Triannual Unionid Report

Report No. 1

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

Compiled by

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

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The following Section 6 projects were funded by the Service at the Asheville Field Office:

Kentucky Department of Fish and Wildlife Resources (KDFWR):

Little-wing pearlymussel and Cumberland bean reintroduction feasibility study/$12K. This project will involve a study of the feasibility of reintroducing these species into the lower Little South Fork of the Cumberland River. This study, which begins in July 1993, will run for 3 years and be conducted by the Service's Tennessee Coop Unit.

Listed mussel/zebra mussel threat analysis/$10K. This project will involve tracking zebra mussel invasions into tributaries of the Tennessee and Cumberland Rivers and studying impacts to native mussels. This study, which begins in July 1993, will run for 3 years and be conducted by the Service's Tennessee Coop Unit. (This is joint project with TWRA.)

North Carolina Wildlife Resources Commission (NCWRC):

Tar spinymussel, little-wing pearlymussel, and dwarf wedge mussel survey and monitoring/$9K. This project will involve surveying for additional North Carolina populations and monitoring the State's known populations. The project will be conducted by the NCWRC.

South Carolina Wildlife and Marine Resources Department (SCWMRD):

Edisto River mussel survey/$12.1K. This project, which begins in July 1993 and runs for at least 1 year, will involve a mussel survey of the Edisto River. We have not determined who the contractor will be.

Tennessee Wildlife Resources Agency (TWRA):

Mussel life history and propagation/$22K. This ongoing project at the Service's Virginia Coop Unit (see report by Neves in this newsletter) is a cooperative effort with the Virginia Department of Game and Inland Fisheries. It will involve investigating the feasibility of long-term holding and propagating of mussels.

Mussel reintroduction feasibility study/$20K. This project, which is in its second year, involves investigating the feasibility of reintroducing mussels to Shoal Creek, a Tennessee River tributary in south-central Tennessee. The project is being conducted by the Service's Tennessee Coop Unit.

Listed mussel/zebra mussel threat analysis/$12.5K. This is a joint project with KDFWR (see project description above).

Other Projects Funded by the Asheville Field Office This Fiscal Year:

Development of the technology for long-term holding of endangered mussels in captivity/$5K. This project will add funds to an existing Service project at the Service's Virginia Coop Unit. (See report by Neves in this newsletter.)

Status survey of Anodontoides denigrata and Lasmigona/$4.5K. This will involve a survey of the upper Cumberland River in Tennessee and Kentucky for *Anodontoides denigrata* (Lea 1852) and the upper Caney Fork River for a possible undescribed *Lasmigona* to determine if these species may qualify for Federal protection. The project will be conducted by the Service's Tennessee Coop Unit.

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Report: This is a multi-agency project set to begin by July, 1993. The program will concentrate on the propagation and management of endangered Ohio species, including federal endangered taxa occurring in the state. Several tasks will run concurrently, including, but not limited to, identification of hosts, monitoring of rare and endangered species, translocation studies, and informative brochures on Ohio species for public use.

Publications:

Watters, G. T. 1992. Unionids, fishes, and the species-area curve. *Journal of Biogeography* **19**:481-490.

Watters, G. T. 1993. *An annotated bibliography of the reproduction and propagation of the Unionacea (primarily of North America)*. Division of Wildlife, Ohio Department of Natural Resources. 130 pp.

Watters, G. T. 1993. *A guide to the freshwater mussels of Ohio (revised edition)*. Division of Wildlife, Ohio Department of Natural Resources. 106 pp.

Authors: Johnie Crance and Mary Freeman

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Interesting, huh Tre?

The Auburn Field Station of the National Ecology Research Center is searching for data on habitat requirements of unionids. We are investigating the feasibility of developing habitat suitability index curves for species that typically inhabit gravel-bars in moderate to large rivers. We would appreciate any references to gray literature or unpublished information concerning life-histories, mussel vulnerability to physical disturbance, and habitat preferences by mussels or their host species. We will synthesize available data for potential use in analyzing effects of disruption by barge traffic in large river systems. Any input on this problem will be welcome.

Unionid Research: Virginia

Authors: Bruenderman, S.A. and R.J. Neves. 1993. Life History of the Endangered Fine-rayed Pigtoe *Fusconaia cuneolus* (Bivalvia: Unionidae) in the Clinch River, Virginia.

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Life History of the Endangered Fine-Rayed Pigtoe *Fusconaia cuneolus* (Bivalvia: Unionidae) in the Clinch River, Virginia

Sue A. Bruenderman[1] and Richard J. Neves

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Abstract. The reproductive cycle, fish hosts, and selected population statistics of the endangered fine-rayed pigtoe *Fusconaia cuneolus* (Lea, 1840) were investigated during 1986-1987 in the Clinch River, Virginia. Examination of gravid females and drift samples indicated that the summer brooder is gravid from mid-May to late July and releases most glochidia in mid-June. Diel samples of stream drift contained a peak of glochidia in early morning. Of 1619 collected and examined fishes of 39 species for glochidial attachment, infestation by amblemine glochidia was highest on cyprinids (27 - 46%). Six species were identified as likely hosts for glochidia of the fine-rayed pigtoe. Induced infestations of fishes with glochidia in the laboratory confirmed eight host species: fathead minnow *(Pimephales promelas)*; river chub *(Nocomis micropogon)*; stoneroller *(Campostoma anomalum)*; telescope shiner *(Notropis telescopus)*; Tennessee shiner *(N. leuciodus)*; white shiner *(Luxilus albeolus)*; whitetail shiner *(Cyprinella galactura)*; mottled sculpin *(Cottus bairdi)*.

Age class and growth rate characteristics, determined by sectioning of valves collected in muskrat middens, were similar between two demes in the river. The fine-rayed pigtoe reaches a maximum length of about 90 mm and age of 35 yr. Annual growth averaged 5 mm/yr through age 10 and decreased to about 2 mm/yr thereafter until senescence. Specimens less than age 10 were uncommon, and no individuals under age 6 were collected. Cohort structure of live specimens and collections of valves indicated that the fine-rayed pigtoe population is declining in the Clinch River, Virginia.

Management: Virginia

Author: Sue A. Bruenderman. Status Surveys of Twenty Species of Freshwater Mussels in the Clinch River, Virginia.

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Qualitative status surveys of the following federal and state endangered and threatened, and federal candidate freshwater mussel species (and their known fish hosts) will be conducted at 3 sites on the Clinch River, Virginia during summer 1993:

Villosa perpurpurea (SE,C2)
Quadrula cylindrica strigillata (ST,C2)
Io fluvialis (ST,C2)
Epioblasma brevidens (SE,C2)
Epioblasma capsaeformis (SE,C2)
Epioblasma triquetra (SE,C2)
Lemiox rimosus (FE)
Cyprogenia stegaria (FE)
Fusconaia cuneolus (FE)
Fusconaia cor (FE)
Hemistena lata (FE)
Cumberlandia monodonta (SE,C2)
Quadrula sparsa (FE)
Hemistena lata (FE)
Lexingtonia dolabelloides (ST,C2)
Pleurobema oviforme (C2)
Ligumia recta (ST)
Plethobasus cyphyus (ST)
Pleurobema cordatum (SE)
Quadrula pustulosa (ST)

Conservation: Virginia

Authors: Weigmann, Kittrell, Costanzo, Bruenderman, Neves. Restoration and Recovery of Freshwater Mussels of the Upper Tennessee River Basin. Proposal accepted by National Fish and Wildlife Foundation: April, 1993. Project duration: June, 1993 - May, 1994.

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PROJECT ABSTRACT

Mussel biologists predict that 45 species of freshwater mussels in North America will become extinct in the next ten years due to habitat degradation in our waterways. The Upper Tennessee River Basin of Virginia, comprised of the Clinch, Powell, and Holston rivers, is one of the finest, last remaining strongholds for freshwater fish and mussels worldwide (Helfrich et al. 1986). However, there are currently 23 species of mussels and three species of fish in the Basin that are listed as threatened or endangered or are candidates for listing by the U.S. Fish and Wildlife Service. Most of the problems that have led to the decline of the freshwater mussels in North America are associated with land use activities and changes in water quality. The proposed project presents an opportunity to address these land use activities and initiate the recovery, protection and reestablishment of native mussels in the Clinch River Basin. The project's three components include: 1) restoration of critically degraded riparian areas, 2) an outreach program designed to educate residents and decision makers in the watershed, and 3) a mussel reintroduction program to establish native mussels into degraded areas.

Three areas within the Clinch River watershed are targeted for riparian habitat restoration in order to reduce agricultural nonpoint sources of pollution. Restoration practices to be implemented include erecting fences to exclude livestock from riparian zones, creating buffer zones to filter sediments and nutrients, providing alternative water sources for livestock, planting trees, and implementing other riparian erosion control methods. Participating landowners will be required to sign a 5-10 year management agreement.

The major elements of the outreach program include two publications and a pilot educational package. This program will encourage cooperation, information transfer, and joint activities among the various participants in the recovery of this unique ecosystem. Moreover, it will help foster a long-term commitment to protecting and preserving this area's exemplary flora and fauna while serving as a prototype to be used for educational efforts in other watersheds across the country.

A mussel reintroduction and translocation program will also be initiated to speed recovery and recolonization of target areas. Native mussels will be introduced to suitable project areas for recolonization while other individuals will be translocated to assess their viability in project areas.

There will be numerous benefits to the aquatic and terrestrial wildlife resources as a result of this project. Aquatic habitats will be restored for rare mussels, fish, and other organisms through the reduction of sediments, nutrients, and contaminants. Furthermore, newly created riparian corridors will provide nesting sites, protection from predators, and migratory pathways for many terrestrial species. Therefore, restoration of riparian vegetation is an essential component for successful recovery of the Clinch River Basin ecosystem.

Conservation: Virginia

Authors: Weigmann, Flynn, Bruenderman, Reynolds, Helfrich, Neves, Angermeier. An Integrated Program for Big Moccasin Creek: Water Quality, Endangered Species, Watershed Management, and Citizen Participation (anticipated acceptance of proposed project: May, 1993). Project Duration: 1993-94.

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EXECUTIVE SUMMARY

The Virginia Water Resources Center, the College of Forestry and Wildlife at Virginia Tech, and the Virginia Department of Game and Inland Fisheries are requesting to partially cover one-year costs for a watershed-specific program designed to improve, protect and maintain water quality, aquatic habitat, riparian corridors, and species diversity in the Upper Tennessee River Basin--the Clinch, Powell and Holston rivers of Virginia and Tennessee. Nonpoint source pollution and loss of riparian habitat have been identified as major contributors to documented declines of numerous wildlife species occurring within the Basin, most notably the many endemic species of freshwater mussels and fish. Because most of the land is privately owned, the cooperation and participation of riparian landholders and watershed residents is vital to the permanent restoration and protection of the Upper Tennessee River Basin. The proposed project is a multi-organizational outreach effort to develop citizen commitment to the conservation of this ecologically significant Basin.

Big Moccasin Creek (Hydrologic Unit 009) is the sub-watershed targeted for this one-year project, comprising public outreach, research and demonstration, and program evaluation. Products of the public outreach component include production and distribution of publications; establishment of a clearinghouse for information transfer; creation of a database of organizations, assistance programs and watershed residents; development of educational packages; and coordination of roundtable meetings between natural resource groups and residents. The public outreach component of the project will seek to stimulate the adoption of agricultural and forestry BMPs through the integration of ongoing programs by local, state, federal, and private natural resource organizations.

We will cooperate with other organizations to establish local BMP demonstrations of relevance to residents of Big Moccasin Creek, as well as helping to publicize and examine the effectiveness of ongoing demonstration projects on existing water quality. Watershed indices of pollution potential will be applied to an existing aerial inventory of land uses to generally characterize Big Moccasin Creek. Mussel surveys will allow comparisons of population densities of eight species over the last decade and possible correlations with land use patterns in the watershed. In particular, this study will examine upstream-downstream water quality and biological samples from three experimental farm sites. One farm has recently installed streamside fencing, and fencing will be installed on two other farms during this research project. All three farms are near mussel sampling sites.

The effectiveness of the integrated watershed program will be evaluated thoroughly to provide a valid model to transfer to other watersheds with critical aquatic habitat. The extent to which the project stimulates the long-term adoption of nonpoint source pollution prevention activities in the watershed will be documented and evaluated. The improvement in water quality and success in preserving and maintaining aquatic habitats in the creek and its tributaries will be documented by an assessment of baseline conditions and by monitoring any changes in water quality and aquatic habitats as project components are implemented.

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Recent publications on unionids:

Hoggarth, M.A. in press. The Unionidae and Corbiculidae of the Little Miami River system in southwestern Ohio. Walkerana, 6:

Hoggarth, M.A. 1992. An examination of the glochidia-host relationships reported in the literature for North American species of Unionacea (Mollusca: Bivalvia). Malacology Data Net, 3(1-4):1-30.

Hoggarth, M.A. 1992. A study of the Unionidae of the Little Miami River system. Final Report to the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Columbus, Ohio. 85p.

Hoggarth, M.A. 1991. A preliminary report on the unionidae of the Little Miami River system. Preliminary Report to the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Columbus, Ohio. 55p.

Hoggarth, M.A. 1991. A study of the Unionidae of the Little Beaver Creek system. Final Report to the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Columbus, Ohio. 30p.

Hoggarth, M.A. 1990. The Unionidae of the Chagrin River: The remnant of a molluscan fauna. Ohio Journal of Science, 90(5):168-170.

Hoggarth, M.A. 1990. A study of the Unionidae of the Olentangy River above Columbus. Final Report to the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Columbus, Ohio. 27p.

Hoggarth, M.A. 1990. A study of the Unionidae of the Chagrin River. Final Report to the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Columbus, Ohio. 23p.

Hoggarth, M.A. 1990. A study of the Unionidae of the upper Cuyahoga River. Final Report to the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Columbus, Ohio. 18p.

U.S. Fish and Wildlife Service. 1990. White Cat's Paw Pearly Mussel Recovery Plan. U.S. Fish and Wildlife Service, Twin Cities, Minnesota. 42p.

Preliminary Results: The Unionidae of the Walhonding River.

Extant populations of 31 species of Unionidae have been found in the Walhonding River in Coshocton County, Ohio. This study, which was begun in 1991 will be completed in the summer of 1993. Extant species included six Ohio Endangered species (*Quadrula cylindrica cylindrica, Plethobasus cyphyus, Fusconaia maculata maculata, Pleurobema clava, Villosa fabalis,* and *Lampsilis ovata*). Shells of three Federal Endangered species were found, including a single freshly dead shell of *P. clava*, and weathered shells of *Cyprogenia stegaria* and *Epioblasma obliquata obliquata* (one complete shell only - dead approximately two-five years).

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Mussel Surveys at Prince William Forest Park, Virginia

Prince William Forest Park is a national park located in Prince William County, Virginia. In a previous natural heritage resource inventory of the park, several sites were examined within the park for rare mussels. The two main watercourses within the park are South Fork Quantico Creek and North Fork Quantico Creek. The two streams join within the park to form Quantico Creek proper near the park boundary. In 1992, field work concentrated on examining sites that were not previously visited. The field work did not reveal any species of Unionidae not found during previous field work within the park. The two species found were *Alasmidonta undulata* and *Elliptio complanata*. Mussels were found only in the South Fork Quantico Creek. The North Fork Quantico Creek appeared very similar to South Fork Quantico Creek; but, I found no mussels there. There is an old surface mine site along North Fork Quantico Creek which has been inactive for decades; and, this may somehow be influencing the habitat negatively. South Fork Quantico Creek has a small impoundment midway along in length. Mussels were found both upstream and downstream of this lake. The water quality of South Fork Quantico Creek appeared to be very good to excellent. Also, South Fork Quantico Creek was free of *Corbicula*, a rare situation in Virginia. No field work is planned in 1993 for this area.

Alasmidonta heterodon on Virginia's Eastern Shore

A survey for *Alasmidonta heterodon* has been undertaken on the Virginia portion of the Delmarva Peninsula. Previously, this species has been reported from Maryland's portion of the Delmarva Peninsula. An investigation of 8 sites in 1992 did not reveal the presence of this species; however, a population of *Elliptio complanata* was found. This is significant as an earlier search for unionids in this area found none and concluded none were present in the Virginia portion of the Delmarva Peninsula. Further field investigation are planned in 1993 concentrating in the streams adjacent to the *E. complanata* site. The stream habitats here resemble some sites where *Alasmidonta heterodon* has been found elsewhere in Virginia. An additional note of interest regards the *E. complanata* population found. I noted these mussels to be different in form and coloration than mainland populations I have seen.

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James Spinymussel (*Pleurobema collina*) in the Rivanna Watershed, Virginia

Field investigations in 1992 were conducted to determine the distribution of the James spinymussel in the Rivanna River watershed. In 1992, all field work was limited to the South Fork Rivanna Watershed upstream of the City of Charlottesville. Initial field work revealed the population of this mussel in one tributary stream was more extensive than previously thought. Also, the site on this stream where the mussels were found in 1989 by Mark Hove of VPI&SU was observed to be recently beaver-dammed. The local segment where the mussels were found is now converted from a free-flowing moderate gradient creek to a long, narrow pool. The future stability of the population will be monitored watching to determine the influence of the beaver ponding on *P. collina* and other mussels. Initial survey in the Mechums River revealed finds of 2 live *P. collina* at disjunct locales along a 9.8 km reach of the river. At a Mechums River site previously reported to contain *P. collina*, none were found. An investigation of the Moormans River, did not result in finds of *P. collina*; however, 2 other mussel species, *Lasmigona subviridis* and *Villosa constricta* were collected. Further field work will be undertaken in 1993 within the Rivanna watershed.

Mussel surveys at Ft. Pickett, Virginia

In 1992, as part of an inventory of the natural heritage resources of U.S. Army facility, Ft. Pickett, Virginia, surveys were performed to determine the distribution of rare unionids within the base. A significant portion of the Nottoway River flows through Ft. Pickett in Nottoway and Dinwiddie Counties. Initial results of investigations of selected tributaries and portions of the Nottoway River indicate that the Atlantic pigtoe, *Fusconaia masoni*, generally occurs in very low numbers within the Nottoway mainstem and one tributary. Other mussels seen include *Anodonta cataracta*, *Anodonta imbecillis*, *Strophitus undulatus*, *Alasmidonta undulata*, *Elliptio lanceolata*, *Elliptio* cf *complanata*, and *Villosa constricta*. A wide variety of morphs are tentatively assigned the name *Elliptio* cf *complanata* and likely includes individuals which are *E. icterina* among others. Shell deposits found on one sand bar indicate that a moderate to large population of *F. masoni* resides in an unsurveyed portion of the river. A notable find among the *Alasmidonta udulata* shells is that there appears to be syntopic occurrence of *A. undulata* sensu stricto and *A. triangulata*, a form synonymized by A. H. Clarke with *A. undulata*. Field results should clarify this find in 1993.

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Constantine Samuel Rafinesque (1783-1840), a controversial and prolific naturalist, had a profound impact on early freshwater bivalve systematics. Bogan (1988) reviewed the bibliographic history of the seven Rafinesque papers which dealt with freshwater bivalves. Rafinesque erected numerous new taxa from subspecies and varieties to subfamilies of unionids in these papers - only a few taxa were poorly illustrated in his 1820 monograph (Rafinesque, 1820). Rafinesque (1831:1), in the continuation of his monograph of the bivalve shells of the Ohio, remarked he had sent specimens to "Clifford, in Lexington, and for the Museum of Transylvania University. I furnished several to my friends, Elliot, Collins, Graham, Hart, &c. in America, and Ferusac [sic], Bronguiart [sic], Swainson, Sowerby, &c. in Europe." He also sold a set of his unionid specimens to Charles A. Poulson of Philadelphia (Rafinesque, 1831:1; Poulson, 1832:v). The Poulson-Rafinesque specimens were bought by the Academy of Natural Sciences of Philadelphia (ANSP) at the Charles Poulson Estate sale and have been part of the ANSP mollusk collection since 1866 (Anonymous 1866; Leidy 1867; Vanatta 1915; Johnson and Baker 1973). Two Rafinesque specimens in the ANSP collection are from the S.S. Haldeman collection. Haldeman very carefully copied all of the information from the Rafinesque labels into the right valve of the specimens, noting the origin of the information. The information is printed in pencil in a small, clear hand and signed S.S. Haldeman. Fortunately these two specimens are accompanied also by Rafinesque's original labels.

The ANSP Rafinesque specimens are accompanied by distinct labels written in Rafinesque's hand. Both valves of the specimens have the species number from Rafinesque's 1820 monograph written in ink. Each Rafinesque label has been pasted to the back of ANSP cardboard labels. The labels are rectangles of paper with the top line being the species name in the genus *Unio*. The species number used in the monograph (Rafinesque, 1820) may follow on the first line immediately or below as Monograph sp. number. The second line is the generic placement within Rafinesque's genera. Followed on the third line by the subgeneric placement. The bottom line often begins with Rafinesque's concept of rarity if rare or very rare followed by the locality.

Some of Rafinesque's specimens sent to Ferussac were identified by Johnson (1973). I identified 32 specimens Rafinesque sent to Ferussac in the mollusk collection at Museum National d'Histoire Naturelle (MNHN) and 10 possible Rafinesque specimens in the Brongniart Collection in the Geology collection of the MNHN. The ANSP and MNHN specimens are the only Rafinesque unionid specimens identified to date. The MNHN specimens are identified by diagnostic labels bearing Rafinesque's original identifications and annotations of the shells in Ferussac's handwriting. Ferussac noted on the label or on the valves that the specimens had been sent by Rafinesque.

I found a ledger sheet in the Museum of Natural History in Vienna, Austria, September, 1992 recording the receipt of six species and seven specimens of unionids from Rafinesque in 1827. However, at that time I was unable to locate the specimens in the collection.

Rafinesque's unionid specimens sent to Clifford, Elliot, Collins, Graham, Hart, Sowerby, Swainson and others have not been located or identified. Location of these specimens would help to clarify the confusion surrounding Rafinesque's described unionid species. Any information regarding potential Rafinesque unionid specimens would be very important. Please contact me at the above address with any information regarding Rafinesque specimens.

Anonymous. 1866. *Catalogue of the valuable scientific collections and library of the late Charles A. Poulson. Shells, fossils, and works relating to general natural history. The conchological collection being unique. To be sold at public sale on Wednesday, December 19th, 1866, at 3 O'clock, P.M. at Thos. Birch & Son's Auction Store, No. 1110 Chestnut Street.* Collins Printer. Philadelphia. 30 pp.

Binney, W.G. and Tryon, G.W. Jr. (eds.). 1864. *The complete writings of Constantine Smaltz Rafinesque, on Recent and fossil conchology*. New York, Baillier Brothers pp. [1-5], 6-96, [1],2-7, 3 pls.

Bogan, A.E. 1988. A bibliographic history of C.S. Rafinesque's work on North American freshwater bivalves. *Archives of Natural History* 15(2):149-154.

Johnson, R.I. 1973. The types of Unionidae (Mollusca: Bivalvia) described by C.S. Rafinesque in the Museum National d'Histoire Naturelle, Paris. *Journal de Conchyliologie* 110(2):35-37.

Johnson, R.I. and Baker, H.B. 1973. The types of Unionacea (Mollusca: Bivalvia) in the Academy of Natural Sciences of Philadelphia. *Proceedings of the Academy of Natural Sciences of Philadelphia* 125(9):145-186.

Leidy, J. 1867. *Proceedings of the Academy of Natural Sciences of Philadelphia.*

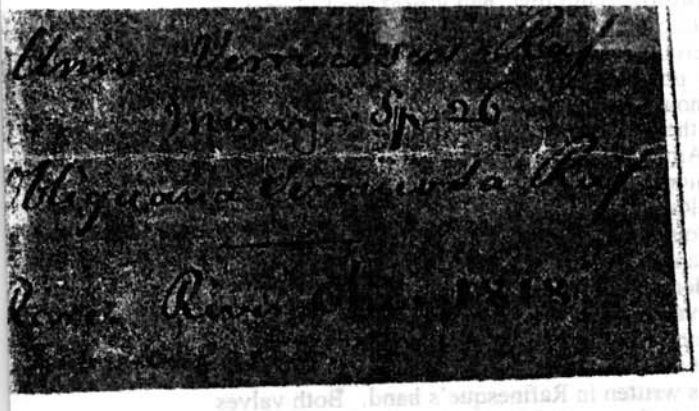
Poulson, C.A. 1832. *A Monograph of the fluviatile bivalve shells of the river Ohio, containing twelve genera & sixty-eight species*. Translated by C.A. Poulson. J. Dobson, Philadelphia, pp. [i-iii],iv-vi, [7-9], 10-70, frontispiece.

Rafinesque, C.S. 1820. Monographie des coquilles bivalves fluviatiles de la rivière Ohio, contenant douze genres et soixante-huit espèces. *Annales générales des sciences Physiques, a Bruxelles*, 15e livraison du 5e tome, pp. 287-322, pls. 80-82.

Rafinesque, C.S. 1831. *Continuation of a monograph of the bivalve shells of the river Ohio, and other rivers of the Western States. By Prof. C.S. Rafinesque (Published at Brussels, September, 1820.) Containing 46 Species, from No. 76 to No. 121. including an appendix on some bivalve shells of the rivers of Hindostan, with a supplement on the fossil bivalve shells of the western states, and the Tulosites, A new Genus of Fossils*. Philadelphia, October, 1831. pp. 1-8

Vanatta, E.G. 1915. Rafinesque's types of Unio. *Proceedings of the Academy of Natural Sciences of Philadelphia* 67:549-559.

Figures: Two examples of Rafinesque labels in the Academy of Natural Sciences of Philadelphia



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Research was conducted last spring at the University of Minnesota to determine suitable hosts for *Cyclonaias tuberculata*, the purple wartyback. Of fifty-one fish species tested, 2 channel catfish and 1 yellow bullhead facilitated metamorphosis of 23 juvenile *C. tuberculata*.

Further research will be conducted this spring. Fish previously identified as suitable hosts will be retested; additionally, thirteen other species will be evaluated. We would like to verify laboratory results with field observations but are having difficulty locating a stream or river which holds *C. tuberculata* and relatively few other mussel species. If you have *any* suggestions please contact: Mark Hove, 200 Hodson Hall, 1980 Folwell Ave., St. Paul, MN 55108., (612) 624-3019 or FAX (612) 625-5299 before the end of June, if possible. Please include your name, phone number, site location, mussel assemblage, and date site was last surveyed. Thank you.

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In January 1993, the Cookeville Office issued a biological opinion to the Louisville District, Corps of Engineers, concerning impacts to the endangered orange-footed pearly mussel from the proposed construction of the new Olmsted Lock and Dam on the lower Ohio River. The mussel is known to occur both upriver and downriver from the construction site. The Service was concerned that sedimentation, alteration of river flows, and disposal of dredged/excavated material could adversely affect the mussel and its habitat.

A "no jeopardy" opinion was issued, based on the Corps' agreement not to dispose of material in the river; to monitor the "health" of the mussel bed before, during, and for five years after construction; to employ state-of-the-art methods for monitoring sediment movement and accumulation; and to take corrective actions in the event that construction activities were found to be impacting the habitat. Sediment monitoring would be accomplished through the use of satellite-monitored sonar altimeters placed in arrays at four locations on the mussel bed. These altimeters would record changes in elevation of the river bed (sediment accumulation) and would be recorded on computers. A new technology would also allow the Corps to generate three-dimensional "maps" of the mussel bed. Comparison of these maps to data collected during mussel monitoring should allow us to determine which areas of the bed contain the highest densities of mussels.

Incidental take for this opinion was based on loss of habitat, determined by accumulation of sediment. Accumulation of two centimeters of sediment for a twenty-four hour period would constitute "take." The Corps would be required to take corrective action within twenty-four hours should sediment monitoring indicate that level of accumulation.

The Service also recommended that the Corps conduct studies on the impact of sediment accumulation on mussels, life histories of mussels in the lower Ohio River, and propagation techniques. We recommended that the Corps also investigate the feasibility of creating mussel habitat, such as creating "side channels" below locks and dams or constructing artificial islands with back chutes.

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The Cookeville Office reviewed an assessment prepared by the Nashville District, Corps of Engineers, in conjunction with TVA, regarding a proposal to employ various methods for control of zebra mussels. These agencies are concerned about the potential for zebra mussels to infest water intakes at steam generating plants and navigation locks. Various methods were evaluated, including mechanical cleaning, application of chemicals, oxygen deprivation, dewatering, and thermal shock.

The initial controls would be employed at Corps and TVA facilities on the Tennessee and Cumberland Rivers, but eventually may be used throughout the drainages. Some of the methods proposed could have significant adverse impacts on endangered mussels.

The Service is concerned about the potential for adverse impacts to mussels from implementation of several of the proposed controls. We recommended that the Corps and/or TVA consult with us as zebra mussel control becomes necessary at individual facilities.

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In December 1992, the Cookeville Office issued two biological opinions and two conference reports to TVA concerning a proposal to issue permits for operation of three chip mill facilities along the Tennessee River. These mills would process approximately 1.9 million tons of hardwood annually, obtained from a 42-county (approximately 12 million acres) "sourcing area" in Tennessee, Alabama, and Georgia. Five alternatives were under consideration: no action (denial of permits) and four issuance alternatives, each containing various protective measures.

The sourcing area for the mills covered portions of the Tennessee, Cumberland, Black Warrior, and Coosa River drainages. These drainages contain some of the best remaining mussel populations in the southeast. Consequently, TVA determined that one or more of the proposed alternatives might affect 79 federally listed, proposed, or candidate (status review) aquatic species. Thirty-six mussel species were included, 13 of which are listed and 8 proposed.

A "no jeopardy" letter was issued to TVA for Alternative 1 (no action). It was determined that TVA could not be held responsible for jeopardy to listed species if all permits were denied. However, based on review of available information, the status of the species involved, and evaluation of cumulative impacts, the Service determined that issuance of one or more chip mill permits under any of the four remaining alternatives would likely jeopardize the continued existence of 8 mussel species. Conference reports issued for the proposed species concluded that all 8 of the proposed mussels would likely be jeopardized by operation of one or more of the proposed chip mills.

If permits were issued, the Service would require TVA to implement reasonable and prudent alternatives to protect mussel species and their habitats. Submission of "pre-harvest" plans, establishment of vegetated buffer zones along streams in harvest areas, enforcement of pre-harvest plans and BMP's, maintenance of accurate records of the level of annual timber harvest, and annual meetings with the Service to discuss the effectiveness of these measures were among the required actions.

The biological opinions and conference reports also addressed incidental take of listed and proposed mussels and provided measures to minimize take.

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FERC and Mussels

The State of Wisconsin contains over 84 existing federally licensed hydropower facilities. Most of these facilities are undergoing FERC (Federal Energy Regulatory Commission) licensing or re-licensing. As part of this licensing, hydropower license applicants are required, under federal law, to consider natural resources along with power development. The states play an active consulting role in the 5 year licensing process with the FERC making the final license condition decisions. Licenses often permit hydropower operations in excess of 30 years.

Besides some of the more high-profile natural resource issues such as fish entrainment, mortality, fish passage and downstream flow regimes, attention has been paid to non-game species such as mussels. In particular, natural resource agency recommendations have included minimization of tailwater elevation fluctuations, impoundment water elevation fluctuations and drawdowns.

Another concern has been habitat and mussel population fragmentation. Pre-1980's inhospitable water quality conditions in Wisconsin is believed to have extirpated a significant portion of the state's mussel resource based on historic distribution records, theoretical calculations and recent findings of subfossil mussels. Recent FERC related field surveys have substantiated this hypothesis and have found no mussel recolonization in zones of water quality recovery. We believe the absence of recolonization is due directly to habitat fragmentation caused by dams and their impoundments. Host fish are unable to move upstream through dams from areas that contain greater mussel species richness. They also are restricted in their downstream movements and survival through turbines. Intervening impoundments which generally contain less that ideal habitat for mussels, serve as additional biological barriers.

One extreme example of the effects of dams and impoundments as biological barriers is the lowest dam on the Wisconsin River. Downstream of this dam 38 mussel species occur. In the riverine portion a short distance upstream of the dam, only 18 species occur. Several of the 20 missing species were recorded upstream historically indicating that they previously occurred there and river degradations extirpated them. No natural biological barrier occurred near the dam site which would account for this abrupt community composition change. Also, a total of 15 fish species occur downstream of the dam and not upstream.

Because translocation of mussel communities has been only marginally successful in the past (due to high mortality), upstream and downstream passage of host fish is the preferred mitigation option. In the absence of dam removal, adequate upstream and downstream fish passage facilities, the only other alternative to ensure recolonization is active mussel and host fish translocation although not the preferred alternative. This alternative has been recommended by the Wisconsin DNR at several projects. In addition to mussels, this strategy is being attempted for fish.

Reproductive biology of *Quadrula metanevra* in Kentucky Reservoir, Tennessee River, Tennessee

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We have just completed a study of the reproductive biology of *Quadrula metanevra* in Kentucky Reservoir, Tennessee River, Hardin Co., Tennessee. Specimens were collected from July 1988 through June 1990 between TRM 200 and TRM 201.3. Histological preparations of the visceral mass, containing the gonadal tissue, were made from each specimen. Gametogenesis was quantified in males by examining transects across a sample of acini in each specimen. Ten acini were examined per specimen in five specimens per sample date. Gametogenesis was quantified in females by measuring the diameters of oocytes along a transect across the entire section of tissue. Fifty oocytes were measured per specimen in five specimens per sample date.

Spawning occurred in both sexes during mid-winter (late December or early January). The process continued through mid summer (late July). Mature glochidia were found in the marsupia of adult female *Q. metanevra* from late March through July. Spawning appeared to be roughly correlated with water temperature, starting when the water temperatures began to rise from their lowest point in winter and continuing until they reach their highest point in summer. In males, the highest rate of gametogenesis appeared to occur during the spring and fall, with reduced production of gametes just prior to spawning. In females, the production of new oocytes appeared to cease during the fall months, but continued for the ramainder of the year.

The sex ratio of the population was 1.45:1 (females to males). Hermaphroditic individuals made up 1.8% of the population. All of the hermaphrodites appeared to be functionally male, with only small numbers of female acini scattered throughout the primarily male gonads. In a comparison of shell morphology between the sexes, no significant differences were found.

Development of an artificial diet for juvenile mussels, preliminary results

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The staff at the Aquatic Resources Center has been working toward developing methods of maintaining juvenile unionids under controlled conditions. The primary objectives of the work are as follows:

1) Development of facilities capable of holding the juveniles, delivering water to them at a controlled rate and removing wastes and contaminants.

2) Determination of appropriate nutrients for the maintenance and growth of juvenile mussels and delivery of these nutrients in a form that is readily usable by them.

Initial experimentation with keeping juveniles in a static system were unsuccessful. The juveniles in these experiments were kept in beakers (100 ml to 250 ml) and the water was changed periodically (from once a day to once every three days). A system with periodically flowing water was recently constructed. This system consists of a pump, which is set on an electric timer, that delivers water to a series of small troughs via PVC piping. Before reentering the small reservoir, the water is passed through activated carbon. Tap water, which has been passed through an organic removal cartridge is used in the system.

Using the static method of juvenile mussel maintenance, we had little success in the early experiments on the determination of an appropriate source of nutrients for juveniles. Both algal diets and artificial diets were tried. However, since the construction of a water circulation system, our results have improved. We have maintained juveniles (*Anodonta imbecillis*) on artificial diet for over 50 days (after transformation *in vitro*). The diet consisted of nothing but dissolved nutrients, including sugars, amino acids and vitamins. The juveniles of this culture died when a toxic substance was introduced to the system, apparently during cleaning. They appeared healthy on the day prior to cleaning the system. The fifty day old juveniles were over 0.5 mm in length, and were developing the oblong shape characteristic of adults. Some of the juveniles were supplied with silt, while others were not. The juveniles maintained on artificial diet without silt fared much better that the ones with available silt. Heavy growths of fungi and bacteria were present in the treatments with silt. Most of the experimentation has been with *A. imbecillis*, but other species successfully transformed using *in vitro* methods include *Anodonta grandis*, *Ligumia recta*, *Megalonaias nervosa* and *Arcidens confragosus*.

Work continues on modification of the system, as well as the artificial diet. No attempts have been made to feed juveniles an algal diet in the circulation system. It may prove impractical to do so. An attempt will be made to determine the role of bacteria, as well as the dissolved nutrients in the survival of the juveniles in the system.

A Survey of the Mussel Fauna of the Upper Hiwassee River , Tennessee

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An unimpounded ca. 12 mile stretch of the Hiwassee River flowing between the Apalachia Dam, North Carolina, and the Apalachia Powerhouse, Tennessee has provided an opportunity to document and evaluate a naiad assemblage unaffected by altered substrate and extremes in meter depth and current typically resulting from the generation of power by hydroelectric dams. This unique habitat is the result of water being diverted from the dam to the powerhouse in an 18-foot diameter "tunnel" that follows along the top of the river bluff.

Collections made by us between July and December 1992 in this stretch of the Hiwassee River, Polk County, Tennessee, yielded a total of 2,600 specimens representing 11 species. Except for two specimens of *Lampsilis ovata*, all shells collected were those of individuals taken by muskrats. *Elliptio dilatata*, *Fusconaia barnesiana*, *Villosa iris* and *Villosa trabalis* are the four most abundant species inhabiting this stretch of the river; the latter mussel is included on the federal list of Endangered and Threatened Wildlife and Plants. A surprising discovery was that of a small population of the federally endangered species *Epioblasma florentina walkeri*, possibly the only one extant in Tennessee.

In an effort to supplement records of present taxa known from the river by determining the former preimpoundment - prehistoric mussel assemblages, collections of shell from two late preshistoric aboriginal sites and a former Cherokee village located along the river were studied. Based on these data, a minimum of 28 mussel species presently occur, or did occur prior to 1750, in the Hiwassee River. A manuscript dealing with the freshwater mussels of the Hiwassee River is nearly completed and will be submitted for publication.

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Community Action Called to "Rescue the Riffleshell"

A collaborative effort to save the northern riffleshell mussel arose among local businesses and citizens, the City of Detroit, Michigan Department of Natural Resources, and the U.S. Fish and Wildlife Service amid growing concern over the rapid decline of native unionids in the Great Lakes following the zebra mussel invasion. Bill Kovalak of the Detroit Edison Company led the rescue mission, which removed northern riffleshell mussels *Epioblasma torulosa rangiana* from Detroit River sediments heavily infested with zebra mussels and transplanted them in the less heavily infested sediments of the St. Clair River. Don Schloesser from Region 8, Sue Walker and John Cooper from Region 3, and Tom Weise from the Michigan Department of Natural Resources played active rolls in this effort.

Freshwater mussels have decreased in diversity, abundance, and range in the Great Lakes and its tributaries because of pollution and habitat destruction and degradation. At the turn of the century, 36 species of freshwater mussels lived in the Detroit River. In 1990 a Belle Isle Aquarium survey found only 21 species. Pockets of remnant mussel populations remain in the area; one pocket occurs in the Detroit River off Belle Isle. Biologists hoped pollution control measures instituted in the Great Lakes region during the past 30 years would stimulate recovery of native mussel populations. This hope faded as scientists, including Don Schloesser at the National Fisheries Research Center -- Great Lakes, documented the effect of zebra mussels on native fauna. Zebra mussels form large masses on native unionids that impede unionid movement and prevent them from closing their shells. There is little doubt that zebra mussels are responsible for the death of freshwater mussels in the Great Lakes. These observations provided the incentive for organizing a rescue mission.

A group of scientists and citizens selected the northern riffleshell, the most endangered of the remaining mussel species in the Detroit River, for the rescue effort. The northern riffleshell's original range included tributaries of the Ohio River, western Lake Erie, and the St. Clair and Detroit Rivers. Channelization, stream bank clearing, agriculture, and chemical and waste water runoff reduced its range by 95 percent. By the 1980's, it occurred in short reaches of six streams in Kentucky, Michigan, Ohio, Pennsylvania, and the upper 2.0 miles of the Detroit River from Lake St. Clair to Belle Isle. Field collections by biologists in August and September 1992 emphasized the urgency of the rescue mission. They found no unionids on the Canadian side of the Detroit River and although some live unionids still existed in U.S. waters, the number of zebra mussels attached to them was similar to the infestation preceding the disappearance of unionids in parts of western Lake Erie. Biologists believe most of the surviving unionids in the Detroit River will die in 1993.

This mission was conceived in March 1992 and executed on October 10, 1992. The rescue group consisted of volunteers including 50 scuba divers from several police departments, 20 Boy Scouts, 6 biologists, and 50 community volunteers. The dive crew, in radio contact at all times with the Detroit Harbor Master's office, collected mussels. Runners transported northern riffleshell mussels, heavily encrusted with zebra mussels, to the shore crew who removed the zebra mussels, and put the cleaned northern riffleshells in holding cages. By the end of the day, volunteers had collected and cleaned 110 northern riffleshell mussels. Twenty-five of these mussels are on public display in the Belle Isle Aquarium; the remainder were transplanted. Everyone agreed they had a great time at "Rescue the Riffleshell."

Any follow planned

The fate of the northern riffleshell and other mussels in the Great Lakes is uncertain. At the time of the rescue mission, the northern riffleshell was on the list of endangered species for the State of Michigan. The Fish and Wildlife Service designated this species and the clubshell mussel (*Pleurobema clava*) Federally Endangered species, effective February 22, 1993. This volunteer effort and similar efforts elsewhere may be necessary to protect other native unionids from extinction.

Tre!

METABOLIC EFFECTS OF SUSPENDED SOLIDS ON UNIONID MUSSELS

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ABSTRACT

Freshwater unionids are an important ecological and economic resource. Their numbers have been declining at astounding rates and many species have already become extinct. Habitat alterations, especially increased amounts of suspended solids entering water systems, are thought to be a leading cause of mussel declines. The purpose of this research was to determine if high concentrations of suspended solids found commonly in rivers and streams in Indiana interfere with normal metabolism in Quadrula pustulosa (Lea 1831), Amblema plicata (Say 1817), and Lampsilis radiata (Lamark 1819). Metabolic shifts that occur in mussels and other aquatic poikilotherms resulting from decreased uptake and/or assimilation of food and oxygen have served as useful indicators of environmental stress.

Metabolic parameters (oxygen consumption rate, total ammonia nitrogen excreted, food clearance rate, and the oxygen to nitrogen ratio) were measured in individual mussels under controlled laboratory conditions before and after exposure to suspended solids and under field conditions after exposure to ambient concentrations of suspended solids in Little Pine Creek. Our results do not support the conclusions of Aldridge et al.(1987). Significant differences in physiological parameters were not detected in Q.pustulosa and A.plicata after exposure to 500 and 1000 mg/l bentonite clay when compared to controls. However, physiological parameters changed significantly over time, suggesting an overall decline in health of mussels maintained under control and treatment conditions. In support of this conclusion, significant differences in physiological parameters were found between field collected and laboratory held populations of Q.pustulosa and L.radiata. Oxygen to nitrogen ratios were significantly greater in laboratory held mussels while the other physiological parameters were generally less in the laboratory held individuals when compared to field collected individuals. Oxygen consumption and food clearance rates, which were the most reliable parameters in L.radiata, were significantly lower in individuals of L.radiata maintained at a first order region of Little Pine Creek than in individuals maintained at a third order region of the stream, suggesting a difference in condition caused by water quality. The upstream site was higher in suspended solids and nutrients, but lower in temperature during that time.

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Mussel Surveys of Commercial Important Mussel Beds in the Wabash and East Fork White River, Indiana

The first year of a three year study designed to determine the distribution, species composition, and population structure of mussel beds in Indiana's primary commercially harvested river segments has been completed. Mussel beds in selected river reaches were located with a crowfoot brail rig as well as through conversations with commercial mussel harvesters. One hundred and sixty miles of the Wabash River and East Fork White River were brailed. Representative mussel beds in various sections of each river were selected for quantitative sampling. Sample design included randomly placed 1 m^2 quadrants along transacts and a more intensive 100 m^2 sample in which 30 m^2 were searched by divers. Each mussel located was identified to species and measured (anterior posterior length). Specimens located in the 100 m^2 area were marked and returned to the capture location. Population age structure of commercially valuable species is being determined from annular rings observed by thin sectioning of shells.

A total of 52 species were observed within the study area during the 1992 sampling year. While 37 species were found alive 15 species were found only as freshly dead shells (2 species) or relic shells (13 species). In addition to the commercially valuable species the federal endangered fanshell, *Cyprogenia stegaria* was located as a freshly dead shell in the Wabash River but was found alive at several mussel beds in the East Fork White River, Martin County. The federal endangered rough pigtoe, *Pleurobema plenum* was also found alive in the East Fork White River. Four federal and 4 state listed endangered species were found only as shells. Of these only the state endangered rabbitsfoot, *Quadrula cylindrica cylindrica* was found as a freshly dead shell.

Quantitative sampling will be repeated in the 100 m^2 plots in 1993. Additional 100 m^2 plots will be established at other locations in the study area and will be sampled 1993 and repeated in 1994.

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Mussel Habitat Suitability and Impact Analysis of the Tippecanoe River

The Tippecanoe River flows through north central Indiana and empties into the Wabash River near Delphi, Indiana. The northern third of the river, characterized by gravel substrates and moderate flow, flows through the Northern Lakes Natural Region and is particularly rich in fish and unionid fauna. The extreme headwaters may be acting as a refugia for species (both fish and unionids) which were once widely distributed throughout the river. Parts of the upper river are being degraded by sedimentation, as well as, pesticide and metal input from point and non-point sources. The middle third of the river flows through the Kankakee Sand Natural Area. Substrates were sand and pea gravel, a substrate not particularly suitable to unionids. The area probably never supported a dense unionid fauna, but the collection of many species as weathered shells indicates a rich unionid fauna once occurred there. A few areas with cobble and gravel, riffle and run habitat were found in the middle river and unionids were abundant in these areas. The lower river flows through the Tipton Till Plain section of the Central Plains Natural Region; a high gradient area with gravel and rubble substrate. Two reservoirs in this section appear to limit fish and unionid distribution. The downstream most reach is heavily influenced by the Wabash River, as many species (both fish and unionids) common in the Wabash River are limited to this reach of the Tippecanoe River.

Tributaries often serve as refugia for many species in the event of a mainstem catastrophe. Tributaries feeding the Tippecanoe River, however, generally had poor water quality and/or were modified. Only six "creeks" were identified that merited sampling. Of these only two harbored live individuals, Trimble Creek and Chippewanuck Creek; two contained mostly weathered shells and a few freshly dead shells, Mill Creek (Fulton County) and Moots Creek; and two contained only weathered shells, Walnut Creek and Big Creek.

Evidence was found of five Federally Endangered Species: *Cyprogenia stegaria*, *Epioblasma obliquata perobliqua, Epioblasma torulosa rangiana, Pleurobema clava,* and *Pleurobema plenum. Pleurobema clava* was collected live throughout the river and is reproducing in the headwaters between Ormas and Site 3, upstream of Warsaw. *Cyprogenia stegaria* was collected live at four sites in the lower river, but may not be reproducing. Only weathered shells of *E. o. perobliqua, E. t. rangiana*, and *P. plenum* were encountered. The *E. t. rangiana* shells collected may be fairly recent. *Epioblasma triquetra, Simpsonaias ambigua,* and *Villosa fabalis,* all Federal Category 2 species, were collected at several sites. Other Indiana Endangered unionid taxa in the Tippecanoe River include *Plethobasus cyphyus* and *Quadrula cylindrica,* currently extant; *Pleurobema pyramidatum,* for which only a relic population remains; and *Fusconaia subrotunda,* which may be extirpated from the river. Three additional Tippecanoe River unionid species collected live in this study (*Lampsilis fasciola, Pleurobema cordatum,* and *Villosa lienosa*) are of Special Concern Status in Indiana.

Several rare fish species occur in the Tippecanoe River, however, their range within the river is currently restricted compared to historic records. No Federally Endangered fish species were collected, however one Federal Category 2 species, eastern sand darter, was collected at two locations. This species was absent from two areas of previous record (Rochester and Delong). Three Indiana Endangered fish species were collected in this study (bluebreast darter, Tippecanoe darter, and gilt darter) as well as one Species of Special Concern (river redhorse). Tippecanoe darter was collected near Winamac, and in the lower river where it was particularly abundant. Gilt darter was only collected near Delong, and was absent from previously recorded sites downstream of Warsaw. Bluebreast darter was rare, but present in the lower river and was absent upstream of the reservoirs. River redhorse was collected only in the lower river. Spotted darter and blue sucker were not collected in this study.

The Tippecanoe River is unique among midwestern streams, in that it still retains excellent fish and unionid habitat as well as species diversity. Much of the original fauna still resides in the river, however, species once widely distributed are now restricted in distribution. Many Tippecanoe River species no longer reside in the Wabash River or in Tippecanoe River tributary streams, leaving no source of recolonization in the event of a catastrophe. This study recognized two high diversity areas in the river: the extreme headwaters and downstream portions. A few areas rich in unionid and fish fauna were also identified in the middle river. We suggest management efforts focus on these regions.

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Report: A draft report, "Environmental Contaminant Impacts of Highway Runoff on Freshwater Mussels, Swift Creek, Nash County, North Carolina", was released by the Raleigh Ecological Services Office for peer review and comment in December. Kate Benkert, former Raleigh Environmental Contaminant Specialist, initiated this study to identify contaminants present near highway stream crossings and to assess the impacts of highway runoff waters on freshwater mussels. The report provides data on elemental contaminants, petroleum hydrocarbons, and polycyclic aromatic hydrocarbons in composite samples of soft tissues from *Elliptio complanata*.

Total aliphatic hydrocarbons (average 0.70 ppm-wet weight; maximum 1.19 ppm) were over 20 times greater in mussels downstream of Interstate 95 relative to upstream reference specimens; levels in downstream mussels indicate chronic low level aliphatic hydrocarbon pollution. Because of the fast depuration rate of aliphatic hydrocarbons, levels well above those identified in this study may be present in mussels receiving highway runoff following rainfall. A final report will be available in June.

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Report: The Raleigh Ecological Services Office is starting a field assessment of freshwater mussel exposure to cholinesterase-inhibiting pesticides in cooperation with the U.S. Fish and Wildlife Service Cooperative Fish and Wildlife Research Unit (NC Coop Unit) at North Carolina State University. The NC Coop Unit has conducted dose-response toxicity studies with organophosphorus and carbamate compounds on freshwater mussels. These two common classes of pesticides operate by inhibiting cholinesterases (ChE), enzymes critical to normal nerve impulse transmission. The NC Coop Unit studies refined the ChE-inhibition assay, commonly used to diagnose organophosphorus and carbamate poisonings of birds, for freshwater mussel applications. The Raleigh Ecological Services Office field testing of the NC Coop Unit protocols will evaluate their utility in documenting in-situ exposure of *Elliptio complanata* to ChE-inhibiting pesticides. Sampling began this month and will continue through this summer. Preliminary results will be offered in future issues of the Triannual Unionid Report.

Greetings to all my collegues of the Unionoida! Research on freshwater bivalves at the Los Angeles County Museum of Natural History is currently directed primarily on members of the Lampsilinae, and secondarily on members of the Central American and South American Mycetopodidae. Should you happen to be working on either of these groups, or planning studies of the same - GREAT! I strongly encourage you to pursue the subject and will do everything I can to lend support in that effort. As a personal philosophy, I would like to see other malacologists working on all of the above taxa. The "Why?" is history. I presented a paper on lanceolate Elliptio at the Ft. Lauderdale meeting of the A.M.U. in 1981. The morning of my paper, I was approached by a prominent malacologist who asked me to reconsider and withdraw my paper from the session as he had recently submitted a research proposal to NSF to fund research on the same group of Elliptio. I did not comply with this request; however, it did serve to instruct me that any individual researcher does not "own" exclusive research rights to any given taxon. Furthermore, valid scientific research does not operate in such a manner, for if it did, medical science might never find cures for cancer, etc. Also, I know of no malacologist who uses all available research methods in their investigations, primarily because if they did it would mean publishing only one paper every ten years.

How can you help? Needed are living gravid females of the type species of each lampsiline genus, taken from the type locality, or at least from the same river drainage as that of the type locality. Living gravid females may be shipped overnight via FED-EX at my expense. Specimens should be packed with one package of "artificial ice" on the bottom of the container with a layer of crumpled paper toweling to insulate the bivalves from the coolant. Specimens are useless without full documentation of the following: locality of collection ("X" on roadmap or latitude and longitude if known), depth of collection, substrate type, date of collection, and name of collector. Write for shipping container, coolant and billing number. Potential collectors should possess or obtain Fish and Game scientific collection permits from the state in which they plan to collect. PLEASE DO NOT ATTEMPT TO COLLECT OR SEND ANY SPECIES THAT IS CURRENTLY LISTED AS ENDANGERED! This is a request for voluntary assistance towards increasing our knowledge of the biology of freshwater Unionoida. All assistance will be gratefully acknowledged. Unfortunately, the Los Angeles County Museum of Natural History does not permit its employees to conduct exchanges with individuals who are not institionally based. If you are employed by a museum, federal or state wildlife agency, or a university and wish to exchange specimens, please send me your list of needed species, and desired state of preservation (ie. dry shells, anatomical, frozen tissue). Please write me and I will be happy to share with you.

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OLD-TIME MUSSEL COLLECTORS FOUND ALIVE AND WELL IN FLORIDA

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Have you ever been vexed and miffed over an inability to locate an historic collecting site due to the usage of long forgotten place names on the original labels? I have long stewed over the location of sites like "Fleming's Mill, Pea River, Coffee County, Alabama" and "Sam Stacey's Landing, Choctawhatchee River, Walton County, Florida", sites with potentially valuable, but unplottable, records. So much so that I decided to take a stab in the dark and call the local historical society in Coffee County to seek an "oldtimer" to ask about the Fleming's Mill locality. A couple of phone calls later, I was conversing with Clayton Metcalf, a member of the Pea River Historical Society. He told me he was unsure as to the old mill site, but offered a guess based on some anecdotal information. Not exactly what I had hoped for, but I was better informed than before. Then he asked me why I wanted to know the information. After my reply, he stated that he used to collect mussels with an uncle in Florida decades ago. When I asked him the name of his uncle, he told me D.B. Gillis, a name I had seen dozens of times in shell lots housed in the Florida Museum of Natural History! I was shocked! Then he told me he also knew a collector friend of Gillis, Louis M. Rushing, whose name I had also seen in numerous collections at the Museum. And to my further surprise, he said Rushing lived in DeFuniak Springs, as did Gillis's brother, Harold, another collector! D.B. Gillis, I found, had died in 1934.

On 7 April 1993, Jim Williams and I had the rare opportunity to meet with these two gentlemen, the first to collect unionids in the lower Choctawhatchee River system in the Florida Panhandle. In fact, the material they obtained, all collected in 1933 and 1934, continue to be the only unionids known from a significant portion of the lowermost mainstem and a couple of tributaries as well. Dr. Thompson H. van Hyning, the founder and first director of the Museum in Gainesville, got the Gillis' interested in collecting mussels for the museum while on a trip to find the site of an old pottery maker very near their Knox Hill home in Walton County, a few miles west of the river. Until Jim and I made contact with Madison and Gillis, we had been unable to put dots on maps for records of several species to be included in an upcoming volume on rare and endangered mussels in Florida. Several of their collections formed the basis for range extensions and new river records for *Amblema perplicata, Glebula rotundata, Medionidus penicillatus,* and *Villosa villosa*, and provided the only known sites for *Ptychobranchus jonesi* in Florida, all records I cited in a recent paper (*Walkeriana*, 1989, 3(10): 239-261). Thanks to Messrs. Rushing and Gillis (and a highly serendipitous phone call!), we now know the location of most of the heretofore unknown Choctawhatchee River place names that have bugged us for years.

UNIONID RESEARCH REPORT

Influence of hydrilla density and the aquatic herbicide fluridone upon the unionid mussel *Elliptio buckleyi*.

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Development of dense, expansive, beds of *Hydrilla verticillata* in Florida's Lake Okeechobee, and use of certain chemical control methods, generated concern from Florida Game and Fresh Water Fish Commission biologists that resident unionid mussel populations might be negatively affected. The SRP (pelleted) formulation of the aquatic herbicide fluridone (trade name Sonar) was used, experimentally, to treat hydrilla infested areas. The prospect of siphoning mussels ingesting concentrated herbicide from fragmented pellets prompted *in situ* and laboratory bioassays using *Elliptio buckleyi*. To ascertain hydrilla effects on mollusc populations, densities of *E. buckleyi, Corbicula fluminea* and *Viviparus georgianus* were estimated beneath three hydrilla densities, and in control areas, using SCUBA and 1/4 meter square quadrats.

Seven days prior to fluridone treatment, caged *E. buckleyi* were placed in treatment and control areas. Cages were constructed from fence wire having a mesh size which allowed enclosed mussels to maintain a normal siphoning orientation. Each enclosure contained ten specimens; two enclosures were placed in plots slated for fluridone treatment and two were placed in a nearby control area. Enclosures were examined 24 hours prior to treatment, with zero mortalities observed. After treatment, enclosed mussels were first examined on a weekly, then biweekly, schedule. After 140 days, treatment and control site mortalities were equal. Survival rate was 95%.

Static laboratory bioassays at 1X, 10X and 100X the highest recommended SRP application rate of 125 μg fluridone/l produced no mortalities after 7 days.

Results of density surveys revealed that *E. buckleyi and C. fluminea* populations declined significantly as hydrilla increased from zero to sparse coverage and from sparse to dense coverage. We attribute these differences to accumulation of oxygen demanding detritus beneath hydrilla beds.

These studies were instituted as a component of a larger project using aquatic invertebrate communities to assess trophic status and water level fluctuations effects upon the biota of Lake Okeechobee. The work was partially funded by federal Wallop-Breaux expansion monies.

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ENVIRONMENTAL CHANGE AND EVOLUTION IN FRESHWATER MOLLUSKS

My study will consider how climate change and the formation of new habitats effect species evolutionarily using the aquatic molluscan fauna of the Great Lakes and their tributaries. This fauna invaded the Great Lakes from southern refugia after the retreat of the ice sheets about 12,500 b.p. Phylogenetic analysis of DNA sequences will be used to deduce the evolutionary relationships of populations of species of gastropods and unionid bivalves from several different habitats and geographic locales. In conjunction, morphometrics will be used to discern the relationship between morphological change, ecophenotypic effects and evolutionary change in species.

To study these effects on a shorter time scale I will analyze populations from the Erie Canal, which was opened in 1825 and subsequently invaded by organisms.

Changes at the end of the Pleistocene profoundly altered the distribution of the freshwater molluscan fauna of North America. Major environmental events have been hypothesized to play an important role in either mediating the stability of species or directing their change, and this study will test this. Studying how species responded to profound environmental changes in the past will also help us predict their response to the equally profound changes in the environment wrought by humans.

This work is being funded by an NSF grant and I will be working with Elisabeth Vrba at Yale University as a postdoctoral fellow. The unionid taxa I will be concentrating on are Amblema plicata (Rafinesque, 1820) and Lasmigona costata (Rafinesque, 1820) and the prosobranch gastropod is the pleurocerid Elimia livescens (Menke, 1830). I would like to sample localities of each of these species from throughout their range in the Ohio-Missippi River Drainage System and in the Erie Canal, and I hope to do a substantial amount of collecting in the upcoming year. I would be very appreciative if any scientists in the course of their collecting might be able to collect specimens of these taxa from any localities and freeze them, if they happen to come across any. In addition, I would be glad to pick up specimens of any taxa that anyone else is interested during the course of my collecting. Moreover, if anyone knows of any particularly rich localities for these taxa I would be grateful if they could let me know.

TRIANNUAL UNIONID REPORT

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The following list describes major activities performed under the commercial musseling project conducted by the TWRA and are detailed in the 1992 Commercial Musseling Report.

Commercial Harvest Survey: The commercial harvest survey revealed that the ebony shell (*Fusconaia ebena*) ranked first in number (42.59%) and weight (36.53%) harvested, followed by the 3-ridge (*Amblema plicata*) at 30.33% by number and 28.75% by weight (sample size = 11,593 mussels). These two species combined to produce 72.92% by number and 65.28% by weight of the total harvest during the survey. Other top ranked species include mapleleaf (*Quadrula quadrula*) (9.23%, 9.02% by number and weight) and washboard (*Megalonaias nervosa*) (6.48%, 15.84% by number and weight). No Federally listed endangered species were encountered during the harvester survey. Price data collected from shell buyers showed prices paid for shell remained fairly constant during the survey period. Average price/lbs ranged from $0.55 - $4.36 depending on species and grade.

Population Surveys: Portions of 16, 5-mile reaches were surveyed, 10 on the Tennessee and 6 on the Cumberland River. The population surveys include data collected from 4 mussel sanctuaries and 1 management study area. Density estimates were collected from 2 sites on the Cumberland and 7 sites on the Tennessee River. Growth rates observed for commercial mussels were highly variable with location. Generally, mussels collected from shallow overbank habitats displayed the fastest growth. Average size and age were calculated by river system for the sub legal and legal size groups of commercially important species. Nine *Lampsilis abrupta* (from 3 sites on Tn and 4 sites on Cm) were the only Federally listed endangered mussels collected during population surveys on the Tennessee and Cumberland Rivers. The Cumberland River produced 543 mussels representing 26 species. Samples collected in the upstream reaches (above river mile 250) were composed mainly of large, older specimens typical of populations in decline. Cold water releases have evidently all but eliminated mussel reproduction in this area, and it is likely that mussel populations will cease to exist in this reach in the near future. *M. nervosa* was the dominant species collected from the Cumberland River. *Q. quadrula* is beginning to reach harvestable size in some overbank areas of Barkley Reservoir.

Sampling efforts on the Kentucky Reservoir portion of the Tennessee River yielded 2,821 mussels from 25 different species. Most of the commercial species were of sub legal size. Indicating that mussel stocks are being harvested as soon as they attain legal size. *F. ebena* was the dominant species collected from Kentucky Reservoir, followed by *Q. quadrula* and *A. plicata*. The highly sought *M. nervosa* made up only 5.8% of samples collected. Legal sized individuals of this species were rare (0.18% of mussels collected) due to the extreme pressure of commercial harvest.

Age and Growth Study: An experiment to determine growth rate and verify formation of annual growth rests was begun. Five species of commercially valuable mussels were divided into groups, individually measured and marked, and assigned to specifically numbered cages. Three-fourths of each cage was filled with a clay, sand, gravel substrate and placed into excavated holes in an overbank habitat location. The mussels will be removed on an annual basis to monitor viability and growth.

March 23, 1993

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The Virginia Cooperative Fish and Wildlife Research Unit is continuing research on the biology and recovery of freshwater mussel populations. As of spring, 1993, four M.S. students, one Ph.D. student, and technicians are conducting projects on freshwater mussels. The brief narratives that follow provide synopses of their research as well as projects being conducted cooperatively by other faculty and personnel affiliated with the Unit.

1. Freshwater mussels of the Ohio River basin: an educational poster. L. A. Helfrich (Fisheries and Wildlife) and R. J. Neves.

   The continued existence of freshwater mussels in the Ohio River basin will largely depend on the degree of public support for mussel protection and recovery programs. However, many people perceive the conservation of mussels, as well as other invertebrates, as unnecessary and wasteful of government funds. This poster, along with the video and teacher's guide which are under development, informed the public of the plight of freshwater mussels; their aesthetic, scientific, and ecological significance; and the value of maintaining these organisms as a component of natural stream ecosystems. Five thousand copies of the poster were printed and are being distributed within the Ohio River watershed.

2. Fish host and propagation studies of endangered freshwater mussels. A. Bond (technician), R. J. Neves, G. G. Schurig (Vet Med), and G. S. Libey (Fisheries and Wildlife).

   All recovery plans specify propagation as a key element in the restoration of these species. The objectives of this project, financed with Section 6 funds from Virginia and Tennessee, are to induce the metamorphosis of several hundred thousand glochidia to juveniles and to propagate the juveniles up to a size suitable for introduction to historic habitats in the upper Tennessee River drainage. Artificial media are being tested to be able to transform glochidia to juveniles without need of a host fish. The medium developed by TVA has been only of limited success. Commercially available media and rabbit serum are being tested for suitability.

3. Development of a diet for raising recently metamorphosed juvenile freshwater mussels. C. M. Gatenby (M.S.) and R. J. Neves.

   This project is being conducted as a component of the previously described study. Objectives of this study are to determine the influence of silt on cultured juveniles, develop a diet for rearing newly metamorphosed juveniles,

and compare growth and survival of juveniles produced from host fishes. Experiments are underway using a tri-algal diet and juveniles of the rainbow and giant floater mussels. Anticipated completion date on this project is fall 1993.

4. Life history of the endangered dwarf wedgemussel. D. L. Michaelson (M.S.), R. J. Neves and P. L. Angermeier.

This mussel species once occurred in at least 70 locations in 15 Atlantic coast rivers from New Brunswick to North Carolina, but is now known from few locations. Extant populations are small and apparently declining because of environmental degradation. This study is collecting biological and ecological data on dwarf wedgemussel populations in the upper Tar River, North Carolina and Aquia Creek, Virginia to provide recommendations for recovery. Specific objectives are to describe the reproductive cycle, identify fish hosts, obtain population statistics, and identify threats to the species. A total of 15 fish species were tested as hosts; three hosts (2 darters, 1 sculpin) have been identified. Valves of specimens collected from the Tar and Neversink rivers, and Aquia Creek were sectioned and are being analyzed for age class structure and growth rates. Laboratory studies of preference for substratum type and water velocity after 7 day trials also were completed. A thesis is expected in summer 1993.

5. Distribution of the James spinymussel in streams of the Jefferson and George Washington National Forests. M. T. O'Connell (technician) and R. J. Neves.

This challenge cost-share agreement was established to determine the distribution of the endangered James spinymussel in streams of two national forests in Virginia. The Forest Service requested this study so that they can plan management activities which could potentially impact the spinymussel and its habitat. Most streams within national forest boundaries have no mussels. However, specimens were collected in the Pedlar River within and downstream of Forest Service land. This project began in fall 1990 and has completed surveys for this species in the two national forests. An assessment of siltation problems in streams with the James spinymussel will be completed in spring 1993.

6. Endangered mussel surveys for the Virginia Department of Transportation (VDOT). R. J. Neves.

A cooperative agreement between VDOT and Virginia Tech was established to provide mussel surveys at roadway and bridge projects as requested by VDOT. The Unit conducts each survey for a fixed price, and funds are used to provide stipends for graduate students. Two projects were completed in 1992 and at least one bridge project is scheduled for 1993.

7. Production of a video on freshwater mussels. L. A. Helfrich and R. J. Neves.

In this century, more than one-third (39%) of the Ohio River system's mussel fauna has been extirpated, listed as endangered or decimated to the point that federal protection is being considered. No other faunal group in the continental U.S. has experienced this degree of change within historic times. This project will produce a half-hour video program to increase the public's awareness of the decline of this faunal group and their riverine ecosystems in the greater Ohio River basin. The intended audience will be high schools, civic groups and other public forums. A draft video has been distributed for agency comment, and the final version is expected in April 1993.

8. Cryopreservation of the early life stages of freshwater mussels. C. Chang (M.S.), G. G. Schurig and R. J. Neves.

Several federally endangered species survive as isolated populations, and the prognosis for their continued survival is gloomy. Unless the genetic material contained in these species can be preserved within this decade, further extinctions will result in the permanent loss of this biodiversity in U.S. rivers. This project is testing current methods in cryogenics to cryopreserve the glochidia or embryos of freshwater mussels. A student from China began his thesis research in fall 1991 in the College of Veterinary Medicine and is being co-advised by the principal investigators. Embryos of the asian clam and glochidia of mussels are serving as test organisms. The extraction, purification, and cryophilization of DNA from foot tissue has been completed, and current research is focused on cryopreservation of embryos or glochidia. This project is scheduled for completion in fall 1993.

9. Source of pollutants influencing point and nonpoint toxicity to the mussel fauna in the Clinch River. D. S. Cherry (Biology), J. L. Farris (Arkansas State) and R. J. Neves

The decline of mussel fauna in the Clinch River appears to be caused by a general degradation of water quality and habitat. This project will attempt to identify various types of point and nonpoint discharges that may contaminate sediments above and below Carbo, quantify mussel and asian clam densities at these sites, and determine the degree of sediment toxicity that may be inhibiting recruitment. One Ph.D. student is doing the sediment toxicity work, another Ph.D. student is studying mussel distributions relative to stream hydrology and hydraulics, and a M.S. student is evaluating differences in growth and age class structure of mussels among sites in the Clinch River. The work is being conducted cooperatively with biologists from AEP. The

Unit is providing technical assistance and serving on committees of three graduate students in Biology.

10. Propagation of juvenile freshwater mussels at the Clinch River Steam Plant, Carbo, Virginia. B. B. Beaty (Ph.D.), R. J. Neves, D. S. Cherry and J. L. Farris.

The recent reduction in copper outputs from the power plant at Carbo, Virginia has improved environmental conditions in the river reach between Carbo and St. Paul, Virginia. Because natural recovery of the freshwater mussel fauna will require decades, the seeding of that reach with juvenile mussels should expedite the recovery process. The goal of this study is to demonstrate the feasibility of on-site production of juvenile mussels at the Clinch River Steam Plant for the subsequent restoration of mussel populations below Carbo. The artificial river channel at the site will be used to compare growth and survival of naturally produced and medium-produced juveniles. Field research will begin in spring 1993.

11. Translocation of freshwater mussels to the North Fork Holston River below Saltville, Virginia. R. J. Neves.

Freshwater mussels were virtually eliminated below Saltville, Virginia because of chronic contamination (mercury) from industrial effluent. Closing of the plant in 1972 and clean-up of this EPA Superfund Site over the last 5 years has created an environment suitable for re-introduction of mussels. The purpose of this study is to translocate mussels of common species to two sites on the North Fork below Saltville and to monitor survival semi-annually. Two sites were selected in 1991, and 8 species of mussels were moved to these sites. In August 1992, both sites were resurveyed, and numerous mussels remain at these locations. The success of these transplants will be evaluated over the next 3 years.

12. Feasibility of protecting Virginia's freshwater mussels from the zebra mussel invasion. J. W. Burress (M.S.) and R. J. Neves.

The zebra mussel invasion into the upper Tennessee River system in southwest Virginia may jeopardize many mussel species if impacts are similar to what has been reported in the Great Lakes. Because the zebra mussel likely will build to a high density and then crash to some level of carrying capacity, it seems appropriate to create a reservoir of reproductive age adults of as many species as possible, should the native populations be drastically reduced in abundance. This project proposes to assess the suitability of suspended culture of mussels. Adult of common riverine species will be suspended in the water column from rafts and monitored for survival, growth

and reproductive state. If successful, then several endangered species will be proposed for testing in this refugium. About 200 mussels were placed in cages in August 1992 at a farm pond in Critz, VA. Additional species and cages are planned for 1993 at a state fish hatchery.

13. Development of techniques for holding riverine freshwater mussels in farm ponds and raceways. J. W. Burress (M.S.) and R. J. Neves.

This project will attempt to demonstrate the feasibility of maintaining and spawning adult mussels in farm ponds and possibly raceways, and to culture juvenile mussels in those farm ponds. Early studies by the U.S. Bureau of Commercial Fisheries indicated that some juvenile mussels could survive and grow in crates floated in the Mississippi River. This proposed study will make use of the 2 farm ponds owned by Virginia Tech at Critz, VA to rear juvenile mussels in fine mesh baskets suspended below the water surface. Fine sediment will be placed in the baskets, and juveniles produced naturally and in our artificial medium will be used to seed those baskets. Field trials will begin in spring 1993.

14. Cellulolytic enzyme assay analysis of mollusks in the Clinch River, Virginia. J. Farris, D. Cherry and R. J. Neves.

The mussel fauna in the Clinch River has experienced a precipitous decline in the last 10 years, to include 8 federally endangered species and numerous candidate species. Because water quality degradation or environmental contaminants are suspected of contributing to this decline, an assessment of the general health of freshwater mussels is needed. The purpose of this project is to use a relatively new technique, cellulolytic enzyme assay, to identify stress in bivalves at sampling sites within the Clinch River drainage. Problem sites identified by this technique will be evaluated further to identify causes for the physiological stress. Field and laboratory assistance by graduate students and FWS personnel will provide assay experience for all participants.

15. Development of recovery plans for 18 endangered fish and mussel species in Virginia. M. L. Warren (post-doc), R. A. Smogor (technician), and P. L. Angermeier.

In 1991 the Virginia Department of Game and Inland Fisheries recognized 13 mussel and 5 fish species as endangered within the Commonwealth. This project includes developing recovery plans and coordinating a recovery team, with the ultimate goal of species recovery and delisting.

16. Culture of juvenile freshwater mussels in a recirculating downweller system. R. J. Neves.

As a result of successful efforts to develop a suitable algal diet for juvenile mussels, it is now feasible to expand efforts for culturing juveniles for several months prior to release. A new greenhouse addition to the Aquaculture Facility will provide sufficient space and light conditions to attempt to rear juveniles in sediment-filled troughs and to culture algae for feeding. Funds are being sought from our Regional Office in Massachusetts to conduct this work. Anticipated starting date on this project is fall 1993.

17. Physiological tolerances of freshwater mussels to environmental parameters. A. Heath (Biology) and R. J. Neves.

In a recent review of scientific literature on mussels by the U.S. Fish and Wildlife Service, few data are available on the tolerance limits of adult mussels to such water quality parameters as dissolved oxygen, temperature, chlorine, ammonia, and other pollutants routinely discharged into freshwater ecosystems. To establish water quality criteria for this family of animals, laboratory testing of behavioral response and tolerance is needed. This proposed project will test numerous species of mussels to attempt to define levels of water quality parameters exhibiting no observable effect. Dr. Heath is a fish physiologist with a Ph.D. student interested in working with adult mussel physiology. We hope to obtain funds from FWS-Raleigh to establish water quality criteria for various genera and species of mussels in North Carolina.

Study 1: Survey of the Freshwater Mussels of the ACF Basin
Study 2: Holding Unionids in Captivity - Preliminary Trials

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At the National Fisheries Research Center in Gainesville, we are working on two projects involving the freshwater mussels of the Apalachicola, Chattahoochee and Flint (ACF) rivers.

I. Survey of the Freshwater Mussels of the ACF Basin

The Apalachicola, Chattahoochee and Flint (ACF) rivers form one of the largest drainages in the eastern Gulf coastal plain. Historically these rivers were known for their rich unionid populations, with as many as 45 species reported from the basin. A comprehensive study of the mussels of these rivers and their tributaries has not been done. Six species of mussels, four of which are endemic to the ACF basin, are of particular concern and are candidates for federal listing as threatened or endangered species (Federal Register, 1991).

In 1991 the U.S. Fish and Wildlife Service began a two year study to determine the status of the six candidate species. A thorough literature and natural history museum search was conducted to obtain published and unpublished reports of unionids in the ACF basin, and to evaluate the historic range and occurrence of the candidate species.

In the summers of 1991 and 1992, collections were made, using SCUBA divers, at over 300 sites in the channels and tributaries of the ACF rivers. Specimens were relaxed, preserved and identified. The reproductive condition of live animals was evaluated where possible. The current distribution and abundance were determined for candidate species, as well as for other unionids in the ACF system.

A manuscript describing the survey results is in preparation. Several of the six candidates will be proposed for listing as threatened species at the federal level, because of low population levels and restricted ranges. In addition, several other species will be designated as new candidates for listing. A variety of factors may have contributed to dwindling mussel populations, including irrigation practices, impoundments, channelization, siltation and contaminants.

Nearly all species of unionids appear to be extirpated from the main stem of the Chattahoochee River. Historically, this river was one of the most productive sites for collecting mussels in the entire eastern Gulf drainage. Mussel populations in the Flint River also are in decline. In order to protect this diminishing fauna, conservation efforts must be refocused to an ecosystem approach.

2. Holding Unionids in Captivity - Preliminary Trials

The decline of many populations of freshwater mussels throughout the southeastern United States has made it imperative that these animals be held successfully in captivity for a variety of reasons, including restocking into less degraded areas. We are currently conducting a preliminary holding experiment to determine the survivorship and growth of mussels held in captivity.

Nine species of freshwater mussels were collected, using SCUBA divers, from the lower Apalachicola River in Liberty Co., Florida. In December, 1992, all mussels were placed in an alizarin red bath for 72 hours, and the height, length and weight of each individual were recorded. Mussels were then placed in floating cages, with half of the mussels placed in substrate, and the other half left free on the bottom of the cage. This was done to evaluate the position in which they were held. For replication, three cages were used, and all cages were placed in a 3,000 gallon tank supplied with well water, which was fertilized to stimulate an algal bloom.

Daily readings were made of dissolved oxygen, temperature, pH and turbidity. The height, length and weight of the mussels were recorded monthly. No mortality was observed until April, 1993, when approximately 25% of the mussels were found dead. The cause of the mortality is not known at this time, but unusually high pH levels may be implicated.

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Report: A literature review was initiated in 1992 to evaluate unionid relocation as a conservation strategy. The preliminary results of the literature review were presented at the Upper Mississippi River Conservation Committee Symposium on the "Conservation and Management of Freshwater Mussels" convened in St. Louis, Missouri on October 12-14, 1992.

We are now preparing a formal literature review paper on unionid relocation as a conservation strategy that will be published in the peer-reviewed literature. We are also preparing a U.S. Fish and Wildlife Service, Research Information Bulletin (RIB) that will be published prior to the journal article to meet the immediate information needs of managers and researchers.

We would appreciate receiving any available information on unionid relocation at the above address for this review.

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Report: Research was initiated in 1991 to develop methods for safely collecting, handling and relocating freshwater mussels. A pilot study was conducted in October 1991 and completed in May 1992. Threeridge mussels (Amblema plicata plicata) were relocated into a marked study area following handling and air exposure treatments of 0, 10, or 60 min. The mortality of mussels was not significant in the controls or treatments. Recovery of marked mussels exceeded 90%.

In June 1992, a second study was initiated to examine the effects of handling and time out of water on four additional mussel species under different seasonal conditions and longer exposure periods (0, 1, 4, or 8 h). During the spring sampling period, exposure to the air for up to 4 hours did not cause significant mortality in any of the species. Mortality of mussels in 8 h treatment was higher than that of other treatment groups, but the difference was not significant. However, only recovered mussels were used to calculate the percent mortality. The recovery of small mussels in the 8 h treatment was low and mortality may have been underestimated.

A fall trial was conducted in October 1992 and a summer trial is planned in 1993.