PO 01*

DISTRIBUTIONAL PATTERNS OF FRESHWATER PHENOTYPES: A CASE STUDY IN *LITHASIA*

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Shell phenotype in gastropods is driven by a combination of genetic and environmental factors, allowing for these organisms to be used in a broad variety of research, including evolutionary, ecological, biochemical, and biomechanical studies. In freshwater mollusks, a long-prevailing assumption is that lotic systems present a one-dimensional, unidirectional habitat gradient for their inhabitants. The expectation would then be that the string of populations living along this cline would be adapted to their local environment, either genetically or ecophenotypically. A prime example of this variation was seen by Ortmann in freshwater bivalves of the United States; a similar pattern was seen by Adams in the snail genus Io. Recent examinations of shell phenotype in freshwater snails have focused on sculpture as an adaptive as well as strictly taxonomic character. Shell sculpture has been shown to increase dislodging potential in flowing systems, as well as decreasing predation. Shape is an equally important component to shell plasticity, and has been explored in numerous biological contexts. We used geometric morphometrics and other statistical methods to analyze phenotype distributions in *Lithasia* c.f. *geniculata* from the Duck River, TN. Shape analyses indicate a correlation between river position (upstream vs. downstream) and shape, and population phenotype composition correlates with the underlying geology of the river. Implications for the ecology, evolution, and classification of these organisms are discussed.

PO 02*

GENETIC ANALYSIS OF SELECTED POPULATIONS OF THE RABBITSFOOT PEARLYMUSSEL (*QUADRULA CYLINDRICA CYLINDRICA*) (BIVALVIA: UNIONIDAE)

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Recovery of many imperiled freshwater mussel species will require re-establishment of populations into historically occupied habitats. However, to retain the necessary genetic diversity, genetic differentiation among populations must be considered prior to transfer of individuals between populations. Thirty-two rabbitsfoot (*Quadrula cylindrica cylindrica*) individuals were sampled from the Duck River, TN, Illinois River, AR, Green River, KY and Ouachita River, AR, and seven individuals were sampled from the rough rabbitsfoot (*Quadrula cylindrica strigillata*) population in the Clinch River, TN. A DNA sequence consisting of 888 base-pairs of the mitochondrial *ND-1* gene was obtained for each sampled individual, and variation among populations was examined. Neighbor-joining phylogenetic analysis identified both the Green and Ouachita river populations as monophyletic, suggesting that any intended augmentation for these populations should carefully consider the source population. Observed genetic variation was not partitioned along currently recognized taxonomic boundaries for the two subspecies of rabbitsfoot pearlymussel. Hence, the results of this study indicate that the smooth and rough forms of the rabbitsfoot pearlymussel may not represent separate taxonomic entities.

PO 03

MOLECULAR EVIDENCE FOR A NOVEL PHYLOGENETIC PLACEMENT OF THE CAROLINA CREEKSHELL, *VILLOSA VAUGHANIANA* (LEA, 1836)

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The Carolina Creekshell, *Villosa vaughaniana*, is a threatened freshwater mussel endemic to the upper coastal plain and lower piedmont regions along the fall line in North and South Carolina. It occupies clay silt or fine gravel/sand substrates along the margins of creeks and smaller rivers in the Catawba, Yadkin-Pee Dee and Upper Cape Fear River basins. As is typical of southeastern unionid species, *V. vaughaniana* is in decline due to a variety of environmental impacts. The NC Department of Transportation previously funded our laboratory to develop propagation techniques as well as microsatellite markers to begin to augment and genetically track populations of *V. vaughaniana*. As a first step in the genetic portion of this project, we felt it necessary to determine the phylogenetic placement of the species to aid in identifying potential related taxa that could be used to test primers during the development phase. We were surprised to find that COI sequence data placed the species in a clade composed of two *Ligumia* species instead of with other *Villosa*. We present genetic, anatomical and conchological evidence to support these findings.

PO 04

CONSERVATION GENETICS OF *PLEUROBEMA COLLINA* IN VIRGINIA AND NORTH CAROLINA

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Following the discovery of a spinymussel population in the Dan River of the Roanoke River basin, the species was tentatively identified as the endangered James spinymussel (*Pleurobema collina*), previously thought to be endemic to the James River basin. Current populations of *P. collina* are demographically separated by 39 to several hundred river kilometers. A genetic characterization of four extant populations of *P. collina* was conducted to assess the taxonomic affinity of the Dan River population and to resolve conservation issues related to recovery planning and management actions. The populations were examined for biological and phenotypic variation, and were characterized phylogenetically using DNA sequences. No quantifiable variation was observed in fish host specificity ($P>0.05$). In addition, specimens in the four populations had the same shape and color, comparable mean number of conglutinates per female, similar fecundity estimates, but differed in size of glochidia ($P>0.05$). A comprehensive analysis was performed for both separate and combined mitochondrial (357 bp of *cytochrome-b*, 916 bp of *ND-1*) and nuclear (502 bp of *ITS-1*) DNA sequences. A monophyletic lineage [congruent with lack of phenotypic, quantitative, or geographic genetic variation among populations] was inferred. Based on comprehensive molecular, morphological, and life history data, populations of *P. collina* sampled from the Dan River sub-drainage do not warrant separate taxonomic designation from *P. collina* sampled from the James River drainage. Data obtained from hyper-variable DNA microsatellites may provide additional evidence to assess whether populations of *P. collina* are genetically distinct from one another. Thus far, seven presumptive microsatellite loci were identified for this species (King et al. unpublished 2005), and the same four populations of *P. collina* were tested for levels of genetic differentiation within and among populations. We will use patterns of within-population genetic variability (i.e., diversity) to assess viability of populations of *P. collina*. Then, patterns of between-population genetic variability will be used to assess the relatedness of the populations and select optimum translocation/re-establishment strategies.

PO 05

INVESTIGATING THE RELATIONSHIP BETWEEN THE FEDERALLY ENDANGERED WAVYRAYED LAMPMUSSEL (*LAMPSILIS FASCIOLA*) AND ITS GLOCHIDIAL HOST, THE SMALLMOUTH BASS (*MICROPTERUS DOLOMIEU*), IN THE GRAND RIVER, ONTARIO, CANADA

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The Wavyrayed Lampmussel was listed under Canada's *Species at Risk Act* (SARA) as Endangered in 2003. This listing provides immediate protection for individuals and allows for additional measures directed at the preservation of critical habitat and residences as they are identified. The dependence of freshwater mussels upon vertebrate hosts for completion of their life cycle raises some unique questions when evaluating appropriate methods for the protection of mussel species at risk. In this study we set out to investigate the relationship between the Wavyrayed Lampmussel and its host, the smallmouth bass, in the upper Grand River watershed of southwestern Ontario in an effort to provide insight into the management of the host species. The Grand River Wavyrayed Lampmussel population is considered one of the three healthiest remaining populations in Canada and is showing current signs of reproduction and recruitment while the smallmouth bass population supports one of the largest recreational fisheries in the province. At three sites covering the extent of the mussel's distribution in the watershed we quantified the timing and availability of glochidia in the water column using a series of standard 100µm mesh drift nets deployed at weekly intervals throughout the period of glochidial release. Simultaneous investigations of host infestation rates were made through collections of host fish obtained by angling, seining and electrofishing over known mussel beds. Examination of host gill tissue revealed that 32% of collected fish were bearing glochidial infestations ranging from 1 to 196 glochidia per individual. Probability of infestation was not size dependant with the exception of the observation that young of the year fish were under represented in the infested fish likely resulting from spatial and/or temporal isolation from the mussel beds.

PO 06

NEW HOST FISH IDENTIFICATIONS FOR THE PYRAMID PIGTOE, *PLEUROBEMA RUBRUM*

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The pyramid pigtoe, *Pleurobema rubrum* (Rafinesque, 1820) is a freshwater mussel that occurs sporadically in large rivers in the Ohio and Mississippi River systems and has been extirpated from a large proportion of its historical range. From 2003 to 2005, 14 *P. rubrum* individuals were collected during both quantitative and qualitative mussel sampling on the Green River, Kentucky. To facilitate reproduction, all individuals collected were placed into a gravity fed, flow-through raceway system at the Center for Mollusk Conservation in Frankfort, Kentucky. On June 15 of 2006, a single female pyramid pigtoe was observed releasing conglutinates. Conglutinates contained few glochidia and consisted mostly of unfertilized eggs. Water temperature at the time of conglutinate release was 22.5 ^{o}C. Nine previously collected fish species were exposed to *P. rubrum* glochidia. After 12-15 days, transformation of glochidia to juveniles occurred on 4 fish species from the family Cyprinidae: *Cyprinella spiloptera*, *Erimystax dissimilis*, *Lythrurus fasciolaris*, and *Notropis photogenis*. All 4 fish species identified as hosts are common in the current range of *P. rubrum*, and all but *L. fasciolaris* are generally associated with the large river habitat of the pyramid pigtoe. All 4 fish species are potentially natural hosts and *C. spiloptera* appears to be a very suitable host fish for propagation purposes.

PO 07*

CONSERVATION OF THE OUACHITA CREEKSHELL *VILLOSA ARKANSASENSIS* (LEA 1852): REPRODUCTION AND HOST FISH SUITABILITY

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The Ouachita creekshell, *Villosa arkansasensis*, is considered endemic to the Ouachita River drainage of Arkansas and Oklahoma and is an Arkansas species of special concern. The objectives of this study were to: 1) determine the period of gravidity for *V. arkansasensis*; and 2) determine suitable host fish from the Saline and Ouachita rivers. Female *V. arkansasensis* were observed gravid beginning in October and continued through August of the following year. Like other *Villosa* species, *V. arkansasensis* was assumed to be bradytictic (long term brooder), becoming gravid in late summer, early fall and releasing glochidia in late spring, early summer. Host fish suitability trials for the Saline River revealed four suitable host fish; shadow bass (*Ambloplites ariommus*), Creole darter (*Etheostoma collettei*), greenside darter (*E. blennioides*), and green sunfish (*Lepomis cyanellus*). The most successful suitable host fish for the Saline River trial was the shadow bass with 15 of 20 total transformations. A second round of trials for the Saline River drainage resulted in 27 transformations from two suitable host fish; Creole darter (*E. collettei*) and greenside darter (*E. blennioides*). The Ouachita River drainage trial resulted in only one transformation from the greenside darter (*E. blennioides*). Investigation of the biogeographical patterns of the suitable host fish species and *V. arkansasensis* indicates an interesting congruence in their distributions. Thus, conservation and management of *V. arkansasensis* not only relies on understanding its ecological requirements, but understanding the ecological requirements of its host fish as well.

PO 08*

REPRODUCTIVE BIOLOGY OF THE RABBITSFOOT MUSSEL (*QUADRULA CYLINDRICA*) IN THE UPPER ARKANSAS RIVER SYSTEM, WHITE RIVER SYSTEM AND THE RED RIVER SYSTEM

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The rabbitsfoot mussel, *Quadrula cylindrica*, is geographically widespread within the Lower Great Lakes, Ohio, Cumberland, Tennessee, Lower Mississippi, White, Arkansas, and Red River systems. Although a few rabbitsfoot populations are robust, many others are nearly extirpated. In the upper Arkansas River system of Kansas and Missouri, the rabbitsfoot is one of the rarest and most critically endangered unionids. We are studying the reproductive biology of rabbitsfoot, including timing of reproduction, fecundity, host infection strategy, and identifying which fish species and populations are hosts for the parasitic glochidia larvae. These data are needed for management actions and may also be useful in assessing diversity among rabbitsfoot populations. We are comparing host requirements among rabbitsfoot populations in the Spring River (upper Arkansas River system), the Little River (Red River system) and the Black River (White River system). Results to date indicate that blacktail shiner, *Cyprinella venusta* from the Black River and Little River (AR) and cardinal shiner, *Luxilus cardinalis*, and red shiner, *Cyprinella lutrensis* from the Spring River (MO & KS) appear to be suitable hosts for all three rabbitsfoot populations. More limited evidence indicates other hosts including spotfin shiner *Cyprinella spilopterus*, rosyface shiner, *Notropis rubellus* and emerald shiner, *Notropis atherinoides.* We observed differences in reproductive timing between the three populations. In the Black River, rabbitsfoot brooded eggs beginning in late May and peaked in late July, while the Spring River, KS rabbitsfoot brooded from mid July to late August. Little River rabbitsfoot brooded from mid June to late July. These results indicate physiological and ecological differences between the three populations.

PO 09*

DAILY BURROWING BEHAVIOR OF FOUR FRESHWATER MUSSEL SPECIES

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Although the burrowing behavior of some freshwater mussel species has been documented, most of these studies have investigated seasonal migrations as related to reproductive cycles. Few studies have focused on the day-to-day movement patterns of freshwater mussels. We documented the burrowing behavior of four common freshwater mussel species, *Actinonaias ligamentina, Amblema plicata, Fusconaia flava,* and *Obliquaria reflexa*. During the summer of 2005, we recorded horizontal and vertical movements of 80 individuals of each species placed in stream mesocosms. The experiment was run for 11 days, and was replicated five times. Mussels were individually labeled and an exterior mark was made on their shells at half the distance between the anterior and posterior margins. To make observations, a grid was placed over the mesocosm; in this design we had eight possible horizontal positions (grid number) and three possible vertical positions (completely burrowed, 25% exposed, and 75% exposed) for each observation. In trial I, burrowing observations were made every three days, and in trials II-V, burrowing observations were made every other day. We found that our four freshwater mussel species varied in their horizontal and vertical movement patterns. *A. ligamentina* was the most active horizontal burrower, while *F. flava* was the least active horizontal burrower. For vertical burrowing position, *F. flava* was generally the deepest burrowed, while the other three species were more exposed to the water column. Because mussel burrowing can influence sediment stability and energy and nutrient transport, our results indicate that different mussel species may have different effects on ecosystem services through their behavior.

PO 10*

MOVEMENT OF FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE) USING MARK-RECAPTURE METHODS IN THE MUSKINGUM RIVER, MUSKINGUM COUNTY, OHIO

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Relocation of freshwater mussels are utilized to mitigate anthropogenic disturbances, thus ensuring conservation of native species. Beginning in July 2002, mussels were relocated from a 26,000 m^2 section of the Muskingum River that included a zone of direct impact and buffer zones near a power plant water intake structure. The entire area of the proposed intake and buffer was cleared of all live mussels using SCUBA hand collections and relocated onto a series of 110 transects over an approximately 5 km reach of the Muskingum River. All mussels were taxonomically identified, marked, weighed, and photograph prior to relocation. Each mussel's relocation transect was recorded at time of initial relocation and each subsequent recapture. All relocation transects were placed in areas with existing mussel populations, indicating suitable substrate stability and composition. Approximately twenty-five percent of the total relocation transects were randomly resampled each of the successive years between 2002 and 2006. Movement was estimated via known location of relocation and standardized length of transects and distance in between transects. A component of monitoring included mortality estimates. In an effort to be conservative, mortality data included transect resampling, searches of adjacent banks including all midden piles. All left valves were identified and measured, with marked shells being noted. GPS data was collected for each transect and midden pile location. Data was then transferred to GIS and distances of each marked individual mussel was measured where possible. Movement varied from zero to 350 meters.

PO 11*

DO FRESHWATER MUSSELS FORM A SINGLE GROWTH RING EVERY YEAR?

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Our objective was to answer the question, "Do freshwater mussels form a single growth ring every year?" While apparently a simple question to answer, previous studies have not rigorously addressed this question. Using Eastern *Elliptio* (*Elliptio complanata*) shells marked 5-7 years before our study began, we developed criteria for recognizing an annual ring. Shells were thin sectioned and viewed microscopically at 7-40x magnification. If the mussels formed true rings or annuli, we should have observed one ring per year of growth. Our determination of annual rings in the shells differed from the actual number in 28 out of 76 sections (from 46 individuals). On average, we counted 0.11 (± 0.10 s.e.) rings more than the expected number. We subsequently re-evaluated the 28 sections we had misread and refined our criteria for recognizing true rings. We were able to apply these criteria to all but one shell. We conclude that, using these criteria, the freshwater mussel *E. complanata* does form growth rings annually.

PO 12

LONG-TERM MONITORING OF GROWTH IN THE EASTERN *ELLIPTIO, ELLIPTIO COMPLANATA* (BIVALVIA:UNIONIDAE), IN RHODE ISLAND: A TRANSPLANT EXPERIMENT

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The lengths of marked specimens of the freshwater mussel, Eastern Elliptio (*Elliptio complanata* [Lightfoot 1786]), were monitored annually in 3 lakes in Rhode Island, USA, from 1991 to 2005. Mussels growing in Worden Pond showed a change in mean shell length of only 4.3 mm over 14 y, whereas mussel growth in 2 nearby lakes was 3 to 8x greater than growth in Worden Pond over the same time period. L_{∞}, the length at which shell growth stops, was significantly different ($p < 0.001$) among lakes and ranged from 60.5 to 87.4 mm. Transplant experiments revealed that mussels moved to Worden Pond stopped growing, whereas mussels moved from Worden Pond to the 2 other lakes grew at rates similar to the rates observed for resident mussels in the 2 lakes. Standard water-quality measures did not explain the observed growth cessation and lower condition indices of mussels in Worden Pond. Our growth data are consistent with food limitation. The consistent slow growth of *E. complanata* in Worden Pond, without high mortality, and its ability to increase growth when placed in environments more favorable than Worden Pond, suggests both growth plasticity and longevity in these animals.

PO 13*

FRESHWATER MUSSELS OF THE HATCHIE RIVER IN WEST TENNESSEE

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The Hatchie River is a 220-mile alluvial stream whose main stem remains largely untouched by the channelization efforts that have impacted many of west Tennessee's rivers and wetlands. A study by Manning (1989) reported 32 native freshwater mussel species from the Hatchie River. The objective of our study is to document changes in species diversity and population density since Manning's study and to provide current baseline data for informed aquatic and land management plans. We found 4,516 individuals from 27 species at 248 of 326 sites sampled in the lower 185 miles of the Hatchie River watershed. Mussel abundance averaged 22.4 (± 2.02 s.e.) individuals per person hour. Unionid mussel abundance was low in the sand-dominated upper river in the Southeastern Plain, while *Corbicula fluminea* abundance was low in the lower river of the Mississippi Valley Loess Plain. We found two species -- *Lampsilis siliquoidea* and *Quadrula apiculata* -- not previously recorded from the Hatchie River, but did not find seven species originally reported by Manning. Our data revealed significant losses in species richness and abundance since the early 1980s at Manning's collection sites.

PO 14*

ABUNDANCE AND DISTRIBUTION OF FRESHWATER MUSSELS IN THE CHIPOLA RIVER BELOW THE DEAD LAKES IN GULF COUNTY, FLORIDA WITH FOCUS ON THE CHIPOLA SLABSHELL, *ELLIPTIO CHIPOLAENSIS*

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Historically, 33 species of freshwater mussels have been observed in the Apalachicola–Chattahoochee-Flint Basin, which resides in Georgia, Alabama, and Florida. The fourth largest river in this basin, the Chipola River, was dammed in 1960 just below the Dead Lakes in Florida, only to be removed in 1987. The location immediately downstream from the removed dam is a very productive site for *Elliptio chipolaensis*, the Chipola slabshell. This species is thought to be endemic to the Chipola River. It is currently listed as threatened by the U.S. Fish and Wildlife Service (USFWS), and critical habitat along the Chipola River is coming under protection by the USFWS. In the summer of 2006, a concentrated survey effort on the Chipola River below the former dam at the Dead Lakes yielded over 70 individuals of *E. chipolaensis,* showing significant congregation at a particular location. The length-frequency curves for these individuals suggest recruitment. Other species, which are considered stable by the USFWS, were found in alarmingly low numbers during the survey.

PO 15*

CURRENT STATUS OF THE UNIONID MUSSEL ASSEMBLAGE IN THE VERDIGRIS RIVER, OKLAHOMA

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The small rivers (Caney, Verdigris, and Neosho) in Oklahoma's Tallgrass Prairie Region have historically supported a number of unionid mussel and fish species of concern at the state and federal levels. In 2006, we initiated a survey to assess the status of these assemblages in each river, with results from the unionid survey of the Verdigris River reported here. The Verdigris originates in Kansas and joins the Arkansas River near Muskogee, Oklahoma. The river contains an impoundment, Oologah Lake, which is infested with zebra mussels, *Dreissena polymorpha*. Timed searches for unionid mussels were conducted at 31sites (20 above and 11 below Oologah Lake) beginning in July 2006. Sites were selected to correspond to an earlier survey of mussels in the Verdigris conducted in 1996 and 1997. Individuals collected during a search were identified and measured before being returned to the river. Taxa richness for the river as a whole, was similar between the two surveys (16 species identified in each), although species composition was different. *Potamilus ohiensis* and *Quadrula quadrula* were found in the 1996/1997 survey, but were absent in 2006. In contrast, *Cyprogenia aberti* and *Quadrula cylindrica* were only found during the 2006 survey. Among all sites, mean species richness and mean mussel abundance (standardized as number of mussels found per hour, MPH) were significantly greater in the 2006 survey, increasing from 3.3 to 5.2 and 17.4 to 39.3, respectively. Byssal threads were found on most unionids below Oologah Lake, although few live zebra mussels were found. This result was consistent with a significant die-off of zebra mussels that occurred in late August. Considering only the 2006 survey, there was no significant difference in species richness or MPH between sites above and below Oologah Lake.

PO 16

THE DISTRIBUTION AND ABUNDANCE OF FRESHWATER MUSSELS FROM THE NELSON-SASKATCHEWAN RIVER DRAINAGE IN SASKATCHEWAN, MANITOBA AND NORTH DAKOTA

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The Nelson-Saskatchewan river drainage originates in the Rocky Mountains, crosses the Canadian prairies and ultimately empties into Hudson Bay in northern Manitoba. The Red River forms the border between North Dakota and Minnesota and contributes to this drainage from the south. Historically 13 species of freshwater mussels have been reported from the Nelson-Saskatchewan drainage. S since the efforts of Cvancara in North Dakota and Clarke in Canada there are few recent studies into this fauna, particularly from the 2 Canadian prairie provinces and North Dakota. I summarize recent studies that investigate the distribution and abundance of this fauna between 2001 and 2006 emphasizing the rivers and streams in Manitoba. These studies document the presence of 12 of the 13 historically recorded species. Species richness declines with distance from the Red River. There has been a decline in the distribution of some species compared to historical records with apparent extirpations in some rivers and in Lake Winnipeg. One result of this apparent decline has been the mapleleaf, *Quadrula quadrula* being assessed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Reasons for this apparent decline of the overall fauna and for the listing of this particular species are anthropogenic activities, in particular those that contribute to declining water quality.

PO 17

FRESHWATER MUSSELS (BIVALVIA: UNIONOIDA) OF THE ANGOLA REGION

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The West African nation of Angola straddles the divide between the Congo Basin and the rivers of southern Africa. The "Angola Region" (as we define it) extends beyond the borders of the political entity to encompass the Congo River including and below the Casai, the Upper Zambezi as far down as the Kafue, the endorheic Okavango Basin, and the Coastal streams from the Cunene north. Based mostly upon museum work but also from our own collecting on the fringes of the Angola Region, we recognize 23 species, including a newly discovered species, *Mutela wistarmorrisi* Graf & Cummings, 2006. All species of the Angola Region are illustrated and distributional patterns are discussed.
This research was funded by the National Science Foundation.

PO 18

FRESHWATER MUSSEL SPECIES DISTRIBUTION AND DENSITIES IN THE FRENCH CREEK WATERSHED

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The freshwater mussel communities of the French Creek watershed are nationally recognized for their importance to biodiversity. The goal of this research was to gather more information on the distribution and densities of these species throughout the watershed. This study utilized timed searches to characterize mussel species richness in a given area and to calculate catch per unit effort (CPUE) values. Quantitative mussel surveys were then utilized to calculate estimates on densities and abundances. Relationships between these data were used to estimate densities on a river-wide scale. Starting in NY, the main stem of French Creek was divided into 28 stretches equal length and one site was randomly chosen within each stretch, favoring optimal habitat for rare species and high species diversity. Tributary sites were chosen in a similar manner. Snorkelers collected as many unionid individuals as possible with a target search rate of $0.5m^2$/minute. Thirty-two main-stem sites and 12 tributary sites were surveyed with timed searches. Mean species richness was 9.8 (8.0, 11.6) and mean CPUE was 39.6 (24.7, 54.6). Quantitative sampling was performed at ten sites using a double sampling design, systematically placed with multiple random starts and $0.25m^2$ quadrats. Density estimates ranged from $0.0/m^2$ to $27.98/m^2$. Abundance estimates range from 0 to 69,848 live mussels per site. For the main-stem, we calculated regression models to estimate densities and abundances at qualitatively sample sites based on the CPUE at quantitatively sampled sites. Extrapolation yields approximately 12 million animals in the 39.6 km of significant riffle/run habitat in the main stem of French Creek.

PO 19

FRESHWATER MUSSEL SURVEYS IN THE NAVIGATIONAL POOLS OF THE ALLEGHENY RIVER, PA

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Freshwater mussel surveys prior to construction of the navigational dams in the Allegheny River documented nearly 30 species of mussels including several rare species. However, little mussel research on the status or distribution within the lower Allegheny has occurred since that time. The goals of this work were to assess the present status and distribution of the freshwater mussel communities in the navigational pools of the Allegheny River. Transects 100-meter long were divided into 10-meter segments and were placed perpendicular to flow. Paired SCUBA divers searched a minimum of 10 minutes in each 10-meter segment, unless conditions were unsuitable. Twenty-eight transects were sampled during the 2005-2006 field seasons. Of those, six transects were sampled in pool 4 (RM 26.6 to 27.3), one in pool 5 (RM 31.3), sixteen in pool 6 (RM 37.0 to 45.4), three in pool 7 (RM 51.7-52.0), and four in pool 8 (RM 53.4-53.8). Eighteen species were located between all pools but the mean species richness (live) across all sites was only 4.3 with a 95 % confidence interval of (3.1, 5.5). Mean species richness (live) in pool 4 was 1.88 (1.69, 2.06) species per transect, 6.99 in pool 6 (6.81, 7.16), 4.60 in pool 7 (1.80, 7.54), and 0.25 (-0.55, 1.05) in pool 8. Mean abundance for pool 4 was 2.91 (2.55, 3.25) animals per 100m transect, 83.79 (77. 85, 89.73) for pool 6, 14.33 (1.83, 26.84) for pool 7, and 0.25 (-0.55, 1.05) for pool 8. We found a negative relationship between numbers of individuals found and increasing maximum depths (p-value =0.05). All but four live mussels were found at depths less than 6.7 meters.

PO 20

DISTRIBUTION OF FRESHWATER SNAILS (MOLLUSCA: GASTROPODA) FROM LOTIC SYSTEMS AND SPRINGS IN PENNSYLVANIA, USA

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Despite a rich history of freshwater mussel inventory, little has been gathered on the freshwater gastropod fauna of Pennsylvania. We wanted to examine contemporary distributions of aquatic gastropods in streams and springs across the state. From 2003-2005, 398 collections were made in all drainage basins. Our research located 39 species representing 7 families. In addition, the data show several species to be rare in the state. This inventory documented *Somatogyrus pennsylvanicus* in Pennsylvania and located several populations of the Ohio pebblesnail, *Somatogyrus integra*. Despite targeted surveys, no collections were made of the buffalo pebblesnail, *Gillia altilis*. Further inventory is needed in lentic and cave systems to provide an accurate picture of the modern day fauna.

PO 21*

FRESHWATER SNAILS OF THE OZARK MOUNTAINS IN ARKANSAS

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Biological inventories provide baseline data necessary for conservation status assessment. Freshwater gastropods represent one of the most imperiled groups of freshwater fauna in North America. Though a few studies have focused on freshwater gastropod fauna of various drainages within the state of Arkansas, no attempt has been made to establish distributions of gastropods across the entire state. The Ozark Mountain region is a large biogeographic feature which, historically, has shown to have a unique composition of freshwater fauna. We surveyed 170 sites within the Ozark Mountains to establish current distributions of freshwater snails occurring in the Ozark Mountain region of Arkansas. Museum records and literature were also incorporated with current field collections to examine historical and current freshwater snail distributions within the region.

PO 22

DIVERSITY AND ECOLOGY OF FRESHWATER GASTROPODS IN BAYOU BARTHOLOMEW, ARKANSAS

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Gastropods can be important factors in ecosystems, however, their ecology and distribution are poorly understood and thus a void is left in the understating of lotic ecology in general. High densities of gastropod grazers can result in shifts in periphyton assemblages and are important dietary components of various fishes, turtles, birds, and invertebrates. Some authors have proposed a continuum for predicting habitat distributions for gastropods, predicting that pulmonates would be more common in headwater streams because of their greater ability to disperse to disturbed habitat and higher tolerance of extreme physical and chemical variables. Prosobranchs then would be more common in higher order areas of the stream due to their greater ability to resist predation through thicker shells and operculum defenses and their inability to tolerate extreme physical and chemical variables. One exception to this proposed distribution may be a bayou system. Bayou systems are poorly studied relative to other aquatic habitat types mainly because, despite being considered lotic systems, they exhibit qualities of both lotic and lentic systems because of their variable flow and tendency to have large, still pools. Thus, organisms indicative of both lotic and lentic habitat types could potentially occur in a bayou system. As part of a larger survey on the distribution, diversity, and ecology of freshwater mollusks in Bayou Bartholomew, Arkansas, we surveyed the freshwater gastropod fauna of the bayou from 74 sites. We report finding 14 species from seven families, with prosobranch and pulmonate distributions following previously published patterns.

PO 23*

ASSESSING CHANGE IN A COMMUNITY OF FRESHWATER MUSSELS: CONSEQUENCES OF URBANIZATION IN THE BLACK RIVER, OHIO

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We investigated the diversity and abundance of unionid mussels in the Black River watershed, Ohio between 2005 and 2006. These results were compared to historical collection records, the presence of urbanization in the watershed and a 1997 fish survey conducted by the Ohio Environmental Protection Agency. Live mussels represented 11 species, and shells were obtained for 10 more, but the present assemblage varied greatly from a collection of shells obtained in a nearby archeological area, and from a collection of species obtained at the turn of the 20th century. Furthermore, levels of diversity, as measured by the number of species found alive at each site, remained fairly constant across the watershed. Diversity is predicted, however, to increase downstream as watershed size increases. Concurrent with a static level of diversity was that abundance of mussels declined greatly in urbanized areas. Fish hosts likewise impacted mussel diversity, but to a lesser extent. The distribution of just three species appeared constrained by the lack of a glochidial host species upstream of the first dam; *Potamilus alatus*, *Leptodea fragilis*, and *Truncilla truncata* all are known to parasitize only one fish, the freshwater drum (*Aplodinotus grunniens*). All three mussel species and this fish were found only in the lower reaches of the river.

PO 24

A COMPREHENSIVE METHOD FOR FRESHWATER MUSSEL SAMPLING AT LONG TERM MONITORING SITES

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Freshwater mussel recovery attempts through the release of laboratory-cultured juveniles have dramatically increased over the last decade. In order to determine success of these activities, a long term monitoring plan is needed in areas were specimens are released. The Virginia Department of Game and Inland Fisheries has established a mussel restoration plan that incorporates 6 designated reaches in the upper Tennessee River drainage including the Powell (1), Clinch (4) and North Fork Holston rivers (1). A site within each reach is selected to monitor longterm success of mussel recovery efforts. In order to accomplish this goal, the monitoring protocol delineates mussel aggregations, determines mean density, species richness and identifies areas suitable for release of laboratory-cultured juveniles within a site. The protocol requires a site to be systematically sampled using one meter quadrats to cover 5% of total habitat. Sampling in this manner determines the areas of highest mussel density. In high density areas, 0.25m quadrats are randomly excavated and sieved to determine the surface and subsurface component of the mussel aggregation and examine recruitment through the presence of juvenile mussels. Finally, a qualitative visual sample is conducted to determine the presence or absence of any species that was not collected during quadrat sampling. Each site is sampled on a 5 year cycle, data derived can then be compared to determine if mussel populations at each site are responding to our recovery efforts.

PO 25*

LAND USE AND FRESHWATER MUSSEL ASSEMBLAGE CHANGES IN THE LOWER WHITE RIVER, ARKANSAS: 1930 TO 2002

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The White River ranked fourth for commercially harvested freshwater mussels in the United States from 1912-1914. Meanwhile, the White River and its associated tributaries have undergone extensive modifications that include construction of 6 large dams on the upper mainstem or its tributaries, dredging to maintain navigation from its mouth to Newport, AR (RM 255), construction of flood control levees, and extensive land clearing for agricultural production. Recent surveys revealed changes in the mussel communities with 49 of 101 (49%) of the historical mussel beds of the White River remaining intact. The goal of this study was to investigate the extent of land use changes in the lower White River watershed. We used a GIS coverage of 12 digit HUCs and associated Arkansas counties and the US Census Bureau county level agricultural datasets on total farmland and total harvested cropland to investigate land use changes in the watershed. Datasets were added to county attribute tables at 5 to10 year intervals from 1930 to 2002. We used the resulting GIS datasets to map and analyze land use changes of counties in the 12 digit HUCs of the lower White River. Overall, % farmland increased 14.5% (±37.6 SD), ranging from -45 to 123%, from 1930 to 2002, while % cropland harvested increased 66.2 % (±90.2 SD), ranging from -60.8 to 238.4% from 1930 to 2002. A negative correlation of a decrease in number of mussel beds and the increase in % cropland harvested was observed. The mechanisms of this relationship were not investigated, but increased sediment loads and habitat alteration may be the processes associated with increased cropland production.

PO 26

USING HYDRAULIC PARAMETERS TO PREDICT MUSSEL DENSITY

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Freshwater mussels are among the most endangered animals in North America. Changes in water quality, land use, and modification of rivers have been implicated in their decline. The St. Croix River is home to a dense and diverse assemblage of mussels and serves as an important refuge for these organisms. Despite their importance in rivers little is known about factors that control their distribution and abundance. Simple habitat factors, such as water velocity, depth and substrate type, are not strong predictors of abundance or diversity. The use of more complex hydraulic parameters shows promise. We randomly selected 40 locations in a 5 km stretch of the St. Croix River between Interstate Park and Franconia, MN. At each location we sampled 3 1-m^2 quadrats quantifying mussels, and collected sediment samples from 1 quadrat. Depth and velocity were measured with an acoustic Doppler current profiler under different discharge levels allowing us to measure the range of hydraulic stresses experienced by the river bottom. Complex hydraulic parameters (Froude number, boundary Reynolds number, shear velocity, etc.) were calculated. Analyses of covariance using the hydraulic parameters as a covariate and location (Franconia or Interstate) showed that there was a significant interaction between location and the hydraulic parameters Froude number, shear velocity and shear stress. The Froude number, shear velocity and shear stress are all higher at Interstate which harbors a greater density of mussels than Franconia. Mussel density was significantly correlated with these parameters (except Reynolds number), with large numbers of mussels corresponding to high Froude number, shear stress, turbulent flow, and thin laminar flow layers. These hydraulic parameters suggest that Franconia is a more depositional riverbed environment, which may account for the overall lower mussel density there. These data suggest that reach-scale hydraulic measurements may be helpful in determining habitat suitability for mussels.

PO 27

DROUGHT EFFECTS AND STREAM QUALITY IN TRIBUTARIES OF THE LOWER FLINT RIVER BASIN, SOUTHWESTERN GEORGIA

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The Flint River Basin of southwestern Georgia is noted for its freshwater mussel diversity, historically supporting 29 species, 7 of which are endemic. Recent declines in mussel abundance and diversity have raised concerns about the long term viability of mussels in the Flint River and its tributaries. While undergoing declines for the past 50 or more years, the development of agricultural irrigation in the 1970's and a recent record drought (1999-2001) have put resulted in diminished stream-flows, stream drying, and extensive mortality in some tributary streams in the lower Flint River. We assessed mussel mortality at 20 sites within the region following the drought and found significant mortality in stream reaches that ceased flowing or dried completely. In 2004, as a part of a larger study, 16 sites were revisited as part of a comprehensive habitat and water quality assessment. Sites were classified by physiographic province, whether they maintained flow, and whether mussel populations were stable or declined during the recent drought. Of the sites showing mussel declines, 87.5% were classified as impaired compared to 37.5% of sites where mussel populations were stable. The primary causes of impairment were stream bank and riparian erosion, and degradation of instream and riparian habitat as indicated by the EPA rapid assessment protocol. Most of the mussel declines occurred in the mid-reaches of tributaries streams where base-flows are dependent on aquifer discharge. This has resulted in remaining mussel populations being increasingly isolated in the headwaters. Much of our study area has been proposed as 'critical habitat' for three endangered mussel species. Our results suggest that conservation plans should include not only insuring adequate instream flows, but restoration of stream banks and riparian corridors to assist in the recovery of mussel populations.

PO 28

A REGIONAL ASSESMENT OF HISTORICAL MUSSEL HABITAT CONDITION IN THE FLINT RIVER BASIN, GEORGIA

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Streams of the Flint River Basin (FRB) remain as viable habitat for many freshwater species and harbor some of the most diverse mussel assemblages in the Southeast. However, land use changes, hydrologic alterations, and declines in native fish species have adversely affected mussel diversity and abundance throughout the region. Protection of rare and sensitive mussels requires the development of timely conservation strategies, supported by knowledge of current riparian and instream habitat conditions that impact their survival and recovery. We examined habitat conditions and selected water quality parameters at 84 stream sites that have historically supported populations of freshwater mussel species in the Basin. Higher nutrient, sediment, and bacterial concentrations were observed in the upper portion (Piedmont) of the Basin, which is characterized by higher gradient streams and percentages of urban land use. Sites in the lower section of the Basin (Fall Line Hills and Coastal Plain) maintained better quality riparian habitat including a larger buffer zone width, greater bank stability, and more vegetative cover. Mussel habitat quality appeared good throughout the Basin. Physiochemical parameters and riparian habitat quality were influenced both by regional geologic differences and patterns of human activity.

PO 29

RAPID RECOVERY OF FRESHWATER MUSSELS IN AN AREA DISTURBED BY BRIDGE CONSTRUCTION

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Freshwater mussels within the area of direct and indirect impact from bridge construction were surveyed over a period of five years after completion of a new bridge. The bridge is located on the Allegheny River in northwest Pennsylvania. A diverse mussel assemblage, including the presence of two federally listed endangered mussels, was present prior to start of construction. Construction activities included demolition of the old bridge and building a causeway to facilitate construction. The direct impacts were expected to result from placement of the causeway fill, areas directly disturbed to construct the causeways, and areas where the existing bridge was dropped into the river. Indirect effects could include change in habitat from pooling or scour which could lead to displacement of animals, interfere with reproduction or potentially affect mortality. Prior to construction mussels within the direct impact area were relocated to sites upriver and mussels within the areas of indirect impact remained in place. Our objectives were to use quantitative sampling to determine 1) the extent of direct and indirect effects on mussel density, diversity and habitat; 2) whether freshwater mussels would recolonize the direct impact area; and 3) which species are first to recolonize an area of disturbed riverbed. Lowest mussel density occurred within the direct impact the first year post-construction, with lowest density in the area of the causeway followed by the area where mussels were removed. By year four densities had recovered to pre-construction levels with little change five years after construction. Mechanisms for recolonization and changes in spatial distribution of mussels in the areas of impact will be presented.

PO 30

THE ALABAMA MILL DAM INVENTORY: A BROAD-SCALE EVALUATION OF THE EFFECTS OF MILL AND LOW-HEAD DAMS ON MOLLUSK, FISH, AND CRAYFISH ASSEMBLAGES

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Impoundments are widely recognized as having dramatic impacts on freshwater mollusk and fish assemblages. Dams transform upstream lotic reaches to lentic-like habitats, restrict downstream sediment movement, alter physicochemical conditions in downstream reaches, and restrict fish migrations. Impacts of larger dams are dramatic and well-documented, but impacts of smaller structures remain poorly understood. Recent emphasis has been placed on potential fragmentation of mussel populations by mill and other low-head dams; however, emerging counter evidence suggests that these structures may enhance mussel habitat in downstream reaches. Understanding impacts of low-head dams (i.e., those <5 m height) is critical to imperiled species management because 1) such structures greatly outnumber larger dams and occur in a greater range of stream sizes and types, and 2) there is increasing conservation interest in removing small dams as part of stream restoration. We have begun to inventory small regulated streams across Alabama to better understand the potential impacts of mill and low-head dams and stream macrofauna. The Alabama Mill Dam Inventory (AMDI), funded by the State Wildlife Grants program, focuses on small dams and their putative impacts on stream habitat and biota in some of North America's most diverse lotic ecosystems. We are using a combination of large-scale spatial (GIS) analysis, intensive small-scale site inventories, and larger-scale rapid assessments to construct and test empirical models that relate physical, chemical and biological response variables to presence, size, condition, and history of low-head dams across Alabama. We identified 3 focal stream sites with dams in each of the State's 10 major drainages, and in 2006 we began quantifying stream mussel, snail, crayfish and fish, populations and their habitat at these sites. Ultimately, we will use focal dam data to model the impacts of small dams on stream habitat and biota across Alabama's complex mosaic of physiographic and biotic diversity.

PO 31

MONITORING MOLLUSCAN RESPONSE TO A LOW-HEAD DAM REMOVAL FROM A MOBILE RIVER BASIN STREAM

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Low-head dams on streams are known to alter habitat, depth and velocity of water, and serve as a break in connectivity between populations of animals dependent on the physical movement or genetic exchange through aquatic ecosystems. In central Alabama, on the Cahaba River, a structure originally constructed as a bridge for large mining trucks, functioned ecologically like a dam by altering habitat and flows in one of the most biologically important reaches. The concrete Marvel Slab dam was 220 feet wide and six feet tall, with 46, three-foot diameter culverts along a midline. This 'Slab' altered habitat and disturbed the connectivity between aquatic populations including seven species protected by the Endangered Species Act.

Stakeholders including US Army Corps of Engineers, The Nature Conservancy, ADCNR, USFWS, and other partners removed this barrier in 2004. Prior to deconstruction, scientists assessed the fish and mollusk communities in nearby reaches. Baseline molluscan data included collecting, sorting and identifying over 12,000 snails and mussels from the demolition zone adjacent to the dam. During 2005-2006, 295, ¼ square meter quadrats were surveyed in the 40 meter reach above and below the former location of the dam for mollusks and substrate characteristics. Gastropod density is highly variable (0-800+ per square meter) but since removal, densities of snails are increasing. Other observations on the mussel and fish communities are being recorded to better inform future projects involving small dam removal and habitat restoration.

PO 32*

IMPACTS OF URBANIZATION ON THE BIODIVERSITY OF THE IMPERILED SNAIL FAUNA (GASTROPODA: PLEUROCERIDAE) OF THE CAHABA RIVER, ALABAMA, USA

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Gastropod species losses from the Cahaba River drainage, Alabama, are of particular concern to conservation biologists because it is part of a global hot-spot for pleurocerid diversity. Although discharge within the Cahaba River is generally unregulated (dams are a major cause of pleurocerid extirpations in other river systems), ongoing urbanization within the watershed will almost certainly have consequences for its snail fauna. In 1992, A. Bogan and M. Pierson surveyed 103 sites in the 4800 km^2 basin and recovered 16 of 20 historically documented pleurocerid species. In 2005, we re-sampled 100 of the 103 locations from the 1993 survey and recovered the same 16 species. Forty sites in 1993 and 41 sites in 2005 had no pleurocerid snails. Of the remaining 63 sites which in which pleurocerid snails were present, nine sites had changed species richness between 1992 and 2005, three sites had increased richness and six sites had decreased richness. The amount of urban land cover for the entire basin increased 4% from 1992 to 2001. However, increases in urban land cover was restricted mostly to the upper basin. Declines in species richness occurred only in the upper basin where as gains in species richness occurred only in the mid and lower basin. A negative correlation ($r = -0.64$) was found between species richness and increased % urban land cover; which suggests that pleurocerid populations are sensitive to alterations in stream habitat due to development within the watershed.

PO 33*

EFFECTS OF HOST EXPOSURE TO SUSPENDED CLAY ON ATTACHMENT AND TRANSFORMATION SUCCESS OF MUSSEL GLOCHIDIA

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The parasitic stage is believed to be the most significant bottleneck in the Unionoid lifecycle. Most larvae never reach a suitable host or successfully transform to the juvenile stage. Many factors affect the success of the parasitic stage, including the availability of suitable hosts, host attraction by lures, and host acquired immunity. However, few if any studies have examined physical factors that might affect the condition of host gills and thereby directly or indirectly affect the attachment and transformation of mussel glochidia on hosts. Sediment is one of the most ubiquitous pollutants in rivers and has important effects on fish gill condition and function. We investigated the effects of fish exposure to suspended clay and silica particles on subsequent attachment and transformation of glochidia. Largemouth bass (*Micropterus salmoides*) were exposed to suspensions of montmorillonite clay (MC, 5 or 2.5 g/L) or diatomaceous earth (DE, 2.5 or 1.25 g/L) for 96 hours. Treated fish and controls were infested with glochidia of fatmucket (*Lampsilis siliquoidea*). Sloughed glochidia and juveniles were recovered from each fish and quantified every other day post-infection. Microscopic examination showed that exposure to MC caused fusion of gill filaments and reduction of lamellae, particularly on distal portions. DE had far less effect, despite the fact that DE is much more abrasive than MC. Previous exposure of fish to MC, but not DE, was associated with both reduced glochidia attachment and reduced transformation success, so that the number of juveniles recovered per fish was approximately 30-40% less in MC-treated fish. It appears that acute exposure of fish to suspended clay can affect their suitability as mussel hosts.

PO 34*

SENSITIVITY OF GLOCHIDIA, JUVENILE, AND ADULT NATIVE FRESHWATER MUSSELS TO A RANGE OF COMMON AND EXTREME WATER TEMPERATURES

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In response to declines in diversity and abundance of unionid mussels, a National Strategy for the Conservation of Native Freshwater Mussels was developed in 1998. This document identified the need to conduct toxicity tests to evaluate the sensitivity of mussels to a variety of environmental stressors, such as temperature. The purpose of this research is to conduct laboratory toxicity tests to evaluate the sensitivity of glochidia and juvenile native freshwater mussels to a range of temperatures that may be encountered during summer periods in streams receiving thermal discharges. Potential endpoints for these tests include survival, heart rate (juveniles), and rate of oxygen consumption (glochidia, juveniles). The second phase of experimentation involves the investigation of the potential effects of temperature stress on adult mussels. Adult tests will be conducted with species common to Atlantic Slope and/or Interior Basin drainages, and will be designed to study acute lethality and sublethal effects of temperature using hemolymph chemistry, physiological profiles or other suitable biomarkers. Laboratory tests will also be conducted with glochidia, juvenile, and/or adult mussels with challenge scenarios in which the sensitivity to changes in temperature will be measured in combination with the addition of a reference toxicant, such as sodium chloride or copper. In addition to laboratory studies, field studies with caged mussels are proposed for streams receiving heated effluents to assess *in situ* responses of mussels to temperature variation. The effects of thermal stress on mussel survival, physiology, and hemolymph chemistry from these studies will be compared to laboratory outcomes.

PO 35*

BIOACCUMULATION OF PLATINUM GROUP METALS IN THE FRESHWATER MUSSEL *ELLIPTIO COMPLANATA*: A NEW INDICATOR OF TRANSPORTATION RELATED IMPACTS?

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The use of catalytic converters for automobile exhaust purification has led to the emission and environmental contamination by the platinum group metals (PGM) platinum (Pt), palladium (Pd), and rhodium (Rh). Preliminary data gathered by our laboratory suggests that concentrations of PGM, particularly Pt and Pd, are accumulating in native freshwater mussel tissue collected from streams adjacent to highways in North Carolina and are correlated with average daily traffic count. The first phase of this study will examine PGM concentrations in mussel tissue and sediment at a minimum of 50 sites throughout North Carolina ranging in average daily traffic count, land-use patterns, and watershed characteristics. Multiple regression, principal component analysis, and GIS analysis will be used to examine relationships between mussel PGM concentrations and average daily traffic count as well as other habitat variables. A standardized 28-d toxicity test with adult Eastern *Elliptio* (*Elliptio complanata*) mussels will be conducted in the second phase of the study to validate the field-derived PGM bioaccumulation data and to examine lethal and sublethal effects of PGM exposure. Upon study termination, PGM concentrations will be confirmed in samples of mussel tissue and exposure water. Endpoints from the laboratory test will include survival, bioaccumulation, and an analysis of biomarkers from mussel hemolymph or other appropriate tissues to assess any sublethal effects of PGM exposure. Results from this study will provide resource managers with the information needed on this emerging group of contaminants to perform robust risk assessments for transportation impacts to natural systems and to develop specific conservation, protection, and mitigation plans for this critically imperiled faunal group.

PO 36*

EVALUATION OF ALA-D IN THE FRESHWATER MUSSEL *ELLIPTIO COMPLANATA* AS A BIOMARKER OF LEAD EXPOSURE AND AN INDICATOR OF TRANSPORTATION IMPACT

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Preliminary data gathered by our laboratory suggests that concentrations of lead (Pb) and platinum group metals, particularly platinum and palladium, in native freshwater mussel tissue collected from streams adjacent to highways in the upper Neuse Basin of North Carolina are correlated with average daily traffic count. The first phase of this study will examine Pb concentrations in mussel tissue and sediment at a minimum of 50 sites throughout North Carolina ranging in average daily traffic count, land-use patterns, and watershed characteristics. Additionally, Pb-induced inhibition of the heme synthesis enzyme ALA-D, a sensitive and specific biomarker of Pb exposure in mammals and fish, will be evaluated in mussel hemolymph. Multiple regression and/or principal component analysis will be used to examine relationships between mussel Pb concentrations, ALA-D, and average daily traffic count as well as other habitat variables. A standardized 28-d toxicity test with adult Eastern elliptio (*Elliptio complanata*) mussels will be conducted in the second phase of the study to validate the field-derived Pb bioaccumulation data and to examine sublethal indicators of Pb toxicity. Endpoints will include survival, metal accumulation, shell thickness and weight, and ALA-D inhibition. Upon study termination, Pb concentrations will be confirmed in samples of mussel tissue and exposure water. Validation of ALA-D in mussel hemolymph would provide a potential non-lethal technique to estimate Pb exposure in this critically imperiled faunal group.

PO 37

EXAMINING MUSSELS FOR BACTERIAL PATHOGENS USING NONLETHAL METHODS

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Prevention of diseases caused by infectious agents is critical for captive propagation of aquatic animals. As captive-rearing of imperiled mussels expands, the detection and prevention of pathogen-induced diseases could become relevant. A preventative strategy will greatly reduce pathogen transmission between reared and wild populations. Determining the presence and prevalence of pathogens is an initial step towards prevention. With this imperiled fauna, any sampling must be nonharmful. In this study, recovery of the fish pathogenic bacterium *Aeromonas salmonicida* from ebonyshell mussels (*Fusconaia ebena*) using nondestructive sampling (fluid, mantle clip, hemolymph) was compared to the recovery obtained using lethal methods (total fluid and soft tissues). The three nondestructive sites were selected because their use was thought to have the least impact on mussels' subsequent health and survival, and because the prevalence of pathogen isolation was suspected to be comparable to that obtained from lethal sampling. *Aeromonas salmonicida* was introduced to the mussels using a pathogen transmission model. In an initial study, groups of *F. ebena* were observed for short-term (up to 3 wks) mortality due to the sampling procedures, themselves. No mortality attributed to the sampling procedures occurred. Other groups of *F. ebena* were infected (100% prevalence) with *A. salmonicida*, placed in tanks for depuration and sampled, over time, comparing the nonlethal to lethal sites for recovery of the bacterium. Fluid accounted for *A. salmonicida* recovery prevalence as good as either lethal site. Mantle clip was comparable to fluid; hemolymph was ineffective. Fluid sampling offers the most promise because it is the least invasive (stressful) to mussels and previous studies have shown the bacterial flora of fluid to correlate with the flora from within soft tissues.

PO 38

AN INVESTIGATION OF SEASONAL MUSSEL DIEOFFS IN THE TENNESSEE RIVER, MUSCLE SHOALS, AL

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Muscle Shoals, Tennessee River, AL historically had the greatest diversity of freshwater mussels worldwide (79 species). The 41 extant species still represents one of the more diverse large-river faunas in the Southeast United States. Significant mussel dieoffs were observed in Pickwick Reservoir, AL in 2002, 2004, and 2006. Several criteria, especially noted in the July 2006 dieoff, offer clues that an etiological agent (i.e., bacterial or parasitic pathogen) and disease might be the cause for the morbidity and mortality. 1) Dieoffs are seasonal (same timeframe, successive years), coinciding with increased water temperatures and perhaps for favorable growth of bacterial pathogens; 2) Host specificity; although various species are affected to some degree, ebonyshell (*Fusconaia ebena*) is predominantly affected, and; 3) Gravidity (spawning stressors), the large percentage of moribund and fresh dead specimens were female *F. ebena*. Our goal is to determine if an infectious agent plays a role in these dieoffs. Our strategy is to determine the expected bacterial and parasitic flora of healthy mussels and use this for comparison with the same from disease-affected animals. Bacterial counts were significantly higher from moribund *F. ebena* in the July dieoff compared with counts before and after the dieoff. Normal bacterial flora represented a variety of bacterial species, whereas primary cultures from moribund *F. ebena* were essential pure and were the same bacterium from a number of the mussels. Our future studies will attempt to determine if this bacterium is pathogenic, or is opportunistic to stressed animals.

PO 39

DOES ELECTROFISHING AFFECT SHORT-TERM SURVIVAL AND PHYSIOLOGICAL CONDITION OF MUSSELS?

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Electrofishing is a common technique used to sample freshwater fish communities and to collect fish for mussel propagation projects. Quite commonly, electro-shocking is conducted over mussel beds and in proximity to mussels; however, little is know of whether this technique causes harm to gravid females or physiological condition of adults. We placed 15 giant floaters (*Pyganodon grandis)* in each of four independent artificial streams. Two treatment streams were shocked continuously at 300 V and 30 Hz (0.45-0.5 ampere output) for 15 s using a Smith-Root LR-24 Backpack Electrofisher, whereas two control streams were not shocked. Electrofishing settings were chosen to reflect those commonly used by us and others for fish collection. During electrofishing, mussels in the treatment streams closed their siphons. Mussels in the control streams, however, exhibited no visible response to placement of a non-electrified cathode and anode into the streams. Thus, siphon closure appeared to be related to the electrical shock, not simply to the physical presence of the electrodes. In treatment systems, all mussels were shocked at least once. Two weeks following electro-shock treatment, three mussels were randomly removed for proximate analysis of tissue from each treatment and control system. This shock treatment was repeated twice more, such that a set of mussels was shocked up to three times. Survival was assessed daily, and final survival was assessed 2 weeks following the third shock treatment. No differences in survival between treatment and controls were observed during the experiment. Results of proximate physiological analysis will be presented.

PO 40*

ASSESSMENT OF A POTENTIAL *POTAMILUS CAPAX* (GREEN 1832) REFUGE: THE USE OF BIOTIC AND HABITAT INDICES AS INDICATORS OF FRESHWATER MUSSEL HABITAT IN THE TYRONZA RIVER, ARKANSAS

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The Tyronza River, Arkansas has been designated by the Arkansas Department of Environmental Quality as a channel altered stream for the Mississippi Alluvial Valley - Delta Ecoregion. The Federal Highway Administration (FHWA) and the Arkansas Highway and Transportation Department (AHTD) have suggested the Tyronza River, Arkansas as a candidate for habitat restoration and a potential refuge for the fat pocketbook, *Potamilus capax*. The objectives of this study are to: 1) complete a qualitative mussel survey of the river to obtain species distribution, relative abundance, and catch per unit of effort (CPUE) data; 2) quantitatively sample nine mussel beds spatially distributed throughout the river; 3) assess habitat and water quality using USEPA protocols for habitat and fish and aquatic macroinvertebrates; 4) characterize stream habitat using the Basin Area Stream Survey; and 5) analyze cumulative watershed effects using GIS. The qualitative mussel survey was initiated in Summer 2006 and will continue through Spring 2007. To date, 247 sites have been sampled and 24 mussel species encountered. The mean CPUE per site was 0.8 mussels min^{-1}, ranging from 0 to 7 mussels min^{-1}. Quantitative samples of selected mussel beds, collection of fish and macroinvertebrates, habitat assessment and characterization, and cumulative watershed assessment will occur in 2007. The results of this study will aid in the development of a FHWA and AHTD agency habitat restoration plan for *Potamilus capax*.

PO 41*

FRESHWATER MUSSEL HABITAT VARIABILITY AND MOVEMENT PATTERNS FOLLOWING RELOCATION: A CASE STUDY OF *POTAMILUS CAPAX* (GREEN 1832)

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Identification of appropriate habitat characteristics are among the most important aspects when selecting a viable relocation site for mussels, yet behavioral patterns following these relocations are little known. The target species of this study is the fat pocketbook, *Potamilus capax,*, designated as "Endangered" in June 1976 by the USFWS. The goal of this project is to better understand the behavior of relocated mussels with the objectives being: 1) to determine movement patterns of resident and relocated *P. capax*; and 2) to determine if *P. capax* prefers certain substrates over others. We hypothesize that relocated *P. capax* will show a greater displacement than resident *P. capax* and that P. capax will chose certain substrates. We examined movement patterns of resident and relocated *P. capax* where 2 study groups were monitored for displacement: the first group monitored from October, 2005 to January, 2006 and July to November, 2006; the second group was monitored quarterly from May, 2005 through March, 2007. Substrate composition, along with water depth and velocity, were determined through perpendicular transects at 10 meter intervals. Substrate, depth and velocity were interpolated using krieging and GIS. Results of this study will help refine relocation monitoring methods involving freshwater mussels with a movement and substrate characteristics in their life history. Because monitoring of relocated *P. capax* has proven to be largely unsuccessful, better understanding their movement abilities will provide a more thorough perspective of how this species uses available habitat and will provide options to refine selection criteria for potential relocation sites.

PO 42*

THE USE OF PROTEIN CONCENTRATION AS A POTENTIAL INDICATOR OF FRESHWATER MUSSEL (MOLLUSCA: BIVALVIA) FITNESS

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Condition factors can be useful indicators of how well individuals respond to management actions compared to only monitoring survival. As part of an assessment of mitigation strategies for mussels, glycogen, lipids, RNA:DNA ratios, and proteins are being used as a measure of fitness for 2 species, *Potamilus capax* and *Quadrula quadrula,* subjected to relocation. In this study, we assess if protein concentration is a suitable surrogate for RNA:DNA ratios, as both RNA and DNA quantification are time and cost intensive. We hypothesize that proteins should be high if the animal is fit, indicating available resources for RNA production and subsequent protein synthesis. Conversely, if the animal is under stress, it will be unable to expend energy for RNA and protein synthesis. Our study design focuses on 2 species, *P. capax* and *Q. quadrula* (total n=497), with 2 treatment groups consisting of relocated animals (relocated) and resident animals (resident). The relocated sample size for *P. capax* is 26 and the relocated sample size for *Q. quadrula* is 50. Resident populations (n= 202) are further divided into a naive control group that provides a baseline at each specific time interval (n= 30 individuals per species per interval) and a second group composed of the resident-recaptured animals (n= 62). Ultimately, results of this study will be used to refine relocation monitoring methods. Tri-Reagent was used to extract the three macromolecule phases from the tissue. High RNA:DNA ratios are hypothesized to indicate a high protein concentration. Conversely, low ratios are hypothesized to indicate a low concentration of protein.

PO 43*

THE USE OF RELATIVE GLYCOGEN CONCENTRATIONS TO ASSESS FITNESS IN FRESHWATER MUSSELS (MOLLUSCA: BIVALVIA)

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The fat pocketbook, *Potamilus capax*, was added to the Endangered Species List in June, 1976 by the USFWS. Concern has increased for the species as human influence has spread through its native habitat. To combat these effects, relocation efforts have been used to mitigate potential negative effects to habitat and individuals. However, the effectiveness of relocation has not been quantified, particularly with respect to the molecular fitness (i.e. condition factor) of individuals. In 2003, the Arkansas State Highway and Transportation Department Planning and Research division began accepting proposals on programmatic biological assessment of *P. capax*, to monitor the effects of human influence. This programmatic biological assessment consists of molecular analysis of the four major bio-macromolecules: carbohydrates, proteins, nucleic acids and lipids. Glycogen, a carbohydrate which effectively measures the short term energy stores of the organism, is used as a fitness measure in this study. To obtain quantifications, non-lethal tissue samples (8 mg ± 2 mg) were taken from relocated (n = 26) and resident (n = 163) *P. capax* and *Quadula quadrula.* Samples were frozen at -70 Cº then subjected to a modified phenol-sulfuric acid method which facilitates a colorimetric reaction. Results were quantified using a spectrophotometer capable of distinguishing between slight color intensity fluctuations between individuals. Preliminary two-factor ANOVA analyses involving a separate study of similar species from the White River confirm methodology and indicate significant differences between species and locality.

PO 44*

SHORT-TERM CHANGE IN MASS OF RELOCATED MUSSELS (BIVALVIA: UNIONIDAE) IN THE MUSKINGUM RIVER, MUSKINGUM COUNTY, OHIO

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Globally, unionid mussel populations are in danger of extinction due to anthropogenic activities and measures are needed to ensure their conservation. A common approach to ensure survival of threatened populations by such activities is relocation. Beginning in 2002, mussels were relocated from the 26,000 m^2 footprint of a proposed water intake structure in the Muskingum River to similar habitat areas immediately upstream. The entire footprint area of the intake structure was cleared of unionid mussels, totaling 4,541 individuals, using SCUBA hand collections. Individual mussels were marked, weighed, photographed, and relocated onto numbered, 120 m^2 transects in areas that already housed healthy unionid populations. Thirty-one percent of these transects were surveyed in 2006 to assess the condition of relocated mussels and the short-term (1-4 year) success of the relocation. During these surveys, a total of 317 individuals were recaptured from previous relocation activities. Preliminary results show that a large number of recaptured relocated mussels exhibited a substantial increase in mass over the period since their initial capture. The survival and growth of the relocated individuals suggests that the relocation process appears to have had little or no detrimental affect on the individuals that were recaptured. This preliminary, short-term study supports relocation as a potentially useful conservation tool for threatened unionid populations.

PO 45*

CAPTIVE SURVIVAL AND POTENTIAL FOR PEARL CULTURE IN THE PINK HEELSPLITTER (POTAMILUS ALATUS SAY, 1817) (BIVALVIA: UNIONIDAE)

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Pink heelsplitter (*Potamilus alatus*) mussels were placed at two bottom locations and suspended pocket nets in a pond at the Freshwater Mollusk Conservation Center (FMCC), Virginia Tech, for one year to evaluate survival in captivity. Survival rate of mussels after 1 year were significantly different, with lowest rate (30 %) in the bottom of the deep end (2.5 m), and no difference between the shallow end (0.6 m) and pocket nets (1-1.5 m). Monthly survival of mussels was exhibited an inverse correlation to water temperature (R = - 0.72). There were significant differences in mean glycogen content of mussels among the three containment locations and wild-sampled mussels (P = 0.001), with the highest value in mussels at the shallow end, and the lowest value at the deep end. Pocket nets were used to hold surgically implanted mussels for pearl culture in two experimental ponds of different nutrient levels. Results showed that non-nucleated pearls and image pearls with purple or purplish luster were successfully produced in *P. alatus*. Pearl weights in mussels held in the two ponds were not significantly different (P = 0.562). Similarly, there were no significant differences in monthly survival rates of mussels in either pond (P = 0.051), or among mussels with surgical implants and the no-surgery control mussels (P = 0.881). Therefore, we consider *P. alatus* as a potentially suitable species for producing purple pearls in farm pond environments.

PO 46

PROPAGATION AND CULTURE OF FRESHWATER MUSSELS IN NORTH CAROLINA (2004-2006)

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Since late 2004, there has been an increased emphasis on propagation and culture of freshwater mussels in North Carolina. During that time period, the College of Veterinary Medicine at North Carolina State University has propagated approximately 60,000 juvenile mussels representing 10 species. Because relatively little was known about host fish requirements on the Atlantic Slope, much of this work includes the discovery of new host species. To increase growout potential of juveniles, a partnership was formed with two state fish hatcheries in North Carolina. A single concrete raceway was set aside for mussel culture at the Table Rock Fish Hatchery near Morganton, NC and at the McKinney Lake Hatchery in Hoffman, NC. To prevent potential escape of small juveniles or larvae released by gravid females, both raceways were retrofitted with a multi-level containment system. After two growing seasons (2005 and 2006), low growth and survival of juveniles at the McKinney Lake facility led us to determine that it was not suitable for the culture of mussels. This was attributed to the acidic waters of the Sandhills region where the hatchery is located. Survival and growth of mussels was much better at the Table Rock Hatchery. There, we have cultured four Lampsiline species to lengths from 20 - 40 mm and have observed 2-year old *Villosa delumbis* become mature and successfully spawn in the raceway.

PO 47

A REPORT ON THE LAND SNAILS INHABITING 18 OHIO RIVER ISLANDS

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During the summer of 2004-2005, 18 islands in the Ohio River were surveyed for the presence of land snails. The two previous years had been extremely wet and many of the islands were under water at various times during these years. The islands are claimed by the state of West Virginia and are located between Paden Island (Ohio River mile 132) and Eight Mile Island (Ohio River Mile 258). Much emphasis during the surveys was placed on looking for *Webbhelix multilineata* as this snail in West Virginia was previously known only as occurring on Blennerhassett Island (ORM 187) near Parkersburg WV. New populations of *W. multilineata* were found on five islands. Land snail populations downstream of the confluence of the Muskingum River (ORM 182) were quite good in diversity and numbers of individuals while upstream populations were poor or non-existent. On-shore sites adjacent to the islands were also searched for *W. multilineata* but none was found.

PO 48

STATUS ASSESSMENT FOR THE SNUFFBOX (*EPIOBLASMA TRIQUETRA*)

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The Ohio River Valley Ecosystem Team, Mollusk Subgroup, has conducted conservation status assessments since 2000 of imperiled wide-ranging mussels centered in the Ohio River system. Those species considered worthy of detailed status assessments were reduced from a larger list of potential species. The latest status assessment has targeted the snuffbox (*Epioblasma triquetra*). This species is a member of *Epioblasma*, the most imperiled genus of mussels in North America, and represents the only member of the genus that is neither extinct nor considered endangered under the Endangered Species Act (Act). The snuffbox is known primarily from smaller streams in the Mississippi River, Ohio River, and middle Great Lakes basins. Historically known from 205 streams and lakes, the snuffbox is extant in 71 streams. However, only six of the extant occurrences are considered "stronghold populations": Wolf River, WI; Sydenham River, ONT, Canada; St. Croix River, MN and WI; Bourbeuse River, MO; French Creek, PA; and Clinch River, TN and VA. Twenty-four extant populations are considered "significant" while the remaining 41 are "marginal" and close to extirpation. Habitat alteration (e.g., impoundments, channelization, mining, pollutants, sedimentation) is thought to be the major cause of imperilment. Based on these data, the Mollusk Subgroup recommends that the snuffbox be considered for elevation to candidate status under the Act.

PO 49

FINALIZING A CONSERVATION ASSESMENT FOR NORTH AMERICAN FRESHWATER GASTROPODS

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In 1993 the American Fisheries Society (AFS) published a general conservation status assessment of freshwater mussels of North America authored by J.D. Williams et al. This mussel assessment was followed by similar assessment for crayfishes (Taylor et al. 1996) and southeastern fishes (Warren et al. 2000). The AFS has granted permission to begin a conservation assessment for North American freshwater gastropods and a status committee has been formed. The final evaluation will be based on our current understanding of freshwater gastropod taxonomy and distribution. Breaking with earlier assessments, we will supplement categorical rankings (i.e. Endangered, Threatened, Species of Concern...), with more definitive global conservation rankings (G ranks), that are actively monitored by NatureServe, sub-national Natural Heritage Programs and Conservation Data Centers, and UNITAS. The results of this effort will include a summary article in *Fisheries* and a comprehensive report by NatureServe consisting of a complete North American (north of Mexico) species list (scientific and common names), sub-national (U.S. state and Canadian province) distribution list, and conservation status assessment. A nearly finalized draft evaluation focusing on 679 species in all 50 states and 11 Canadian Provinces was completed in 2006. This assessment determined 65 species of freshwater snails are likely extinct, and at least 365 additional species rank as G1 or G2. With another 74 species listed as G3, fully 74% of currently valid taxa are extinct, endangered, threatened, or of vulnerable (GX/GH, G1, G2, or G3). This is the highest imperilment rate for any major taxa group in North America, including mussels. As these preliminary results are finalized, taxonomic, distributional, or status updates (i.e. corrections, additions, and deletions) are encouraged. The finalized draft checklist will be presented and comments from symposium participants solicited.

PO 50

IF SEDIMENT IS A PROBLEM ...

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Field data and photographic examples are presented from several recent case studies to demonstrate the effectiveness of active and passive equipment specifically designed to manage fine bed sediments in aquatic systems. This equipment can be used for sampling sediment-impacted habitats and sediment-associated contaminants; for selectively removing the harmful fine sediments from bed surface and subsurface deposits, to restore critical habitat and allow biological recovery or recolonization; and even to protect mussel populations and/or fish spawning habitats from sedimentation threats in localized river reaches or throughout major stream systems.

For decades, the scientific literature and regulatory environmental assessments have identified sedimentation as a/the major freshwater pollutant, and a serious threat to water quality and aquatic biological systems, including numerous mussel species. Clearly, the regulatory focus primarily on sediment-related BMP's and prevention has been ineffective. A variety of research, regulatory, and watershed management applications for fine sediments are outlined herein, to allow the professional aquatic community to better assess the role of fine sediments in streams, and where desired, to selectively remove the harmful pollutant, restore the impacted habitats, and allow recovery or recolonization of impacted biota.

PO 51*

ONLINE OHIO MUSSEL ATLAS

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Spatial representation of data can be a very powerful tool for understanding conservation issues. The objective of the Online Ohio Mussel Atlas mapping program is to provide a method for dissemination of geographic information about mussel records contained in The Ohio State University Museum of Biological Diversity Division of Molluscs collections. This poster exhibits some of the applications of mapping technology in examining changes in geographic distribution of all native Ohio mussel species as they have altered (typically narrowed) over time.

PO 52

COMMUNITY STRUCTURE OF FRESHWATER MUSSELS IN THE LAKE ERIE WATERSHED

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The unionid fauna of the Lake Erie watershed is young and no species are endemic. The entire region was colonized only after the last glaciers receded, and as such, the communities present in the lake's southern tributaries exist in a dynamic equilibrium that can be modeled over time based on rates of immigration and extinction. The characteristics that provide the most explanatory power for the species composition are potential source assemblages, which constrain diversity, and watershed size, which corresponds tightly to the total number of species likely to be found in any one stream. Historically, mussels likely immigrated from the old Maumee River when it flowed towards a then smaller Lake Erie in what is now just the eastern basin. In the last 10-12,000 years, the lacustrine habitat of the modern lake would have restricted movement of some species, while the recent loss of mussels in Lake Erie due to invasive Dreissenids has effectively stopped immigration by that route today. A second past immigration source would have been headwater capture from Ohio River tributaries as streams reversed direction after glacial melt. These changes to the watershed, which are accompanied by extensive urbanization at many river mouths, have isolated communities that now are in decline from anthropogenic influences. Overall, the region remains diverse, as even closely neighboring rivers may have very different faunal composition. However, no colonization accompanies the continuous trend towards extirpation, especially of less common species, and the end result is destined to be low diversity and/or abundance of this important macroinvertebrate fauna.