 32.2% of the (tripled) densities were from the marked unionids; 33.3% of the mussels were from the pre-project (ambient) density. The remaining 34.5% of the tripled densities were from an unknown source. Perhaps pre-project densities were the result of diver efficiency or other sampling artifact, and/or else densities increased after 1993 high water. Two marked, threatened unionids were recovered, with no mortalities found among 33 relocated, threatened unionids. One new species was added to the site list. (The seventh quadrat sampled yielded 74% of 100 specially marked unionids placed in a 1.0 m^2 area; pre-project density in this quadrat was represented by 31 unmarked unionids found in 1993; no dead specimens were in the special quadrat).

The Conchologists of America and Malacological Consultants sponsored the August 1994 relocation followup. 31 random 0.25m^2 quadrats yielded 478 living unionids (mean density 61.9/m^2), including 152 living marked mussels (plus 2 dead). Another marked dead mussel was found during a random search. All marks on the anterior valves were clearly legible after 2 years, even on the 3 dead specimens. Survival among marked unionids was 98.9% (mean density 19.9/m^2; 31.8% of total living). 326 unmarked living mussels were found; 2 unmarked Alasmidonta viridis (Rafinesque, 1820) and 1 Simpsonaias ambigua (Say, 1825) were uniquely marked. Since 1992 Elliptio dilatata (Raf., 1820) has increased from 71.4% to 73.3% (1993) to 78.9% (1994). Few fresh-dead mussels were among 152 empty shells; most were sub-fossil or fragments. Site density was slightly lower than in 1993, but 9 juveniles were found.

Ten of the 100 specimens from the 1992 special quadrat were recovered a second time, even though these specimens were returned to the river from the surface in 1993 because divers ran out of air; none of those specially marked unionids have been found dead. These data show our methods resulted in a successful relocation, 2 years post-project, even at doubled to tripled densities, although the relative abundance of the dominant species increased slightly.

Myra Marcum and Steve Bakaletz, Rt. 3 Box 401, Oneida, TN 37841 615/569-9778

COAL MINE DRAINAGE WATERSHED RESTORATION PROJECT

The Big South Fork of the Cumberland River is located at an interstate watershed which lies in both Tennessee and Kentucky. A large portion of this watershed is classified and operated as a National River and Recreation Area, a region that was once home to more than 45 species of fresh water mussels. However, due to the effects of coal mine drainage and logging, ten of these species are now thought to be extinct.

There are approximately 110 abandoned coal mines within the boundaries of the Big South Fork NRRA, the result of six decades of coal mining. The Big South Fork NRRA, as "caretakers" of this valuable resource, is currently in the process of restoring the watershed by treating areas having extremely high concentrations of coal mine drainage. Managers of the area hope to achieve this through the implementation of the anoxic alkaline drain treatment system developed by Turner and McCoy, a project which will be implemented through four different phases:

Phase I - Develop a sampling plan
Phase II - Implement the sampling plan and characterize Mine Drainage sites
Phase III - Design and construct Mine Drainage Remediation Treatments
Phase IV - Evaluate and monitor treatment systems

Currently, the Big South Fork Acid Mine Drainage Watershed Restoration Project is in *Phase II*. The characterization has been performed, dividing sites into three separate groups:

Type I - *Discreet Discharge Point* - a single discharge, generally coming from one or more mines' openings having flow rates $\geq$ 25 gal/min.

Type II - *Cluster of Seeps and Small Discharges* - includes a number of small discharges and seeps having similar and dissimilar water qualities that can be readily collected as a whole to form a single waste stream responsive to treatment.

Type III - *Coal Waste Rock/Refuse Piles and Banks* - includes waste rock (gob piles) which generally have dispersed discharges reaching a relatively large area.

Typifying the sites in such a manner will allow project managers to rank each in order of the severity of AMD. This furthermore will reduce costs which would otherwise be incurred by characterizing and treating each site separately.

Although *Phase II* is nearing completion, the project is still in the stages of infancy. At its completion, however, not only will the level of water quality of the Big South Fork National River and Recreation Area be improved, but also other areas as well. Furthermore, as an added bonus, mussel populations should also increase, thus benefiting many others in the immediate area interested in the preservation of North American mussels.

Ligumia recta host suitability tests

Mark Hove, Robin Engelking, Elaine Evers, Margaret Peteler, Eric Peterson
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Glochidia from *Ligumia recta*, a threatened species in Ohio, were used in fish host suitability tests conducted this summer and fall. Bluegill were found to be suitable fish hosts for *L. recta* glochidia (Table 1).

Table 1. Results of fish host suitability tests using *Ligumia recta* glochidia.

transformation observed			no transformation observed		
Species	Number tested	Days to metamorphosis	Species	Number tested	Period of attachment
bluegill*	4	17-24	green sunfish**	3	11-15 d
			smallmouth bass	1	8 d
			largemouth*** bass	1	8-11 d
			yellow perch	3	11-15 d
			yellow bullhead	4	8 d
			longnose gar	1	1 d

Average water temperature was 19 ± 2°C.

Juveniles were not collected from aquaria holding green sunfish or largemouth bass although they have been shown by others to be suitable hosts (Coker et al. 1921 and Lefevre and Curtis 1912 respectively). Last year we observed largemouth bass facilitate transformation of *L. recta* glochidia. However, last year bluegill did not facilitate transformation of *L. recta* glochidia. Variability in individual fish susceptibility to infestation may explain this year's negative results with largemouth bass and green sunfish. These species will be retested in the future.

We will continue our host suitability studies on various species of mussels living in the upper Mississippi River next year. In particular, we plan to conduct study the fish host requirements of *Cumberlandia monodonta* and *Tritogonia verrucosa*.

If you would like further information, or would like to share freshwater mussel life history information please contact Mark Hove at: mh@finsandfur.fw.umn.edu, or at 200 Hodson Hall, 1980 Folwell Ave., St. Paul, MN 55108, (612) 624-3019, FAX (612) 625-5299.

* Natural infestation described in Wilson, C. B. 1916. Copepod parasites of fresh-water fishes and their economic relations to mussel glochidia. Bull. U. S. Bur. Fish. 34: 331-374.

** Laboratory transformation "unsatisfactory or not uniform" described in Coker, R. E., A. F. Shira, H. W. Clark, and A. D. Howard. 1921. Natural history and propagation of fresh-water mussels. Bull. U. S. Bur. Fish. 37: 75-181.

*** Laboratory transformation described in Lefevre, G., and W. C. Curtis. 1912. Studies on the reproduction and artificial propagation of fresh-water mussels. Bull. U. S. Bur. Fish. 30: 105-201.

Cyclonaias tuberculata host suitability tests

Mark Hove, Robin Engelking, Elaine Evers, Margaret Peteler, Eric Peterson
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Fish host suitability tests using *Cyclonaias tuberculata* glochidia were conducted this summer. Efforts were made to finish our host suitability analysis on *C. tuberculata* glochidia but our inability to retest black bullheads, stonecats and channel catfish will postpone the closure of this study until next year. This summer, yellow bullheads were the only fish species tested which facilitated *C. tuberculata* glochidia metamorphosis to the juvenile stage (Table 1). To our knowledge only the yellow bullhead and channel catfish have been shown to be suitable hosts for *C. tuberculata* glochidia under laboratory conditions.

Table 1. Results of fish host suitability tests using *Cyclonaias tuberculata* glochidia.

transformation observed			no transformation observed		
Species	Number tested	Days to metamorphosis	Species	Number tested	Period of attachment
yellow bullhead	2	23-24	pumpkinseed	2	1-3 d
			shovelnose sturgeon	4	2-4 d
			banded killifish	1	15 d
			longnose gar	5	3-6 d

Average water temperature was 19 ± 2°C.

This fall and winter further host suitability tests will be conducted on *C. tuberculata* glochidia in addition to *Anodonta imbecillis*, *Anodontoides ferussacianus*, *Lasmigona compressa*, and *Ligumia recta* glochidia. We will also observe the development of *Anodonta imbecillis* glochidia throughout the winter to verify glochidia metamorphosis within the female's marsupia.

If you would like further information, or would like to share freshwater mussel life history information please contact Mark Hove at: mh@finsandfur.fw.umn.edu, or at 200 Hodson Hall, 1980 Folwell Ave., St. Paul, MN 55108, (612) 624-3019, FAX (612) 625-5299.

1994 MRRC meeting abstracts

Mark Hove, Department of Fisheries & Wildlife, University of Minnesota
(612) 624-3019

Below is a list of presentations and posters about freshwater bivalves presented at the 26th annual meeting of the Mississippi River Research Consortium. If you would like a copy of any of the abstracts contact me via e-mail at mh@finsandfur.fw.umn.edu, or at 200 Hodson Hall, 1980 Folwell Ave., St. Paul, MN 55108.

The next meeting will take place during 27-28 April 1995 at LaCrosse, WI. All are invited to attend!

titles and authors of presentations and posters

Unionids and margaritiferids (Mollusca: Bivalvia), Saint Croix River, Afton and Wild River State Parks, Minnesota, June 1992. *Marian E. Havlik*

Fingernail clam population densities in relation to the Arrowhead Island Habitat Rehabilitation and Enhancement Project. *Randy Burkhardt*, Robert Gaugush, and Carl Korschgen

Update on zebra mussels (*Dreissena polymorpha*) in the Illinois River. *Scott. D. Whitney*, Douglas Blodgett, and Richard E. Sparks

Suitable fish hosts of three freshwater mussels from the St. Croix River, Minnesota. *Mark C. Hove*, Robin A. Engelking, Erin M. Long, Margaret E. Peteler, and Laurie A. Sovell

Settlement, growth rate, and habitat colonization of zebra mussels in the upper Mississippi River. *W. Gregory Cope*, Teresa J. Naimo, and Michelle R. McPeak

The spread of zebra mussels (*Dreissena polymorpha*) through the inland waterway system, 1993. *Andrew C. Miller*, Barry S. Payne, Douglas Blodgett, and David C. Beckett

Effects of zebra mussels, young bluegills, and water retention time on experimental food webs. *William B. Richardson* and Lynn A. Bartsch

Mussels of the Ozark and Cumberland River drainages. (paraphrased) *David H. Stansbery* (No abstract written.)

Candidate antioxidants for preventing zebra mussel attachment: toxicity to fish. W. Gregory Cope and *Michelle R. McPeak*

Fingernail clams: Have they changed after the crash and do they like pollution? *Michael A. Romano*, Brian L. Sloss, Richard V. Anderson, Richard E. Sparks, and Teresa J. Naimo

Effect of water temperature on locomotion and burrowing in unionid mussels. *Diane L. Waller* and Jeffrey J. Rach

Effects of zebra mussels (*Dreissena polymorpha*) on native unionid mussels in the Illinois River. *Scott D. Whitney*, Douglas Blodgett, and Richard E. Sparks

U.S. Fish & Wildlife Service Opens Southwestern Virginia Field Office - The U.S. Fish and Wildlife Service has opened the new Southwestern Virginia Field Office (SVFO), in Abingdon, Virginia. As a satellite office to the Virginia Field Office, the SVFO is working with local, State, and Federal partners on various projects that will contribute to the recovery of threatened and endangered aquatic species within the Upper Tennessee River Basin (UTRB). The UTRB in Virginia contains one of the highest concentrations of listed species in the United States, harboring fourteen species of endangered mussels and four species of threatened and endangered fish. Another four species of mussels from the Upper Tennessee River Basin were proposed recently for listing as endangered. You can contact SVFO at the following address:

Southwestern Virginia Field Office
P.O. Box 2345
Abingdon, VA 24212

(Express Mail Delivery
252 W. Main St.
Abingdon, VA 24210)

Phone: 703-623-1233
Fax: 703-623-1185

Tom Wilcox, Aquatic Analyst
Virginia Department of Game and Inland Fisheries
4010 West Broad Street
Richmond, VA 23230
(804) 367-0909

REPORT: The Virginia Department of Game and Inland Fisheries is in the early stages of developing a freshwater mussel database. If you have been involved in such a process, I would appreciate any input on types of fields, acquisition of data, etc. Please contact Tom Wilcox, Aquatic Analyst, Virginia Department of Game and Inland Fisheries, 4010 W. Broad Street, Richmond, VA 23230, (804) 367-0909, fax# (804) 367-2427.

Author: Terry Balding and Dan Kelner

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Report: A quantitative description of several unionid beds in the Flambeau River near Holcombe, Wisconsin will be compared to similar data for the Red Cedar River near Barron, Wisconsin. GPS will be used to locate the beds. Data is for an M.S. to be completed in December of 1994.

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September 28, 1994

The following projects were initiated through or funded by the Asheville Field Office since last report.

Title: Mussel refuge
Researcher: Virginia Cooperative Fish and Wildlife Research Unit
Project objective: Determine the feasibility of moving native mussels that are threatened by zebra mussels into a river reach that will likely be only minimally infested by zebra mussels.

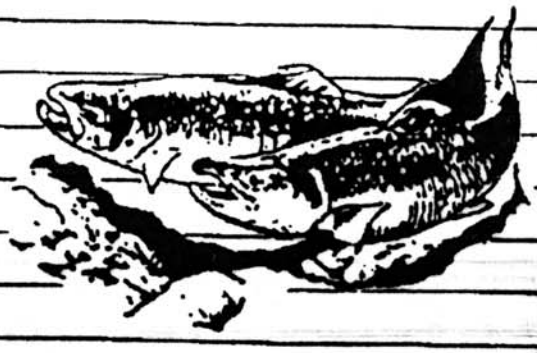
Title: Zebra mussel removal
Researcher: National Biological Survey, LaCross, Wisconsin
Project objective: Develop techniques to quickly remove zebra mussels from native mussels. These techniques will be needed if we have to move large numbers of native mussels out of infested waters.

Title: Mussel propagation/holding
Researcher: Tennessee Cooperative Fisheries Research Unit
Project objective: Determine the feasibility of holding and propagating mussels in a hatchery raceway.

Title: Update of TN Rare Wildlife/Mollusks
Funding source: Tennessee/Section 6 funds
Researcher: University of Tennessee, Knoxville, Tennessee
Project objective: Develop a document for public distribution that discusses the status of all Tennessee's mussels.

Title: Riparian habitat restoration/Clinch and Conasauga Rivers
Researcher: Tennessee Chapter of the Nature Conservancy
Project objective: Identify and restore riparian habitat in the of the Clinch River, Tennessee and Conasauga River, Tennessee and Georgia.

Research
Information bulletin
U.S. DEPARTMENT OF THE INTERIOR
NATIONAL BIOLOGICAL SURVEY



Number 58
1994

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.

Species	Percent recovery		Percent migration	
	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