...spiny mussel proposed for inclusion on the ... Endangered Species. Supplementary studies ... in the lower Roanoke River System (13 sites) ... Neuse River System (14 sites) to assess the ... occurrence of *E. steinstansana* there.

... River System is highly productive and, except ... below Rocky Mount, has good water quality. We ... species there of which 14 are Unionidae. The whole ... is being impacted by *Corbicula fluminea* which ... there in 1979 or 1980. By the summer of ... dominant (ca. 1000/M^2) below Old Sparta and ... N.C. Hwy. 44 north of Tarboro. By the summer ... ascended an additional 40 miles to near Spring ... soon be conspicuous throughout the system. ... Roanoke River below Lake Gaston is heavily ... only fresh empty shells of *Anodonta implicata* ... *complanata* and abundant *Corbicula*. In a ... Cashie River (a Roanoke tributary), we found ... of *Anodonta implicata* and *Lampsilis ochracea*, ... of *Ligumia nasuta*, and no *Corbicula*. The ... between Raleigh and Seven Springs yielded ... *complanata*, a rare unionid of unknown identity, ... Among Neuse tributaries, the Trent River is ... Trenton and apparently has no mollusks ... Little River is productive and supports a diverse

Additional Species Found

Actinonaias carinata
Amblema plicata
Anodonta grandis grandis
Anodontoides ferussacianus
Carunculina parva
Cyclonaias tuberculata
Elliptio dilatata
Fusconaia flava
Lampsilis radiata siliquoidea
Lampsilis ventricosa
Lasmigona complanata
Lasmigona costata
Leptodea fragilis
Ligumia nasuta
Ligumia recta
Obliquaria reflexa
Obovaria olivaria
Pleurobema coccineum
Proptera alata
Ptychobranchus fasciolare
Strophitus undulatus
Truncilla donaciformis
Truncilla truncata
Villosa iris

... NAIAD MOLLUSCS OF THE DETROIT RIVER. ... M. **Freitag,** U.S. Army Corps of Engineers, Detroit

...gh not a planned survey, qualitative mussel ...ons were made at two shore sites on the Detroit ...dge site near the mouth in Gibraltar, Michigan, in ...om near the head of the river on Belle Isle, De... in 1983 and 1984. Dredge site shells, although ...aring recent, are probably from long-dead in... shells from Belle Isle were from muskrat middens ...ad vestiges of flesh. Some live individuals were ...ities of several species suggest that reproduction ...ace. Species composition was similar at both ...al of 29 recent species were found at Belle Isle. ...ndangered species were: *Dysnomia torulosa ran...mpsoniconcha ambigua,* and *Villosa fabalis*. ...t species were: *Dysnomia triquetra* and *Obovaria* ... Detroit River museum specimens of species not ...is survey were: *Alasmidonta marginata, Alasmi...s, Lampsilis fasciola* and *Quadrula quadrula*. Liter...rds of *Anodonta imbecillis, Lasmigona compressa* ...*drula pustulosa* are probably accurate since these ...e found in adjacent waters. However, the literature ... *Fusconaia subrotunda* is probably in error and the ... *Leptodea leptodon* is doubtful. The presence of the ...ndangered species, *Dysnomia sulcata delicata*, in ... River is doubtful, since the identity of museum ...ens is uncertain and no recent specimens have been ...he original fauna of the Detroit River consisted of ... species.

AN EXAMINATION OF SOME C.S. RAFINESQUE NORTH AMERICAN UNIONID TAXA (BIVALVIA: UNIONIDAE). Arthur E. Bogan, Department of Malacology, Academy of Natural Sciences of Philadelphia, Pennsylvania, **Lynn B. Starnes,** Tennessee Valley Authority, Knoxville and **James D. Williams,** Office of Endangered Species, U.S. Fish and Wildlife Service, Washington, DC.

The work of Samuel C. Rafinesque during the early half of the 19th century in natural history has long been a source of confusion and aggravation. His work examined here is restricted to those papers which discuss freshwater bivalves (1818–1832). Rafinesque's publications follow close upon the heels of Lamarck and Say's work on North American unionids and are contemporary with the works of Barnes, Conrad, Hildreth and the early work of Isaac Lea. Major problems with Rafinesque's freshwater bivalve work have been claimed by numerous authors. These problems include: lack of type materials or the deposition of materials in collections where the specimens could be examined, poor and inadequate descriptions, inadequate or no illustrations, and publication in obscure or inaccessible journals. A point of major concern at the time was Rafinesque's excessive splitting of what were then considered good species or genera. A major factor in the rejection of Rafinesque's unionid work was Isaac Lea's publication of a list of 108 Rafinesquean specific names as unidentifiable, while recognizing only 16 Rafinesquean specific names in his four synopses of the Unionidae (1836–1870). This attitude was further entrenched by the observations of Amos Binney about the sad state of Rafinesque's mental health. The rejection of Rafinesque's names

and the general belief that most of his taxa were unrecognizable from their descriptions led C. T. Simpson to treat most Rafinesquean names as *nomina dubia*. Interestingly, Simpson missed some 20 species names coined by Rafinesque. This trend continues today. A complete tabulation and thorough examination of all the generic, specific, and varietal names has never been presented. We present a tabulation of his generic, specific and varietal level taxa. The list includes 34 generic and subgeneric names, 124 specific names and 55 varietal names. We specifically consider Rafinesque's species which have known extant types (61 species). The final picture which emerges of the work of Rafinesque is not that of a sick, deranged crackpot, but a dedicated eccentric naturalist with insufficient patience or funds, who was many years ahead of his time. As Bryant Walker observed, many of Rafinesque's names will have to be accepted based on a close examination of the original work and extant shell materials; other Rafinesquean names will obviously fall into synonomy, while many others will remain as either *nomina nuda* or *nomia dubia*.

OCCURRENCE AND DISTRIBUTION OF JUVENILE FRESHWATER MUSSELS IN A THIRD-ORDER STREAM. James C. Widlak, Virginia Cooperative Fishery Research Unit, V.P.I. & S.U., Blacksburg.

Potential habitats of juvenile mussels were systematically sampled to document their location and abundance. Fifteen quadrat samples (573 cm^2) were collected from each of three habitat types (riffle, run, pool) and two microhabitats (behind rocks, along banks). The 75 substratum samples were sieved into 5 particle size classes, and substratum composition was determined as percentage of total dry weight. Each fraction was examined for juvenile mussels under a dissecting microscope.

A total of 66 juvenile mussels were found ranging from 0.8–25.1 mm in length; 51% were found behind rocks, 19% in riffles and runs, 9% in pool habitat, and 2% along stream banks. Young-of-year (age 0) mussels were most abundant behind rocks, and older juveniles (age I–III) occurred in habitats similar to those of adult populations. Juveniles had a clumped distribution, apparently surviving better in riffles and behind rocks than in other habitats. Population stability appears to be maintained by the large number of age classes rather than high juvenile recruitment each year.

VALIDATION OF ANNULUS FORMATION ON FRESHWATER MUSSEL SHELLS AND A COMPARISON OF TWO AGEING TECHNIQUES. Steven N. Moyer, Virginia Cooperative Fishery Research Unit, Virginia Polytechnic Institute and State University, Blacksburg.

Age composition and growth characteristics of freshwater mussel populations are determined almost exclusively from external growth checks (annuli) on shells. However, shell erosion, environmentally-induced checks, and the obscurity of growth checks near shell margins usually result in approximate ages for this faunal group, particularly among older specimens. An internal ageing method involving thin-sectioning of valves was used to achieve the following objectives: 1) validate the deposition of one annulus each year and 2) compare the utility of the thin-sectioning technique to counts of external annuli on valves.

To validate annulus deposition, mussels of four species were collected, tagged or marked, measured, and returned to three streams in southwestern Virginia. Following a set time period (1 to 3 years), tagged mussels were recovered and their shells examined internally and externally for the occurrence of annuli. Annulus formation was documented on many specimens representing all four species. Slow growth (< 1 mm/yr) prevented annulus confirmation on the remainder of recovered specimens.

Comparison of the internal and external ageing techniques was completed using specimens of *Fusconaia ebena* and *Pleurobema oviforme* aged by both methods. Counts of external growth checks on valves consistently underestimated ages of specimens when compared to ages obtained by thin-sectioning. The thin-sectioning technique was the most accurate for ageing freshwater mussels and should be used, particularly for older specimens.

EFFECTS OF CONTAMINANTS ON NAIAD MOLLUSCS (UNIONIDAE): A REVIEW. Marian E. Havlik, Malacological Consultants, La Crosse, Wisconsin and **Leif L. Marking,** National Fishery Research Laboratory, La Crosse, Wisconsin.

The literature contains numerous reports on uptake by shell, storage in tissues, and elimination of contaminants; information on toxic effects of contaminants to naiad mollusks is limited. Contaminants appear to have destroyed naiad populations and entire beds in some instances directly by toxic effects or indirectly by eliminations of food organisms or host fish. Fry of fish infected with 20–35 naiad glochidia were more sensitive than uninfected fish when exposed to toluene, naphthalene, and crude oil. Manganese seems to be the element that is most readily taken up and stored in tissues; some reports indicate tissue concentrations in thousands of ppm and suggest that the element is important in metabolism. Zinc and cadmium also accumulate at high levels in tissues. Concentrations of contaminants that were toxic to naiad mollusks were 16 ppm of arsenic trioxide, 0.1 ppm of copper, 10 ppm of copper sulfate, 700 ppm of phenol, 11 ppm of potassium, 1000 ppm of Thimet or Satox, and 3 ppm of ammonia. In long-term exposures, concentrations of copper as low as 25 ppb were lethal to naiades. Although specific impacts of contaminants on naiades are evident in the literature, circumstantial evidence leaves little doubt that contaminants are responsible for decreases in population density, range and diversity. Few long-term toxicity tests have been done to assess sublethal effects or effects on growth and reproduction. The assignment of individual stresses responsible for the disappearance of naiad mollusks in contaminated areas is difficult or impossible with existing information. Rarely have individual components been quantitatively and qualitatively correlated with the composition and size of the naiad fauna, especially for contaminants