PL 01

DEVELOPMENT OF A STRATEGIC HABITAT PLAN FOR THE MOBILE RIVER BASIN. Jeff Powell, U.S. Fish and Wildlife Service, Daphne, Alabama; Pat O'Neil, Geological Survey of Alabama, Tuscaloosa, Alabama; Paul Hartfield, U.S. Fish and Wildlife Service, Jackson, Mississippi; Paul Johnson, Alabama Department of Conservation and Natural Resources – Alabama Aquatic Biodiversity Center, Marion, Alabama; Allison Jenkins, Alabama Clean Water Partnership, Montgomery, Alabama.

In 2004, the U.S. Fish and Wildlife Service (USFWS) designated 26 river and stream segments (units) in the Mobile River Basin (MRB) (69 FR 40084) as critical habitat (CH) for eleven listed freshwater mussel species. The units encompass approximately 1,093 miles (1,760 kilometers) of the best remaining habitat in the MRB. These units also contain a major proportion of the MRB's other imperiled aquatic fauna including mussels, fishes, snails, and crayfish. In 2008, the USFWS in cooperation with the Alabama Aquatic Biodiversity Center (AABC) of the Alabama Department of Conservation and Natural Resources (ADCNR), the Geological Survey of Alabama (GSA), and the Alabama Clean Water Partnership (ACWP) initiated efforts to create strategic management opportunities for imperiled species in the MRB. This initiative has been and continues to be facilitated through the following activities: 1) Establishment of strategic habitat units (SHU) for each of the 26 CH units using a Geographic Information System (GIS) database; 2) Development of SHU-specific watershed information database. For imperiled species management and recovery to proceed systematically with some reasonable expectation of success, watersheds must be understood from a biological, water quality, and land use perspective; 3) Using the SHU evaluation techniques to identify and prioritize stream reaches that need protection, management, or restoration; and 4) Development of SHU action plans. This involves a cooperative partnership of local landowners, local and county governments, local businesses and farmers, state and federal agencies, environmental organizations, and watershed partnerships.

NOTES:

PL 05

STATUS SURVEYS OF IMPERILED MOLLUSKS IN THE ALABAMA RIVER DRAINAGE. Michael Buntin, Jeff Garner, Todd Fobian, Paul Johnson, Alabama Department of Conservation and Natural Resources, Alabama Aquatic Biodiversity Center, 2200 Highway 175, Marion, AL 36756.

The Alabama River drainage has been the focus of three ADCNR mollusk inventory projects over the past two years. In 2009 primary tributaries and selected reaches of the river were qualitatively surveyed for freshwater mussels. A total of 70 sites within 36 streams were sampled and 25 species of unionids were collected, including 2 federally protected species (*Hamiota perovalis* and *Pleurobema decisum*). The second project carried out in 2010, was a quantitative assessment of a single large mussel bed in the Alabama River using a multiple systematic grid design. This project was used to gather data on the last known population of the federally endangered Heavy Pigtoe (*Pleurobema taitianum*) and to establish a baseline for future population studies. A total of 1,920 mussels of 14 species were found, including 2 live *P. taitianum*. The density of all species was 12.8 mussels m^{-2} while the density of *P. taitianum* was 0.013 m^{-2}. The third project was a systematic survey of the Alabama River for the federally endangered Viviparidae gastropod *Tulotoma magnifica* in 2010. Potential habitat, large-boulder substrate, was located using side-imaging sonar. Dive surveys were then conducted at potential sites to confirm the presence of suitable habitat and to search for snails. Over 600 instances of likely habitat were identified by sonar and 86 dives performed. *T. magnifica* colonies were found in 5 locations, 4 of which were previously unknown.

NOTES:

PL 02

FRESHWATER MOLLUSK POPULATION RESTORATION PLANS FOR THE CUMBERLANDIAN REGION AND MOBILE BASIN: GOALS, OBJECTIVES AND POLICY ISSUES. Steve Ahlstedt, U.S. Geological Survey (retired), PO Box 460, Norris, TN 37828; Paul Johnson, Alabama Department of Conservation and Natural Resources, 2200 Highway 175, Marion, AL 36756; Bob Butler, US Fish and Wildlife Service (USFWS), 160 Zillicoa St., Asheville, NC 28801; Paul Hartfield, USFWS, 6578 Dogwood View Parkway, Jackson, MS 39213; Jeff Powell, USFWS 1208-B Main Street, Daphne, AL 36526.

Two teams of state, federal, and non-governmental biologists recently completed 2 strategy documents to restore populations of imperiled molluscan faunas of the Cumberlandian Region (CR) (comprising the Cumberland and Tennessee River drainages) and Mobile River Basin (MB) (comprising the Alabama and Tombigbee River drainages), respectively. When separately crafting the draft documents, team members saw the need to coordinate efforts and generate a single set of goals, objectives and policy issues, thus making the Plans nearly identically (although the species covered in each shared no overlap whatsoever). The goal of the Plans is to provide a framework for the restoration of freshwater mollusk resources and their ecological functions to appropriate reaches of the respective basins through the reintroduction, augmentation and controlled propagation of priority mollusks. Objectives include complying with the USFWS controlled propagation policy for federally listed species, establishing propagation protocols, coordinating among partners, prioritizing imperiled mollusks in a three-tier system, recommending priority conservation actions and stream reaches for activities, and complying with existing state and federal permitting requirements. Additional sections of the Plans cover justifying population restoration activities, identifying reintroduction and augmentation opportunities, developing site plans and monitoring plans for specific activities, selecting brood stock and source population streams, providing genetics guidelines and other aspects of population restoration actions. Individual species accounts and priority conservation activities will be addressed in the following presentation.

NOTES:

PL 06*

MUSSEL BIODIVERSITY INCREASES PREY SUBSIDIES TO TERRESTRIAL ECOSYSTEMS. Daniel C. Allen and Caryn C. Vaughn, Ecology and Evolutionary Biology Program, Oklahoma Biological Survey and Department of Zoology, University of Oklahoma, Norman, 73019

Species loss and habitat alteration are causing dramatic biodiversity losses in freshwater mussel communities, which perform important ecosystem services in streams. Mussels recycle nutrients from the water column to the benthos, stimulating periphyton production, and are also associated with increased standing crops of aquatic insect larvae. However, recent research has shown that emerging adult aquatic insects are an important source of prey for terrestrial predators such as spiders, birds, and bats; linking aquatic and terrestrial ecosystems. Because mussel biodiversity has been shown to have strong effects on aquatic insect larvae, the importance of freshwater mussels may extend into terrestrial ecosystems if they also strongly affect the production of emergent adult aquatic insects. Accordingly, we conducted a comparative field study and a manipulative mesocosm experiment to test if mussel biodiversity influences the production of aquatic insects into terrestrial habitats. Results from the comparative field study of mussel beds on two rivers show that emergence rates of aquatic insects were higher at more speciose mussel beds. Results from the mesocosm experiment show that mussels increase the production of benthic algae and adult aquatic insects relative to controls, and that mussel biodiversity enhances these effects. Because aquatic and terrestrial ecosystems are linked by emerging aquatic insects, this study suggests that declines in mussel biodiversity have consequences for terrestrial ecosystems in addition to the aquatic ecosystems they live in.

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PL 03

FRESHWATER MOLLUSK POPULATION RESTORATION PLANS FOR THE CUMBERLANDIAN REGION AND MOBILE BASIN: SPECIES ACCOUNTS AND CONSERVATION PRIORITIES. Paul Johnson, Alabama Department of Conservation and Natural Resources, 2200 Highway 175, Marion, AL 36756; Bob Butler, US Fish and Wildlife Service (USFWS), 160 Zillicoa St., Asheville, NC 28801; Paul Hartfield, USFWS, 6578 Dogwood View Parkway, Jackson, MS 39213; Steve Ahlstedt, PO Box 460, Norris, TN 37828; Jeff Powell, USFWS 1208-B Main Street, Daphne, AL 36526.

Separate teams of malacologists recently completed two strategy documents to restore populations of imperiled molluscan faunas of the Cumberlandian Region (CR) (comprising the Cumberland and Tennessee River drainages in seven states) and Mobile Basin (MB) (comprising the Alabama and Tombigbee River drainages in four states), respectively. These two basins harbor more than half of North American freshwater molluscan fauna. At least 21 species mussels and 40 snails became extinct over the last century in these watersheds. The Plans address imperiled mollusks that remain extant, including numerous federally listed mussels (35 CR and 18 MB), snails (4 CR and 9 MB) and candidate species (3 CR). A total of 57 mussels and 25 snails in the CR and 26 mussels and 31 snails in the MB were assigned relative imperilment rankings within a 3-tier priority system. Brief accounts summarizing conservation status were drafted for each taxon and included prioritized conservation actions. Most Tier-1 mussels have < 3 remaining populations, hence making propagation and reintroduction priority conservation actions. Conversely gastropods (3 CR and 7 MB) are known only from single sites, so habitat conservation is priority objective. Host fish relationships, habitat requirements, development of culture protocols, population status assessments, systematic reviews and long-term monitoring requirements were also conservation priorities. These priority items should be updated ≈ 5 years as new data becomes available and has recovery activities take place.

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PL 07*

ASSESING HABITAT SUITABILITY FOR NATIVE FRESHWATER MUSSELS ALONG LAKE ERIE'S COAST. Trevor Prescott[1], Robert Krebs[1], and David Klarer[2]. [1]Department of Biology, Geology and Environmental Science, Cleveland State University, 2121 Euclid Ave. Cleveland, OH 44115. [2]Old Woman Creek National Estuarine Research Reserve, 2514 Cleveland Road, East Huron, OH 44839.

After the introduction of dreissenid mussels (Dressenidae) into Lake Erie in the mid 1980's, native mussel (Unionidae) populations plummeted as a result of being out-competed for food. Multiple studies have documented the decline of native mussels in the Great Lakes as well as their connecting rivers. However, several coastal areas along Lake Erie have been noted as refugia for native mussels; two of the most notable areas being Metzger Marsh and Crane Creek in northwest Ohio. Given the possibility that unionid species could be using estuaries as refugia, our research sought to investigate unionid distributions within freshwater estuaries (flooded river mouths of small streams) across northern Ohio. We surveyed 10 streams within 5 river miles of Lake Erie. The surveys consisted of at least 4 person-hours per site and between 2 and x sites per stream, employing mussel rakes in the soft estuarine substrates. Only two of the rivers lacked unionids, while numerous live individuals were collected in the other eight. Five species were found in at least half the estuaries surveyed: *Pyganodon grandis* (80%), *Toxolasma parvum* (70%), *Quadrula quadrula* (60%), *Lasmigona complanata* (50%), and *Leptodea fragilis* (50%). Living specimens were also found for four additional species, two of which are state threatened, *Uniomerus tetralasmus* and *Obliquaria reflexa*. Variation among these streams is compared with respect to their aquatic chemistry and land use within their watersheds.

NOTES:

PL 04

HOW A STATE-WIDE STREAM SURVEY CAN AID IN UNDERSTANDING FRESHWATER MUSSEL (BIVALVIA: UNIONIDAE) ECOLOGY: EXAMPLES OF UTILITY AND LIMITATIONS FROM MARYLAND.

Matthew J. Ashton. Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Division, 580 Taylor Ave. C-2, Annapolis, MD 21401.

Gaps in our knowledge of freshwater mussel life history, distribution and ecology remain even though their study has increased considerably over the past few decades. These types of studies have traditionally taken place within a population, river, or larger drainage unit, but rarely across a broad landscape, such as a state. Given the imperiled status of a majority of freshwater mussel species alternative opportunities to collect potentially valuable data cannot be overlooked. We present results from a statewide biological monitoring program, the Maryland Biological Stream Survey, offer examples of analyses that can be conducted with such data, and discuss the utility and limitations of incorporating freshwater mussels into stream assessments. Since 2007, we have encountered 11 of the 16 unionid species extant in Maryland during assessments of wadeable streams by using an informal visual survey and recording incidental observations. On several occasions, we have discovered new populations of imperiled mussels or extended a species distribution. The biological and physiochemical data collected at sites coincident with freshwater mussel presence has allowed us to investigate factors potentially limiting species distribution, such as fish-host dynamics, habitat quality, nutrient concentration, and land use. We feel that by adding minimal effort into a biological monitoring program, invaluable data can be collected that can help resource managers, malacologists, and researchers answer a variety of questions. Further work is needed to investigate the cost-benefits of additional sampling effort as this could vary markedly among molluscan faunal regions and project specific objectives.

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PL 08*

MODELING THE DISTRIBUTION AND DIVERSITY OF SOUTHEAST LOUISIANA FRESHWATER MUSSELS.

Wesley M. Daniel [1], Kenneth M. Brown [1], Michael Kaller [2], William Kelso [2 1] Biological Sciences Department, Louisiana State University, Baton Rouge, LA 70803 [2] School of Renewable Natural Resources, Louisiana State University, Baton Rouge, LA 70803

Unionoids are important in aquatic ecosystems, yet despite their continued loss in diversity, little is known about their distribution and ecology. To study Louisiana mussel distribution and diversity, we sampled 65 sites within six major watersheds in the Florida parishes, LA. Second through sixth order streams were surveyed for local (e.g. substrate, water chemistry) and landscape variables (host fish communities and riparian land use). A structural equation model suggested to two major variables were important: 1)habitat stability, influenced by water velocity, percent of substrate in fine sediments, number of known fish hosts, and stream order and 2) anthropogenic disturbance influenced by agricultural land use in riparian corridors and water quality. These two major variables in the model explained 85% mussel species richness and 48% of total mussel abundance. Mussel diversity and abundance increased with stream order, and higher order sites in the lower river basins flooded less frequently. We suggest the lower river basins have extensive riparian wetlands that ameliorate the effects of frequent floods, and promote habitat stability and increase mussel diversity. Our long term goal is to develop a practical model as a tool for predicting mussel diversity and abundance, to help state wildlife personnel manage rivers to conserve mussel assemblages.

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PL 09

GENETIC STRUCTURE AND INTRASPECIFIC PHYLOGEOGRAPHY OF THE SHEEPNOSE MUSSEL (*PLETHOBASUS CYPHYUS*). Kevin J. Roe, Natural Resource Ecology and Management, Iowa State University, Ames, IA 50010

Genotypes for 16 microsatellite loci and mitochondrial haplotypes for the NADH dehydrogenase gene were used to infer population structure and test hypotheses concerning gene flow across eight populations of the sheepnose mussel (*Plethobasus cyphyus*), a candidate species for listing by the USFWS. Genetic data collected for ~100 indicate that extant populations appear to be genetically isolated from each other, with very few shared alleles or haplotypes. The microsatellite data reveals a pattern consistent with isolation by distances whereas the mitochondrial data do not. A test of the individual populations for evidence of the occurrence of genetic bottleneck indicates that only a single population (Wisconsin River) was consistent with this hypotheses, however the sample size for this population was small and could have resulted in erroneous conclusion. The conservation implications from this study are that each of these populations should be managed as independent entities for purposes of captive rearing and propagation until evidence indicates a particular population may benefit form the introduction of novel genetic information.

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PL 13*

SHREDDING INSECTS' POTENTIAL CONTRIBUTION TO FRESHWATER MUSSEL NUTRITION Renae Greiner[1], Jay Levine[1], Christopher Osburn[2], Thomas Kwak[3], Arthur Bogan[4], David Buchwalter[5] [1]Aquatic Epidemiology and Conservation Laboratory, College of Veterinary Medicine, NC State University, Raleigh, NC, 27606 [2]Marine Earth and Atmospheric Sciences, NC State University, Raleigh, NC, 27695 [3]US Geological Survey, NC Cooperative Fish and Wildlife Research Unit, NC State University, Raleigh, NC, 27695 [4]NC State Museum of Natural Sciences, Raleigh, NC, 27607 [5]Department of Environmental and Molecular Toxicology, NC State University, Raleigh, NC, 27695

Aquatic ecosystems are a complex assemblage of fauna influenced by the dynamic biotic, physical and chemical processes defining habitats. Freshwater mussel biologists acknowledge the critical role of fish in the reproduction of most freshwater mussels, but other sympatric species may contribute to their survival. Freshwater mussels are filter feeders, and algae are considered an important component of their diet. Typically mussels reared in research facilities are fed a diet of commercially available algae, but these animals apparently grow more slowly than young mussels found in the wild. Shredding aquatic insects play an important functional role by breaking down leaf litter in streams. This shredding process creates fine particulate organic matter suspended in the water column. We hypothesized that shredders contribute to freshwater mussel diet by production of fine particulates. In controlled studies, shredders increased overall quantity and protein content of particles available for mussel ingestion. Protein and other nutrients contributed by shredders may be important to mussel health. Subsequent studies examining the direct effects of shredder production on juvenile freshwater mussel growth showed increased mussel growth when compared to controls in one study, but not in a second. Future research is needed to improve our understanding of the role of shredders in mussel nutrition and how co-culture of shredding insects may enhance growth of mussels in captivity.

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PL 10*

CONSERVATION AND SYSTEMATICS OF *LEPTOXIS* (GASTROPODA: PLEUROCERIDAE). Nathan V. Whelan[1], Philip Harris[1], and Paul D. Johnson[2]. [1]University of Alabama, Department of Biological Sciences, Box 870345, Tuscaloosa, AL 35487, [2] Alabama Department of Conservation and Natural Resources, Alabama Aquatic Biodiversity Center, 2200 Highway 175, Marion, AL 36756.

The critically imperiled freshwater snails of the genus *Leptoxis* have been overlooked in recent systematic reviews. Current taxonomy for 21 species of *Leptoxis* is based on morphologically plastic shell characters and geography. Furthermore, *Leptoxis* is not defined by any discrete synapomorphies and current taxonomy may not accurately reflect actual species boundaries. This complicates management efforts because species boundaries, which are the basis for management units, may not reflect biological reality. Although paraphyletic groups have been shown in previous studies, limited taxon sampling and a one locus phylogenetic approach obscures confident conclusions. This systematic revision of *Leptoxis* utilizes a multi-locus phylogenetic approach in addition to documenting life history strategies (i.e. egg laying behaviors, period of oviposition) and soft tissue coloration patterns, to evaluate synapomorphic and autapomorphies characters for the genus. This is the first phylogenetic study to have complete ingroup *Leptoxis* sampling and adequate outgroup sampling. A review of type specimens and historical synonymies is also underway. Preliminary phylogenetic evidence shows *Leptoxis* as paraphyletic, and currently described species are not distinct evolutionary lineages. Additionally, when mapped onto the phylogeny there are synapomorphic life history characters that define clades. The taxonomy of *Leptoxis* will be revised so genera are natural groups and species are defined as distinct evolutionary lineages. Revised species boundaries will have implications on conservation efforts of *Leptoxis* as defined management units will need to be reconsidered. Refining this approach will begin to provide a sound foundation for the evaluation of additional genera within the Pleuroceridae.

NOTES:

PL 14*

THE USE OF FISH CELLS AS A SUPPLEMENTAL FORM OF NUTRITION FOR IN VITRO PROPAGATION OF FRESHWATER MUSSELS. T. R. Fox and J. F. Levine,
Aquatic Epidemiology and Conservation Laboratory, College of Veterinary Medicine, North Carolina State University, 4700 Hillsborough Street, Raleigh, NC 27606.

The *in vitro* culture of freshwater mussels is a propagation technique that bypasses the need for an obligate fish host and transforms juveniles in an artificial media. Although the transformation percent of juveniles cultured *in vitro* can greatly exceed that of juveniles reared on fish hosts, the physiological health and survival of *in vitro* transformed juveniles is often poor. During transformation, glochidia receive nutrients from the host fish through continual contact with fish blood and plasma and also through the digestion of gill or fin tissue that is trapped between the closed valves. The artificial media attempts to mimic the availability of nutrients, however it does not provide any gill tissue for the glochidia to digest. We hypothesized that cells harvested from *in vitro* fish cell lines would provide a reasonable surrogate for glochidial attachment, provide essential nutrients, and improve the survival and growth of transformed juveniles. In this pilot study, a new technique was devised to facilitate glochidial enclosure of cultured fish cells using fathead minnow epithelial skin cells as a nutritional supplement for *Lampsilis fullerkati* glochidia. Over a 90-day period the juveniles that were cultured with fish cells showed a significant increase in both growth and survival when compared to control juveniles that were reared in medium without cells. Additional studies with three cell lines, two species of mussels, and 10 treatment combinations are planned to continue examination of the role co-culture with fish cell lines can play in *in vitro* mussel propagation.

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PL 11*

THE GEOGRAPHIC GENETIC STRUCTURE OF *QUADRULA QUADRULA* (BIVALVIA: UNIONIDAE): POST-GLACIAL COLONIZATION OF THE GREAT LAKES BASIN. Philip T. Mathias[1], David T. Zanatta[1], and Chris C. Wilson[2 1] Central Michigan University, Biology Department, Mount Pleasant, MI USA 48859 [2] Trent University/OMNR, Peterborough, ON Canada K9J 7B8

Two of the major spillways that drained the young Laurentian Great Lakes at the end of the Wisconsinan glaciation were the Wabash-Maumee spillway (draining early Lake Erie) and the Chicago-Illinois River spillway (draining early Lake Michigan). Most fish from the Mississippian refugium were hypothesized to have colonized the Great Lakes via one or both these two spillways; parasitizing these fish were unionid glochidia. Understanding post-glacial colonization and the geographic genetic structure of a less-imperiled unionid species, *Quadrula quadrula* (Mapleleaf), can help build a foundation for the conservation of threatened or endangered mussel species. This study will establish the etiology of *Q. quadrula* in the Great Lakes basin. In order to test the alternate hypotheses of post-glacial invasion to the Great Lakes basin, non-lethal mantle biopsies were taken from *Q. quadrula* throughout the northern expanse of its range: across both the Wabash-Maumee and Chicago-Illinois River spillways from southwestern Ontario, the midwestern United States, and south to hypothesized glacial refuges (27 rivers, 45 sites, and over 1300 samples). Genomic DNA was extracted from the mantle biopsies, amplified at eight microsatellite DNA loci, and genotyped on an automated sequencer. After population genetic analyses are performed, hypotheses of post-glacial etiology for *Q. quadrula* in the Great Lakes basin will be tested and management recommendations for populations in the region will be made. These recommendations will provide insight for augmenting and re-establishing populations of species of conservation concern with similar ranges to *Q. quadrula*.

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PL 15*

FRESHWATER MOLLUSK CULTURE AND RECOVERY AT THE ALABAMA AQUATIC BIODIVERSITY CENTER. Todd Fobian, Michael Buntin, Paul Johnson and Jeff Garner. Alabama Department of Conservation and Natural Resources, Alabama Aquatic Biodiversity Center (AABC), 2200 Highway 175, Marion, AL 36756.

Mass culture techniques utilized at the AABC are now producing larger animals within an annual time frame and should prove a powerful recovery tool. In a laboratory setting, newly metamorphosed juvenile mussels ≈ 250 µm shell length (SL) are cultured with a mix of well and pond water, supplemented with marine shellfish diets. During this critical period, the goal is to achieve juvenile growth to 2-4 mm SL over 60-90 days (d). Juvenile mussels were than transferred to suspended upwelling bucket systems (SUPSYS) held inside pond culture fields. SUPSYS cultured mussels usually attained 30 mm SL within 180 d post-metamorphosis. Mussels metamorphosed in July 2009 had a mean percent survival of 84% at 60 d post-metamorphosis. In 2010, over 65,000 metamorphosed juveniles were produced with a mean survival of 4% for all species (range 0 to 20%), but survivorship increased late in the culture season. However, once juvenile mussels attain 2-4 mm SL and are transferred to SUPSYS systems; survivorship exceeded 90% and growth improved dramatically. Freshwater snails are produced in large tanks with appropriate flow, temperature, and biofilm conditions supporting adult animals. Conditions are established for adults to copulate and continually ovideposit over a 60 d interval. Adult brood stocks are than removed and tanks heated to hatch juveniles. The ≈ 300 µm shell width (SW) juveniles are cultured to 2-5 mm over a 4-8 month period. Survivorship is difficult to approximate but 30-60% mortality is observed during the first 6-months. Cultured snails have successfully established a reproducing colony of a federally endangered species within 3 years.

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PL 12*

PHYLOGEOGRAPHY OF THE ROUND PEARLSHELLL, *GLEBULA ROTUNDATA*(Lamarck,1819)(BIVALVIA:UNIONIDAE). N.A.Johnson[1,2], J.D.Williams[3], and J.D.Austin[1,4] [1]School of Forest Resources and Conservation, Program in Fisheries and Aquatic Sciences, University of Florida, Gainesville, FL 32611. [2]U.S. Geological Survey, Southeast Ecological Science Center, Gainesville, FL 32653. [3]Florida Museum of Natural History, University of Florida, Museum Road and Newell Drive, Gainesville, Florida 32611. [4]Wildlife Ecology and Conservation, University of Florida, Gainesville, FL 32611.

The genus *Glebula* (Conrad, 1853) is monotypic, restricted to Gulf Coast drainages, and known to occur from the Ochlocknee River in Florida west to the Guadalupe River in eastern Texas. We are investigating the phylogeographic structure of *Glebula rotundata* throughout its range using mitochondrial DNA sequences of two protein-coding genes (*CO1* and *ND1*). Thus far, forty-three individuals from seven major river basins east of the Mississippi River have been sequenced. Maximum sequence divergence of *CO1* and *ND1* haplotypes are 0.72% and 0.89%, respectively. Sequence analyses reveal congruent patterns between individuals for both genes and haplotype sharing between adjacent drainage basins east of the Mississippi. Results will be presented in light of geologic history of the region and several biological features of *G. rotundata*, both of which make it particularly likely that recent gene flow has been important in its evolution.

NOTES:

PL 16*

PICKING APART THE IMPORTANCE OF PARTICULAR PARTICLES FOR PROPAGATION OF MUSSELS. Andrew McDonald, Jacob Culp, Adam Shepard, Fritz Vorisek and Monte McGregor. Center For Mollusk Conservation (CMC), KY Dept. of Fish and Wildlife. Frankfort, KY

Two experiments were performed at the CMC in Frankfort, KY to determine the importance of DOM, bacteria, and larger particulates such as algae in the culture of newly metamorphosed *Villosa taeniata* juveniles. Each replicate consisted of airlift-driven downwellers in separate tanks to allow for replication and strict control of the culture environment. The first experiment investigated the ability of mussels to survive on a diet with no particulate matter added, but with different levels of algae- and sediment-derived DOM added. The second experiment compared growth and survival of mussels fed a standard algae- and sediment-based diet to the DOM-based diet. Two other treatments were employed by ozoning the previous diets before feeding to eliminate live bacteria. All water in each system was replaced daily to prevent unwanted additional growth of bacteria. The results of the first experiment demonstrated that addition of the DOM solution improved mussel growth and survival compared to the control groups. However, it was hypothesized that the mussels were in fact obtaining their nutrition from bacteria that grew upon the DOM within the tanks. The second experiment validated this hypothesis, because it was found that mussels in treatments containing live bacteria all performed equally well, regardless of the presence of particulates. Mussels in treatments where ozoning destroyed the majority of bacterial cells performed very poorly and had rapid mortality. In conclusion, it appears that live bacteria is essential in the diet of juvenile mussels, and more work on investigating the role of bacteria in mussel digestion, and on isolating and culturing the desired bacteria should improve propagation efforts' success.

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PL 17

UNDERSTAFFED AND OVERTASKED TENNESSEE'S APPROACH TO MUSSEL MANAGEMENT. Don Hubbs, Tennessee Wildlife Resources Agency, PO box 70, Camden, TN 38320, Stephanie Chance, U.S. Fish and Wildlife Service Tennessee Ecological Services Field Office, 446 Neal Street Cookeville, TN 38501-4027, Sally Palmer, The Nature Conservancy, 2021 21st Ave. South Suite C-400, Nashville, TN 37212

As the commercial mussel fishery expanded during the late 1980's Tennessee recognized the need for increased protection and management of its mussel resources. TWRA responded by adding a per pound fee on commercial wholesale mussel transactions. Revenue generated from the shell fee along with increased license fees were allocated toward funding a full time biologist, technician, and enforcement officer to perform stock assessments, increase regulatory compliance, and evaluate program performance. Much has changed in the last twenty years, the mussel industry has declined, funding for endangered species and state wildlife grant programs have improved to address longstanding research and restoration needs. Disinclined to obligate fluctuating federal funds to hire additional staff, TWRA instead contracted with universities and NGO partners to perform research and made significant progress developing knowledge and understanding the biology of Tennessee's mussel resources. Since 1994, over thirty mussel species have benefitted from the $1.6 million federal section six allocations spent on status surveys, life history, propagation, translocation, reintroduction, zebra mussel impacts, population demographics, development of long term holding techniques, habitat improvement and protection, threat analysis and solution development research conducted by TWRA and its partners. State wildlife grant funds have been used to identify species conservation status and restoration potential via creation of two comprehensive plans, one for the population restoration and conservation of Cumberlandian imperiled mollusks, and a second Tennessee strategic mollusk plan. These plans will be used to direct Tennessee's future mollusk restoration activities.

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PL 22*

DESCRIPTION OF GONAD DEVELOPMENT IN A PLEUROCERID SNAIL, *LEPTOXIS CARINATA*, USING MORPHOLOGICAL AND HISTOLOGICAL TECHNIQUES. Serena Ciparis[1], William Henley[2], and J. Reese Voshell[1] [1]Virginia Tech, Department of Entomology, Blacksburg, VA [2]Virginia Tech Freshwater Mollusk Conservation Center, Department of Fisheries and Wildlife Sciences, Blacksburg, VA

Little is known about the timing of sexual development of pleurocerid snails or the effect of environmental conditions on this process. The objectives of this study were to describe gonad development in *Leptoxis carinata* with respect to snail size and season, and to compare this process between streams with different environmental conditions. Morphological and histological examinations of two generations of *L. carinata* were conducted for 16 months at two stream sites in the Shenandoah River watershed (Virginia, USA); one site represented reference conditions and the other was impacted by agricultural activities. Water temperatures were similar between sites during the sampling period (paired t-test, p=0.84). Population sex ratios were consistently female-biased at the impacted site (mean 81% females), compared to balanced sex ratios at the reference site (mean 49% females). Morphologically, sexes did not become fully distinct at the reference site until approximately 15 months after hatching, and there was an additional 7 month delay in morphological development at the impacted site. Histological observations demonstrated that gamete production began earlier than indicated by external morphology; the majority of snails from both sites were producing gametes 8-9 months after hatching. Histological comparisons of mature snails showed differences in gamete quality between sites, both male and female snails at the impacted site had smaller acini and a greater proportion of atrophied acini than at the reference site. The differences in sex ratios, timing of gonad development, and gamete quality between the two study sites suggest that environmental factors other than water temperature may affect sexual development of pleurocerid snails.

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PL 18

CUMBERLAND RIVER AQUATIC CENTER A COOPERATIVE DEVELOPMENT BY TWRA, USACE, TVA, AND USFWS. David Sims, Tennessee Wildlife Resources Agency, Ellington Agricultural Center, PO box 40747, Nashville, TN 37204, Don Hubbs, Tennessee Wildlife Resources Agency, PO box 70, Camden, TN 38320

TWRA has partnered with the Tennessee Valley Authority (TVA), US Army Corps of Engineers (USACE), and United States Fish and Wildlife Service (USFWS) to renovate a fish hatchery at TVA's Gallatin Fossil Plant (GAF) on the Cumberland River. TWRA, through construction assistance provided by TVA, has refurbished ten concrete raceways and added office, lab, class room, and maintenance/boat storage buildings. Renovation included cleaning the facility, replacing the main water supply valve, warm water pumps, and roof covering the raceways. All electrical wiring, lighting, and plumbing were replaced. Hatchery operation focuses on freshwater mussel holding and propagation along with non-game aquatic species research and propagation. Unique to this site is the availability of warm water from the cooling water discharge during winter months which can extend the growing season. Adult freshwater mussels have been held in the raceways for over three years and juvenile mussels are currently showing promising growth. Over 5,000 adult mussels have been held and processed for translocations with an additional 1,000 processed through the hatchery for biomonitoring of the TVA Kingston fly ash spill. This assemblage represents 31 species, three of which are endangered. Since 2007, lake sturgeons have been raised in the raceways growing from three inches in length to over 28 inches and five pounds in less than twelve months before stocking into the Cumberland River. Educational tours for general public and school groups are conducted as part of our environmental education program.

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PL 23*

ESTABLISHMENT OF BASELINE SEASONAL HEMOLYMPH CHEMISTRY PARAMETERS. Andrea K. Fritts and Robert B. Bringolf University of Georgia, Warnell School of Forestry and Natural Resources

The Southeastern U.S. is home to a diverse assemblage of freshwater mussels. Threats to this group include habitat degradation, pollution, and alterations to natural flow regimes. Many of the aforementioned threats are of serious concern in the Flint River Basin in southwest Georgia, a system highly impacted by agricultural water usage. The Flint Basin is home to a diverse assemblage of aquatic organisms, including five federally listed mussel species. Due to the imperiled status of these mussels, the development of effective nonlethal biomonitoring techniques is imperative. Changes in hemolymph chemistry profiles are potential biomarkers for non-lethally monitoring stress in freshwater mussels. To assess the long-term effects of foot tissue biopsies and hemolymph extraction from adductor muscles, two mussel species (*Elliptio crassidens* and *Villosa vibex*) were held for >6 months in floating baskets in an aerated pond. Survival was > 96% in all treatments for *E. crassidens* and ranged from 80 to 93% for *V. vibex*. There was no difference in survival among the treatment groups and the control for either species. To establish baseline seasonal hemolymph chemistry parameters, *Villosa vibex, V. lienosa* and *E. crassidens* were sampled during the spring, summer and fall seasons at six field sites in the Lower Flint River Basin. Hemolymph was analyzed for a suite of parameters with a Hitachi Blood Chemistry Analyzer. Initial results show that elevated levels of two enzymes, alanine aminotransferase and aspartate aminotransferase, as well as an increase in hemolymph bicarbonate in two *Villosa* species coincided with a low flow event. The establishment of baseline hemolymph chemistry levels will allow for further advances in the development of stress biomarkers for wild populations of imperiled freshwater mussels.

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PL 19

MUSSEL MANAGEMENT IN PENNSYLVANIA: WHERE WE ARE AND WHERE WE ARE GOING. Nevin T. Welte. Pennsylvania Fish & Boat Commission, 450 Robinson Lane, Bellefonte, Pennsylvania 16823 Christopher A. Urban. Pennsylvania Fish & Boat Commission, 450 Robinson Lane, Bellefonte, Pennsylvania 16823

Despite the state's rich malacological history, mussel management efforts in Pennsylvania are still in their infancy. The Pennsylvania Fish & Boat Commission (PFBC) contracted a malacologist in 2006 for the purpose of advising the agency on mussel issues. Currently the PFBC uses two approaches to mussel management. The first approach is reactive management through the adoption of regulations protecting mussels and case-by-case management through environmental review. The second management approach has been more proactive. Large-scale mussel surveys have gathered baseline information and narrower efforts have focused on updating old species occurrence records. Current PFBC management efforts include the development of species action plans for state-listed and priority mussel species, collaborating with state and federal partners for augmentations and reintroductions, and considering protection for mussels at a landscape level. The current approaches and emphasis on proactive protection are steps towards the larger goal of developing and implementing a statewide comprehensive mussel management strategy.

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PL 24*

FERTILIZATION EFFICIENCY OF LAMPSILIS STRAMINEA IN RELATION TO DISTANCE AND WATER FLOW. Tyler Lee Mosley[1], Wendell R. Haag[2], and James A. Stoeckel[1] [1]Department of Fisheries and Allied Aquacultures, Auburn University, 203 Swingle Hall, Auburn University, AL 36849 [2]USDA Forest Service, Southern Research Station, Center for Bottomland Hardwoods Research, Oxford, MS 38655

Previous studies suggest that fertilization of mussel eggs is dependent on the distance between males and females and may fail at low mussel density. This has critical implications for conservation of sparse populations. We examined the effects of distance and water flow on fertilization of the Southern Fatmucket (*Lampsilis straminea*). We constructed four experimental raceways (31 x 4 m) in 0.1 ha hatchery ponds; two raceways had no flow, and two had low flow (mean= 0.026 m/s) provided by an air lift system. We placed 10 mature, non-gravid female *L. straminea* in 2 m^2 corrals at 1, 10, and 25 m from males. A fifth control raceway contained only females. We initiated the experiment in August 2010 and collected all females in November 2010 then quantified fertilization efficiency as the percentage of gravid females, fecundity (number of glochidia standardized for mussel size), and the percentage of unfertilized eggs. Fertilization was high (mean = 97% of females gravid, <10% unfertilized eggs) and did not differ between 1 and 10 m treatments regardless of flow. Fertilization efficiency was more variable at 25 m but remained high in both flow treatments (flow= 80% females gravid± 14% SD, static= 60% ± 57% SD; <10% unfertilized eggs in both). No females became gravid in the control raceway. These results show that fertilization efficiency is high even at very low mussel density and under no flow conditions. Further, there is no evidence that this species can store sperm or become facultatively hermaphroditic at low density.

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PL 20

A MITIGATION ALTERNATIVE TO NATIVE MUSSEL RELOCATION: PUTTING BRIDGES TO WORK FOR MUSSELS. Mike Davis[1], Richard Baker[2], Bernard Sietman[2], Peter Leete and Jason Alcott[3]. [1]MN Department of Natural Resources, 1801 South Oak Street, Lake City, MN 55041,; [2]MN Department of Natural Resources, 500 Lafayette Rd, St. Paul, MN 55155; [3]MN Department of Transportation, 395 John Ireland Blvd., MS 620, St. Paul, MN 55155

A common solution to mitigate impacts to protected mussels has been relocation. However, sometimes relatively few protected mussels are moved at great expense, and for unclear benefit species recovery. For example, relocation for a bridge replacement on the St. Croix River in 1996 moved over 18,000 individuals but included only 5 state listed individual animals and 4 individuals of the federally Endangered *Lampsilis higginsii*. The cost of this relocation exceeded $150,000. In response to anticipated federal funding for infrastructure nationwide, including bridges, we proposed and implemented a different approach to mitigate impacts to mussels. We intend to continue requiring initial surveys at bridge sites, and when significant mussel communities are found, to quantitatively measure mussel populations and determine mitigation likely to benefit the listed species present. Under some circumstances relocation will continue to be the best mitigation choice. However, when data indicates a small number of state listed individuals are to be lost we may choose to apply the probable cost of their relocation to a fund to be used for a statewide mussel research, propagation, education, management, and reintroduction programs. Infrastructure projects can benefit from this approach by anticipating mitigation needs and avoiding delays while populations of listed mussel species will benefit from an infusion of scarce research and management cash; a win-win situation for our state agencies and our highway and aquatic ecosystem infrastructure.

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PL 25*

INFLUENCE OF SESTON DENSITY ON FRESHWATER MUSSEL GROWTH AND FERTILIZATION SUCCESS. Andrew M. Gascho Landis[1], Wendell R. Haag[2] and James A. Stoeckel[1] [1]Auburn University, 203 Swingle Hall, Auburn, AL [2] US Forest Service, Oxford, MS.

Eutrophication is a ubiquitous problem in aquatic systems and its effect on freshwater mussels is poorly understood. We performed an experiment to assess the effect of increased productivity on growth, energetic investment, and fertilization success of two mussel species, *Pyganodon grandis* and *Ligumia subrostrata*. Six, 0.1 ha ponds were maintained from April-November at three different seston densities, low (<5 mg/L), medium (6-24 mg/L), and high (>25 mg/L) using liquid fertilizer. In each pond all individuals of each species were housed together in suspended pocket nets (n = 38 individuals/pond/species). At the end of the experiment, we evaluated differences in growth among treatments by calculating changes in mass and length of individuals, differences in energetic investment by measuring caloric density in somatic tissue, and assessed fertilization by examining females for gravidity. Neither growth nor energetic investment was significantly different among productivity treatments for either *P. grandis* or *L. subrostrata*. Fertilization success of *L. subrostrata* was highest in low productivity ponds, with 63-87% of females producing glochidia. In moderately productive ponds only 15-21% of females were gravid, and none were gravid in the high productivity ponds. *P. grandis* were also assessed for fertilization success, however, males and females could not be distinguished so proportion fertilized could not be calculated. Fertilization success was instead determined from proportion of fertilized to unfertilized eggs. Large amounts of suspended sediments in the water column may interfere with female mussels' ability to capture sperm or may reduce filtering efficiency such that brooding cannot be sustained. These results suggest that eutrophication can negatively impact recruitment of freshwater mussels.

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PL 21

CONSERVATION AND MANAGEMENT OF MUSSELS IN MISSOURI.

Stephen E. McMurray, Resource Science Division, Columbia Missouri

With over 45% of the fauna considered Species of Conservation Concern, native freshwater mussels rank 2nd only to crayfish as the most endangered faunal group in the state. Threats to freshwater mussels in Missouri include loss of habitat due to the construction of dams and other alterations of natural waterways, decreases in water quality, and invasive species. The *Missouri Mussel Conservation and Management Plan*, completed in April 2008, described four goals for the conservation of mussels in Missouri: 1. Implement the conservation and management actions necessary to restore, protect, and use Missouri's mussel fauna; 2. Evaluate conservation actions through integrated monitoring of the status, distribution, diversity, and fitness of Missouri's mussels, and relevant aspects of habitat and water quality; 3. Increase awareness of conservation needs for Missouri's mussel fauna; and 4. Advance our knowledge of mussel biology and ecology through research. There are a number of conservation initiatives underway in Missouri, including faunal surveys to document species distributions, research into artificial propagation methods, population genetics research, research into the effects of hydropower facilities and heavy metal contamination, ecotoxicological research to document the effects of contaminants on the various life stages of freshwater mussels and provide for more stringent water quality criteria, and working with private landowners to protect mussel habitats. Current research and management efforts in Missouri will be highlighted.

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PL 26*

H-NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY FOR EVALUATING CATABOLISM IN *ELLIPTIO COMPLANATA*.

J. Hurley-Sanders[1], J. Levine ,[1], A. Tikunov [2], J. MacDonald[2], S. Nelson[3], M. Law[1], W. Showers[3], M. Stoskopf[1] [1] College of Veterinary Medicine North Carolina State University, 4700 Hillsborough St. Raleigh NC 27606
[2] University of North Carolina, Department of Biomedical Engineering, 5022 Burnett-Womack, Chapel Hill NC 27599
[3]Center for Earth Observation, Department of Forestry and Environmental Resources, Campus Box 7106, North Carolina State University, Raleigh NC 27695
[4]Department of Marine Earth and Atmospheric Sciences, North Carolina State University, Jordan Hall, Raleigh, NC 27695

Numerous questions remain about what mussels eat. Inadequate nutrition due to resource competition, habitat change and loss of forage resources are considered factors in the decline of freshwater mussel populations. Additionally, freshwater mussels are often fasted for up to three weeks during toxicologic studies. The extended fast potentially results in a catabolic state, altering physiologic responses to study variables. By defining catabolic processes in freshwater mussels, we can: 1) Highlight metabolic markers associated with starvation; 2) Suggest alternate pathways mussels use to meet demand during periods of limited food resources; and 3) Determine whether fasting is appropriate in determining response to a pollutant. We hypothesized that use of H-nuclear magnetic resonance spectroscopy could identify factors reflecting catabolic processes in freshwater mussels. The objective of this study was to determine if a metabolic spectrographic signal could be detected and described in freshwater mussels. The metabolic profile of fed and fasted *Elliptio complanata* was compared. Preliminary investigations showed that *E. complanata* produces the polyamine putrescine in varying quantities. Putrescine presence and level varied with the tissue sampled. The possibility that presence of putrescine in freshwater mussels may suggest a use of the ornithine-urea cycle where ornithine decarboxylase is used to convert ornithine to putrescine species will be discussed.

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PL 27

LANDSCAPE CONSERVATION COOPERATIVES: A PLATFORM FOR REGIONAL CONSERVATION OF FRESHWATER MOLLUSKS. Rachel Muir, U.S. Geological Survey, 12201 Sunrise Valley Drive, Mailstop 953, Reston, VA 20191

Landscape Conservation Cooperatives (LCCs) are management-science partnerships created by the U.S. Department of the Interior to provide scientific research and monitoring information addressing climate change and other stressors within and across landscapes. They link science and conservation delivery. They are bringing new support and new partners to counter the impacts from threats such as habitat fragmentation, climate change, invasive species and increased competition for water resources. There are twenty-one LCCs active or proposed for the national landscape. At the core of each LCC will be a scientific and technical staff with an applied resource-management focus. That staff and capacity will operate under the direction of a steering committee, consisting of resource-management representatives. LCC steering committees will include representatives from governmental entities (federal, state, tribal and local), as well as non-governmental organizations who are prepared to contribute to the joint effort. It is vital that freshwater mollusk researchers participate in the LCC partnerships to assure that the science supported by LCCs partners addresses the conservation needs of the Nation's most endangered fauna. The organization and structure of LCCs will be explained and examples of research already underway by the U.S. Geological Survey, the U.S. Fish and Wildlife Service and other public and private partners related to freshwater mollusks and their habitats will be discussed.

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PL 33

***DREISSENA*-INDUCED CHANGES IN UNIONID COMMUNITIES OF LAKE ST. CLAIR AND THE ST. CLAIR DELTA.** David T. Zanatta and Matthew T. Rowe. Central Michigan University, Biology Department, Mount Pleasant, MI USA 48859

Lake St. Clair (in the Great Lakes system) was among the first bodies of water in North America to be invaded by *Dreissena* in the mid-1980s. The impacts of *D. polymorpha* on the lake's native freshwater mussel communities (Unionidae) were massive with unionid densities dropping below detectable levels and species diversity declining to zero by the mid-1990s. Extirpation of unionids from the lake was assumed. However, in the late 1990s, low-density unionid communities were rediscovered in the shallow bays of the St. Clair delta. Between 1999 and 2003, 22 species were found alive including several species of conservation concern. Renewed monitoring in 2010 at sites on the Michigan side of the delta revealed that the ecosystem remains in flux. Rates of *Dreissena* infestation on unionid shells decreased significantly between 2003 and 2010 ($P<0.05$) at all sites. Unionid densities are also changing, with some sites showing marked decreases, some showing stability, and others showing significant ($P<0.05$) increases. The reasons for these ongoing changes in the bivalve communities in the St. Clair delta are still being investigated. New research is now beginning on the genetic population structure and source-sink dynamics of unionids in the St. Clair delta refuge and surrounding tributary streams, giving insight for conservation prioritization.

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PL 28

PROTECTING AND RESTORING FRESHWATER MUSSELS IN WEST VIRGINIA. Janet L. Clayton and Craig W. Stihler, West Virginia Division of Natural Resources, PO Box 67, Elkins, WV 26241

Prior to the early 1990s only federally endangered species of mollusks were protected in West Virginia. In response to mussel poaching activities for the cultured pearl industry, mussels became protected species and it became illegal to possess any mussels or parts thereof. This single act lead to significant growth of the state's mussel program. Priorities for early management activities included surveys, creation of a database, and protection from in-stream impacts such as bridge projects, pipeline crossings, and dredging. Before the establishment of replacement values by the American Fisheries Society, the WVDNR began assessing and evaluating mussel kills.

Our Wildlife Conservation Action Plan was completed in 2006 and included 62 species of mussels. Because status information was limited within the state, the plan listed most as "species in greatest need of conservation". Mussel program personnel plan to re-evaluate this list using data collected over the last decade.

Much effort during the last three to five years has been involved with restoration of mussel populations throughout the state. This included both relocation of mussels from streams such as the Allegheny River in Pennsylvania and propagation efforts undertaken as part of a Natural Resources Damage Assessment on the Ohio River which have included infecting host fish, rearing juveniles in cages and collecting broodstock for other cooperators. Monitoring of population trends has also become a priority and, to date 15 permanent monitoring sites have been established in streams across the state. The sites are scheduled to be monitored every five years and some sites have already been surveyed twice showing mixed results.

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PL 34

PATTERNS OF FRESHWATER MUSSEL RICHNESS AND ENDEMISM IN AFRICA AND MADAGASCAR. Daniel L. Graf[1], Kevin S. Cummings[2]. [1] Department of Biological Sciences, University of Alabama, Tuscaloosa, AL 35487. [2] Illinois Natural History Survey, University of Illinois, Champaign, IL 61820.,

Patterns of richness and endemism are among the top species-based criteria for identifying biodiversity hotspots. In order to assess these patterns among freshwater mussel species at the scale of the 90 freshwater ecoregions of Africa and Madagascar (and associated islands), we sampled specimen records from 17 major research collections on three continents. Of 6632 museum lots representing 87 species in four families, 5612 had locality data precise enough to assign them to an ecoregion. More the half of freshwater mussel species occurred in two or fewer ecoregions (48 spp.). At the opposite end of the spectrum, only three species occurred in greater than 20 ecoregions: *Etheria elliptica, Chambardia wahlbergi* and *Mutela rostrata*. Twenty-five ecoregions had no mussel records, and the two most species-rich ecoregions were the adjacent Upper Nile and Lake Victoria Basin (16 and 17 spp., respectively). The region-wide patterns of freshwater mussel richness and endemism are significantly correlated with both fish and general freshwater mollusk distributions. The relevance to these analyses to freshwater mussel conservation in Africa will be discussed.

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PL 29

USING MUSSEL RELOCATIONS AT BRIDGE SITES TO ADVANCE REGIONAL MUSSEL CONSERVATION. Patricia A. Morrison[1] and Catherine M. Gatenby[2]. [1]USFWS, Ohio River Islands National Wildlife Refuge, 3982 Waverly Road, Williamstown, WV. [2]USFWS, White Sulphur Springs National Fish Hatchery, 400 East Main Street, White Sulphur Springs, WV.

Often times mussels are moved from bridge construction or demolition sites in order to protect them from direct impacts and minimize or eliminate expected take of endangered species. In many cases those animals are moved to areas of suitable habitat upstream of the anticipated impact, often in areas already occupied by other mussels. During the recent construction of a new bridge and instream demolition of an old bridge on the Allegheny River at East Brady, PA, federal and state resource agencies, in cooperation with PennDOT, took a different approach. Over 8000 common mussels were transported up to 300 miles away to help restore 12 species of mussels to areas within their historic range. Many of these areas had lost their fauna due to recent or historic pollution or habitat damage. Another 2500 went into captivity at White Sulphur Springs National Fish Hatchery for long term care, propagation of juveniles, and studies related to physiological condition and diet. Results of those studies have widespread application for captive care of common and endangered mussels. Techniques developed for propagation of *Epioblasma torulosa rangiana* (northern riffleshell) will further advance its recovery. Resource agencies will monitor the mussel relocation sites for survival and reproduction.

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PL 35

DAM REMOVAL AND FRESHWATER MUSSEL ASSEMBLAGES IN A HIGHLY URBANIZED OHIO STREAM. Fleece, W.C.,[1] J.K. Kiser,[2] and M.A. Hoggarth[3] [1] Stantec, 11687 Lebanon Road, Cincinnati OH 45241, cody.fleece@stantec.com; [2]Stantec, 1901 Nelson Miller Parkway, Louisville, KY 40223, james.kiser@stantec.com [3]Otterbein University, Westerville, Ohio 43081, MHoggarth@otterbein.edu

The 5th Avenue Dam, located near downtown Columbus, Ohio, and was initially constructed in 1935 is approximately 500 feet wide, eight feet tall, and built of structurally reinforced concrete. Construction documents are currently being prepared for the removal or partial removal of this low head dam. Several special status freshwater mussel species were historically known from this river including *Pleurobema clava*, *Epioblasma triquetra*, *Epioblasma torulosa rangiana*, *Quadrula cylindrica*, and *Villosa fabalis*. As part of the Clean Water Act permitting process, field studies were conducted to determine the presence or probable absence of federally listed mussels. Visual and tactile searches were conducted to locate mussels in the construction footprint and in high quality habitats in the two-mile stretch of the Olentangy River between the dam and the confluence with the Scioto River. Qualitative searches were supplemented by quantitative methods involving excavation of river bed substrates. Despite the highly urbanized nature of the project area, the qualitative surveys yielded 285 live animals comprised of 11 species in 1,140 minutes of search effort. The quantitative surveys sampled 80 square meters of substrate and yielded 68 live animals comprising 11 species. *Lampsilis fasciola* and *Alasmidonta marginata*, both Ohio Species of Concern, were collected during these surveys but no federally endangered or threatened species were collected. This presentation will summarize data on the mussel assemblage present in the project area, discuss measures to avoid or minimize impacts to freshwater mussels, and discuss design features intended to promote colonization of mussels in the formerly impounded area.

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PL 30

APPALACHIAN ELKTOE RELOCATION ASSOCIATED WITH A DAM REMOVAL PROJECT IN WESTERN NORTH CAROLINA. John M. Alderman, Alderman Environmental Services, Inc., 244 Red Gate Road, Pittsboro, NC 27312. Joseph D. Alderman, Alderman Environmental Services, Inc., 202 Lakeshore Dr., Hillsborough, NC 27278

The Appalachian elktoe (*Alasmidonta raveneliana*) is a federally listed endangered mussel species with extant populations largely restricted to Tennessee River Basin tributaries in western North Carolina. One of the largest populations occurs in the Tuckasegee River. Since 2000, Duke Energy has been engaged in the FERC relicensing process associated with three river basin hydroelectric projects. Part of the mitigation process was the license surrender of the Dillsboro Hydro Project, which included dam removal, relocation of a downstream local Appalachian elktoe population, and monitoring of mussel fauna at 4 sites: relocation site, depletion site (just downstream from the dam), and 2 sites downriver from the depletion site. Using numerous techniques to minimize disturbance of individual elktoes, three intensive depletion passes resulted in relocation of 1,137 elktoes. In 2010, following dam removal in 2009, intensive monitoring of live elktoes occurred during May and October. October's monitoring results included 1,309 animals (resident plus relocated elktoes) at the relocation site, 457 animals at the depletion site, and a total of 209 at the other 2 monitoring sites. Confirmed mortality to date is 7 elktoes at the relocation site.

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PL 36

RANDOM LARGE RIVER MUSSEL SAMPLING PROTOCOL. Rick Spear, Daniel Counahan[1], and Tom Jones[2] [1]Pennsylvania Department of Environmental Protection SWRO 400 Waterfront Drive Pittsburgh, PA 15222. [2] Department of IST Marshall University 1 John Marshall Drive Huntington, WV 25755

An integrated large river assessment using water quality, physical habitat, and biological measures was conducted on portions of the Monongahela and Allegheny Rivers in 2008, 2009, and 2010. The biological components included fish, benthic macroinvertebrate, and mollusk sampling. We developed a mussel sampling methodology that incorporated random sampling that would allow us to sample mussels in river reaches where we sampled fish and benthic macroinvertebrate components. This protocol is composed of 12 five-minute dives that are randomly spaced from both the downstream sampling point and the shoreline. Prior to the timed dive, the researcher also excavated an area near the anchor. The excavated material was transported to the surface in a five-gallon bucket to be analyzed for both mussels and substrate composition. The project's objective was to build Pennsylvania's capacity to assess conditions of large rivers by providing a foundation for the development of large river assessment protocols for non-wadeable streams. These large river protocols will provide the capability to conduct bioassessments and monitor environmental conditions with a scientifically defensible method applicable to Pennsylvania's non-wadeable rivers. This presentation will focus on the protocol and the results from the first three years of sampling.

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PL 31

SEARCHING FOR STREAM BOOTY: SUMMARY OF A STATEWIDE MUSSEL SURVEY IN ILLINOIS. Sarah A. Bales, Alison L. Price, Diane K. Shasteen (Professional), Illinois Natural History Survey, 1816 South Oak, Champaign, IL 61820

Freshwater mussels are considered one of the most imperiled groups of organisms in the world, and populations in Illinois are not an exception. Illinois historically supported 80 freshwater mussel species, yet only 50 species are currently extant and 46% of these are listed federally or by the state. Habitat degradation, historical harvesting, declining water quality and potentially loss of fish host have contributed to the decline in freshwater mussel populations. In 2006, the Illinois biological stream ratings were updated to incorporate integrity and diversity measures. Freshwater mussels were included as an aquatic taxon to measure diversity. While broad geographic information is available on the distribution and abundance of mussels in Illinois, few consistently collected mussel-community data sets exist. Since 2009, we have collected baseline freshwater mussel data at IDNR/IEPA Intensive Basin Survey sites in 25 basins in Illinois. Many of these locations were novel sites or had not been sampled within 50 years. Through this geographically intensive search effort, we have documented several range expansions and new records for state-listed species. These data are informing state biologists on the current status of both stable and listed species. In addition, species data collected are being used to revise current mussel community indices and integrate a mussel component into future aquatic community assessments.

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PL 37

KNOWN KNOWNS AND KNOWN UNKNOWNS: WHAT DO WE REALLY KNOW? Jason M. Wisniewski, GA Department of Natural Resources, Wildlife Resources Division, Nongame Conservation Section, 2065 Hwy 278 SE, Social Circle, GA 30025 Phone: (706) 557-3032 e-mail: jason_wisniewski@dnr.state.ga.us. James T. Peterson USGS, Georgia Cooperative Fish and Wildlife Research Unit, University of Georgia, Athens, GA 30602. Sandra Abbott US Fish & Wildlife Service, Fort Benning, GA. Colin P. Shea Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA, 30602. Carson Stringfellow Columbus State University, Department of Biology, Columbus, GA 31907

In 2005, we began a long-term mussels tagging study in Sawhatchee Creek, Early County Georgia. The goals of the study were to generate estimations of population size, survival, growth, and gravidity for three federally listed unionids. A 100-meter reach of the creek was sampled every June from 2005 until 2010. Target species were identified, measured, sexed, tagged, and released back into the study reach. This information was recorded yearly for all previously tagged individuals and all newly collected individuals were tagged. Nine hundred forty total mussels were tagged since 2005. Mean capture per sample was 242 and ranged from 208 to 300 individuals. Capture probabilities for the Oval pigtoe (*Pleurobema pyriforme*), Gulf moccasinshell (*Medionidus penicillatus*), and Shinyrayed pocketbook (*Hamiota subangulata*) were 0.36, 0.24, and 0.31, respectively. No individuals have been collected on all 6 sampling occasions and only 3% of individuals have been collected more than 3 times. During the first 4 years of the study, 1st captures accounted for more than 50% of the total catch while the frequency of subsequent captures increased. These results suggest that capture efficiency of endangered unionids in our study site was poor despite fairly large sampling crews and ideal sampling conditions.

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PL 32

A PRELIMINARY ANALYSIS OF DETECTABILITY OF FRESHWATER MUSSEL SPECIES USING TIMED SEARCH DATA FROM WADEABLE STREAMS OF ILLINOIS. Alison L. Price, Sarah A. Bales, Diane K. Shasteen, and Kirk W. Stodola. Illinois Natural History Survey, Institute of Natural Resource Sustainability, University of Illinois

Statewide mussel monitoring programs are an integral component of mussel conservation. The objectives of many such programs are to provide information on species distributions or population trends to inform management actions. However, describing population trends or species distribution requires the use of quantitative sampling methods that account for species detectability. Without accounting for detectability, changes over time or space may simply reflect changes in detection, thus obscuring true phenomena. Certain types of quantitative sampling for freshwater mussels are time and labor intensive and typically require a preliminary qualitative sample, or timed search, of the site. It is well understood that qualitative mussel data have limited utility for predicting density, abundance, or measuring recruitment. Timed searches, however, are still widely used by aquatic biologists for preliminary data of a stream reach or for a count of species richness. We used timed search data to examine how site and species characteristics influence the detectability of common mussel species from wadeable streams in Illinois. Data were collected for a statewide mussel survey from 2009 to 2010 in 25 basins in wadeable streams in Illinois. We utilized a 4-person hour timed search, which we used as replicate samples. Each timed search was sub-divided into 1-hour segments and data were pooled among samplers for each hour. We modeled species detection and used site and species variables as covariates. The best-fitting model was selected using an information theoretic approach. Resulting detection probabilities can be used to adjust data for incomplete detection.

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PL 38

A MULTIDISCIPLINARY INVESTIGATION OF NATURAL AND ANTHROPOGENIC FACTORS AFFECTING CLINCH RIVER MOLLUSK ASSEMBLAGES Brett Ostby, Virginia Tech, 100 Cheatham Hall, Blacksburg, VA 24061 Jennifer Krstolic, USGS, Virginia Water Science Center, Richmond, VA Greg Johnson, USGS, Tennessee Water Science Center, Knoxville, TN

The Eastern Region Initiative on the Clinch (ERIC) is a multi-disciplinary investigation into a mollusk assemblage collapse in a 50 mile reach of the Clinch River in Virginia. Beyond this proximate goal, we seek to provide a hydrologic, biological, and geographic framework that will inform process-level studies of ecosystem response to changes in land use and energy extraction in this globally significant river. Over the first 2 years of this ongoing 3-year study, we have collected discharge, water quality, sediment quality, and habitat quality information. We have also documented mollusk assemblages and conducted *in situ* mussel juvenile growth and survival studies at sites upstream, within, and downstream of the impacted reach. We documented a gradient of increasing mollusk density and richness from upstream impacted reaches in Virginia to presumably healthy reaches downstream in Tennessee. Growth and survival of *in situ* juveniles have not reflected this gradient and may be influenced by local drivers. We have collected paired discrete water quality samples (nutrients, metals, major ions, suspended sediment) at one impaired site and one downstream healthy site during both base-flow and storm events. We have also sampled polycyclic aromatic hydrocarbons (PAHs) during storm events. Differences in major ion chemistry at base-flow and metals concentrations during storm events might provide some insights that help explain the mollusk assemblage gradient. Additionally, continuous monitoring has detected higher specific conductance and turbidity in the impacted reach than in the healthy reach. Preliminary results of this study are being used to refine hypotheses and more effectively direct investigations in the Clinch River.

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PL 39

AQUATIC CHEMISTRY ARCHIVES FROM FRESHWATER MUSSEL SHELL GEOCHEMISTRY. Goodwin, David H., Department of Geosciences, Denison University, Granville, OH 43023; Gillikin, David P., Department of Geology, Union College, Schenectady NY 12308; and Watters, G. Thomas, Department of Evolution, Ecology and Organismal Biology, The Ohio State University, Columbus, OH 43212

The accretionary skeletons of bivalve mollusks contain a wealth of information about the environment in which they grew. Unlike their marine counterparts, however, the resolution and fidelity of freshwater mussel shell archives of aquatic chemistry remain relatively poorly constrained. Here we present the preliminary results of a yearlong calibration study that focused on *Lampsilis cardium* grown at the Columbus Zoo & Aquarium Freshwater Mussel Conservation & Research Center. Specimens were grown in cages in the O'Shaughnessy Reservoir and in an indoor husbandry facility. Beginning January 1, we recorded temperatures at each site every hour for one year. We also collected weekly samples from each site ($\delta^{18}O_{water}$, [DIC], $\delta^{13}C_{DIC}$, Chlorophyll *a*, alkalinity, dissolved trace elements, $\delta^{13}C_{POM}$, $\delta^{15}N_{POM}$, conductivity, turbidity, and DO). In addition, for two separate weeks (spring and fall) we collected the all of the above for seven consecutive days from each site. Finally, for one day in each of these weeks, we collected samples every hour for 24 hours. We also have access to fortnightly samples of [NO_3], [NH_4], [H_3PO_4], total P, atrazine, algae surveys and vertical temperature profiles from the reservoir water column. With these data, together with shell derived data (e.g., $\delta^{18}O_{carb}$, $\delta^{13}C_{carb}$, $\delta^{15}N_{org}$, and trace elements), we will investigate the resolution and fidelity of mussel shell archives of aquatic chemistry. In addition, we will apply a newly developed Bayesian statistical approach to reconstruct intra-annual growth rates. This project is likely to further understanding freshwater mussel shell archives with implications for ecology, restoration and reconstruction of past environmental conditions.

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PL 44*

GRAVIDITY, FECUNDITY, AND HOST FISHES OF THE BARRENS HEELSPLITTER (*LASMIGONA SP*.) Stephanie D. Barton[1] and James B. Layzer[2] [1]Tennessee Cooperative Fishery Research Unit, Tennessee Technological University, Cookeville, TN 38505; [2]US Geological Survey, Tennessee Cooperative Fishery Research Unit, Tennessee Technological University, Cookeville, TN 38505

The Barrens Heelsplitter, *Lasmigona* sp., is a rare, unrecognized species known from only seven streams in the headwaters of the Caney Fork River system and in the upper Duck River, an area known as the Barrens region of middle Tennessee. Several other mussel and fish species are endemic to this area. Virtually nothing is known about the Barrens Heelsplitter. We used a systematic sampling design with three random starts to estimate density and abundance of mussels in Pocahontas Branch, a second-order, spring-fed stream. Mean density was 3.4 mussels/m^2 and an estimated 1,500 individuals were present in the 70-m-long study site. The only other mussel species present was *Venustachoncha sima*. Fish and mussels were collected monthly from September 2009 to August 2010. Spawning occurred in late July or early August. Females released glochidia from October to April and were fully spent by May. Fecundity of gravid females (N=34) ranged from 9,000 – 54,000 glochidia per mussel. Host fish were determined by both field and laboratory work. Glochidia-infested fish were collected from October 2009 through May 2010. Sixteen of 18 species of fish collected from Pocahontas Branch had encysted Barrens Heelsplitter glochidia. Eleven of these species were artificially infested in the laboratory and confirmed as hosts.

NOTES:

PL 40

OCCURRENCE OF DISTURBANCE RINGS IN FRESHWATER MUSSEL SHELLS. A. L. Rypel [1,2], W. R. Haag [2]. [1]Biology Department, Washington University in Saint Louis, Box 1137, One Brookings Drive, Saint Louis MO 63130. [2]USDA Forest Service, Center for Bottomland Hardwoods Research, 1000 Front Street, Oxford, MS 38655

Disturbances experienced by mussels often leave records in the shell in the form of rings which can be distinguished from annual growth rings. We explored the periodicity and occurrence of disturbance rings in freshwater mussels by examining shell thin-sections. Disturbance was of general occurrence in mussel populations, occurring in at least one individual in 15 of 16 populations. . However, in all populations the frequency of disturbance was low, and among years occurred in only 0–15% of individuals (mean = 5%). The two populations with greatest frequency of disturbance (after normalization by time-series length) were from streams with altered hydrology (i.e., upstream or downstream of dams). For 4 of 11 populations, annual indices of growth were significantly lower during years in which disturbance occurred. No population had significantly higher growth during a disturbance year. Furthermore, for 2 of 4 species, Von Bertalanffy growth curves were significantly depressed in individuals that experienced a disturbance compared to those without disturbance rings showing that disturbance can have lasting effects on mussels. In 4 of 7 species, logistic regressions predicted the occurrence of disturbances in specific calendar years based on streamflow and climate variables, but r^2 values for these models were low (range of significant models: 0.07–0.24). We conclude that the occurrence of disturbance in freshwater mussel populations has a large stochastic component but might be increased by anthropogenic impacts to stream stability. Analyzing historical patterns of mussel disturbance could be useful for evaluating how human activities have diminished the stability of aquatic systems over time.

NOTES:

PL 45*

HOST FISHES AND CONSERVATION STATUS OF *ALASMIDONTA MARGINATA* (MOLLUSCA: BIVALVIA) IN MINNESOTA. Kylie H. Bloodsworth[1,*], Ben R. Bosman[1], Bernard E. Sietman[1], Mark C. Hove[2], and J. Mike Davis[3] [1]Minnesota Department of Natural Resources, Division of Ecological and Water Resources, 500 Lafayette Road, Saint Paul, 55155. [2]University of Minnesota, Department of Fisheries, Wildlife and Conservation Biology, 1980 Folwell Avenue, Saint Paul, 55108. [3]Minnesota Department of Natural Resources, Division of Ecological and Water Resources, 1801 South Oak Street, Lake City, 55041. *Corresponding author- khbloodswort@gmail.com

Within its genus, the elktoe mussel (*Alasmidonta marginata*) is one of the most widespread species in North America yet it is a species of special concern in the US and threatened in Minnesota. Although potential hosts have been identified for this species, no suitable hosts have been confirmed, and a more thorough review is needed. The objectives of this study were to identify suitable glochidial hosts for *A. marginata*, and describe its current distribution and status within Minnesota. Of the 85 fish and one amphibian species tested, juveniles were recovered from 27 fishes in 6 families (sucker, sculpin, minnow, killifish, stickleback and live bearer). Among these groups, suckers produced the greatest number of juveniles per fish. These host relationships are similar to other *Alasmidonta* species that are presumably sister to *A. marginata*. From extensive surveys within Minnesota, we found extant populations of *A. marginata* in the St. Croix, Mississippi River below St. Anthony Falls, and Minnesota River systems with reproducing populations in the St. Croix, Pomme de Terre, Zumbro, and Root rivers. Habitat degradation and barrier falls have influenced *A. marginata*'s current distribution more so than the range of its hosts. Our results have provided important information for improving conservation efforts of a rare mussel species, as well as contributed to the overall understanding of freshwater unionids.

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PL 41

FRESHWATER MUSSEL SHELL AND THE RECONSTRUCTION OF PRE-HUMAN IMPACT RIVERINE ENVIRONMENTS: A SURVEY OF STABLE ISOTOPE TECHNIQUES. David L. Dettman, Geosciences Department, University of Arizona, Tucson, AZ 85721.

River management, habitat restoration work, and ecological research often require baseline data on aquatic systems, information on the environment prior to major human modification of the landscape. Accurate historical records with the precision and temporal resolution needed are very often lacking. Recently a number of techniques have been adapted from geochemistry and paleontology to use easily preserved hard parts, e.g. shell, bone, or teeth, to construct a partial view of aquatic environments that are hundreds to thousands of years old. Museum specimens and archaeological materials can be used to build chronologies of environmental change. Although these reconstructions cannot present a complete picture of the habitat, they can yield important information about the ancient to modern change in river runoff, temperature, turbidity, nutrient inputs, and food resources. Oxygen isotope ratios in shell carbonate respond to both the seasonal temperature cycle and isotope ratio of river water. Growth banding in combination with oxygen isotope analysis can easily distinguish between winter growth bands and other growth interruptions. The latter may be due to turbidity events or extreme summer temperatures. Growth rates measured between winter growth-checks can be compared year-by-year between ancient and modern to infer habitat fitness changes through time. Periostracum (when preserved) or conchiolin layers buried within shell can be analyzed for both carbon and nitrogen stable isotopes to document changes in the food and nutrient resources. Nutrient loading, agricultural runoff, and changes in aquatic productivity can lead to changes in the isotopic composition of organic particulates in rivers, which lead to changes in the shell organics. Finally, carbon-14 analysis of shell can be used to document variability in upwelling in deep freshwater lakes.

NOTES:

PL 46*

POPULATION CHARACTERISTICS OF AN EXPANDING POPULATION OF THE ROUND HICKORYNUT, *OBOVARIA SUBROTUNDA* (BIVALVIA: UNIONIDAE) IN THE DUCK RIVER, TENNESSEE. Chase Ehlo[1] and James B. Layzer[2]. [1]Tennessee Cooperative Fishery Research Unit, Tennessee Tech University, Cookeville, TN 38505. [2]U.S. Geological Survey, Tennessee Cooperative Fishery Research Unit, Tennessee Tech University, Cookeville, TN 38505

The round hickorynut*, Obovaria subrotunda,* was found throughout the Tennessee, Cumberland, and Ohio river drainages, and the Great Lakes systems, but it has been extirpated from many streams and remaining populations have declined. However, the population in the Duck River has increased dramatically in the past 30 years. To determine the characteristics of a healthy, expanding population, we used a systematic sampling design with three random starts to sample four sites. At each site, we excavated 62 to 268 quadrats ($0.25m^2$) to estimate density, abundance, sex ratio, and size structure. Gravidity was determined by examining all females collected in quantitative and qualitative sampling. The smallest gravid female found was 18 mm long. Fresh-dead shells were collected from muskrat middens and thin-sectioned to determine age and growth. A positive relationship between size and age was found for each sex, and males grew faster and attained a larger size than females.

NOTES:

PL 42

MODELS OF UNIONID DISTRIBUTION AND ABUNDANCE IN A REACH OF THE UPPER MISSISSIPPI RIVER. Steve J. Zigler[1], Teresa J. Newton[1], and Douglas Olsen[1]. [1]U.S.Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI

We analyzed data from a quantitative survey of native mussels done in 2007 that was conducted in a 42-km impounded reach of the Upper Mississippi River (Navigation Pool 18) using a systematic design (n=377 sample locations). For each sampling site, we estimated a suite of simple physical and complex hydraulic variables that have been shown to be useful descriptors of mussel habitat in the Upper Mississippi River. Mussel presence-absence and abundance were analyzed with classification and regression tree (CART) models. Cross-validated prediction success of the CART models for presence-absence of mussels ranged from 67-77%. The regression tree model accounted for nearly 60% of the variation in mussel density and primarily relied on complex hydraulic variables (e.g., shear stress) and a variable dividing the reach into thirds. Depth, bottom slope and current velocity were also important predictor variables. Geospatial models, which were based on CART model results, predicted few mussels in backwater areas (e.g., floodplain lakes) and the navigation channel, whereas main channel border areas with high geomorphic complexity (e.g., river bends, islands, side channel entrances) and small side channels were predicted to be more favorable to mussels. Future work is needed to elucidate the causes of the pattern of high mussel densities predicted in lower third of the reach, which could result from unmodeled factors such as host fish distributions, hydraulically driven large-scale patterns in dispersal, and patterns in primary production and food availability.

NOTES:

PL 47*

BYSSUS PRODUCTION IN FRESHWATER MUSSELS (UNIONOIDEA). Megan E. Bradley, Department of Biology, Missouri State University, 901 S. National Ave. Springfield, MO 65897 Tel. 540-354-5154, Bradley2011@live.missouristate.edu; M.C. Barnhart, Department of Biology, Missouri State University, 901 S. National Ave., Springfield, MO 65897 Tel. 417-836-5166, chrisbarnhart@missouristate.edu

Although byssus production in the Unionidae has been reported in the literature for over 100 years, the function, mechanism of production, and phylogenetic distribution of byssus in Unionidae are poorly known. 56 species have been observed to produce it, representing 4 of the 6 tribes of Unionids. The roles of age and size in byssus production is difficult to pinpoint, with juvenile *Lampsilis rafinesqueana* up to 27.19 mm maintaining threads and many other species producing them only briefly. 70-80% of newly transformed *L. rafinesqueana, L. siliquiodea*, and *L. abrupta* show evidence of byssus versus 30% of newly transformed *Fusconaia ebena*. In further experiments there also appears to be a difference in byssus production dependent on the species present and their number with mean byssus production varying from zero for a lone *Ligumia recta*, to 1.8 for a mix of 6 *Lampsilis siliquoidea* and 6 *L. recta*, to 5 for twelve *L. recta*. Further experiments examining the impact of the presence of conspecifics are underway. Many questions regarding byssus production remain unanswered, but its significance in the life history of juveniles is likely great and warrants further inquiry.

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PL 43

FRESHWATER MOLLUSK MANAGEMENT IN NORTH CAROLINA.

Stephen J. Fraley, Ryan J. Heise, and Robert B. Nichols. North Carolina Wildlife Resources Commission, Aquatic Wildlife Diversity ProgramDivision of Inland Fisheries, 1721 Mail Service Center, Raleigh, NC 27699-1721

The North Carolina Wildlife Resources Commission (NCWRC) is responsible for the conservation and management of the state's freshwater fish, crustacean, and mollusk resources. North Carolina's aquatic mollusk fauna includes Interior Basin (Cumberlandian and Ohioan) and South Atlantic Slope faunal groups across the Blue Ridge, Piedmont, and Atlantic Coastal Plain physiographic regions. The current North Carolina Wildlife Action Plan identifies priorities, goals, and objectives to guide management of non-game wildlife resources, including aquatic mollusks, through 2015. Habitat conservation and restoration are primary objectives, but research into basic life history and specific management questions, as well as restoration of populations in recovering habitats, are also priorities. Habitat conservation is accomplished through a variety of means, including cooperative agreements, land purchases, easements, stream channel restoration and other manipulations, and technical guidance to mitigate impacts. Research in partnership with regional universities and other cooperators is funded through NCWRC and state-administered federal funds, often in partnership with other stakeholders (e.g. NCDOT). As unoccupied habitats and adequate techniques and technologies are available, restoration of mollusk populations are a high priority. The NCWRC has invested in captive propagation, both through NC State University cooperators and in-house at the Conservation Aquaculture Center at Marion State Fish Hatchery. Examples of specific projects and intiatives from across the state will be highlighted.

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PL 48*

EFFECTS OF TEMPERATURE AND PHOTOPERIOD ON LURE DISPLAY AND GLOCHIDIAL RELEASE IN *LIGUMIA SUBROSTRATA*.

Andrew M. Gascho Landis[1], Tyler L. Mosley[1], Wendell R. Haag[2] and James A. Stoeckel[1] [1]Auburn University, Auburn, AL
[2] US Forest Service, Oxford, MS

We examined the effects of temperature and photoperiod on host infection strategies (mantle lure display and conglutinate release) of *Ligumia subrostrata*, specifically, whether temperature mediates a shift between the two strategies. In the first experiment, we held gravid female mussels in four temperature treatments (5, 15, 25 ,35 ºC) for 30 days, increasing the photoperiod every ten days (10:14, 12:12, and 14:10 light: dark). Mussels displayed lures in all treatments but experienced 80% mortality at 35º, all other temperatures had 100% survivorship. At 5º, display was low initially but increased with day length. At 15º, display was consistent at all photoperiods. At 25º, display mostly ceased after conglutinates were released. All individuals at 25° and 35° released conglutinates, but none were released at 5° or 15°. In the second experiment, we held gravid females in the laboratory under ambient conditions from February-June (10-33º). From 10-22º, >80% of individuals displayed, but display decreased sharply above 23ºC and largely ceased at 28º. In contrast, conglutinate release did not occur at <15° but increased coincident with decrease in lure display and 75% of conglutinates were released at >23º. Release of conglutinates by *L. subrostrata* appear to be a secondary strategy employed only after a lengthy period of lure display. This secondary strategy may be an adaptation to decrease loss of glochidia that must be released in preparation for deposition of the subsequent brood. Although day length was confounded with time, these results also suggest that lure display occurs most frequently at an optimal temperature range (~15º) but can be induced at low temperatures by increasing day length.

NOTES:

PL 49

BIOGEOGRAPHY AND CONSERVATION OF FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE): DRIVERS OF DIVERSITY AND THREATS. Lyubov E. Burlakova and Alexander Y. Karatayev (Great Lakes Center, Buffalo State College, Buffalo, NY), Vadim A. Karatayev (University Honors College, SUNY at Buffalo, Buffalo, NY), Marsha E. May (Texas Parks and Wildlife Department, Austin, TX), Daniel L. Bennett (Inland Fisheries District 3C, Texas Parks and Wildlife Department, Tyler, TX), and Michael J. Cook (SWCA Environmental Consultants, Bismarck, ND)

The knowledge of geographic patterns of species distribution and the factors contributing to species endangerment is necessary for the development of integrative conservation strategies. We studied the large-scale environmental and anthropogenic factors affecting the diversity of freshwater molluscs (Bivalvia: Unionoida). Unionid assemblages were surveyed in all major Texas river basins in 2003 - 2009. Multivariate statistics was used to test for differences among environmental parameters and unionid communities in different bioprovinces, and to determine the extent to which the multivariate pattern of species distribution was affected by environmental factors. We found a positive correlation among biotic and environmental similarity matrices, which indicated concordance of the differences among unionid communities and environmental factors that could cause these differences. Lake surface evaporation rate and percentage of forest cover on the watershed were among the most important parameters explaining the differences in unionid communities. Human population density negatively correlated with the proportion of rare species. The proportion of species found live to the total number of live and relic species found in our surveys, and to the number of historically known species, decreased with the increase in human population density on the watershed. Therefore, increased human population density and negligence of assessing the unionid conservation status were associated with loss of rare species. This extinction debt presents a challenge for species conservation by underestimating the consequences of human impacts on biodiversity.

NOTES:

PL 54

LIFE HISTORY AND CONSERVATION OF *ELLIPTIO CRASSIDENS* FROM THE BLUE RIVER, INDIANA. Cassandra L. Hauswald 5885 Wulfman Road SE, Laconia, IN 47135

This study assessed life history components for the elephantear freshwater mussel, *Elliptio crassidens* (Lamarck, 1819). The research examined potential for host-limitation versus reproductive limitation to learn if loss of host fish is a cause of *E. crassidens'* low abundance and skewed population size structure in the Blue River of south-central Indiana. This was accomplished by examining *E. crassidens* from this river for reproductive viability and then infecting various fish species with glochidia from *E. crassidens*.

The goal of this research was to use laboratory inoculations to determine fish hosts for *E. crassidens*. In addition, observations on reproductive timing and glochidia size and behavior were made. A subset of specimens collected from the Blue River, Indiana were analyzed using a thin-sectioning technique to determine the age class of this species in the Blue River. Finally, a Geographic Information System (GIS) analysis of overlap between *E. crassidens* distribution and various fish species' distribution was performed to predict which species might be suitable as fish hosts for *E. crassidens*.

This research tested two hypotheses. 1) that individuals of *Elliptio crassidens* in the Blue River, Indiana are senescent. 2) that host fish for *Elliptio crassidens* is absent in the Blue River.

These experiments addressed the apparent lack of recruitment of juvenile *E. crassidens* by establishing whether the Blue River population is too old to be reproductively viable as well as by determining if any of the fish species present in the river can act as suitable hosts for larval *E. crassidens*.

The information presented should provide a helpful starting point for future investigations into fish host studies for the elephantear with the ultimate goal of increased populations throughout the species' range.

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PL 50*

ALTERATION OF NUTRIENT DYNAMICS BY UNIONID MUSSELS

Carla L. Atkinson and Caryn C. Vaughn. University of Oklahoma and the Oklahoma Biological Survey

Nutrient cycling is a key process that ties all organisms together. This is especially apparent in stream environments in which nutrients are taken up readily and cycled through the system in a downstream trajectory. Freshwater mussels may have the ability to greatly alter nutrient dynamics through preferential excretion and egestion. Ecological stoichiometry predicts that biogeochemical cycles of different elements are interdependent because the organisms that drive these cycles require fixed ratios of nutrients. Consumers that are at relatively high densities have the potential to influence stream nutrient dynamics through differential excretion of limiting and non-limiting nutrients. The maintenance of homeostasis by dense aggregations of freshwater mussels may create biogeochemical hotspots within riverine habitats by altering what nutrients limit production in the system. These changes may lead to higher species richness and greater community evenness. We conducted a nutrient-diffusing substrate experiment (NDS) in conjunction with excretion experiments at 18 sites in 3 rivers (Kiamichi, Little, and Mt. Fork rivers) during the summer 2010. Basic water chemistry was measured and quantitative mussel samples were also done. Our results indicate that mussels alter the nutrients that limit production; sites with high densities of mussels were co-limited, while sites with no mussels were N-limited. These findings corroborated with our excretion experiments. Due to the excretion of ammonia by mussels, strict N-limitation is alleviated, and the system switches to being co-limited. These results show that mussels can have a large influence on stream nutrient dynamics.

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PL 55

THE ROUND GOBY, *NEOGOBIUS MELANOSTOMUS*, AS A HOST FOR UNIONID SPECIES AT RISK.

M. Tremblay[1], T.J. Morris[2], and J.D. Ackerman[1], [1]University of Guelph, Guelph, ON, N1G 2W1, [2]Fisheries and Oceans Canada, Burlington, ON, L7R 4A6

The invasive Round Goby (*Neogobius melanostomus*) is of particular concern in conserving endangered unionid populations because it frequently out-competes or preys upon host fishes, and is a potential molluscivore. Moreover, it has recently invaded endangered mussel "hot spots" (areas with high diversity) in southwestern Ontario. However, if Round Gobies are able to serve as fish hosts for unionids, the negative effects of the invasion on these mussels could be mitigated. This hypothesis was investigated in the laboratory by examining the infestation and metamorphosis rates of two Species at Risk (Snuffbox (*Epioblasma triquetra*) and Wavyrayed Lampmussel (*Lampsillis fasciola*)), and one common species (Mucket (*Actinonaias ligamentina*)) on Round Gobies. Experiments included a comparison with primary host fishes (*Percina caprodes*, *Micropterus dolomieu* and *Micropterus salmoides)*, which have high infestation and metamorphosis rates, and marginal hosts (*Cottus bairdi* for all three mussel species), which have lower rates, to ensure the validity of the results. The glochidia from each of 3 gravid female mussels were used to infest the Round Goby, the primary host, and the marginal host (4 fish per treatment). *E. triquetra, L. fasciola* and *A. ligamentina* glochidia infested and metamorphosed on the Round Goby, but at much lower rates than on their primary and marginal hosts. Natural infestations on Round Gobies in the field will be determined from fish that have been collected, geo-referenced and preserved by Fisheries and Oceans Canada. The results of laboratory and field studies will provide valuable information on the potential effects of Round Goby invasion on common and endangered unionid mussels.

NOTES:

PL 51

RELOCATED UNIONID SURVIVAL, 15 YEARS LATER, WOLF RIVER, WISCONSIN. Heidi L. Dunn, Ecological Specialists, Inc. and Lisie Kitchel, Wisconsin Department of Natural Resources

Unionid relocation is often used to mitigate direct impacts of instream construction projects. However, unionids are seldom monitored for more than a few years. In 1995, over 23,000 unionids of 21 species were relocated from the U.S. 29 bypass bridge area in the Wolf River, Shawano County, Wisconsin. *Epioblasma triquetra*, *Alasmidonta marginata*, and *Tritogonia verrucosa* (Wisconsin threatened and endangered species) were placed in grids, and other species were distributed upstream in a 100m x 30m area. In 1997, 55.5% of the T&E species were recovered, mortality was only 4.2%. 34% of the recovered T&E species had moved, and growth was apparent. In 2010, 9472 unionids of 20 species were relocated from U.S. 22 bridge construction area, approximately 550m upstream of the U.S. 29 bypass bridge, and 100 to 200m upstream of the U.S. 29 bypass bridge unionid relocation area. Fourteen individuals of five species (*Actinonaias ligamentina*, *Elliptio dilatata*, *Ligumia recta*, *Lampsilis cardium*, and *Potamilus alatus*) were found marked at the U. S. 22 bridge site, indicating they had moved upstream at least 100m in the past 15 years from the U.S. 29 relocation site. Six live and one shell of male *E. triquetra* relocated in 1995 were recovered within T&E grids. Live *A. ligamentina*, *L. costata*, and *P. alatus* were also recovered in the U.S. 29 relocation area. Most of the construction areas under the U.S. 29 bypass bridge contained suitable unionid habitat, and unionids had recolonized. Approximately 8 unionids/m^2 were removed from the U.S. 29 bridge area in 1995, and density in 2010 was 5.0 unionids/m^2 (±2.8). Thus, at least some unionids have survived 15 years after relocation, some moved over 100m, and unionids recolonized construction areas.

NOTES:

PL 56

DAILY, SEASONAL, AND ANNUAL PATTERNS OF UNIONID BURROWING BEHAVIOUR WITH EMPHASIS ON SPECIES AT RISK. Todd J. Morris, Vanessa Minke-Martin, Amy Robinson and Izabella Sagan. Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, 867 Lakeshore Rd. Burlington, On, Canada, L7R 4A6.

It is well accepted that many unionids are active burrowers spending only a portion of their time at substrate surface actively filtering, respiring and reproducing. Despite this knowledge, it is not well understood how much time is apportioned to these two options (above or below the substrate) for any individual or species or how this pattern may vary through space and time. We selected 3 watersheds in southwestern Ontario to examine daily, seasonal and annual patterns of burrowing behaviour. Within each river a 400 m^2 site with a known high density of unionids was selected to serve as a study location. One site (Grand River) was sampled weekly through the summer of 2008, one site (Maitland River) was sampled weekly through summer of 2009 and one site (Thames River) was sampled weekly through summers of 2008 and 2009. In addition the Thames River site was sampled repeatedly (every 3 hours) over a 27 hour period on Aug 5 2009. During each sampling event individuals at surface were identified, measured, sexed when possible, checked for gravidity, tagged (*Lampsilis fasciola* only) and returned to the substrate. Displaying females were photographed. Seasonal patterns across species ranged form unimodal early season risers to unimodal late risers with several species including *L. fasciola* showing bimodal distributions. Seasonal patterns were strikingly similar across years and waterbodies. *Lampsilis fasciola* showed a high degree of activity over the diel cycle both in terms of luring and burrowing behaviour. Careful consideration should be given to daily and seasonal burrowing cycles when designing sampling programs.

NOTES:

PL 52

USING ENTIRE MOLLUSCAN COMMUNITIES (EVEN THE LIMPETS!) TO PREDICT HABITAT TYPE. Daelyn A. Woolnough[1], Daryl Kuipers[1] Daniel Auer[1] and David T. Zanatta[1]. [1]Biology Department, Central Michigan University, Mt. Pleasant, Michigan 48859.

Pelecypod and gastropod communities were studied in southwestern Michigan to determine taxonomic diversity and variation in and among riverine, wetland, and lake habitats. These faunal groups are two of the most understudied, least understood and most at risk of extirpation in North America. The mollusk communities were compared to the non-molluscan macroinvertebrate communities. In each river, a systematic quadrat sampling method was used that to survey the unionid community. We sampled approximately 20% of 400 m^2 at two sites per river (4 rivers total). Unionids in lake habitat were sampled by snorkeling timed-searches. Gastropoda and Sphaeriidae were sampled for using kick, sweep D-net technique. At each site (n=15 for wetlands, n=5 for lake habitat, n=8 for rivers) 3 replicated D-net samples were collected. Unionidae and Gastropoda were identified to species and Sphaeriidae to Genus. Other macroinvertebrates were keyed a classic 27-group classification. Biotic and abiotic conditions and indicies associated with unionid, gastropod and sphaeriid communities in the rivers, lake, and wetlands were ordinated using principal component analysis (PCA). The PCA revealed that entire molluscan communities explained over 30% of the variation of measured abiotic parameters, while Gastropoda and Sphaeriidae communities explained over 50% and 60% of the variation respectively. We show that molluscan community data may better predict habitat compared to classic macroinvertebrate indices. Aquatic invasive species like the zebra mussel (*Dreissena polymorpha*), asian clam (*Corbicula fluminea*), and the Chinese mystery snail (*Cipangopaludina chinensis*), while currently absent from most of the habitats studied, pose a threat to these ecosystems because of their ability to disrupt native mollusk communities and alter these important abiotic and biotic factors.

NOTES:

PL 57

PRELIMINARY RESULTS OF MANIPULATIVE EXPERIMENTS OF MUSSEL RECRUITMENT IN PONDS. Wendell R. Haag[1] and James A. Stoeckel[2] [1]US Forest Service, Oxford, MS [2]Auburn University, Auburn, AL

We examined the influence of host fish abundance and host infection strategy on mussel recruitment in twelve, 216 m^2 ponds at the Auburn Fisheries Station. We used two species with different infection strategies: *Pyganodon grandis*, which passively broadcasts glochidia in mucus webs; and *Ligumia subrostrata*, which actively attracts hosts with mantle lures. We tested the hypotheses that 1) recruitment of host attractors is less dependent on host abundance than broadcasters, and 2) the host-attractor strategy is more efficient especially at low host abundance. We used a factorial design with four host abundances (*Lepomis macrochirus*; 10, 50, 200, 500 individuals), and 10 gravid females of each species in each pond either alone or in combination. We initiated the experiment in February 2009 and sampled ponds for recruits in November 2009. Several ponds experienced high fish predation from birds or otters. Nevertheless, the experiment yielded several interesting results. For both species, mussel recruitment generally increased with host abundance. At the highest host abundance, total recruitment was 135 individuals (*L. subrostrata*) and 181 (*P. grandis*). Even at low host abundance (10 fish), *L. subrostrata* produced 34 recruits. In ponds with both species, recruitment was higher for *P. grandis*, suggesting that the broadcasting strategy was more efficient than mantle lures. Recruits grew rapidly (mean length 54.4 mm) and most females were fully gravid by November at age < 9 months. In addition to their surprisingly early maturity, these results show that fertilization is efficient even at low mussel density (<0.16/m^2), and both species have the potential for rapid colonization and population growth in lentic environments. We are currently repeating this experiment with provisions for excluding predators.

NOTES:

PL 53

HISTORICAL AND MODERN LANDSCAPE USE IN THE SOUTHEAST PIEDMONT, THE ONE-TWO PUNCH LEADING TO PROBABLE CAROLINA HEELSPLITTER EXTINCTION. John M. Alderman, Alderman Environmental Services, Inc., 244 Red Gate Road, Pittsboro, NC 27312. Joseph D. Alderman, Alderman Environmental Services, Inc., 202 Lakeshore Dr., Hillsborough, NC 27278

From the late 1700s – early 1900s, agriculture was the dominant land-use in the North and South Carolina Piedmont. Vast quantities of sediment were deposited in most creek and small river valleys leading to aggradation of stream beds and associated valleys. Based upon known element occurrences, many local populations of the Carolina heelsplitter (*Lasmigona decorata*), an endangered slate-belt endemic species, were probably extirpated as a result of early agricultural impacts. Following this period, woodland, including dramatically increasing reliance on loblolly pine monoculture since the 1980s, and pastureland dominated the landscape. Because of these land use changes, sediment input to stream valleys was significantly reduced. Now, instead of aggradation, degradation of stream valleys and stream beds has been negatively affecting habitat quality within many streams in the Carolina heelsplitter's range, thus limiting the species' ability to expand its range. In addition to unstable stream valley geomorphology, water yields are declining dramatically within the heelsplitter's range, largely due to loblolly pine's relatively high evapotranspiration rates plus severe droughts occurring during the recent past. In some cases where watersheds are dominated by loblolly pine stands, long reaches of the heelsplitter's occupied streams are drying resulting in die-offs of resident heelsplitters and other aquatic taxa. Additionally, in some urbanizing areas where heelsplitters were once relatively common, increased impervious surfaces appear to be causing stream drying and accelerated stream bed and bank instability. Because current, range-wide land uses suggest incompatibility with the Carolina heelsplitter, this species will probably become extinct within the foreseeable future.

NOTES:

PL 58

DO UNIONID MUSSEL LIFE HISTORIES DIFFER BETWEEN HEADWATER STREAMS AND LARGE RIVERS? DATA FROM LOUISIANA RIVERS. Kenneth M. Brown, Wesley Daniel, and Gilisa Taylor
Department of Biological Sciences Louisiana State University Baton Rouge, Louisiana

In spite of their endangered status, relatively little is known of life history variation in unionid mussels. We sampled mussels along a continuum from headwater streams to large order rivers in south eastern Louisiana, and sectioned shells to determine growth rates, life cycle lengths and ages at maturity. Rather than headwater and large river specialists, what we found instead was a small group of mussels that were cosmopolitan, mostly Lampsilids, with the remaining species found only in larger order rivers. Ages at maturity were about two years in both groups, but large river species had heavier shells, and life expectancies averaging 21 vs. 15 years. Large river species also moved smaller distances in laboratory experiments, and were less likely to stay ahead of lowering water levels. Rather than specific life history strategies, we think species inhabiting headwaters, which are both flashier and more subject to drying than large order rivers in Louisiana, may be able to move at faster rates, due to their thinner shells, and avoid lowering water levels during dry periods.

NOTES:

PL 59

METABOLIC SCALING IN UNIONIDS: A REVIEW. Jeff Kovatch and Mariah Clements. Department of Biological Sciences
Marshall University, Huntington, WV

Proposed universal metabolic scaling laws suggest that metabolic rates scale allometrically to ¾-power of body mass over many orders of magnitude of tissue mass for aerobic organisms. Few studies have consistently reported such allometric relationships and no review is known for North American Unionids. Contrary to across-taxa scaling laws, Eurasian reviews suggest a scaling exponent less than ¾. Deviation of scaling exponents from ¾ may be a product of inconsistent techniques and methodologies for dealing with the mass of the metabolically inactive shells. Relative masses of shells and soft tissue can vary greatly among species. We present a current review of metabolic literature for North American species and present a comparison to proposed universal patterns for animals. In addition to novel data, data were obtained from the literature. Of interest were studies that reported some metric of metabolic rate as a function of total organismal, wet, dry or ash-free dry mass. The data are normalized, and across Unionid metabolic scaling relationships are estimated. Across species and interspecific variations in allometric relationships are discussed. The utility of metabolic scaling in freshwater mussels is further discussed in the symposium theme of preparing for the future, including the estimation of the influences of seasonal temperatures on energetic needs and the extrapolation of the impacts of communities of mussels on the energy flow in ecosystems.

NOTES:

PL 65

AN ASSESSMENT OF FRESHWATER MUSSEL POPULATIONS AND HEAVY METAL SEDIMENT CONTAMINATION IN THE LEAD MINING-IMPACTED BIG RIVER, MISSOURI. Andrew D. Roberts[1], Dave Mosby[1], John Weber[1], John Besser[2], Josh Hundley[1], Stephen E. McMurray[3], and J. Scott Faiman[3]. [1]U.S. Fish and Wildlife Service, Columbia Missouri Ecological Services; [2]U.S. Geological Survey, Columbia Environmental Research Center, Columbia Missouri; [3]Missouri Department of Conservation, Resource Science Division, Columbia Missouri

An assessment of freshwater mussels and heavy sediment contamination was conducted to determine the downstream extent of heavy metal contamination of sediment; to determine distribution, diversity, and abundance of freshwater mussels; and to evaluate the relationship between heavy metal concentrations in sediment and mussel community characteristics in the lead mining-impacted Big River, Missouri. Sediments exceeded Probable Effects Concentrations for over 180 river km downstream of mining for Pb, and for approximately 80 km downstream of mining for Zn and Cd. Mussel species richness and CPUE and mussel sediment toxicity data showed broad-based negative associations with metals in sediments. Species richness was also significantly lower at sites below mining areas compared to past data. Further, mean mussel densities at 6 sites downstream of mining areas ranged from 0 to 0.4 individuals/m^2, significantly lower ($p<0.0001$) than average densities at 2 reference sites (1.9 and 9.1 individuals/m^2). These mussel community data indicate that mussel populations in a reach extending 159 km downstream from mining inputs are impacted from heavy metal contaminated sediment in the Big River.

NOTES:

PL 60

VETERINARY AND ENVIRONMENTAL TOOLS FOR UNIONID AND ECOSYSTEM HEALTH ASSESSMENT. J.F. Levine[1], J.P. Bucci[2], F.M. Holliman[3], C.B. Eads,[1]J.L. Hurley-Sanders[1] [1] Aquatic Epidemiology and Conservation Laboratory, College of Veterinary Medicine, North Carolina State University, 4700 Hillsborough Street, Raleigh, NC 27606. [2] Department of Natural Resources and Environment, University of New Hampshire, Durham, NH 03824. [3]Smith-Root Inc., 14014 NE Salmon Creek Ave., Vancouver, WA 98686.

When a health problem is identified in a pet or farm animal, a consultation with a veterinarian is a good first step towards diagnosing the problem and identifying potential therapies. When an environmental problem is suspected, a wide array of water quality measurements support efforts to identify and mitigate problem. Veterinary diagnostic techniques and environmental monitoring techniques also play a key role in assessing the health of unionid populations and the aquatic ecosystems in which they reside. Hemolymph samples can be used to conduct hemocyte cell counts, assess biochemical parameters that reflect organ function, help identify the presence of pathogens, and support toxicologic analysis. Nuclear magnetic resonance spectroscopy and imaging techniques can be used to detect biochemical disparities, examine internal anatomic structures, and identify pathology. Whole body nutritional analysis, elemental analysis of bivalve shells, and other assays can be used to assess unionid nutritional status and health. When these tests are paired with histopathologic assessment of tissue changes, health effects can be identified that would otherwise go undetected. Microbial species profile and biochemical analysis of stream sediments provide clues for assessing the impact of land-use practices and factors altering food resource availability. In situ monitoring devices for measuring valve gape, stable isotope analysis for assessing food-web processes, toxicological analysis for specific contaminants further expand the tool-box available for studying unionid populations. A review of these techniques and appropriate examples from on-going or completed studies will be provided.

NOTES:

PL 66

IS GLOCHIDIA VIABILITY ACCURATELY DETERMINED BY NACL EXPOSURE? Robert B. Bringolf*[1], Andrea K. Fritts[1], M. Christopher Barnhart[2], W. Gregory Cope[3] [1]University of Georgia, Athens, GA 30602-2152. [2]Missouri State University, Springfield, MO 65897. [3]North Carolina State University, Raleigh, NC 27695-7633

Glochidia viability is widely assessed to determine if glochidia are suitable to be used in host fish trials, as an endpoint for toxicity tests, and for a variety of other applications. Viability is most commonly determined by quantifying the valve closure in response to NaCl exposure. Glochidia that are able to close are deemed 'viable', those that do not close are 'nonviable' and the assumption is that viable glochidia are healthy and capable of attaching to a suitable host fish for metamorphosis into the juvenile stage. However, despite the importance of an accurate assessment of viability, to our knowledge the assumption has not been tested and little is known about the ecological relevance of the valve closure response to NaCl. To test this basic assumption, we have compared glochidia viability (determined by valve closure response to NaCl) to infectivity (ability to attach to host fish and metamorphose successfully into the juvenile stage). Glochidia were extracted from female mussels and maintained in aerated dechlorinated tap water at 20^{o}C. Subsamples of glochidia were removed at six time intervals (0, 6, 24, 48, 96, 144 hr) and tested for viability (exposure to NaCl) and infectivity (exposed to the primary host fish). Tanks with host fish were monitored for sloughed glochidia and metamorphosed juvenile mussels. We report quantitative comparisons of viability and infectivity for two mussel species and discuss plans for additional testing.

NOTES:

PL 61

REPRODUCTIVE SEASONALITY AND ANNUAL FECUNDITY IN *ARCIDENS CONFRAGOSUS* (UNIONIDAE: UNIONINAE: ANODONTINI) FROM TENNESSEE RIVER, ALABAMA. Thomas M. Haggerty, University of North Alabama, UNA Box 5182, Florence, AL 35632; Jeffrey T. Garner, Alabama Division of Wildlife and Freshwater Fisheries, 350 Co. Rd. 275, Florence, AL 34633; Amy E. Crews and Remina Kawamura, University of North Alabama.

Arcidens confragosus (Say, 1829) were collected monthly from the Tennessee River, Pickwick Reservoir, Alabama, USA, between 21 March 2000 and 26 February 2001. A total of 143 individuals were examined. Microscopic and gross examinations of gonadal and marsupial tissue were used to determine temporal patterns of gamete production, spawning, brooding, and glochidia discharge. In addition, 14 females were collected between October and January to obtain estimates of annual fecundity and three gravid females were used to study internal morphology of gill tissue. The male-to-female sex ratio was equal in the population and individuals reproduced once during their annual cycle. Gametogenesis began in May, peaked in July and August, and spawning occurred between August and September. Embryos were found in September and mature glochidia were brooded between September and February. Fecundity estimates ranged from 75,833 - 897,500 ($\bar{x}$ = 408,452). Secondary water tubes were found within the marsupial gills and were similar to those of other members of the Anodontini.

NOTES:

PL 67

EFFECTS OF COAL IN SUBSTRATE ON ORGAN TISSUES OF *VILLOSA IRIS*. William F. Henley, Histology Laboratory, Freshwater Mollusk Conservation Center, Department of Fisheries and Wildlife Sciences, Virginia Tech, Blacksburg.

To determine effects of pulverized coal in substrate on mortality of *Villosa iris*, a pilot study was conducted using 4-37 L closed recirculating tanks. Thirty *V. iris* were held in 100% sand, 90%/10% coal, 75%/25% coal, and 50%/50% coal. Water quality measures were not significantly different in the tanks, except for turbidities. At the end of the 7-wk experiment, no significant differences in mortalities were shown among mussels from the substrate mixtures. A subsequent experiment was conducted to determine the histological effects of coal in substrate on organ tissues of *V. iris*, including gills, digestive glands, kidneys, and gonads. During the 20-wk experiment, 20 mussels were held in 8 of the same tanks. Four tanks contained a 50%/50% coal substrate mixture, and 4 contained 100% sand. Organ tissues of 5 mussels from each tank were collected at 8, 16, and 20 wk. Quantitative dependent variables included fractions of reproductive acini containing developing and/or mature gametes, acini containing resorbing gametes, kidney diverticula containing lipofuscin, gill filament termini without cilia, and digestive gland diverticula with vacuolated cells. No differences in mortalities were shown, but fractions of gill filament termini without cilia and vacuolated digestive gland cells were significantly higher in mussels held in coal. Females from coal showed significantly higher fractions of acini containing resorbing oocytes than females held in sand, but no differences were observed among males. Although there were no meaningful differences in water quality measures, higher fractions of lipofuscin in kidney diverticula of coal mussels suggested that unidentified contaminants were present in the water of the coal substrate replicates.

NOTES:

PL 62

INVESTIGATIONS INTO THE MATING SYSTEM OF A FRESHWATER MUSSEL, *VILLOSA LIENOSA.* Jim Stoeckel[1], Andrew Gascho Landis[1], Tyler Mosley[1], Nicole Rankin[2], and Greg Moyer[2]
[1]203 Swingle Hall, Department of Fisheries and Allied Aquacultures, Auburn University, Auburn AL 36849. [2] U.S. Fish and Wildlife Service, Warm Springs Fish Technology Center, 5308 Spring Street, Warm Springs, GA 31830.

The relationship between fertilization and distance between male and female mussels is poorly understood. While some studies suggest that fertilization success is poor at low mussel densities, others suggest that females can be fertilized by males located far upstream. We integrated a variety of methodologies to investigate the mating system of a natural population of *Villosa lienosa* in a small Alabama stream. We hypothesized that if fertilization efficiency decreased rapidly with increased distance, male and female mussels would aggregate during the spawning season. Furthermore if males can only fertilize downstream females, males may migrate upstream whereas females may migrate downstream prior to the spawning season. Glochidia in downstream females should also exhibit a greater degree of multiple paternity than in the upstream portion of a mussel bed. To test these hypotheses, we tagged and mapped the location of mussels along a 60 m reach of the creek every two weeks from May to November in 2010. Results from mark-recapture studies indicated that we had tagged a majority of individuals within the reach. Gamete extracts from neighboring populations showed that spawning occurred from mid-August to early September. At the end of the study period we obtained genetic samples from 135 individuals, including glochidia from 43 gravid females. We are currently analyzing our mapping and genetic data to examine mussel movement in relation to spawning, patterns of multiple paternity in relation to position within mussel beds, and relationship between fertilization success and male – female distances.

NOTES:

PL 68

NUTRIENTS AND MUSSELS: FACTORS INFLUENCING MUSSEL DISTRIBUTION IN ILLINOIS. Diane Shasteen, Alison Price, Sarah Bales (Professional), Illinois Natural History Survey, 1816 S Oak, Champaign, IL 61820

Recognized as one of the most imperiled groups of organisms in North America, populations of freshwater mussels have steadily declined since the mid-1800s. These populations are declining for many reasons including habitat degradation, introduction of invasive species, declining water quality, and changes in water quantity and flow. The loss of this group from lotic systems could seriously affect ecosystem function, as they provide food resources and structure for other organisms, influence nutrient cycling, and may be indicators of water quality or integrity. In 2009, we began collecting baseline mussel data from 33 stream basins in the state of Illinois in conjunction with the IDNR/IEPA Intensive Basin Surveys. A wide range of parameters are collected during these surveys, including nutrient parameters for nitrogen, phosphorus, and ammonia. We used mussel community data collected at wadeable stream sites in 2009 and available nutrient data to determine the relationship between nutrient levels and mussel presence and absence in Illinois streams. Our analysis of stream data will determine if any of the aforementioned indicators are useful for predicting mussel presence or absence. Our results will elucidate the direction for further analyses regarding unionid distribution in Illinois.

NOTES:

PL 63

SPERM BALLS AND HOW TO EXPLODE THEM. G.T. Watters

Museum of Biological Diversity, Department of Ecology, Evolution, and Organismal Biology, The Ohio State University, Columbus, OH 43212 USA. B. Wolfe Department of Wildlife and Conservation Medicine, The Wilds, Cumberland, OH 43732 USA

Most, if not all, freshwater mussels release sperm in *Volvox*-like structures called spermatozeugmata. These consist of a double-walled structure into which the sperm are imbedded, head first into the outer layer. This outer layer forms a pocket around the sperm head. For sperm to fertilize the female's eggs they must first dissociate from this structure. How this happens is not clear. It is known that salt added to spermatozeugmata will cause them to dissociate. We present here evidence that the fluid in the intra-branchial portion of the female's ctenidia contains a substance that causes dissociation on contact, liberating the individual sperm for fertilization. We tested a variety of agents and conditions on spermatozeugmata to attempt to identify this substance. NaCl at low concentration (<1%) causes dissociation; higher concentrations cause dissociation followed by sperm death. CaCl2 also causes dissociation, but not as rapidly. Heparin appears to cause excitement without dissociation -- the spermballs 'vibrate'. If you add NaCl, the vibration stops. Glycerin does not cause dissociation, but causes the balls to stick to the slide. Simethicone has no effect.

NOTES:

PL 69

POTENTIAL HEALTH HAZARDS ASSOCIATED WITH BEING AN AQUATIC BIOLOGIST. J. F. Levine,

Aquatic Epidemiology and Conservation Laboratory, College of Veterinary Medicine, North Carolina State University, 4700 Hillsborough Street, Raleigh, NC 27606.

We walk through the woods, climb down stream banks, and wade, snorkel and scuba in streams. Each of these activities poses a hazard. The physical hazards are readily apparent but the infectious agents and toxins we may encounter are not routinely on the mind of biologists as they step into that stream, river, lake or pond. The more time you spend in the field the more likely you are to encounter a venomous snake, or develop a wound infection after receiving an abrasion or cut. We have all pulled ticks off after we have walked back and forth from stream sites. Which ones pose a risk of Rocky Mountain spotted fever, Lyme disease, ehrlichiosis, or babesiosis? Giardiasis, amoebiasis, cryptosporidiosis, and cutaneous schistosomiasis are all water-associated illnesses. How do I know if i'm infected? What are the clinical signs? When should you seek medical attention? There are things you can do to reduce the risk of injury, or infection. Various infections, and hazards associated with being an aquatic biologist will be described and preventive measures that should be taken discussed.

NOTES:

PL 64

LONG TERM MONITORING OF HEMOLYMPH PARAMETERS IN FRESHWATER MUSSELS IN CAPTIVITY. Barbara A. Wolfe, DVM, PhD, [1] Hope Valentine, DVM, [1] Mary Jo Burkhard, DVM, PhD,[2,3] Sarah Leavell,[2] Kody Kuehnl, PhD,[4] Priya Bapodra, DVM,[1] and G. Thomas Watters, PhD[4] [1]Department of Wildlife and Conservation Medicine, The Wilds, Cumberland, OH, USA; [2]Department of Veterinary Biosciences, College of Veterinary Medicine, The Ohio State University, Columbus, OH, USA; [3] Center for Microbial Interface Biology, The Ohio State University, Columbus, OH, USA; [4] Department of Ecology, Evolution, and Organismal Biology, The Ohio State University, Columbus, OH, USA

Relocation and captive propagation are widely supported as conservation measures for unionids in compromised habitats. However, these efforts are compromised by limited health diagnostic methods in these species. The objectives of this study were to: 1) optimize methods for handling and transport of freshwater mussel hemolymph; 2) identify reference ranges and changes in hemolymph chemistry and hemocyte parameters at baseline and over time in captivity; and 3) characterize changes in immune function of hemocytes over time in captivity. Hemolymph samples were collected from 40 animals of three species: *Amblema plicata, Quadrula quadrula,* and *Quadrula pustulosa* from the Muskingum River in Devola, Ohio. Thirty animals were translocated into captivity and sampled routinely for one year. Significant differences in hemolymph chemistries were found between genera at baseline and within genera over time ($p<0.05$). Cell differentials were found to be genus-specific at baseline and for the first month in captivity ($p< 0.05$). Eosinophilic granulocytes predominated in both genera, ranging from 44-73% of cells, followed by large agranulocytes (19-41%), basophilic granulocytes (1-27%) and small agranulocytes (<1 to 3%). All parameters varied over time throughout the year. This study provides a foundation for reference ranges and a preliminary understanding of changes in health parameters of freshwater mussels in captivity over time.

NOTES:

PL 70

OPEN

PL 71

NORTH AMERICAN FRESHWATER LIMPETS. John B. Burch
Museum of Zoology, University of Michigan, Ann Arbor, MI 48109, U.S.A.

Limpets are common and widely distributed snails that have an uncoiled, cap-shaped shell. Such a shell---peculiar for freshwater gastropods, the great majority of which have coiled shells---is the culmination of a line of evolutionary changes that have reduced the coiled shell spire to an uncoiled obtuse cone. In the 18th and early 19th centuries, such freshwater snails were mostly given the generic name *Ancylus*, but after it was noticed that the various species could---on the basis of their shell characters, especially the shell apices---be placed into several different groups, additional genus names were proposed for the several species-groups. The genus *Ancylus* as now understood is restricted to Eurasia (although in North America, in *Rhodacmea*, *Ancylus* has a close relative). In North America, four freshwater snail families have species with limpet shells, the Acroloxidae, Ancylidae, Lymnaeidae, and Planorbidae. The majority of the lymnaeid species have coiled shells, with only relatively few species being limpets, whereas all of the known species of the Acroloxidae and Ancylidae have limpet shells. In the North American Planorbidae, only one species has a limpet-like shell, although the shell does have a tiny apical coil. Species of the Acroloxidae and Lymnaeidae have dextrally organized (right-coiled) bodies, while the bodies of the Ancylidae and Planorbidae are sinistral (left coiled). In these four basommatophoran (hygrophilan) families, 52 species or subspecies of limpets have been named for North America north of Mexico. Recent molecular phylogenetic studies have clarified relationships within the Ancylidae, and have relegated some of the nominal species to synonymy (and taken several species out of alleged synonymy). Similar studies are needed in the three other freshwater basommatophoran families.

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PL 75

PROPAGATION AND CULTURE OF TWO FEDERALLY ENDANGERED FRESHWATER MUSSEL SPECIES IN NORTH CAROLINA. C. B. Eads, and J. F. Levine. Aquatic Epidemiology and Conservation Laboratory, College of Veterinary Medicine, North Carolina State University, 4700 Hillsborough Street, Raleigh, NC 27606.

We determined required hosts in the laboratory, propagated, and reared juveniles of two federally endangered freshwater mussel species: the Carolina Heelsplitter (*Lasmigona decorata*) and the Tar River Spinymussel (*Elliptio steinstansana*). Adult mussels of both species were held at two fish hatcheries in North Carolina where they successfully spawned and became gravid. Gravid females were transported to the laboratory where glochidia were exposed to a variety of fish species that co-occur with each mussel species. Gravid *L. decorata* were found to release their glochidia in loosely formed conglutinates, so we exposed them to serotonin to induce release of the brood. Individual *E. steinstansana* released multiple broods each year from April-July. Glochidia of both mussels transformed on multiple minnow (Cyprinidae) species. Initial growout was done in the laboratory before they were moved to the hatchery setting. Propagated *L. decorata* are now 4 years old and have reached maturity and spawned at the hatchery in consecutive years. The initial cohort of *E. steinstansana* have now reached over 30 mm in length at 2+ years old.

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PL 72

RESURRECTION OF *UTTERBACKIANA* FRIERSON, 1927 FOR A CLADE OF EASTERN NORTH AMERICAN FRESHWATER MUSSEL SPECIES (MOLLUSCA: BIVALVIA: UNIONIDAE: UNIONINAE: ANODONTINI). Arthur E. Bogan[1], Jeffrey T. Garner[2], James D. Williams[3], Nathan Johnson[4,5], Bryan S. McLean[6], Karen Mock[7], Morgan E. Raley[1] [1]North Carolina State Museum of Natural Sciences, MSC 1626, Raleigh, North Carolina 27699, USA. E-mail: arthur.bogan@ncdenr.gov; morgan.raley@ncdenr.gov [2]Alabama Division of Wildlife and Freshwater Fisheries, 350 County Road 275, Florence, Alabama 35633, USA. E-mail: bleufer@aol.com [3]Florida Museum of Natural History, University of Florida, Museum Road and Newell Drive, Gainesville, Florida 32611, USA. E-mail: fishwilliams@gmail.com [4]School of Forest Resources and Conservation, Program in Fisheries and Aquatic Sciences, University of Florida, Gainesville, FL 32611; [5]U.S. Geological Survey, Southeast Ecological Science Center, Gainesville, FL 32653, USA. E-mail: najohnson@usgs.gov [6]Department of Biology and Marine Biology, University of North Carolina at Wilmington, 601 College Road, Wilmington, NC. 28403 E-mail: bsm9056@uncw.edu [7]Department of Wildland Resources, Utah State University, Logan, Utah 84322 E-mail: karen.mock@usu.edu

Generic level classification of eastern United States *Anodonta* has long been unstable and a source of controversy. Several taxa, once placed in the genus *Anodonta* s.l. because they lacked any evidence of hinge teeth, have been split into monophyletic clades, including *Pyganodon* and *Utterbackia*. The type species of *Anodonta* is restricted to western Europe and the range of *Anodonta* s.s. appears to be confined to Europe. Two mitochondrial genes [COI and ND1] were sequenced and analyzed to test the relationships of eastern United States species currently placed in *Anodonta*. Our findings agree with previous studies, which indicate five species, *A. suborbiculata, A. couperiana, A. hartfieldorum, A. heardi, A. implicata*, belong to a monophyletic clade and do not belong in *Anodonta* s.s., *Pyganodon* or *Utterbackia.* These species formerly placed in *Anodonta* s.l. are now recognized as belonging to the genus *Utterbackiana* Frierson, 1927 based on analyses.

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PL 76

ADAPTIVE MUSSEL CULTIVATION: GROWING BIGGER AND BETTER MUSSELS AT VIRGINIA'S AQUATIC WILDLIFE CONSERVATION CENTER. Amanda E. Duncan[1], Joseph J. Ferraro[1], Jonathan E. Orr[1], and Michael J. Pinder[2]. Virginia Department of Game and Inland Fisheries, [1]1724 Buller Hatchery Rd., Marion, Virginia 24354; [2]2206 South Main Street, Blacksburg, Virginia, 24060.

The Virginia Department of Game and Inland Fisheries established the Aquatic Wildlife Conservation Center (AWCC) in 1998 to recover freshwater mussels in the upper Tennessee River System of Virginia. Twenty-five species have been propagated producing 4,089,173 juveniles since 2003. Prior to 2008, the main goal was to release propagated mussels one to two months after transformation. Because individuals released using these methods were rarely recovered at augmentation sites, we shifted our strategy in 2008 to culturing individuals to larger sizes before their release. While this change has resulted in producing fewer mussels, the ones produced are large enough to be tagged and recovered. The shift to growing mussels to larger sizes has resulted in developing or adapting new systems and techniques. Juvenile mussels are held in a variety of outdoor flow-through and indoor recirculating systems. Our indoor recirculating systems control diet, flow and temperature and use multiple containers that have grown 15 species to 16+ mm in one year. Food and water for our outdoor systems are provided by a 0.25 acre pond. Newly metamorphosed juveniles are raised in 0.92 m diameter insulated tanks using filtered pond water. We have grown nine species to 2-8 mm sizes using this system in one growing season. Other systems used to grow mussels to larger sizes include upwellers that are modified from marine oyster cultivation and the Barnhart Flupsy units. The ability and desire to change strategies and techniques is critical to the cultivation, and ultimately, the restoration of freshwater mussels.

NOTES:

PL 73

PROGRESS TOWARD A COMPREHENSIVE AND ANNOTATED ILLUSTRATED CATALOGUE OF PLEUROCERIDAE PRIMARY TYPES. Jeffrey T. Garner[1], Ellen E. Strong[2], Arthur E. Bogan[3], Thomas A. Tarpley[4], and Paul D. Johnson[4]. [1]Alabama Department of Conservation and Natural Resources (ADCNR), Mussel Management, 350 County Road 275, Florence, AL 36756; [2]National Museum of Natural History, Department of Invertebrate Zoology, PO Box 37012, MRC 163, Washington, DC 20013; [3]North Carolina State Museum of Natural Sciences, MCS 1626 Research Laboratory, Raleigh, NC 27699; [4]ADCNR, Alabama Aquatic Biodiversity Center, 2200 Highway 175, Marion, AL 36756.

The Pleuroceridae (Cerithioidea) is the second most speciose family of North American freshwater gastropods and the most imperiled. Recent conservation status reviews have estimated that 110 of 161 (68%) currently recognized North American species are extinct (34), endangered (33), threatened (38), or vulnerable (35). However high levels of intraspecific variation, coupled with a profusion of names (~1000) applied by 19th century taxonomists has led to widespread confusion about validity of taxonomic entities recognized and names applied to them; this confusion has broad conservation implications. Many pleurocerid's require conservation action but stabilizing nomenclature is essential to enhance communication and ensure the accuracy of further status assessment (survey), listing, or recovery efforts. The first major step toward achieving this goal is to complete a comprehensive survey of pleurocerid primary (i.e. name-bearing) type specimens, which are scattered in natural history museums across North America and Europe. The objective of this project is to locate and photograph pleurocerid primary types and verify their status as type material. To date over 750 lots of presumptive primary types from 13 natural history museums have been compiled and photographed. A standard format for individual photographic plates has been developed, and to-date over 300 composite plates completed. When verifiable type material cannot be located, stabilizing nomenclature will require designation of neotypes.

NOTES:

PL 77

RECENT PROJECTS AND PROGRESS OF THE MUSSEL PROPAGATION PROGRAM AT THE GENOA NATIONAL FISH HATCHERY. Nathan L. Eckert[1] and Jorge T. Buening[1]. [1]S5631 State Hwy 35, Genoa, WI 54632.

The Genoa National Fish Hatchery (GNFH) has long been known for its' work on the federally endangered Higgins eye pearlymussel recovery program. The majority of culture efforts were conducted in submerged wire cages designed to hold infested host fish and concentrate juvenile drop-off into a confined space. Free release of glochidia inoculated host fish was also utilized as a recovery tool. After completion of program requirements the Higgins eye culture program has begun to wind down and propagation efforts at Genoa NFH have shifted to new species. An increased effort has been placed on the endangered winged mapleleaf. A propagation program is being established for the candidate sheepnose, and the newly proposed snuffbox based on research done by regional partners. Upcoming research at GNFH centers on *Pseudomonas flavescens,* a bacterium which has shown promise in the ability to serve as a biological control for the exotic zebra mussel. Juvenile mussels of various ages will be provided for testing to determine susceptibility to the bacteria. If proven harmless to juvenile mussels, further tests will determine if the bacteria can be used to prevent fouling of mussel culture cages by zebra mussels.

NOTES:

PL 74

THE COLLECTION OF MOLLUSKS AT CINCINNATI MUSEUM CENTER, OHIO- A VALUABLE RESOURCE FOR SYSTEMATIC AND DISTRIBUTIONAL STUDIES OF FRESHWATER MOLLUSCA.

Francisco J. Borrero[1] & Cody Fleece[2] [1]Cincinnati Museum Center, Cincinnati OH 45203, borrerofcoj@gmail.com; [2]Stantec, 11687 Lebanon Road, Cincinnati OH 45241, cody.fleece@stantec.com

Cincinnati Museum Center's Museum of Natural History is arguably the oldest museum of its type in the Midwestern USA. Molluscan holdings comprise primarily dry shells of marine, terrestrial and freshwater Mollusca of the United States, but also from a worldwide distribution. Especially well represented are temperate and tropical malacofaunas. The size of the collection is not known, but it has been estimated to include 100,000 lots. North American freshwater mussels are particularly well represented, mainly from Midwestern and Southeastern faunas, but also including less numerous freshwater bivalves from Africa, Asia, South America and Australia. Similarly, Midwestern and Southeastern USA operculate gastropods, particularly Pleuroceridae, are well represented, but the collection also contains many lots of prosobranch and pulmonate snail families of worldwide distribution. Several important collections have been acquired at various times, greatly enhancing the overall value of the collection. Among the largest, one-time acquisitions were the collections of the University of Cincinnati in 1989 (itself consisting of several collections, including those of E.D. Cope, A.G. Wetherby and some material from T. Say), and that of Mr. K. Vickery in 2006. New material is currently acquired mainly from ongoing field studies (shells, tissues and whole bodies). The collection is maintained in a modern, climate-controlled facility, and is organized by families (genera and species for Unionidae). Most of the collection remains to be catalogued with a unified system, and is not data-based or geo-referenced; these are the main ongoing efforts. In this presentation, we review the value of the collection and the sub-collections contained and highlight significant holdings, challenges and opportunities.

NOTES:

PL 78

PROPAGATION OF FRESHWATER MUSSELS IN THE LOW MOUNTAIN RANGE OF THE ARDENNES IN LUXEMBOURG.

Thielen F, Eybe T, Muller T, Molitor M, Arendt A Natur & Emwelt, Project Life Nature Freshwater Pearl Mussel, Kierchestrooss 2, 9753 Heinerscheid, Luxembourg

The river Our, located between Belgium, Germany and Luxembourg still harbours small populations of *Margaritifera margaritifera* and *Unio crassus*. Both species are still reproducing but the population of *M. margaritifera* is only potentially functional and will, without assistance disappear in the near future in this area. Therefore within a LIFE NATURE Project founded by the European Commission and the Luxembourgish Government; the old mill of Kalborn in northern Luxembourg was transformed into a rearing facility.

The aim of this rearing facility is to enhance the declining freshwater mussel populations in the area. Firstly the host fish for *M. margaritifera* are artificially infected with glochidia and released during the following spring. Secondly one subset of the infected fish is used to collect juvenile mussels at the rearing facility. These mussels are subsequently reared under semi natural and more intensive laboratory conditions.

Since 2007, 15,500 *Salmo trutta fario* have been infected with *M.m.* and were released into the river Our (prevalence 97% mean intensity 770 +/- 400). The culture of juvenile *M.m.* under semi natural conditions is possible but the surviving rate is so far low. The culturing of juvenile *M.m.* mussels under more intensive laboratory conditions is possible and very promising. Results achieved and problems encountered so far are presented. Initial attempts to infect suitable host fish with *Unio crassus* and to collect juvenile *U.c.* were conducted during 2010 and are presented.

The results from the utilisation of different systems and methodologies have so far shown to be very promising but water quality issues and feeding concentrations and rates still need further improvement.

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PL 79

USING LIFE HISTORY TO PREDICT THE SENSITIVITY OF FRESHWATER UNIONID MUSSEL POPULATIONS TO HUMAN INDUCED PERTURBATIONS. Jennifer A. M. Young, Marten.A. Koops and Todd.J. Morris. Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, 867 Lakeshore Rd. Burlington, On, Canada, L7R 4A6.

Roughly two thirds of freshwater mussels native to North America are considered imperilled. There is a strong need for modelling of these species to inform management and recovery of at-risk populations, but species-specific information to populate such models is scarce. Here we present an exploratory elasticity analysis of freshwater unionid mussels to assess the relative impacts of human induced perturbation of vital rates on population growth. Three distinct elasticity groups were identified: (i) species strongly sensitive to changes in juvenile survival; (ii) species most sensitive to changes in adult survival; and (iii) species more sensitive to changes in rates related to reproduction (fecundity, age at maturity, and glochidial survival). Membership in these groups can be predicted from an incomplete or generalized life history and predictions are most accurate when at least fecundity and age at maturity are known.

NOTES:

PL 83

SIDE SCAN SONAR SURVEY TO ASSIST IN DEFINING AREAS OF UNSUITABLE MUSSEL HABITAT IN LARGE RIVER SYSTEMS, Craig Fortenbery, Pat Hahs, Mainstream Commercial Divers, Inc., Murray, KY 42071;

Is high definition side scan sonar capable of identifying unsuitable mussel habitat in large river systems? In 2010 and continuing into early 2011, we are utilizing a Klein® 3900 high definition side scan sonar system to attempt to identify substrate types over three-mile long sections of the Cumberland and lower Ohio Rivers in an attempt to identify areas of unsuitable mussel habitat. Within the large river systems of our area, private and governmental projects may impact long reaches of the river and the purpose of the project is to see if it is feasible to use side scan sonar to identify areas of unsuitable habitat, allowing us to concentrate our survey efforts in other, more suitable areas. In order to do this, we are using the side scan data results to divide the sampled river reaches into areas with similar types of bottom returns. Divers are then utilized to "ground truth" each representative type of bottom return. The ground truthing consists of collecting a bottom sample to allow us to calibrate the type of sonar return to a type of substrate. Our hope within the Cumberland River is to be able to easily identify bedrock substrates, and within the Ohio River to identify areas of unstable shifting sand, thereby eliminating the need to survey areas of extremely poor mussel habitat when performing diver surveys over very large areas.

NOTES:

PL 80

RESPONSE OF NATIVE MUSSELS TO WATER LEVEL MANIPULATION IN THE UPPER MISSISSIPPI RIVER. T. Newton[1], S. Zigler[1], R. Kennedy[1], A. Hunt[2], M. Davis[3] and P. Ries[1]. [1]USGS Upper Midwest Environmental Sciences Center, La Crosse, WI. [2]USFWS Upper Mississippi National Wildlife Refuge, Winona, MN. [3]MN Department of Natural Resources, Lake City, MN.

Managers in the Upper Mississippi River (UMR) are using reductions in the river's water levels during summer to mimic historical water regimes and rehabilitate habitats for vegetation and other species. Concerns for the unintended effects of these actions on mussel populations threatened to halt these projects. Our objective was to characterize the movement and survival of 2 mussel species in the UMR associated with a water level drawdown. During 2009 (non-drawdown year) and 2010 (1.0' summer drawdown) we glued PIT (passive integrated transponder) tags and buoyant fluorescent line to 10 *Amblema plicata* and 10 *Lampsilis cardium* at each of 11 sites. Five sites were in shallow areas minimally affected by the drawdown, and 6 sites were in shallow areas directly affected by the drawdown. Mussels were located about weekly from June to November 2009, and June to September 2010. Mussel locations were mapped by trilateration from surveyed stakes at each site. Recovery of tagged mussels was >88% in 2009 and 2010. Individual mussels were relocated ~14 times each. Mortality of tagged mussels averaged ~5% in 2009 and ~22% in 2010. During the drawdown, *A. plicata* appeared to move vertically and burrow into the substrates, whereas *L. cardium* appeared to move horizontally and follow the receding water. Analysis of movement trajectories of mussels is ongoing. Results from this study are being used by resource managers to better evaluate the effects of this management tool on native mussel populations.

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PL 84

LONG-TERM QUANTITATIVE MONITORING OF THE MUSSEL COMMUNITY IN THE TENNESSEE RIVER IN ASSOCIATION WITH CONSTRUCTION AND OPERATION OF A NAVIGATION LOCK ADDITION AT KENTUCKY LOCK AND DAM. Richard Tippit. Water Management Section, USACE Nashville District, Nashville, TN 37202.

The US Army Corps of Engineers is constructing an additional navigation lock at Kentucky Lock and Dam on the Tennessee River (TRM 22.4). The new lock's purpose is to eliminate a navigation traffic bottleneck caused by limited capacity of the existing lock. The new lock was to be completed by 2009; however completion has slipped to 2016. Valuable aquatic resources exist in proximity to the construction area. A significant remnant of the rich mussel community that once inhabited the entire Tennessee River continues to thrive downstream from Kentucky Lock and Dam. Recent studies have revealed a mussel fauna of at least 37 species in the subject river reach. Concern about possible changes that could result from construction and operation of the new lock have lead to a long-term mussel monitoring program. Four sites from .8 to 4.5 miles downstream from the dam were selected based upon presence of mussels in large areas of suitable substrate. A diver conducted, quantitative sampling regime has been performed biennially since 2003. The main goal of the monitoring is to define natural variability of the extant mussel community in each site and assess habitat variability. Our monitoring has collected more than 30 species of Unionid mussels. The fauna is dominated by *Fusconaia ebena.* It and four other species, *Amblema plicata, Obliquaria reflexa*, *Quadrula pustulosa*, and *Truncilla donaciformis*, comprise about 90% of each site's community. Age frequency analyses demonstrate the dynamic nature of mussel recruitment and mortality while long-term monitoring provides a view over time rather than a snapshot of current conditions.

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PL 81

LIFE HISTORY TRAITS PREDICT LOCAL COLONIZATION AND EXTINCTION OF FRESHWATER MUSSELS. Caryn C. Vaughn, Oklahoma Biological Survey, Ecology and Evolutionary Biology Graduate Program and Department of Zoology, University of Oklahoma, Norman, OK 73019.

Mussels have life history attributes that control their dispersal abilities, which ultimately influence their distribution and abundance. Mussels vary in the type and number of fish hosts used, the mechanism employed in infecting the host(s), and the timing of glochidial development and release. This variation has consequences for mussel reproductive output and dispersal abilities, which determine their population dynamics. In rivers, mussels often occur as patches of individuals (local populations) separated by areas in which they don't occur and over which their larvae must disperse to maintain the overall population (metapopulation). I examined the relationship between mussel traits and local (patch) colonization and extinction rates for 16 mussel species from the Red River drainage of Oklahoma and Texas from 14 sites across an 80 year time period. I assigned mussels to groups based on size, tribe, and life history traits (primary groups of fish hosts, host generalists vs. specialists, primary host infection mode, and brooding length). I then used AIC model comparison to examine how mussel traits best explained local colonization and extinction rates. Host specialists had the highest local colonization rates, but specialists also had higher local extinction rates than generalists. Long-term brooders had higher local extinction rates than short-term brooders, and short-term brooders are currently much more abundant throughout the region. Overall, local extinction rates exceed local colonization rates, indicating that mussels are declining in the region.

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PL 85

HYDROGRAPHIC SURVEY TO DETERMINE RELATIONSHIPS OF BOTTOM ELEVATION CHANGES AND MUSSEL DENSITY IN THE KENTUCKY DAM TAILWATER, Jim Sickel[1], Pat Hahs[2], Chad Lewis[3], Craig Fortenbery[2], and Richard Tippit[4]. [1]24 Richmond Dr., Savannah, GA 31406; [2]Mainstream Commercial Divers, Inc., Murray, KY 42071; [3]Lewis Environmental Consulting, LLC, 3967 Browns Grove Rd, Murray, KY 42071; [4]U.S. Army Engineer District, Nashville, P.O. Box 1070, Nashville, TN 37202.

Why are mussels found at certain locations in a large river system, and not at other locations in the same river? What effect does changing flow patterns have on mussel distribution? How do barge and other river traffic affect mussel distribution? We believe that monitoring a river bottom using hydrographic survey can help answer these questions. In 2004, '05, '08 and '09, hydrographic surveys were conducted in conjunction with mussel sampling at 4 sites in the Kentucky Dam tailwater, Tennessee River, as part of the Kentucky Lock Addition Project. The generated maps were compared to determine bottom elevation change, accretion or erosion, over the entire sample area. Mussel density at each 0.25 m^2 quadrat sample location was compared to elevation change from one survey to the next. In the first three surveys, mapping was done with single beam, survey quality equipment and differential GPS with approximately 1 m horizontal position accuracy. For the 2009 survey, RTK-GPS was incorporated to significantly improve accuracy. The inherent problems of single beam equipment are obvious, therefore we are encouraging the use of multi-beam, scanning equipment to provide complete bottom coverage in future surveys. Since the bottom substrata at our sites are relatively stable, and provide good mussel habitat, we observed only slight elevation changes and no correlation with mussel density. However, these studies provide valuable background information in case future changes do alter mussel density and distribution.

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PL 82

FRESHWATER MUSSELS OF FLORIDA PROJECT. James D. Williams[1], Gary L. Warren[1], and Robert S. Butler[2] [1]Florida Fish and Wildlife Conservation Commission, Gainesville, FL 32653
[2]U.S. Fish and Wildlife Service, Asheville, NC 28801

The project objective is to produce a book on the freshwater mussels of Florida. Of the 300 species of mussels in the U.S., about 60 (in 20 genera) occur in Florida. The mussel fauna is highly endemic, with 39 species confined to the Florida and rivers flowing into the state from Alabama and Georgia. Presence of seven additional species is considered hypothetical as they occur only in river drainages in Alabama and Georgia that flow into Florida. Most of the mussel diversity is found in the river drainages from the Escambia River east to the Suwannee River. Peninsular Florida supports limited diversity, 12 native species and one introduced, but has large populations in most rivers and lakes. Shell morphology, soft anatomy and genetic analysis are being used to delineate distribution, identify cryptic diversity and evaluate taxonomic status of poorly known mussels. Ongoing field efforts include sampling all major river drainages of Florida. Review of museum collections will provide the historical baseline for evaluating the current distribution and conservation status of the fauna. The final product will include shell description and photographs, dot distribution maps, life history and host fishes information, habitat, ecology and conservation status.

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PL 86

PROTECTION AND RESTORATION EFFORTS IN THE PAINT ROCK RIVER. Paul Freeman[1], Traci George[2], Paul Johnson[3], Michael Buntin[3], Todd Fobian[3] [1]The Nature Conservancy, 2100 First Ave North, Suite 500, Birmingham, AL 35203. [2]Alabama Department of Conservation and Natural Resources, 64 N. Union Street Montgomery, AL 36130.
[3]Alabama Department of Conservation and Natural Resources, Alabama Aquatic Biodiversity Center, 2200 Highway 175, Marion, AL 36756.

The Paint Rock River of the Tennessee River drains approximately 460 square miles of Northeast Alabama and Southeast Tennessee and is home to dozens of rare plant and animal species. The historic assemblage of 98 fish and 58 mussel species includes numerous rare and imperiled species. Recent survey efforts have detected 47 species of mussels. Up to six extirpated mussel species are candidates for reintroduction.
Efforts to conserve the unique ecological settings over the past decade have been a team effort of agencies and organizations who have worked to build partnerships and trust with local landowners. Partners contributing expertise and implementing programs and projects include: US Fish and Wildlife Service (USFWS), USDA-Natural Resource Conservation Service (NRCS); US Environmental Protection Agency, (EPA); US Army Corps of Engineers (USACOE); Tennessee Valley Authority (TVA); Alabama Department of Conservation and Natural Resources (ADCNR); Geological Survey of Alabama, (GSA); The Nature Conservancy (TNC); several universities and private consultants. To date, partners have permanently protected over 21,000 acres of public and private lands and initiated over 22 stream and bottomland restoration projects to protect crucial habitat and water quality. Recent biological monitoring indicates some short-term improvements in populations of some of the nine Endangered, Threatened or Candidate fish and mollusks. Continued conservation efforts, will hopefully lead to further protection and restoration of the globally significant Paint Rock River watershed.

NOTES:

PL 87

***ELLIPTIO LANCEOLATA* – WHAT THE HECK IS IT AND WHERE DOES IT OCCUR IN VIRGINIA?** B.T. Watson[1], A.E. Bogan[2], and M.E. Raley[2]. [1]VA Department of Game & Inland Fisheries, 1132 Thomas Jefferson Road, Forest, VA 24551; [2]NC State Museum of Natural Sciences, MSC 1026, Raleigh NC 27699-1026.

The taxonomy and identification of the Atlantic Slope *Elliptio* species is one of the most confusing and difficult of the mussel fauna in North America. Long recognized as a diverse species complex, in 1970 Johnson synonymized 169 species to 13, which included three major groups. *Elliptio lanceolata* (yellow lance) was one such group, comprised of 25 lanceolate species leaving only three lanceolate species from the previously identified thirty-four. However, based on morphological and habitat differences, some malacologists believe the yellow lance is a valid species separate from other lanceolate *Elliptio* mussels within this group. Recent genetics studies have corroborated that the yellow lance is a valid species. In Virginia, the yellow lance is a species of concern yet it has been documented in most Atlantic Slope river basins, with numerous abundant and reproducing populations. This has lead to significant uncertainty as to the status of this species within Virginia – is it indeed widespread and common or has lumping with other lanceolate *Elliptio* species masked its decline and rarity? The ND1 and COI genes from 241 lanceolate *Elliptio* specimens within the six Virginia Atlantic Slope river basins were examined to better determine the distribution and status of the yellow lance. Results indicate that the yellow lance occurs within four of the river basins and it is not as widespread as previously reported, occurring from only a single stream in one river basin. Given many populations are in decline and some extirpated, the yellow lance warrants state listing and federal listing may be warranted as well.

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PL 91

HABITAT RELATIONSHIPS AND MOVEMENT OF ENDANGERED FAT THREERIDGE (*AMBLEMA NEISLERII*) IN THE APALACHICOLA AND LOWER CHIPOLA RIVERS, FL. M.M. Gangloff[1], K.J. Herrington[2], S.C. Pursifull[2], and B. Zettle[3] [1]Appalachian State University, Department of Biology, 527 Rivers Street, Boone, NC 28608. [2]U.S. Fish and Wildlife Service, 1601 Balboa Avenue, Panama City, FL 32405. [3]U.S. Army Corps of Engineers, Mobile District, P.O. Box 2288, Mobile, Alabama 36628-0001

The Apalachicola River contains the largest remaining population of federally-endangered fat threeridge mussels (*Amblema neislerii*). Previous surveys found that *A. neislerii* are largely aggregated along channel margins at water depths <2 m and rare in deeper, mid-channel habitats. Reduced flows resulting from reservoir operations may therefore strongly affect this population. Our goal was to determine how flows influence fat threeridge habitat use and movement in the Apalachicola and Chipola rivers. *Amblema neislerii* are abundant at moderately sloping sites on the up- and downstream ends of point bars. Beginning in 2007 we used GIS to map these habitats and verified *A. neislerii* occurrence at 182 sites. We randomly selected 40 sites for quantitative mussel sampling. We re-sampled several sites under both low (5000 cfs) and moderate (9000 cfs) flows in 2010 to quantify mussel movements. At all flow levels *A. neislerii* were highly clumped with the greatest densities occurring at depths < 1 m. Fat threeridge were generally able to follow declining flow levels. However, many became exposed along low-slope banks or in backwater habitats. Our results suggest that local-scale flow, substrate, and channel slope conditions may influence *A. neislerii* abundance more than micro-habitat parameters because mussels move along the bank slope to maintain optimal conditions during falling water levels. Understanding how channel geomorphic parameters influence mussel aggregations will be essential to future attempts to mitigate reservoir management impacts on *A. neislerii* populations in the Apalachicola River.

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PL 88

ROBUST SHELL PHENOTYPE IS A LOCAL RESPONSE TO STREAM SIZE IN THE GENUS *PLEUROCERA*. Robert T. Dillon, Jr., Department of Biology, College of Charleston, Charleston, SC.

Although local correlations between shell phenotype and stream size have often been documented in freshwater mollusks, the species and even genus-level taxonomy of pleurocerid snails has historically been based almost entirely on aspects of the shell. Here I test the hypothesis that lightly-shelled pleurocerid populations inhabiting smaller rivers in east Tennessee and north Georgia, variously assigned to genus *Goniobasis* or *Elimia*, may be local variants of heavily-shelled *Pleurocera* populations downstream. Populations of the nominal species *Goniobasis* ("*Elimia*") *acutocarinata*, *G. clavaeformis*, and *Pleurocera unciale* were sampled from the Powell, Little, and Hiwassee subdrainages of the Tennessee River, and populations nominally *Goniobasis carinifera* and *Pleurocera vestita* sampled from the Coahulla subdrainage of the Mobile Basin. A population of *Goniobasis simplex* was sampled from four subdrainages to calibrate expected levels of genetic divergence. Gene frequencies at 10 polymorphic allozyme-encoding loci (15 populations, 30 individuals per population) revealed that each population of *Pleurocera* was more closely related to its local populations of *Goniobasis* (or "*Elimia*") than to any other population of *Pleurocera*. All nine populations identified as *G. acutocarinata*, *G. clavaeformis*, and *P. unciale* appear to be conspecific, their minimum genetic identity of 0.771 much greater than the 0.356 minimum identity among the four *G. simplex* controls. The specific relationship between the nine Tennessee populations and populations of *G. carinifera* and *P. vestita* from the Mobile Basin is ambiguous, with identities ranging down to 0.284. This larger set of 11 populations is here referred to as the *carinifera* group. Evidence that intraspecific variation in shell morphology has risen to the level of genus suggests that *Goniobasis*, *Elimia*, and several other generic nomina be subsumed under *Pleurocera* (Rafinesque, 1818).

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PL 92

EXTIRPATION AND RECOLONIZATION OF FRESHWATER MUSSELS IN THE MINNESOTA AND MISSISSIPPI RIVERS. Nicole K. Ward, Bernard E. Sietman, J. Mike Davis. Minnesota Department of Natural Resources, 500 Lafayette Rd. St. Paul, Minnesota, 55155

Within the greater Minneapolis-St. Paul area, the Minnesota and Mississippi Rivers historically supported over 30 and 40 species of mussels, respectively. Industrial, sewage, and storm wastewater heavily polluted the Mississippi in the late 19th to mid-20th century, extirpating nearly all mussel species. Mississippi water quality improved incrementally from the 1940's to 1970's, however, extensive brailing surveys in 1978-79 found only 20 live individuals of nine species in this reach. Production agriculture, which covers 92% of the Minnesota River drainage, drastically increased intensity and impact on the watershed from 1945-1970. The same brailing surveys of 1978-79 found no live mussels in the Minnesota River. Establishment of the Clean Water Act and a successful citizen's campaign in the late 1970's resulted in dramatic water quality improvements in the Mississippi by the 1990's. To determine the current status of mussels in these areas, we surveyed 235 sites in the Minneapolis-St. Paul reaches of the Mississippi and Minnesota Rivers from 2000-2010 using SCUBA to conduct timed searches. We found 18,342 live individuals of 30 species in the Mississippi, but only 117 individuals of ten species in the Minnesota River. Mussels have successfully recolonized the Mississippi after at least a half century of extreme water pollution. However, the continued land use associated with agriculture in the Minnesota River drainage and the resulting low water quality and habitat instability has prevented mussels from recolonizing in significant numbers. Improvements to land use and water treatment in the Minnesota River drainage are needed if mussels are to recover as they have in the adjacent Mississippi River.

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PL 89

GENETIC STRUCTURE AT A SMALL GEOGRAPHIC SCALE: *ELLIPTIO COMPLANATA,* ALONG A PORTION OF THE ATLANTIC SLOPE DRAINAGE. Curt L. Elderkin Department of Biology, The College of New Jersey, Ewing, NJ 08638

The Atlantic slope fauna is unique, although mussel diversity (especially in northern areas) is relatively low. The rivers that form the drainage east of the Appalachian mountains are separated into distinct drainages that drain directly into the Atlantic ocean; which serves as a barrier to dispersal. Mussels in these areas are thought to spread from one drainage to the other by river capture during severe flooding. Also, fish (and mussels) may have spread back into these areas from one or more coastal refugium following the Pleistocene glacier. One common mussel taxa that is widespread throughout the drainage is the Eastern Elliptio mussel (*Elliptio complanata*). *E. complanata* is common and occurs in large numbers, and most likely has genetic diversity that is still relatively intact compared to co-distributed taxa that are endangered and/or threatened. Prior research using allozyme loci indicated a northern and southern *E. complanata* lineages with a proposed dispersal barrier at the Delmarva peninsula. Mitochondrial DNA from the COI gene was amplified, sequenced, and compared, among populations from the Delaware, and Susquehanna Rivers. Results thus far indicate that genetic structure was the greatest among drainages with little structure within rivers. A notable exception is the Susquehanna River which appears to have genetically divergent populations between southern and northern tributaries. Overall, there were two distinct mitochondrial lineages in *E. complanta*, and analysis supports the evidence for a dispersal barrier at Delmarva peninsula. However, preliminary analysis of 4 Microsatellite (MS) loci from using the same individuals does not support the previous results. Analysis and laboratory work are continuing and future data may include three additional MS loci and sequences from nuclear loci such as 18 and 28S.

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PL 93

IS STREAM RESTORATION (SPECIFICALLY FLOODPLAIN RECONNECTION) A VALID MITIGATION TOOL IN THE CAROLINA PIEDMONT? John M. Alderman, Alderman Environmental Services, Inc., 244 Red Gate Road, Pittsboro, NC 27312

River restoration/enhancement is a $1 billion per year industry in the United States, and its use as a project mitigation tool is increasing. There are many categories of river restoration ranging from land acquisition (least common and least funded category) to water quality management (e.g., riparian buffer management). This is a focus on the floodplain reconnection category, one of the most common (~10,000 projects within the United States), yet expensive, kinds of stream restoration currently practiced. From the 1700s through the early 1900s agriculture was a dominant land use in the North and South Carolina Piedmont. Aggradation of stream valleys and stream beds was a dominant geomorphic process. Since the early 1900s, degradation of these same stream valleys and stream beds has been a dominant process. Thousands of stream miles are being affected by a natural process of incision leading to the removal of millions of tons of agriculturally derived sediments. Basically, streams are cutting back to their original beds, and through time (thousands of years), valley fills will be removed, thus reconnecting the streams with their original floodplains. Current permitted and funded floodplain reconnection projects regularly focus on reconnecting incised streams with their floodplain seen at the peak of past agricultural activity. Essentially, these streams are being “restored” to a state of maximum disequilibrium, which is an illogical use of limited conservation dollars. The U.S. Army Corps of Engineers and state permitting agencies need to seriously reconsider their current use of mitigation ratios which direct “mitigation” toward certain types of restoration projects, such as floodplain reconnection, and away from others, such as land acquisition.

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PL 90
OPEN

PL 94
MAXIMUM ENTROPY HABITAT MODELING OF FOUR ENDANGERED MUSSELS IN THE OHIO RIVER BASIN, USA. Theodore C. Weber
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Freshwater mussels are the most imperiled taxa in North America. This study examined the utility of maximum entropy (Maxent) modeling and spatial application to identify potential habitat for four endangered mussels in the Ohio River basin in the USA: *Cyprogenia stegaria, Epioblasma torulosa rangiana, Plethobasus cyphyus*, and *Pleurobema clava*. We compared occurrence data for each of these four mussel species to flow, geomorphic, buffer, and impairment data by stream segment, as well as land cover, permeability, and impairments within their cumulative catchment. Maxent models predicted between 0.2 and 1.3% of the basins to contain suitable habitat. Further, most suitable stream segments identified by the model and also containing endangered mussels were >10 km. Within stream segments, microhabitat features like substrate and bank stability may be important factors. However, we hope that coarse-scale aquatic modeling like that described here can help prioritize surveys, and emphasize the importance of catchment-scale geomorphic and land use conditions to aquatic species like freshwater mussels.

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