

Abstracts of Posters and Other Presentations

Illinois Mussel Sanctuaries on the Mississippi River: Community Composition

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In response to increasing harvest pressure, a mussel die-off of unspecified origin, and a need for baseline information seven mussel sanctuaries were established by the Illinois Department of Conservation in the reach of the Mississippi River bordering Illinois. Baseline information collected on these sanctuaries from 1990 to 1992 included species composition, density, and population demographics. Samples were collected qualitatively using systematic trawling surveys and quantitatively using divers. Mussel communities in the sanctuaries were quite different in terms of both density and species composition in spite of similarities in habitats. Species diversity in the sanctuaries, based on Shannon's diversity using base 10, ranged from approximately 0.5 to 1.5. With the exception of the ubiquitous threeridge, *Amblema plicata*, most of these sanctuaries had one to three numerically dominant species, but the dominant species were often different from site to site. For example, the butterfly, *Ellipsaria lineolata*, was dominant in the Pool 20 sanctuary but was absent or occurred at only low densities at the other sites. Mean mussel density varied from 10 to over 100/m². Based on shell length frequency distribution patterns and evaluation of annuli, none of the sanctuaries exhibited much recruitment, with few young individuals present in any of the populations. These baseline surveys should provide background information necessary to evaluate subsequent changes in the mussel communities or their environment.

Use of Regression Analysis to Characterize Mussel Communities

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Several researchers have developed length-weight and/or annuli-length regression models when examining mussel populations. These models have been used to evaluate growth rates and reproductive activity in mussel populations. By comparing regression models developed independently for populations at a number of locations, we examined the possibility of using regression analysis to characterize the health and reproductive activity of mussel communities. At many sites, slopes and y-intercepts of length-weight regressions for species were not significantly different and a community model could be developed. It is suggested that deviation in either slope or y-intercept would indicate either an adverse or a beneficial change in the mussel environment dependent on the direction of the change. It is possible to detect the change with only a few mussels even of different species when the community model developed is powerful. Similarly, the point at which annuli-length regression deviates significantly from a slope of 0 indicates the onset of reproductive activity in the mussel population. Comparing the point at which this occurs between sites may be used to evaluate the habitat quality at the site. By establishing baseline growth and development models for mussel communities it may be possible to more readily evaluate habitat and environmental perturbations and thus more effectively manage this important resource.

Responses of Native Unionids to Encrustation by Zebra Mussels

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Zebra mussels (*Dreissena polymorpha*) heavily encrust native unionids in Lake Erie. In order to assess the effects of encrustation on unionids, a three-month field experiment and a field survey were conducted in western Lake Erie in 1990. The field experiment compared mortality and energetic fitness of encrusted and unencrusted *Amblema plicata* and *Lampsilis radiata*, while the surveys examined correlations between degree of encrustation and fitness. In the field experiment, *L. radiata* suffered higher mortality and reduced fitness when encrusted, with greater sensitivity exhibited by females. *A. plicata* showed reduced fitness but no differences in mortality when encrusted. At three sites in western Lake Erie, higher mortality was found in the subfamilies Anodontinae and Lampsilinae than in the subfamily Ambleminae. Differential mortality may have been caused by subfamily differences in life history strategy and/or shell morphology. There were no consistent patterns between severity of encrustation and biochemical indices of stress in field-collected unionids. These results lead to the conclusion that encrustation by zebra mussels has a severe energetic cost to native unionids, a group of organisms that has evolved in the absence of large biofouling organisms. The sex- and species-specific responses suggest that bivalve community structure will shift to domination by amblemines in lakes that have large populations of zebra mussels.

An Assessment of the Commercial Mussel Fishery on Wheeler Reservoir, Alabama

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A creel survey of the commercial mussel fishery on Wheeler Reservoir (Tennessee River, Alabama) was initiated utilizing nonuniform probability sampling. The total estimated harvest of mussels from July 1991 through February 1992 was 349.02 metric tons. Total number of mussels harvested and harvest rates by month peaked in September and then declined sharply. Total estimated effort in terms of musseler-hours was highest for divers (46,912) followed by waders (15,669) and brailers (8,875). Musseler expenditures for gas, food, and lodging over the sample period total, \$232,308. Expenditure by hour averaged \$3.25. Funding for this study was provided by the Tennessee Valley Authority (TVA) and the Alabama Universities / TVA Research Consortium.

A Survey of the Mussels of the Minnesota River, 1989

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A survey of the mussels of the Minnesota River of southern Minnesota was made during the summer of 1989. Fifty-nine sites were studied, and 1,268 live specimens representing 20 species were examined for size, condition, and abundance. The distribution of both live and dead species was determined from the site analyses. Both quadrats and timed searches were employed to gather the data. Many of the extant species are considered to be in some degree of trouble. No signs of reproduction or recruitment were found at many sites, and at others they ranged from poor to good. Both reproduction and recruitment success differed among the species. Density was found to be low at most sites, and no mussels were found at a few others. Both density and diversity (as number of species) were highest just below dams as the result of fish congregating there and the reasonably stable habitat provided by the dam. Among the variety of limiting factors affecting the mussels of the Minnesota River, drought, unstable substrates, excessive siltation, and perhaps chemical pollution emerge as the most important. In its present condition, the Minnesota River mussel fauna cannot tolerate commercial harvesting.

Virginia's Aquatic Nongame Program: Current Recovery Efforts for Endangered Freshwater Mussel Species in the Upper Tennessee River Drainage

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Thirty-four species of freshwater mussels currently listed as threatened or endangered occur within the headwaters of the Tennessee River in southwest Virginia. Fifteen federally endangered, 13 state-endangered, and 6 state-threatened mussel species inhabit the Clinch, Powell, and/or Holston rivers of Virginia, and are receiving top priority in the Department of Game and Inland Fisheries' aquatic threatened and endangered species recovery efforts. In 1991-1992, the aquatic nongame program coordinated and funded a project to develop "community approach" recovery plans for 13 state-endangered mussel species and initiated a long-term monitoring program for these species in southwest Virginia streams. Future efforts to identify degraded habitat and sources of sedimentation are planned which will contribute to a larger, ongoing cooperative effort to protect and restore the upper Tennessee River basin.

Factors Affecting the Distribution and Abundance of Freshwater Mussels in the Clinch River (Virginia, Tennessee)

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The Clinch River, a 5th-6th order Appalachian stream, supports a diverse assemblage of mussel species, including 16 Cumberlandian endemics and 12 federally endangered species. Results from a preliminary habitat study identified percent bedrock, particle size, mean depth, and direction of streamflow as the most significant habitat variables affecting mussel density. In order to test these findings over a larger area, a second study was conducted using 42 sites from a mussel survey of 141 sites conducted by Tennessee Valley Authority biologists between 1978 and 1983. Fourteen habitat variables were measured at each site. Additionally, geologic features, dip and strike, were measured where possible. Comparisons between habitat values associated with high and low quality mussel sites were made using Wilcoxon two-sample tests. Discriminant analysis (DA) was applied to highly significant variables from the Wilcoxon tests. Best variables selected by DA, followed by partial R^2 values in parentheses, from all sites combined were percent bedrock (0.4034), d84 particle size (0.3776), valley floor width (0.0778), and direction of streamflow (0.1112). Analysis of azimuth direction of streamflow and mussel site quality revealed patterns of habitat distribution that can be explained in terms of geologic characteristics of the Clinch River basin.

An Evaluation of Mussel Relocation as a Conservation Strategy

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State and federal resource agencies, recognizing the importance of preserving the native mussel fauna, have used relocation of mussels as a conservation and management tool. Relocation has been used to recolonize mussels in areas where populations had been eliminated by prior pollution events, to remove mussels from construction zones, and to re-establish populations of state- and federally endangered species. More recently, relocation has been considered as a potential mechanism for protecting unionid populations at risk from colonization by the zebra mussel, *Dreissena polymorpha*. We conducted a literature review of mussel relocations and evaluated their relative success to determine the usefulness of relocation as a conservation and management strategy. We found that approximately 62% of all relocations were conducted because of construction projects and that only about 10% were monitored for more than five consecutive years. Survival of relocated mussels varied among studies and species and was difficult to assess. Presently, there is little guidance on methods for relocation projects or for monitoring the subsequent long-term status of the transplanted mussels.

Adopted Site-Specific Copper Criteria to Provide Protection of Freshwater Mussels in the Clinch River, Virginia

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Reaction to the Virginia Water Control Board's adopted special standards and requirements concerning the effect of copper on unionids has reflected the apparent lack of confidence in appropriate endpoints for standardized toxicity testing. Various regulatory and environmental interest groups were reluctant to accept the results of a series of site-specific studies to determine effluent impact in a portion of the Clinch River that has been designated as habitat for several endangered species of freshwater mussels. As a result of 32 chronic and 75 acute toxicity tests using test standardized and resident species, site-specific chronic and acute criteria of 12.4 and 19.5 µg Cu/L, respectively, were established. These criteria were developed using specific sensitive endpoints for mussels to provide adequate protection at this site and are approximately 25% more stringent than the Virginia and U.S. Environmental Protection Agency criteria for copper. The results of testing with up to 17 resident species reiterated the appropriateness of incorporating nonstandardized test endpoints since both acute and chronic criteria were so heavily weighted toward mussel responses.

An Examination of Growth Rates of Three Freshwater Mussel Species in the Clinch River, Virginia to Tennessee

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Muskrat midden shells were used to examine and compare growth rates of three freshwater mussel species in the Clinch River via the thin section technique. The objectives were to determine the effects of reproductive activity and longitudinal position in the river on growth rates of freshwater mussels. Differences in growth within the sexually dimorphic species *Lampsilis fasciola* were examined and compared over a range of three to 35 years of age. The males and females exhibited similar growth rates as juveniles. At approximately five years of age they diverged significantly, with the males having a higher rate of growth than the females. Species that were not obviously sexually dimorphic were examined for an increase in growth rate from the headwaters in Virginia downstream to Tennessee. This objective was examined to determine the amount of natural variability of growth rates within three healthy mussel populations over a range of 138 river miles. The results of these studies will be used to validate or refute the use of growth rate as an indication of the health of mussel communities.

Mussel Culture and Field Surveys at the Aquatic Resources Center

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In vitro culture with fish plasma and rabbit serum in CO₂ incubators has been used to transform glochidia of *Anodonta imbecillis*, *A. grandis*, *Ligumia recta*, and *Megaloniais nervosa* to the juvenile stage of the life cycle. Transformation rates have been as high as 95% with both fish plasma and rabbit serum. Transformation has yet to be achieved with 11 other species of unionids. Juvenile mussels, primarily *A. imbecillis*, have been fed combinations of silt and algae (*Chlamydomonas* sp., *Chlorella* sp. and *Selenastrum* sp.), as well as other defined and undefined nutrient sources for up to 36 days after transformation. Surveys of portions of the Duck River system revealed only one site with potential for recolonization with *Lemiox rimosus*. Small populations of transplanted *L. rimosus* were found at the Tennessee Valley Authority transplant sites on the Nolichucky and North Fork Holston rivers in both 1991 and 1992. A recruit (approximately five years old) was encountered at the latter in 1991. The 1991 survey of the Buffalo and Duck River sites revealed only one individual on the Buffalo. Results of the 1992 surveys on these two rivers were reported.

Distribution and Population Structure of Commercial Mussel Beds in the Black River, Arkansas

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The commercial shell beds of the Black River, White River drainage, in northeastern Arkansas were studied during the 1991 and 1992 field seasons. Preliminary information regarding location and size of commercially valuable shell beds was obtained by interviews and field reconnaissance with commercial shellers. Systematic surveys were then conducted in the Black River from the Arkansas - Missouri state line (River Mile 165) downstream to its confluence with the White River. Divers located and defined the areal extent of shell beds prior to taking population analysis samples. Beds were stratified based on physical parameters such as substrate, water depth, current velocity, and river morphology (bendway versus straightway). Ten to 100 stratified random square meter samples were taken from each bed, the species identified, and total length measured for each individual. Analyses of bed composition, percent harvestable shells, and species associations were calculated for each species within each bed.

Documentation of Available Data: *Lampsilis higginsii* (Lea, 1857), Prairie du Chien, Wisconsin, Area, Mississippi River Mile 628 to 646, 1972-1990

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Information was presented on 3,243 *Lampsilis higginsii* found in the Prairie du Chien, Wisconsin, area, 1972-1990. A detailed database, done for USFWS, includes Mississippi River Mile (MRM), measurements, and age. Data were available for 468 live *L. higginsii*: 215 males, 88 females, 13 juveniles, and 152 sex unknown. Of 2,775 empty shells, 18% were fresh; most are in museums. Specimens were divided between downstream (1,689) and upstream (1,554) of City Dock, MRM 635.0. Only 112 were found alive downstream of Dock, while 356 were found alive upstream of Dock; more shore collections occurred downstream; more diving occurred upstream. Data were transferred to aerial maps. Scale for two maps was 400 feet/inch; Prairie du Chien inset map was 200 feet/inch. Each live *L. higginsii* was represented by a color-coded dot. Dots, with data, were placed where living *L. higginsii* were found. Dots on shore summarized data on empty shells found, per year, regardless of whether specimen was on shore or mid-river. Thus, '88 and 10/20 meant 10 fresh-dead and 20 worn-dead were collected in 1988; '87, #151, M, meant a living male, found in 1987, was marked #151. Other color codes depict damaged shell sites, dredge and disposal areas, fleeting capacity, and proposed harbor sites.

Effects of Commercial Navigation on Unionids Near the City Dock, East Channel, Mississippi River, Prairie du Chien, Wisconsin, October 1990

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Unionids were sampled by divers, Mississippi River Mile 634.7–635.2, East Channel City Dock, Prairie du Chien, Wisconsin. Seven transects were established. Two 0.25-m² quadrats were sampled every 15 m, plus qualitative samples. Three thousand three hundred eight unionids (34 species) were collected; 16% of 94 quadrats were negative. Maximum density = 116/m²; mean density = 39.4/m². One thousand two hundred forty living specimens (28 species) were measured and inspected for damage, including five *Lampsilis higginsi* (Lea, 1857). We sampled more sites, but 10 *L. higginsi* were reported in area in 1987. In 1980 a 5 X 5 foot quadrat contained three *L. higginsi* with two adjacent to quadrat; a 1980 Dock site yielded 102 live unionids; we found four. Of sexually dimorphic females, 85% were gravid. One 1987 downstream transect yielded 404 unionids; we found 203. Despite harvest, *Amblema plicata* (Say, 1817) increased from 53% (1980) to 61%, but declined in actual abundance. Fourteen percent of 754 *A. plicata* were legal height; none of 104 *Magnonains nervosa* (Raf., 1820) was 102 mm. Two *A. plicata* from one quadrat, both 67 mm long, were eight and 23 years. *A. plicata* lengths showed bell curve; age data showed bimodal distribution with decline in 14 year age class (birth year = 1976 channel dredging). Regression of *A. plicata* and *M. nervosa* age vs. length = R² of 0.71 and 0.79, respectively. Some shells may have had barge damage.

A Recovery Plan for the Federally Endangered Winged Mapleleaf Freshwater Mussel

The Winged Mapleleaf Recovery Team (David J. Heath, presenter)

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The winged mapleleaf (*Quadrula fragosa* [Conrad, 1835]) freshwater mussel was listed as federally endangered effective 22 July 1991. No reliable records of living individuals have been reported since the 1920s. During 1987 a small population was rediscovered in the Saint Croix River, Wisconsin and Minnesota. The species is thought to be absent from about 99% of its original geographic range and presently occupies about 15 miles of river. The U.S. Fish and Wildlife Service appointed a recovery team to draft a recovery plan and make interim recommendations to the Service for species protection. The preliminary manuscript of the recovery plan includes species description, geographical description, threats, conservation and aspects of biology, ecology, habitat requirements, limiting factors, and recovery actions with an implementation schedule. Interim actions include a study on microhabitat and an instream flow study at the extant site to be conducted during the 1992 field season.

Host Fishes of Three Freshwater Mussels

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Host fish of *Medionidus conradicus*, *Lasmigona costata*, and *Ptychobranchnus subtentum* were determined by artificially infecting 20 fish species representing seven families. Transformation periods varied among mussel species, ranging from 10 to 40 days. *Medionidus conradicus* transformed on rainbow darters (*Etheostoma caeruleum*) and striped darters (*E. virgatum*). Five species were identified as hosts for *P. subtentum*: rainbow darters, redline darters (*E. rufilineatum*), fantail darters (*E. flabellare*), barcheck darters (*E. obeyense*), and banded sculpin (*Cottus caroliniae*). *Lasmigona costata* juveniles were recovered from 11 fish species.

Morphological and Electrophoretic Approaches to the Identification of *Elliptio* Species on the Savannah River Site, South Carolina

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Surveys of the bivalve fauna of the Savannah River Site were undertaken in 1989 and 1990. The primary goal was to determine the status of the "Mill Creek *Elliptio*" described by Britton and Fuller (1979). External shell morphology was determined using standard measures and computer-assisted imaging. Protein electrophoresis was used to characterize genetic variation within and between populations and species. A search of museum specimens was done to select appropriate nomenclature for shell morphologies. "Mill Creek *Elliptio*" referred to *Elliptio hepatica*. Differentiation among *Elliptio complanata*, *E. errans*, *E. lugubris*, *E. icterina*, and *E. raveneli* populations of the site was also described.

Heavy Metals in the Threeridge Mussel *Amblema plicata plicata* (Say, 1817) in the Upper Mississippi River

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Concentrations of mercury and zinc in threeridge mussels, *Amblema plicata plicata*, sampled in 1987 from Pools 3 and 10 in the Upper Mississippi River, were comparable to concentrations in mussels from moderately contaminated systems, while copper concentrations were similar to concentrations in mussels from more polluted waters. Cadmium concentrations in mussels were significantly less at a lightly contaminated site (Pool 10, range 0.53 to 0.92 mg/g dry weight) than at a site where metal abundances were strongly influenced by industrial and domestic inputs (Pool 3, range 0.80 to 1.25 mg/g dry weight). Yet cadmium concentrations in mussels from Pool 3 were an order of magnitude less than values reported for mussels from more metal-polluted systems. In contrast, copper, mercury, and zinc concentrations did not differ between sites. Cadmium and zinc concentrations generally increased with size of the mussel, copper concentrations decreased with size, and mercury concentrations were unrelated to size.

Effect of Fish Hosts on Genetic Variation in Unionid Mussels

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Gene flow among populations of organisms is reflected by their ability to disperse, and the extent of gene flow is determined by the extent of genetic variability within and among populations. Dispersal in unionid mussels is assumed to be accomplished during the larval stage of the life cycle as parasites on fish. To test this hypothesis we compared the genetic variability among populations of *Obliquaria reflexa* and *Quadrula pustulosa*. These species differ in their fish host affinities in that *O. reflexa* is thought to complete development without parasitism, while *Q. pustulosa* has at least six fish hosts. Genetic data were gathered at 15 presumptive loci using starch-gel electrophoresis. Populations of *Q. pustulosa* exhibited increased polymorphism, greater numbers of alleles at a locus, and increased heterozygosity compared to *O. reflexa*. Given that *Q. pustulosa* has fish host affinities that would predict increased levels of gene flow among populations, the hypothesis that fish are the main dispersal mechanism is supported.

Effects of Handling and Time Out of Water on the Survival of Freshwater Mussels

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The mortality of freshwater mussels following displacement by field surveys, relocation projects, and commercial harvest is assumed to be insignificant. However, the factors affecting survival, such as water temperature, time out of water, habitat preference, and species sensitivity, are often not considered. The objective of this study was to evaluate the effects of handling and time out of water on the survival of freshwater mussels following displacement. The study was conducted in an existing mussel bed in Pool 7 of the Upper Mississippi River (RM 713.2). The study design was a randomized block and consisted of a 3 x 3 m grid divided into nine 1-m² squares. Two squares within a block were controls, and one was the placement square. There were three treatments (0-, 10-, and 60-minute exposure to the atmosphere) and 30 mussels per replicate. The mussels were collected by divers, marked, treated, and placed back into the placement square. The grid was reexamined after 6 months to measure mortality in the control and placement squares. Natural mortality was estimated from the percentage of dead shells taken from the placement square prior to study initiation. These results were compared to the percentage of dead shells collected from the control squares during reexamination.