

Abstracts of Presentations

Relocation

Monitoring Components of a Relocation Project on the St. Croix River

Diane L. Waller¹, W. Greg Cope¹, and Heidi L. Dunn²

¹National Biological Service, Upper Mississippi Science Center, La Crosse, Wisconsin

²Ecological Specialists, Inc., St. Peters, Missouri

We conducted a mussel relocation in the St. Croix River in conjunction with a bridge replacement by the Wisconsin Department of Transportation (WIDOT). A 2-year monitoring program was developed to address the concerns of state and federal cooperators, particularly the fate of special-status species and the cost effectiveness of proposed methods. The monitoring program included evaluation of (1) overall mussel survival, (2) growth and survival of special-status species, (3) handling methods, (4) placement methods, and (5) mussel condition and survival from different source sites. A suitable destination site was identified and sampled prior to relocation to characterize the mussel community and physical habitat. About 8,000 mussels were relocated to a general site by two methods, hand-placement by a diver or surface broadcasting by boat. Mussels in the two treatments were uniquely marked to compare mortality during future monitoring. Two 5 x 5-m areas, each composed of 25 1-m² cells, were designated within the destination site for placement of special status species. These species were uniquely marked, measured, aged, and placed into a cell. A third area, a 6 x 4-m grid divided into 24 1-m² cells, was designated for placement of mussels in handling and source site treatments. Resident unionids were removed from 18 of the cells and replaced with mussels in the experimental treatments. Six cells served as resident controls. Source site treatments included mussels from opposite sides of the river channel; handling treatments included processing mussels underwater or above water for 40 minutes. During processing, mussels were marked, identified, measured, and aged. They were then placed into the grid. Mortality was assessed 1 month after relocation by a cursory search of the general destination area and of all three monitoring grids. One year after relocation, more intense monitoring was conducted of the three grid areas and the general area. This study demonstrates several different methods for monitoring mussels after relocation.

An Evaluation of Relocation of Unionid Mussels Into an Artificial Pond

Teresa Naimo¹, Pamella Thiel², and Kurt Welke³

¹National Biological Service, Upper Mississippi Science Center, La Crosse, Wisconsin

²U.S. Fish and Wildlife Service, La Crosse Fishery Resources Office, Onalaska, Wisconsin

³Wisconsin Department of Natural Resources, Prairie du Chien

In many large rivers, unionid mussels are at risk from the exotic zebra mussel. Artificial ponds, such as those at National Fish Hatcheries (NFH), are being evaluated as temporary holding locations for mussels until the immediate threat of zebra mussels has passed or until artificial propagation has been successfully developed. Our objective was to compare data on growth and survival of mussels relocated to a pond with data on mussels processed similarly but returned to the upper Mississippi River (UMR). In May 1995, we obtained five species (*Amblema plicata*, *Fusconaia flava*, *Leptodea fragilis*, *Obliquaria reflexa*, and *Quadrula quadrula*) of mussels from the UMR. Each mussel was scrubbed "free" of zebra mussels and placed into a quarantine pond for 35 days. After 35 days, all mussels were reinspected for zebra mussels, individually tagged, and length, height, and wet weight were recorded. Mussels were randomly assigned to treatments (placement or orientation of mussels into the substrate) at either a 0.25-acre pond at the Genoa NFH or the UMR. There were four replicates of each of four treatments; each replicate contained a total of 24 mussels (3-8 mussels from each species). A total of 384 mussels was assigned to each location. We found no zebra mussels on any live mussels after the 35-day incubation. Mean survival during the 35-day quarantine was 83% and ranged from 55% in *L. fragilis* to 97% in *Q. quadrula*. There were no significant differences in mean length, height, or wet weight of mussels among treatments within a location. Both the pond- and river-relocated mussels will be monitored for growth and survival twice a year for a minimum of 2 years.

An Evaluation of Relocation Techniques for Freshwater Mussels of the Apalachicola River: River and Laboratory Trials

Hannah Hamilton, Jayne Brim-Box, and James D. Williams

National Biological Service, Gainesville, Florida

The Apalachicola River is one of Florida's most significant natural resources and home to a diverse population of freshwater mussels. This river is also the site of Jim Woodruff Lock and Dam, which requires regular maintenance dredging to maintain a navigation channel. For a year-long relocation study, four species of freshwater mussels were removed in July 1993 from a gravel bar scheduled for dredging. One of these species, *Elliptoideus sloatianus*, is federally proposed for endangered species status. Mussels were relocated to corrals in different habitats within the river and also held under various laboratory conditions. Substrate and its effect on survivorship of relocated mussels was examined. Survivorship of all four species in the river nearly 1 year after relocation was high; in some cases all of the relocated mussels survived. In the laboratory overall survival was approximately 50% after 1 year. Mortality tended to occur in the first and last months of the study. *Megaloniaias boykiniana* had the highest percent survival of the four species studied in the laboratory, and *E. sloatianus* the lowest. Mortality rates could be attributed to a number of factors: water quality, lack of or poor-quality food, laboratory habitat, or unknowns. Pond trials survival was greater than 75%. Starvation trial survival rates corresponded to mussel size, the larger the mussel the higher the rate of survival.

Long-term Evaluation of Large-scale Mussel Transplants

John J. Jenkinson

Tennessee Valley Authority, Chattanooga

In 1982, Tennessee Valley Authority biologists transplanted 1,000 specimens of the birdwing pearly mussel, *Lemiox rimosus* (= *Conradilla caelata*), from the central Duck River in Tennessee to each of four locations where the species no longer occurred. Marked animals were placed in a regular pattern within a well-identified 250-m² area at each receiving site. During the past 12 years, these transplants have been monitored often and in a variety of ways. Quantitative and qualitative techniques have been used several times to estimate population size and distribution in each stream, females have been routinely checked for gravidity, and various techniques have been used to search for juveniles. The recovery of two small, unmarked birdwing mussels indicates that at least one of these transplanted populations has reproduced successfully. Various types of data and observations will be presented to document what has occurred at these transplant sites with the intention of assisting others in achieving similar, or better, transplantation success.

The Kankakee River Story; Long-term Monitoring of Translocated Freshwater Mussels

H.E. Kitchel¹, J.M. Berlocher², and Mark J. Wetzel²

¹Wisconsin Department of Natural Resources, Madison

²Illinois Natural History Survey, Center for Biodiversity, Champaign

Concern for the decline of the freshwater mussel fauna has led the federal and state governments to recommend that significant mussel populations be protected. To this end, the U.S. Fish and Wildlife Service recommended that mussels be relocated from a bridge that was to be replaced over the Kankakee River at Kankakee, Illinois. Illinois Natural History Survey biologists translocated over 3,000 mussels, representing 29 species, in 1987. Survival, recruitment, and growth of these mussels has been monitored through 1994. Mussels were collected by hand, marked, and translocated to two sites upstream. One site has been monitored intensively. Mussels occurring naturally at the transplant sites were tagged and monitored as well. Percent recovery of marked mussels varied between sites, but consistently declined over the 7 years of the study. Retrieval of live mussels and shell material after the first year was estimated at 57%, the second year 24%, and 7 years later only 5.6% of the original marked mussels were recovered. These rates were based on recovery of individuals encountered in subsamples from both inside and outside the transplant boundaries. Loss of mussels may be a result of movement into or out of the plot boundaries, which may also account for the origin of an increasing number of unmarked mussels in the plots. Growth, as

measured by increased shell length, was evaluated individually over time, and averaged 3 to 5 mm for most of the transplanted species. Juveniles of most of the mussel species have not been collected to date, but gravid females have been observed for many of the species. Little data exist to compare long-term monitoring of transplanted populations with natural mussel beds. Many concerns remain as to whether transplanting mussels is a reasonable method to protect the continued existence of mussel populations.

Stream and State Status Surveys

A Survey of Mussels in the Upper Platte River and Associated Irrigation Canals and Lakes of Central Nebraska (Mollusca: Bivalvia)

Mark M. Peyton and Jeremiah L. Maher

Central Nebraska Public Power and Irrigation District, Gothenburg

Limited data exist on historic or present diversity, distribution, and abundance of freshwater mussels in the Platte River system of Nebraska. In association with FERC relicensing of Project No. 1417, we surveyed a 120-km stretch of the upper Platte River and associated irrigation canals and lakes for mussels. Over 8,000 specimens representing 10 species were identified. Eighteen specimens representing five species were identified from the Platte River, 589 specimens representing six species were identified from 10 lakes, and 8,206 specimens representing nine species were identified from seven irrigation canals. Three species—*Toxolasma parvus* Barnes, *Sphaerium* sp., and *Strophitus undulatus* Say—not previously collected in the Platte River system or whose existence within the system was questioned, were identified. The disproportionate number of specimens located in the irrigation canals and associated lakes indicates these canals and lakes provide more habitat for freshwater mussels than do the channels of the Platte River.

A Survey of the Unionid Mussels of the Illinois River: A Recovering Resource

Scott D. Whitney, K. Douglas Blodgett, and Richard E. Sparks

Illinois Natural History Survey, S.A. Forbes Biological Station, Havana

The last comprehensive mussel survey of the Illinois River, conducted during 1966-1969, revealed that 25 of the 49 species once found in the river had been extirpated; extensive stretches of the upper river, once densely populated with mussels, did not yield a single living specimen. In the past three decades, mussel populations have been subject to three major changes: (1) commercial harvest for the Japanese cultured pearl industry, (2) dramatic improvement in water quality, and (3) invasion of two nonindigenous bivalves, the Asiatic Clam (*Corbicula fluminea*) and the European zebra mussel (*Dreissena polymorpha*). In 1993, we began a comprehensive survey to assess the impacts of these changes and determine the current status of mussel populations in the Illinois River. Wading and brailing were used for preliminary site assessment and for comparison with previous studies. However, the majority of the collections were made by divers using quantitative and qualitative collection techniques. The information we have collected indicates that mussel populations are showing signs of recovery. The most dramatic improvements have been recorded in the upper river where we found numerous live mussels representing 12 unionid species, including juveniles. Throughout the entire river, we have collected a total of 24 species to date, including several species once listed as extirpated. Average densities ranged from less than 1/m² to 38/m², with population density and species abundance increasing in the downriver direction. Within specific mussel beds, species composition has improved from a population composed of a few species to one with several abundant species. Shell annuli and length frequency distributions of different species indicate that most populations are comprised of both adults and juveniles. Despite signs of improvement in unionid density and species diversity, the recent invasion and proliferation of the zebra mussel threatens to set back years of recovery for the Illinois mussel populations.

Current Distributions of Freshwater Mussels (*Bivalvia: Unionidae*) in Rivers of Southwestern Ontario

Todd J. Morris and Joanne Di Maio

University of Windsor, Department of Biological Sciences, Windsor, Ontario, Canada

With the drastic decline during the past century of the once-rich unionid populations in North America, concern has increased over the conservation status of freshwater mussels. Information on the current distribution and abundance of mussels is required before effective conservation measures can be implemented. Nine drainages in southwestern Ontario were sampled to assess the status of unionid species and comparisons were made with available historical data. Nineteen species represented by 1,120 individuals were encountered during 2 years of sampling. Rivers of the Lake Huron drainage possessed the richest unionid communities of the area with 16 species compared to 13 species in the Lake St. Clair-Detroit River drainage and only 4 species in the Lake Erie drainage. Six of the nine drainages were dominated by the locally common *Pyganodon grandis*; however, several rare and uncommon species were detected in the Lake Huron and Lake St. Clair drainages. Two species (*Ptychobranthus fasciolaris* and *Lampsilis fasciola*) not previously reported from the Lake Huron drainage were detected during the second sampling year. Rivers of the Lake Huron drainage appear to have maintained their unionid fauna over the past century while rivers of the Lake St. Clair-Detroit River drainage appear to have undergone serious declines.

An Investigation of Freshwater Mussels, Fish, and Fine Sediments in the ACF Basin, With a Special Emphasis on Imperiled Mussel Species

Jayne Brim-Box, James D. Williams, Robert Dorazio, and Christine O'Brien

National Biological Service, Gainesville, Florida

The Apalachicola, Chattahoochee, and Flint (ACF) rivers harbor approximately 40 species of freshwater mussels, including 6 species that have been recently proposed for federal endangered and threatened status. In general, mussel populations in the ACF basin are depressed, and many localities that historically had abundant and diverse mussel populations are currently depauperate. Although many possible reasons have been given for the decline of mussel populations in the basin, little quantitative work has been done to establish direct causes of these declines. This study examined two possible causes of the decline: the impact of fine sediments on mussel populations, and the correlation between fish and mussel abundance and diversity. Quantitative methods were used to collect fish, mussels, and sediment data from 30 sites in the coastal plain of the basin. A total of 2,688 mussels was collected from 2,832 quadrats, and over 2,500 sediment cores also were collected. Preliminary analysis showed there were few differences in mussel density or species richness among three arbitrary habitat types (bank, slope, and middle). Associations between the abundance of mussels and various characteristics of their habitat, including percentage of fine sediment, will be examined statistically. Fish-mussel associations likewise will be discussed.

The Status of Unionids in Michigan

Renee Sherman¹, Richard Trdan², and Paul Marangelo¹

¹*University of Michigan Museum of Zoology/Mollusk Division, Ann Arbor*

²*Saginaw Valley State University, Department of Biology, University Center, Michigan*

Forty-six species of unionids are found in Michigan. Of these, three are federally endangered, four are considered endangered by the state, and two are state threatened. The greatest diversity and concentration of threatened and endangered species is in southeastern lower Michigan, where human population pressures are increasing. The Michigan Department of Natural Resources has enforced protection when construction will affect watersheds with listed unionids. However, prevention of zebra mussel introductions is needed. Zebra mussels now occur in inland areas of seven river basins. This distribution includes the upper Clinton River in Oakland County, which contains an abundant population of the snuffbox mussel, *Epioblasma triquetra*, as well as three other state-listed species. Healthy unionid populations unlikely to be affected by high zebra mussel densities remain in areas such as the lower

Belle River in St. Clair County. However, lands surrounding these waters are privately owned, making enforcement of quality watershed practices more difficult. Although rivers with listed species have been studied, surveys throughout the rest of the state are needed to monitor common species and update distribution records. This information also will help assess impacts of illegal harvests, particularly on the Grand River.

Status of the Freshwater Unionoid Bivalve Fauna of Pennsylvania

Arthur E. Bogan¹ and Thomas Proch²

¹*Freshwater Molluscan Research, Sewell, New Jersey*

²*Department of Environmental Resources, Pittsburgh, Pennsylvania*

The historic freshwater unionoid bivalve fauna consisted of 64 species including *Margaritifera margaritifera*. Historically, the greatest diversity, 53 species, occurred in the upper Ohio River basin in western Pennsylvania. Twenty-two species have been extirpated but two of the extirpated species have recently reinvaded the upper Ohio River. Twenty-four species have been reported from Lake Erie and its tributaries before the introduction of the zebra mussel (*Dreissena polymorpha*). Thirteen species have been reported historically from the Susquehanna River basin in Pennsylvania (2 of the 13 species were reported from the basin in error). Fifteen species have been reported from the Delaware River basin, and seven species have been reported from the Potomac River basin in Pennsylvania. Nine federally endangered species historically occurred in the state but only two are known to be living in the state; *Pleurobema clava* and *Epioblasma torulosa rangiana*. Thirty species are considered endangered, including the federally listed species, and eight species threatened at the state level. The decline of the freshwater bivalve fauna has been tied to impoundments, pollution, acid mine drainage, and the zebra mussel.

Life History and Genetics

Chemosensory Abilities of Female Freshwater Mussels and Glochidia (Unionidae)

William F. Henley and Richard J. Neves

*Virginia Polytechnic Institute and State University, Virginia Cooperative Fish and Wildlife Research Unit,
Department of Fisheries and Wildlife Sciences, Blacksburg*

Behavioral responses in gravid *Lampsilis fasciola* and *Villosa iris* indicate their ability to distinguish host fish (*Micropterus dolomieu*) and nonhost fish (*Cyprinus carpio*) and their mucus. Behavioral observations of adult mussels included degree of mantle presentation, pulse rate, glochidial ejection, shell spread, and inhalant aperture length. Measurements associated with these observations were used to create a composite behavioral index. Whereas *L. fasciola* was more active with exposure to host fish and mucus, behavioral responses decreased with exposure to nonhost fishes and mucus. Also, activity levels were higher with exposure to host fish than to their mucus. Similar behavioral responses were noted with *V. iris*. *Lampsilis fasciola* was found to be more active during the day, whereas *V. iris* was more active at night. Glochidia of *V. iris* were tested for valve closure time and percentage of total glochidia closed after 1 minute with exposure to components of host fish and nonhost fish mucus and blood. Fibrinogen was found to induce the strongest responses in glochidia.

Developmental Shifts in the Feeding Biodynamics of Juvenile *Utterbackia imbecillis* (Mollusca: Bivalvia)

Richard A. Tankersley¹, J.J. Hart², and M.G. Wieber²

¹*University of Maryland, Department of Biological Sciences, Baltimore County*

²*Gonzaga University, Biology Department, Spokane, Washington*

Ontogenetic shifts in the feeding mechanisms utilized by juvenile mussels (*Utterbackia imbecillis*) immediately following transformation were determined and associated with morphological changes in pallial feeding structures.

Video recordings of feeding activities indicated juvenile *U. imbecillis* utilize a combination of interstitial suspension and deposit feeding to capture and ingest particles. Cilia located on the foot, gills, and anterior edge of the mantle produce anterior inhalant currents that draw suspended particles into the mantle cavity for ingestion. Deposited particles were collected and drawn toward the pedal gape using both pedal-sweep and pedal-locomotory feeding. The relative contribution of each feeding mode to the ingestion rate of 8-, 14- and 24-day-old juveniles was determined by examining the gut contents of mussels fed fluorescently labeled latex beads. Dominant feeding mode varied with age, with younger juveniles relying more heavily upon deposit feeding mechanisms than older mussels. The rate of deposit feeding was enhanced by the presence of fine silt (<202 μ m), suggesting that particles too large to ingest may serve as important substrata for deposit feeding. Ontogenetic shifts in the mode of particle acquisition were accompanied by changes in the functional morphology of suspension feeding structures, including the size and number of ctenidial filaments and ciliary tracts.

The Distribution, Habitat Preference, and Population Biology of the Louisiana Pearl-Shell Mussel *Margaritifera hembeli*

Paul D. Johnson¹ and Kenneth M. Brown²

¹University of Texas at Arlington, Department of Biology, Arlington

²Louisiana State University, Department of Zoology, Baton Rouge

We examined the distribution, habitat preference, and intraspecific variation in density, size, dispersion, growth, and shell morphology in the Louisiana pearl-shell mussel *Margaritifera hembeli*, a species classified as endangered until October 1994. Populations of *M. hembeli* were located in 11 streams in the Bayou Rigolette drainage, from which it was previously unknown, doubling its previously known distribution. Temperature, dissolved oxygen, conductivity, Ca+2, pH, and redox potential were poor predictors of mussel abundance within a stream, but good predictors of abundance across drainages. Physical habitat characters, such as channel width and depth, granulometry, sediment organic content, sediment compaction, and current velocity, were more successful in predicting mussel habitat in a Canonical Discriminant Analysis (Wilks=0.71, p=0.02), with sediment size, compaction, and channel width explaining most of the variation. Mussel densities were estimated both randomly and inside mussel beds. Random measurements were different among sites, whereas densities inside beds were not, and a contagious distribution pattern was found at each site. Size frequency differed among sites, with evidence of recruitment at a few sites. Growth rates measured as increase in shell length of tagged individuals averaged from 1 to 3 mm mean increase in shell length per year, suggesting a 15- to 20-year variation in lifespan among sites.

Discontinuity in the Genetic Population Structure of the Green Floater *Lasmigona subviridis* and Recommendations for Genetic Conservation in Freshwater Mussel Salvage Programs

Tim L. King, Rita F. Vilella, Mary E. Smith, Michael S. Eackles, and David P. Lemarié

National Biological Service, Leetown Science Center, Aquatic Ecology Laboratory, Kearneysville, West Virginia

Green floaters (*Lasmigona subviridis*) from four geographic populations were subjected to polymerase chain reaction amplification and restrictionase digests of the internal transcribed spacer region (ITS-1) of nuclear ribosomal DNA and the cytochrome oxidase I (COI) region of mitochondrial DNA. Diagnostic genetic differentiation was observed in both ribosomal and mitochondrial DNA among geographic populations of *L. subviridis*. The 570 base-pair (bp) ITS-1 fragment, digested with the enzyme *Dde* I, produced a restriction site polymorphism between a Sideling Hill Creek, Pennsylvania, population and populations in West Virginia and North Carolina. The Pennsylvania population also exhibited a restriction site polymorphism in the 710bp COI region of mtDNA when digested with the enzyme *Cfo* I. Preliminary results suggest the presence of considerable genetic differentiation between Sideling Hill Creek, Pennsylvania *L. subviridis* and southern populations, and possibly the absence of gene exchange. The U.S. Fish and Wildlife Service has proposed collection or salvage of native species in areas of heavy zebra mussel infestations in the Ohio River drainage. The primary concern of conservation efforts in any salvage program should be conservation of the gene pool. In the absence of definitive population genetics data, we suggest a conservative approach (i.e., assume genetic distinctness) to the management and conservation of *Lasmigona subviridis* and all freshwater mussel species. Recommendations for genetic conservation in freshwater mussel salvage programs were discussed.

Micro- and Macro-geographic Genetic Differentiation Among Mussel Populations

David J. Berg¹, Sheldon I. Guttman², and Emily G. Cantonwine³

¹Miami University, Department of Zoology, Hamilton, Ohio

²Miami University, Department of Zoology, Oxford, Ohio

³Savannah River Ecology Laboratory, Aiken, South Carolina

Recent work has shown that unionid bivalves contain significant levels of intrapopulation genetic variation. Variation among populations is a function of gene flow, which in the case of unionids is almost certainly dependent on transport of glochidia by vertebrate hosts. We used starch gel electrophoresis to examine the partitioning of genetic variation within and among populations of *Quadrula quadrula* in the Mississippi River basin. Individuals were collected from seven sites: four sequential mussel beds in a 31-km stretch of the Ohio River near Middleport, Ohio; 80 km downstream near Huntington, West Virginia; Kentucky Lake, Kentucky (>800 km downstream of the first sites); and Tensas River, Louisiana (>1,500 km downstream). Results show no differentiation in allele frequencies among the four upstream sites and extremely low genetic distances. Comparisons among more-distant sites show that allele frequencies vary over greater geographic distances. These results indicate that individual mussel beds are not isolated and that metapopulations, composed of several mussel beds, exist within a river system. Most likely, this is due to movement of host fishes. Changes in allele frequencies that occur over large geographic distances represent a combination of isolation by distance and selection in response to environmental conditions.

Selected Community Characteristics of Freshwater Mussels (Unionacea) in the White River, Arkansas

Alan D. Christian¹, John L. Harris², and George L. Harp²

¹Miami University, Department of Zoology, Oxford, Ohio

²Arkansas State University, Department of Biological Sciences, State University

The White River originates in northwest Arkansas and flows approximately 1,210 km through two states (Arkansas and Missouri) until its confluence with the Mississippi River in southeastern Arkansas. Research was conducted on the lower 433 km of the White River. Mussel beds were mapped. Divers used a hookah and randomly sampled using a 1-m² quadrat of 2.5-cm PVC pipe. Four regions were delineated. Seventeen major beds (minimum area of 500 m²) and 34 minor beds (area < 500 m²) were found. Two-hundred-eighty-four 1-m² samples were taken and 5,183 individuals identified with a mean of 18.2 individuals per m² from Mbeds. Thirty-four species were identified. *Quadrula quadrula* dominated numerically with 29.2% of the total in Mbeds. Percent legally harvestable mussels on collected individuals was 19.3%. Significant differences in shell depths of five species were observed among the four regions delineated. One federally endangered species, *Lampsilis abrupta*, was represented by four individuals at four sites within the survey area.

Distribution and Abundance of Mussel Beds in the West Fork of the White River in and around Muncie, Indiana

Thomas A. Sobat and Jennifer K. David

Bureau of Water Quality, Muncie, Indiana

Observations have shown a decline in mussel densities in the West Fork of the White River. For the last 4 years, the Bureau of Water Quality has been conducting a study designed to give a better understanding of some factors that affect the distribution of freshwater mussels in the White River, Muncie, Indiana. It is the intention of the Bureau to increase mussel densities in the White River within the city through glochidial host infection if the stream bed is deemed receptive. With the primary objective to determine the characteristics of a true mussel bed, four sites were visited annually between June 1992 and July 1995. Sample sites consisted of three densely populated mussel beds above Muncie and one station within the city that historically contained a healthy mussel community. In addition to mussel concentration information, each site was examined for canopy cover, substrate profile, flow, depth, width, and ground water recharge/discharge zones. The Bureau also has been collecting baseline information for the last

23 years on 47 physiochemical parameters, fish, and macroinvertebrate communities. These data will be used to aid in characterizing these stations. These data as well as the conclusions from our study and our future plans for host infection were discussed in detail.

Mussel (*Bivalvia: Unionidae*) Habitat Suitability Criteria for the Otter Tail River, Minnesota

Rick A. Hart

North Dakota State University, Department of Zoology, Fargo

Habitat suitability data for 4,851 mussels representing 13 species were collected from five sampling sites on the Otter Tail River, Minnesota. Habitat suitability criteria were developed for seven species of unionid mussels. Threeridge (*Amblema plicata*), Wabash pigtoe (*Fusconaia flava*), fluted shell (*Lasmigona costata*), and squawfoot (*Strophitus undulatus*) all had similar suitability values for water velocity, depth, substrate, and cover. Velocities most suitable were about 80 cm/s with velocities < 25 cm/s having zero suitability. Depths of 150 cm had the highest suitability; depths < 60 cm had zero suitability. These four mussel species were found most often in gravelly substrates with no instream cover. Areas most suitable for fat mucklets (*Lampsilis siliquoidea*) and plain pocketbooks (*Lampsilis cardium*) were characterized by fast (90 cm/s and 115 cm/s, respectively), deep water (175 cm), with large, coarse substrates. Threeridge, pigtoes, fluted shells, squawfoots, fat mucklets, and pocketbooks were found most often in the run habitats of the Otter Tail River, Minnesota. Habitat suitability values for giant floaters (*Pyganodon grandis*) were the highest in slow-moving (about 10 cm/s), deep waters (135 cm) where aquatic vegetation was present. These suitability criteria will be used in the Instream Flow Incremental Methodology, aiding in the establishment of protected stream flows, preserving the run habitats most suitable for the mussels residing in the Otter Tail River, Minnesota.

Instream Flow and Habitat Requirements of Freshwater Mussels: A Case Study of the Lower St. Croix River

Shawn L. Johnson¹ and Daniel J. Hornbach²

¹*Minnesota Department of Natural Resources, Fergus Falls*

²*Macalester College, Department of Biology, St. Paul, Minnesota*

The instream flow and physical habitat requirements of freshwater mussels were examined downstream of a hydroelectric peaking dam on the lower St. Croix River, a large tributary of the upper Mississippi River. Hydraulic and habitat modeling were executed using the Physical Habitat Simulation System. Hydraulic data were collected along nine transects established across the channel. Habitat-use data were collected from 150 samples representing 29 species and 1,174 individuals. Mussel densities and species richness were highest in habitat having moderate to deep depths (>50 cm depth), moderate velocities (20-65 cm/s), and substrate comprised of sand, gravel, and cobble. Shallow areas with low velocities supported few mussels. Suitable mussel habitat was relatively abundant over the range of naturally occurring flows (from 2,000 to 10,000 cfs). Suitable mussel habitat was limited at flows of 800 and 1,600 cfs, the minimum releases from the dam during winter and summer peaking operations. Habitat was limited at these low flows due to low velocities, shallow depths, and loss of wetted area. Mussels were rare or absent from areas of the stream channel dewatered during peaking operations. These results were used to develop flow recommendations to protect the habitat of mussels, including numerous rare species, in the lower St. Croix River.

Methods

Application and Efficiency of Adaptive Cluster Sampling in Freshwater Mussel Surveys

David R. Smith, David P. Lemarié, Rita F. Vilella, and David A. Weller

National Biological Service, Leetown Science Center, Aquatic Ecology Laboratory, Kearneysville, West Virginia

Precise quantitative estimates of mussel density are difficult (some say impossible) to attain because mussel distributions are clustered. Thompson (1990) recently developed an intuitively appealing method to sample clustered populations which allows sampling effort to increase in response to observations at randomly selected locations. Because of its potential efficiency, we evaluated this method, called adaptive cluster sampling (ACS), in freshwater mussel surveys. We simulated sampling of known mussel populations, which permitted us to evaluate a wide range of specific designs and sample sizes. Our computer simulation was based on mussels in a 1,200-m² pool and a 1,800-m² riffle which were mapped at a resolution of 0.25 m². Three species were mapped: *Elliptio complanata*, *Elliptio fisheriana*, and *Lampsilis cariosa*. We compared variances from ACS and simple random sampling for fixed effort to determine efficiency. In addition, we applied ACS in a survey of freshwater mussels in the Cacapon River, West Virginia, to evaluate the practicality of the method. Sampling unit size, initial sample size, and the criteria to adapt all help determine the efficiency of ACS. Final sample size is a random variable in ACS that can result in exhausted resources prior to completing a survey. Because of theoretical and practical reasons, ACS tends to be a good idea when sampling low density mussel populations.

Environmental Impacts

Responses of *Utterbackia imbecillis* Early Lifestages to Copper (Transformation Method Comparisons)

Sarah A. Clem, Margaret L. Barfield, and Jerry L. Farris

Arkansas State University, Ecotoxicology Research Facility

As freshwater mussel populations are diminishing, consideration is being given to determining effects levels of contaminants to the more-sensitive early lifestages. Levels thus far have been based upon water quality criteria using standard toxicity test organisms that may be underprotective of these early lifestages. In order to protect future populations, criteria should include glochidia and juvenile responses to contaminants. The toxicity of copper to the early lifestages of *Utterbackia imbecillis* was examined using 24-hour acute glochidia tests, 72-hour acute tests using 7-day-old juveniles reared by *in vivo* and *in vitro* methods, and postexposure transformation counts. Comparisons of LC₅₀ values revealed juveniles from *in vivo* transformation were less sensitive than glochidia and *in vitro* transformed juveniles. Glochidia were less sensitive than *in vitro* transformed juveniles. Postexposure *in vitro* transformation counts revealed a decrease in transformation in glochidia as exposure levels increased. Nine-day static renewal acute tests are being used to reinforce results of *in vivo* and *in vitro* comparisons.

Discrimination of Environmental Factors Affecting Unionid Mussel Distribution in the Clinch River, Virginia

John H. Van Hassel¹, Donald S. Cherry², Mindy M. Yeager², and Jerry L. Farris³

¹American Electric Power Service Corporation, Columbus, Ohio

²Virginia Polytechnic Institute and State University, Blacksburg

³Arkansas State University, Jonesboro

The Clinch River of Virginia and Tennessee historically contained 45 species of unionid mussels. Currently, there are 11 federally listed endangered species, and recent surveys indicate that the mussel fauna is in decline in several areas of the river. A 4-year study of factors affecting the structure and function of mussel assemblages at 16 sites encompassing 200 miles of the Clinch River in Virginia was initiated in 1991. Significant spatial and temporal

associations were found between mussel densities or physiological condition and differences in several physical and chemical habitat variables. Fish host availability was found not to be a factor in the decline. Significant factors were validated using reciprocally transplanted mussels among selected sites. Validation of these factors will allow evaluation of specific management options for the protection and enhancement of unionid mussel resources of the Clinch River.

Abstracts of Posters

Upper Mississippi River Shallow Channel Border Habitat as a Refuge and Nursery for Unionid Mussels

Richard V. Anderson and Jennifer Eichelberger

Western Illinois University, Department of Biological Sciences, Macomb

Mussel die-offs, commercial harvest, and zebra mussel colonization have reduced density in mussel beds of the upper Mississippi River (UMR). However, quantitative sampling in the shallow channel border habitats of UMR Pool 19 has shown that density has not changed over the past 15 years in this habitat. Recent studies have found that the mussel community in this habitat has a higher proportion of young (1- and 2-year-old) mussels than in traditional mussel bed areas. Growth rates in this habitat were as good as or better than those determined from mussels collected in mussel bed areas. The density of zebra mussels that had colonized on native mussels was lower in shallow channel border habitats than in deeper water areas containing native mussel beds. Native mussels have also rapidly inhabited shallow channel border habitat where aquatic macrophytes have been eliminated following the 1993 flood. These characteristics of the mussel community of shallow channel borders may indicate that this habitat serves as a nursery and refuge for native mussels in the UMR.

Responses of Freshwater Mussels From Different Habitats to Declining Dissolved Oxygen

L.Y. Chen¹, A.G. Heath¹, and R.J. Neves²

¹*Virginia Polytechnic Institute and State University, Department of Biology, Blacksburg*

²*Virginia Polytechnic Institute and State University, Fisheries and Wildlife, Blacksburg*

The primary objective of this study was to determine the dissolved oxygen levels below which normal physiological function begins to fail in adult freshwater mussels so that the dissolved oxygen criteria can be derived. For this purpose oxygen consumption and heart rate of several species have been measured under declining dissolved oxygen levels. The effects of temperature, diurnal behaviors, and sex also were investigated for some species. The results show that species living in lakes (i.e., *Pyganodon grandis*), pool areas (i.e., *Elliptio complanata*), sand areas (i.e., *Elliptio lanceolata*), and bank margins (i.e., *Elliptio fisheriana*) of the river have better ability to regulate oxygen consumption than those found in the riffles (i.e., *Villosa iris* and *Villosa constricta*). *Villosa iris* is especially sensitive to hypoxia and handling stress. *Pyganodon grandis* is tolerant of handling stress and a good regulator of heart beat under declining dissolved oxygen. The ability to regulate oxygen consumption was improved considerably at lower temperature for *P. grandis* and *V. iris*. Diurnal behavior was found in the lake-living species *P. grandis* but not found in riverine species in this study. For *V. constricta*, the brooding females have higher oxygen consumption and lower ability to regulate oxygen consumption than the males.

Using Sidescan Sonar to Define River Bottom Environments for Resource Assessment and Management

Ronald C. Circé¹ and Patricia A. Morrison²

¹U.S. Geological Survey, Reston, Virginia

²U.S. Fish and Wildlife Service, Parkersburg, West Virginia

In February 1993, a workshop on freshwater mussel survey design was hosted by the Ohio River Islands National Wildlife Refuge in Parkersburg, West Virginia. Refuge staff established four objectives for monitoring freshwater mussels: (1) identify and characterize native mussel populations around the islands in the Ohio River, (2) establish a baseline for monitoring populations and contaminants, (3) monitor colonization of zebra mussels and their effect on native mussel populations, and (4) implement a salvage operation of native fauna if necessary. An interagency pilot project to address the objectives of the Ohio River Islands National Wildlife Refuge was undertaken by the U.S. Geological Survey, U.S. Fish and Wildlife Service, the National Biological Service, and the West Virginia Division of Natural Resources. This 2-year project was designed to augment existing data and data collections techniques by utilizing nondestructive, acoustical methods for delineating and defining sedimentary environments of the river bottom. Two hypotheses were tested: (1) sidescan sonar is an effective tool for river bottom habitat mapping, and (2) sidescan sonar can actually delineate discrete areas of the riverbed inhabited by freshwater mussels. By using sidescan sonar techniques and ground-truthing areas with scientific divers, four primary sedimentary environments were defined and delineated along the river bottom surrounding 11 islands in the study area. These areas included (1) silt/clay/sand/gravel: found primarily in the main river channel; (2) silt/clay: observed on both sides of islands (main channel and back channel), when seen in the main river channel it appears in long stretches of the river; (3) sand/gravel/cobble: found primarily at the heads of islands in both the main channels and back channels; and (4) submerged aquatic vegetation beds seen predominantly along the shoreline of the islands and riverbank, especially in the back channel areas. As a result of this pilot study, the first hypothesis was accepted. The second was rejected, in part because areas of the upper Ohio River inhabited by freshwater mussels are hard substrates, which reflect sonar signals strongly. The acoustic signal of the hard bottom is indistinguishable from that of the mussels. However, there is a strong correlation, through brailling and ground-truthing, of sedimentary type 3 and freshwater mussels.

Unionid Relocation and Monitoring, Meramec River Bridge Construction Site, Jefferson and St. Louis Counties, Missouri

Heidi L. Dunn¹ and Gene Gardner²

¹Ecological Specialists, Inc., St. Peters, Missouri

²Missouri Highway and Transportation Department, Design Division, Jefferson City

Bridge construction involving instream work can seriously disturb unionids and their habitat; however, impact area can be minimized and unionids in impact areas can be relocated. The Missouri Highway and Transportation Department (MHTD) coordinated with regulatory personnel to design temporary causeways (necessary for construction) that would impact a minimum area and allow uninterrupted river flow. However, *Lampsilis abrupta*, a federally endangered species, and several species with special status in Missouri would be affected by causeway and pier construction. Instream construction areas and a buffer zone around construction areas were delineated and all unionids (4,514 of 21 species) were removed from these areas and relocated to an existing unionid bed upstream of the bridge. *Lampsilis abrupta* as well as *Fusconaia ebena* (endangered in Missouri), *Arcidens confragosus* (rare in Missouri), and *Obovaria olivaria* (on Missouri's watch list) were measured, aged, marked with a unique number, and placed in grids for future monitoring. No mortality was observed 1 month following the relocation. One year following relocation 86% of the *L. abrupta* and 100% of the *F. ebena* were recovered; however, only 29% of the *A. confragosus* was recovered. No mortality was observed. Follow-up monitoring will be conducted in 1996.

Habitat Characteristics and Mussel Community Parameters Associated with Endangered Species in the St. Croix River, Minnesota and Wisconsin

Daniel J. Hornbach, Tony Deneka, and Patrick Baker

Macalester College, Department of Biology, St. Paul, Minnesota

Due to the rarity of endangered mussels, it is often difficult to examine their biology and ecology. We examined the habitat characteristics associated with endangered species and compared these with habitat characteristics for the mussel community in general. Our hypothesis was that endangered mussels are found in high-quality mussel habitat rather than in peculiar niches. If this hypothesis is supported, endangered mussels can be managed by improving overall mussel habitat, and mussel community measures can be used to signal the status of endangered mussels. We conducted this study in the St. Croix River, a Mississippi River tributary, which contains 38 mussel species including two federally endangered species, *Lampsilis higginsii* and *Quadrula fragosa*. Using SCUBA, 266 0.25-m² quadrats were examined to characterize the mussel community. The sediment size, water depth, and flow were measured. We also conducted searches specifically for *Q. fragosa* and *L. higginsii*. When a specimen was located a 0.25 m² quadrat was sampled to examine the habitat and mussel community associated with the mussel. The densest and richest mussel communities were associated with specific substrate types in conjunction with particular water depth and flow regimes. *Quadrula fragosa* and *L. higginsii* were found in areas of rich and diverse mussel assemblages; consequently, these endangered species did not have peculiar niches, indicating that a community assessment technique may be helpful in endangered mussel management.

Bivalve Survey of the Sandy River Drainage, Minnesota

Mark C. Hove¹, Chris E. Freiburger², and Robin A. Engelking¹

¹University of Minnesota, Department of Fisheries and Wildlife, St. Paul

²Minnesota Department of Natural Resources, Grand Rapids

Freshwater mussels have been shown to be useful bioindicators of water quality. A qualitative bivalve survey of the Sandy River basin, located in north-central Minnesota, was conducted during August-September 1994. The Sandy River drainage, composed of the West Savanna, Prairie, Tamarack, and Sandy rivers, was surveyed at 32 sites for freshwater bivalves. Pill clams (Sphaeriidae) and eight species of unionids were observed, including *Anodontoidea ferussacianus*, *Lampsilis cardium*, *L. siliquoidea*, *Lasmigona compressa*, *Ligumia recta*, *Pyganodon grandis*, *Strophitus undulatus*, and *Utterbackia imbecillis*. Numerous populations of *Lampsilis siliquoidea*, *Pyganodon grandis*, *Anodontoidea ferussacianus*, and Sphaeriidae were observed throughout the drainage. Populations of *Lasmigona compressa*, *Ligumia recta*, and *Utterbackia imbecillis* were scattered among two or three of the four tributaries. Very few *Lampsilis cardium* or *Strophitus undulatus* were observed. Greatest unionid diversity occurred in the Prairie River, most of which flows through the Savanna State Forest. Highest catch per unit efforts (CPUEs) were recorded at sites in the West Savanna River, situated primarily in the Savanna Portage State Park. Lowest unionid diversity and CPUEs were observed in channelized reaches of the Sandy River. Lower unionid abundance and diversity were observed in agriculturally developed areas with channelized stream beds than in pristine portions of the drainage.

Distribution and Population Structure of Mussel Beds in the Flambeau River, Wisconsin

Daniel E. Kelner and Terry A. Balding

Eau Claire, Wisconsin

The overall purpose of this study was to determine the distribution and population structure of unionids within beds and define the physical boundaries of the beds within a portion of the Flambeau River, Wisconsin. A systematic sampling design with 0.25-m² quadrants was used by a diver in SCUBA which determined the boundary and as a result the total area of the bed. For each mussel bed, species association analyses were conducted using 2 x 2 contingency tables with no significant associations found. Chi-square tests of species distribution revealed the species were distributed evenly throughout all the beds regardless of substrate type or depth. However, the distribution of unionid densities (without respect to species) within the beds and their relation to substrate type was

statistically significant for three of the four mussel beds. Among the beds the lowest density occurred in a sand/gravel substrate. Overall, the highest densities occurred in a sand, gravel, or combination of sand/gravel substrate with a boulder composition of 50%. This study establishes baseline data on the community composition within these well-defined beds, which could be used in future studies to determine any adverse changes within the beds. This is of particular concern because two state endangered species, *Cyclonaias tuberculata* and *Plethobasus cyphus*, and a species of special concern, *Pleurobema coccineum*, were all found within the beds.

Genetics and Systematics of Freshwater Mussel Species: A Tissue Repository

Tim L. King, Mary E. Smith, Rita F. Vilella, Priscilla I. Washington, and David A. Weller

National Biological Service, Leetown Science Center, Aquatic Ecology Laboratory, Kearneysville, West Virginia

Recognizing a need for phylogenetics research, the National Biological Service – Leetown Science Center's Aquatic Ecology Laboratory has established a tissue repository and associated database to coordinate tissue samples collected for genetics and systematics research. The repository provides a centralized location for researchers to obtain properly catalogued and preserved adductor muscle, mantle, foot, gill (including glochidia), and digestive gland tissue samples. All data generated for the repository are maintained in the PARADOX for Windows relational database package. Collection information compiled for each specimen includes date, site name, site description, and habitat characteristics. Database content reports are generated and provided to interested researchers. Currently the database contains 254 individuals representing 46 species inhabiting Atlantic slope and interior basin drainages. All researchers utilizing the repository are required to accommodate a standard numbering scheme to allow comparisons of the same individuals among diverse studies and methodologies. Potentially, the repository would reduce the number of animals sacrificed and sampling time while providing comprehensive data to multiple researchers. A single collection of mussels can provide ecophenotypic, protein, DNA, and immunological information for species and population structure delineation. This poster describes the development of the repository and presents data collection protocols, preservation methods, database structure, and a current report of the database contents.

Evaluation of Tag Types and Adhesives for Marking Freshwater Mussels

David P. Lemarié, David R. Smith, Rita F. Vilella, and David A. Weller

National Biological Service, Leetown Science Center, Aquatic Ecology Laboratory, Kearneysville, West Virginia

External identification of individual mussels is highly desirable for following passive and active movements, population studies, and labeling for studies of growth, reproduction, genetics, and physiology. Ideally, tags must be easy to apply, inexpensive, and provide excellent long-term legibility and retention. In this study we evaluated three varieties of tags (Northwest Marine Technology Visual Implant Tag, Floy Fingerling Tag, and Hallprint Shellfish Tag), two types of adhesives (3M two-part epoxy and Crazy Glue cyanoacrylate), and four bonding times before immersion in water (2, 5, 10, and 15 minutes). Tags were applied to shells of dead animals. Tag/glue combinations showing good initial legibility after complete curing of the adhesive were further tested under natural conditions in a shallow stream and in a standard gem tumbler containing coarse metal shavings. This poster provides an illustrated summary of the advantages and disadvantages of each of the tag types and adhesives tested. Preliminary results suggest that the best combination is a flexible polyethylene shellfish tag bonded to the shell with cyanoacrylate. Cyanoacrylate can be immersed in water in as little as 2 minutes after application.

Spatial Distribution Patterns of Freshwater Mussels in Rivers of Open and Forested Riparian Zones

Todd J. Morris and Lynda D. Corkum

University of Windsor, Department of Biological Sciences, Windsor, Ontario, Canada

To investigate the roles played by terrestrial inputs and streamside vegetation in shaping unionid distributions, six drainage basins in southwestern Ontario were selected: three basins with grass-dominated riparian zones (open sites) and three with densely treed riparian zones (forested sites). Environmental variables related to the riparian classes and relative abundance of mussel species were measured at a total of 24 sites (4 sites per drainage basin). Forested sites had significantly wider riparian zones ($n=144$, $p<0.001$), steeper valley ($n=144$, $p<0.05$), and plain slopes ($n=144$, $p<0.01$), and tended to receive less incident solar radiation. A total of 17 species was found in all six drainage basins. Mean species richness did not differ between the two riparian types ($n=24$, $p>0.05$). Discriminant analysis on the basis of mussel species abundance confirmed a priori riparian zone classification in 100% of the cases. Open sites were characterized by *Pyganodon grandis* and *Strophitus undulatus*, whereas forested communities were characterized by *Elliptio dilatata*, *Lampsilis radiata*, *Lampsilis cardium*, and *Alasmidonta marginata*. It is apparent that some mussel species are associated with particular riparian types and that their distribution can be predicted on the basis of riparian characteristics.

Host Fish Attraction Strategy and Host Fish Identification for *Lampsilis subangulata*

Christine A. O'Brien, Jayne Brim-Box, and Andre Daniels

National Biological Service, Gainesville, Florida

Lampsilis subangulata, the shinyrayed pocketbook, is one of five mussels currently proposed for endangered status from the Apalachicola, Chattahoochee, and Flint River basins (ACF). Endemic to the ACF, this species has been described as one of the most beautiful mussels in North America. In June 1995 the release of a superconglutinate by *L. subangulata* was observed for the first time and recorded on video. A superconglutinate is a "modified external structure" used to lure host fish by mimicking a small minnow in both size and color. The female mussel releases the mimic minnow on a translucent mucus strand. Once detached from the female, the translucent strand becomes snagged around rocks or branches in the stream, and the mimic minnow is suspended in the water column where it awaits a predator (Centrarchidae). When the predator attempts to consume the mimic minnow, thousands of glochidia are released into the mouth and gills of the deceived predator. The *L. subangulata* superconglutinate is similar in appearance to that of *Lampsilis perovalis* as described by Haag et al. (1995). Centrarchids have been observed as hosts for *L. subangulata* in both field and laboratory studies.

Comparison of Quantitative and Qualitative Sampling Methods for Assessing Unionid Mussel Beds in the Neosho River, Kansas

Brian K. Obermeyer¹, Edwin J. Miller², David R. Edds¹, and Carl W. Prophet¹

¹Emporia State University, Division of Biological Sciences, Emporia, Kansas

²Kansas Department of Wildlife and Parks, Independence

We surveyed nine sites in the Neosho River, Kansas, for unionid mussels during summer 1994 to compare quantitative and qualitative sampling methods for evaluating species richness, diversity, size structure, and evidence of recruitment. At each site, snorkel searches were employed in a 10 x 100-m stretch. Captured mussels were placed back into their original position, and then 40 1-m² random substrate samples were taken from the same stretch. A total of 856 mussels was caught from 12 hours of snorkel searches and 889 from 360 1-m² quadrats, with *Quadrula metanevra* the most abundant species from both sampling methods. Species richness was 18 and 20 from qualitative and quantitative searches, respectively, whereas species diversity (Shannon's index, log base₂) was 2.6 and 2.4 in timed searches and quadrats, respectively. Both sampling methods revealed little evidence of recent recruitment.

A Flexible Multistage Design for Sampling Freshwater Mussel Populations Using Double Sampling for Stratification

David R. Smith, Rita F. Villeda, David P. Lemarié, and David A. Weller

National Biological Service, Leetown Science Center, Aquatic Ecology Laboratory, Kearneysville, West Virginia

We present a sampling design for estimating mussel density within a watershed. The stages of sampling are stream reaches within a watershed and quadrats or line transects within a stream reach. A distinctive feature is the use of a rapid assessment at each selected stream reach as a basis for further sampling. Implementation of the design is as follows: An initial sample of stream reaches is selected from the target population, and the density of mussels is rapidly assessed at each. The rapid assessment could be a timed search for live mussels, for example. As a result, stream reaches are classified into density strata (e.g., low/high density). For high density strata, all (or most) of the reaches are sampled quantitatively; however, fewer of the low-density reaches need to be sampled further. As a result, the time spent sampling where mussels are at low density (or absent) can be minimized. Average estimates within each strata are combined using appropriate weighting to arrive at an estimate of density for the population of interest. An added advantage of the design is that quantitative sampling method within a reach can depend on density strata, thereby increasing the flexibility and efficiency of the design.

Freshwater Mussel Atlas Development for Three New England States

Susanna von Oettingen, Chris Fichtel, Mark McCollough, and Marea Gabriel

U.S. Fish and Wildlife Service, Concord, New Hampshire

The U.S. Fish and Wildlife Service, Maine Department of Inland Fisheries and Wildlife, Vermont Fish and Wildlife Department, and New Hampshire Fish and Game are coordinating the inventory of streams and rivers for freshwater mussels in an effort to develop state atlases. To date, little information particular to the New England states is available for freshwater mussels. These atlases will be an important step in educating the general public and regulatory authorities on the importance of freshwater mussel conservation. Massachusetts, Connecticut, and Rhode Island also are establishing comprehensive databases of freshwater mussel locations with the future possibility of developing state atlases. Since 1993, biologists in Maine, New Hampshire, and Vermont have been systematically surveying streams and rivers and documenting freshwater mussel presence and absence. Site locations are then entered into GIS (Geographic Information Systems) format. Each state is developing atlases that are particular to that state's needs, but will cover similar information, such as an overview of freshwater mussel life history, species-specific descriptions, and general information regarding conservation. An atlas for Vermont is in the final stages of completion; four counties in New Hampshire have been surveyed, mapped, and a minipublication completed; and four counties in Maine have been surveyed.

Population Dynamics of Zebra Mussels in the Illinois River 1993-1995

Scott D. Whitney, K. Douglas Blodgett, and Richard E. Sparks

Illinois Natural History Survey, S.A. Forbes Biological Station, Havana

Since 1993, we have quantitatively assessed the demographics of newly established zebra mussel (*Dreissena polymorpha*) populations in the middle and lower Illinois River. This research is designed to provide a better understanding of riverine zebra mussel populations and their impacts on specific riverine species and on the riverine ecosystem. In summary, zebra mussel populations in the Illinois River display two patterns. In the middle reach of the river, populations increased gradually from the initial invasion (1989-1991) to densities of 3,000 to 7,000 in 1993-1994, where they have remained relatively stable. In contrast, populations in the lower river exploded in 1993, reaching densities near 100,000/m², and crashed to less than 1,000/m² in 1994. The population explosion was attributable to a massive settlement event in 1993, most likely due to one pulse of veliger larvae carried far downriver by the record flood of 1993. The crash was most likely attributable to unfavorable environmental episodes, particularly the low oxygen levels that the zebra mussels may have contributed to because of the respiratory demand

exerted both by the live mussels and by the decay of dying mussels. We believe the upriver/downriver differences in mortality, growth, and recruitment have been greatly influenced by overpopulation and environmental conditions of the river. Dramatic fluctuations in flow and water quality factors in the Illinois River are expected to continue to result in a "boom or bust" cycle in the lower river while populations in the middle river remain relatively stable ($<10,000/m^2$) and continue to serve as source of veligers to resupply the lower river.

Ohio River Mussel Survey

U.S. Army Corps of Engineers, Louisville District

A trail survey was carried out during the summers of 1993 and 1994 to determine the geographical limits and other characteristics of mussel (Mollusca: Unionidae) beds in the lower Ohio River from its mouth at Cairo, Illinois, to near Foster, Kentucky. A total of 31 species was found, including two federally listed endangered species, *Potamilus capax* and *Pleurobema clava*, and two federal candidate species, *Quadrula cylindrica* and *Plethobasus cyphyus*. All 48 mussel beds described on the basis of the last comprehensive survey (1982) were investigated; 40 of them were found to still qualify as beds. In 30 of those cases their geographical limits have now contracted, in 4 they have remained the same, and in 6 they have expanded.