Walkerana, 1995-1996, 8(19): 81-105

STATUS SURVEY OF THE LITTLE-WING PEARLYMUSSEL, *PEGIAS FABULA* (LEA 1838)

Steven Ahlstedt[1,2] and Charles Saylor[1]

ABSTRACT — Mussel sampling for the Little-Wing Pearly Mussel, *Pegias fabula*, was initiated in July, 1984, under Memorandum of Agreement No. 14-16-004-84-927 between the United States Fish and Wildlife Service, Endangered Species Field Office, Asheville, North Carolina, and the Tennessee Valley Authority. The status survey was conducted to determine the species rarity and its possible candidacy for federal listing. Historically, this endemic species was considered rare and known from 24 stream reaches, all tributaries of the Tennessee and Cumberland river systems. Sites chosen for sampling were locations where the species had previously been documented. Extant populations were found to occur in the upper North Fork Holston (Tennessee River system) and the Little South Fork Cumberland River, Horse Lick Creek, and Cane Creek (Cumberland River system). Since completion of this study the species has been documented from the upper Clinch and Little Tennessee rivers, and the Big South Fork Cumberland River. The Little-Wing Pearly Mussel is extremely rare, and was federally listed in November 1988 as endangered.

Key words: Tennessee River, Cumberland River, Unionidae, *Pegias fabula*.

INTRODUCTION

The Tennessee and Cumberland River systems possess an extremely diverse freshwater mussel fauna. Included are many endemic forms characteristic of the Cumberland Plateau region, an area which encompasses portions of seven States bordering the southern Appalachian Mountains. This geographic area is considered an important center for mussel speciation, and endemic forms occurring in this region are referred to as Cumberlandian.

The U.S. Department of Interior presently lists 23 North American freshwater mussels as endangered; 13 of which are endemic to the Tennessee and Cumberland River drainage basins. The current status of the Little-Wing Pearly Mussel, *Pegias fabula,* an endemic Cumberlandian species, is presently being studied to determine if the species should remain on the Federal list of threatened and endangered species.

---

[1] Tennessee Valley Authority, Office of Natural Resources, Norris, Tennessee 37828, U.S.A.; prepared for the Endangered Species Field Office, United States Fish and Wildlife Service, Room 224, 100 Otis Street, Asheville, North Carolina 28801, U.S.A. The data presented here constitute the Final Report for Contract No. 14-16-0004-84-927.

[2] Present address: United States Geological Survey, 1013 North Broadway, Knoxville, Tennessee 37917, U.S.A.

DESCRIPTION

Pegias fabula was described by Isaac Lea (1838) as *Margaritana fabula* with the type locality "Cumberland River, Tennessee." The species is a member of the family Unionidae, subfamily Anodontinae. The subfamily includes two tribes: Anodontini and Alasmidontini (Morrison, 1956; Clarke & Berg, 1959; Clarke, 1981). The tribe Anodontini contains the genera *Anodonta, Anodontoides* and *Strophitus,* which are Holarctic in distribution and characterized by relatively thin, unsculptured shells with absent or rudimentary hinge teeth. The Nearctic tribe Alasmidontini contains nine genera including *P. fabula.* These genera are characterized by thickened shells, which may be sculptured, and the presence of pseudocardinal hinge teeth. Lateral teeth are developed in most species with an interdental projection (Clarke, 1981).

Pegias fabula (Fig. 1) attains a size of 35 mm long, 22 mm high and 12 mm wide (Simpson, 1914). Shells are thickened anteriorly, becoming relatively thin posteriorly with a sharp posterior ridge preceded by a wide radial depression that ends in a basal sinus. The anterior margin is semicircular and evenly rounded while the ventral margin is flatly curved anteriorly and straight or concave posteriorly. The posterior margin is bluntly pointed above the midline, obliquely truncated below, and angular or bluntly pointed again at its junction with the ventral margin. Beaks project slightly above the hinge line and are of moderate width, bluntly pointed, and located approximately one-third the distance from the anterior to posterior margin of the shell. Beak sculpturing consists of heavy, subconcentric ridges most prominent and persistent on the posterior ridges, but are usually obliterated in most specimens because of heavy shell abrasion. Growth rests are apparent but not gener-

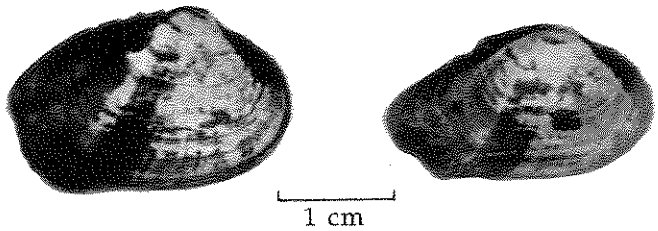

FIG. 1. *Pegias fabula* (Lea 1838), male (left), female (right). (Photo courtesy of Dr. Paul Parmalee, Frank H. McClung Museum, University of Tennessee, Knoxville).

ally strong, especially in older specimens. The periostracum is usually eroded giving a chalky or ashy white appearance. When present, the periostracum is light green or dark yellowish brown with broad to smaller dark rays apparent along the anterior portion of the shell. The hinge ligament is short, narrow, dark brown, and located immediately behind the umbo region. Hinge teeth are also well developed. The left valve has an irregular triangular pseudocardinal tooth, sometimes with the vestige of another tooth in front of it. Lateral teeth are short, vestigial, or entirely absent. The right valve has a single triangular pseudocardinal tooth in front of the beak. Beak cavities are deep and compressed with sunken anterior muscle scars. The nacre is whitish on the anterior border and usually salmon or flesh colored in the beak cavities (Simpson, 1914; Clarke, 1981; Bogan & Parmalee, 1983). The species is sexually dimorphic, a trait unknown in other species of alasmidontines (Simpson, 1900, 1914; Ortmann, 1914; Stansbery, 1976).

DISTRIBUTION

Historical

Lea (1838) first reported *"Margaritana" fabula* from the Cumberland River, Tennessee, and later (as *Margaritana curreyiana*) included the Stones River, a Cumberland River tributary near Nashville, Tennessee (Lea, 1840). Stansbery (1976) reported its former presence from Tennessee and Cumberland drainage streams in Virginia, Kentucky, Tennessee and Alabama. In the Cumberland River system, Stansbery included records as far downstream as the West Fork Red River, Todd County, Kentucky. Down-stream limit in the Tennessee River system appears to be Blue Water Creek, Lauderdale County, Alabama. All known records indicate a distribution limited to tributaries of the Tennessee and Cumberland River systems. Based on these records, *Pegias fabula* is strictly a Cumberlandian species endemic to the southern Appalachian Mountains and the Cumberland Plateau region (Ortmann, 1925). Historic and fossil records for this species are presented in Table 1.

LIFE HISTORY AND ECOLOGY

The life history of *Pegias fabula* is unknown, but is probably similar to other unionids in that a fish host is required for the species to

complete its reproductive life-cycle. Recent field observations indicate that the banded sculpin (*Cottus carolinae*) and the redline darter (*Etheostoma rufilineatum*) were observed nesting and/or hiding under large flat rocks and present on gravel shoals' where *P. fabula* was found. These fish may be candidate hosts for this species. Numerous crayfish also were observed under large rocks where specimens were found; however, crayfish have never been identified as hosts for freshwater mussels.

Gravid females reported in September and October indicate *Pegias fabula* is a winter or long-term brooder (bradytictic), holding glochidia from midsummer to spring of the following year (Ortmann, 1914; Starnes & Starnes, 1980; Clarke, 1981). During this study, gravid specimens were found laying on top of the substrate in late September in the North Fork Holston River (Smyth County, Virginia) and Horse Lick Creek (Rockcastle County, Kentucky). Nongravid or spawned females were also observed in Cane Creek (Van Buren County, Tennessee) in March 1986. In Cane Creek, specimens were buried into the substrate but were obtained by searching under flat rocks and digging into the substrate. This suggests the only time this species comes up out of the substrate is during spawning and probably accounts for the eroded shell condition of specimens observed.

Pegias fabula is known only from smaller, cool, high gradient tributary streams. As with almost all Cumberlandian mussel species, *P. fabula* is strictly a riffle species. Blankenship (1971), while sampling Horse Lick Creek, reported specimens laying on top of the substrate, free to be moved by churning water. Starnes & Starnes (1980) reported specimens in the Little South Fork Cumberland River either partly buried or on top of the substrate in the transition zone between a long pool and riffle. Di Stefano (1984) reported six specimens from Horse Lick Creek buried in gravel and sand substrate, and under large rocks.

Wilson & Clark (1914) considered the species rare after collecting only two live specimens during an extensive survey of the Cumberland River drainage. The rarity of the species throughout historic and recent times may be attributed to it being overlooked due to its small size and often eroded condition, or its occurrence in high gradient streams located in inaccessible areas. An additional factor may be the short time (spawning period) when specimens are near the substrate surface where they can be observed. This phenomenon has been observed for other rare or uncommon mussel species which were found to be less rare than was previously thought (Ahlstedt, 1991a).

Further, most mussel surveys are conducted during low flow periods in warm water conditions (summer or early fall). Using wet suits while sampling for mussels in water temperatures between 50° and 70°F during late spring (May and June) and late fall (October and November) has yielded numerous species that were observed partially buried or laying on top of the substrate spawning (*e.g., Quadrula intermedia, Q. sparsa, Dromus dromas, Epioblasma capsaeformis, E. brevidens*). Resampling those same locations during warmer water conditions has yielded fewer specimens, and then only after extensive digging.

METHODS AND MATERIALS

Because of widespread distribution and limited funding, sampling for *Pegias fabula* occurred at locations where the species had been reported since the mid-1960s. Those sites were examined first to (1) update these records, (2) determine habitat requirements, and (3) refine species-specific sampling techniques. A number of streams within the species geographic range were not searched because mussel surveys conducted in the late 1970s and early 1980s did not include records of the species. Some smaller streams previously unsampled were searched in hopes of finding new populations. A list of collection sites, including totals for all mussel species found, is presented in the Appendix (Table A-1).

Field sampling was conducted at various dates between June 1984 and March 1986 during clear, low-flow conditions. Many of the streams sampled were too shallow to float-survey due to small size and drought conditions; therefore, sampling was conducted at locations accessible by road. Each set of locality data was taken from 1:24,000 topographic maps and consisted of the following: stream name, landmark, date, river mile or highway location, county, and state. Shoal (riffle) and pool areas were sampled by snorkeling. All small mussels observed were removed from the substrate, sorted and identified. Larger mussels observed were often not collected because of the single purpose of the survey. Occasionally, a garden rake was used to disturb gravel and sand substrates and then searched for exposed mussels.

At sites where live *Pegias fabula* were found, 10 random square-meter quadrat samples were collected to provide population estimates. Quantitative sampling consisted of placing a metal square-meter sampling frame on top of the substrate. Starting from the downstream edge of the sample frame, all rocks and rubble were removed from the area down to a depth of 76 mm. All substrates were searched for mussels (including *Corbicula fluminea* and *Sphaerium* sp.); animals found were sorted, identified, counted, and recorded on field data sheets. (Large numbers of *C. fluminea* in Little South Fork Cumberland River precluded counts of that species.) Voucher specimens were preserved in 10% formalin and taken to the TVA fisheries laboratory in Norris, Tennessee, for cleaning, verification and storage. No live federally listed endangered mussels were taken as voucher specimens. Voucher specimens were deposited with the Academy of Natural Sciences, Philadelphia, Pennsylvania.

In addition to instream sampling, streambanks were searched for shell middens. All fresh-dead shells (*i.e.,* evidence of flesh attached to the shell and/or shiny nacre with hinge ligament intact) were identified in the field, recorded on field data sheets, and placed in cloth collecting bags with an appropriate field identification label.

Museum records for *Pegias fabula* cited in this report (Table 1) were extrapolated from published reports and personal contacts with field biologists and museum cura-

tors. Records cited represent the most current information available on the distribution of this species.

RESULTS AND DISCUSSION

Since the early 1970s, live specimens of *Pegias fabula* were known from only one tributary stream in the Tennessee River drainage and four streams in the Cumberland River system. Eight live specimens were reported from the upper North Fork Holston River at Nebo, Virginia (Stansbery, 1972; Stansbery & Clench, 1974; Clarke, 1981), and one live specimen was found in the North Fork Holston River at Broadford, Virginia, in 1984 (Dr. Richard Neves, Virginia Polytechnic Institute and State University at Blacksburg, Virginia, personal communication). To date, these are the only records of the species from the Tennessee River system, aside from relict or subfossil specimens (Table A-1).

In recent years, tributaries of the Cumberland River contained the largest extant populations of *Pegias fabula.* Specimens have been reported from the Little South Fork Cumberland River, Rockcastle River, Horse Lick Creek, and Buck Creek. The lower 21 km of the Little South Fork reported the largest population at Freedom Church Ford and Ritner Ford (Starnes & Starnes, 1980; Starnes & Bogan, 1982). Live specimens were also found in the Rockcastle River and lower 14 km of Horse Lick Creek, a tributary to the Rockcastle River (Blankenship, 1971; Blankenship & Crockett, 1972; Harker *et al.,* 1980; Di Stefano, 1984; Glen Fallo, Eastern Kentucky University at Richmond, personal communication). In 1983, Fallo collected one live specimen approximately three km above the mouth of Horse Lick Creek. Recently, Thompson (1985) searched extensively throughout the Rockcastle River system including the Middle and South Forks without finding a single specimen of *P. fabula.* During the present study, one relict shell was found in the Rockcastle approximately three km above the confluence of Horse Lick Creek.

Stansbery (1976) collected one live specimen of *Pegias fabula* from Buck Creek at Stab, Kentucky, in 1974. Recent sampling in Buck Creek during this investigation at four sites (Kentucky routes 461, 39, and 70 bridge crossings) failed to locate any specimens. Additional mussel sampling throughout Buck Creek by Eastern Kentucky University students (Dr. Schuster, Eastern Kentucky University at Richmond, personal communication) have also failed to produce any evidence of its continued survival in this stream.

Robert Butler (Eastern Kentucky University at Richmond, personal

communication) found fossil specimens of *Pegias fabula* in Pittman Creek during summer 1984. During this study, Pittman Creek near Somerset, Kentucky, was sampled at five sites but no specimens were found (Table A-1).

Herb Athearn (Cleveland, Tennessee, personal communication) reported live specimens of *Pegias fabula* in the mid-1960s from the Collins River at Shellsford Bridge and Irving College near McMinnville, Tennessee, and Cane Creek at Sweetgum where a large number (38) of specimens were reported. All three sites were intensively sampled during the present study with live specimens found only in Cane Creek.

Based on museum records and published surveys, this species was historically reported from Wallen Creek, tributary to the Powell River; Valley Creek, tributary to the Watauga River; and Blue Water Creek, tributary to the lower Tennessee River (Ortmann, 1918, 1925; Stansbery, 1976; Dr. Arthur Bogan, personal communication, 1985). Recent sampling in each of these streams found no evidence of its continued existence.

Recent sampling by a number of individuals have failed to find additional populations of *Pegias fabula* from the following Tennessee River tributaries: Elk River (Ahlstedt 1983, 1991b), Duck River (Ahlstedt, 1981, 1986), Powell River (Neves *et al.*, 1980; Ahlstedt & Brown, 1980, 1991b; Dennis, 1981, 1985), Clinch River (Stansbery, 1973; Bates & Dennis, 1978; Neves *et al.*, 1980; Dennis, 1985; Ahlstedt, 1991a), Copper Creek (Ahlstedt, 1981), South and Middle Forks Holston River (Stansbery & Clench, 1978; Neves *et al.*, 1980; Dennis, 1985), Holston River (Ahlstedt, 1991b), and Big Mocassin Creek (Neves & Sale, 1982; Dennis, 1985). In the Cumberland River system it is believed extirpated from the Rockcastle River (Thompson, 1985), Buck Creek (Dr. Schuster, personal communication 1985), Pittman Creek, (Robert Butler, personal communication), Stones River (Schmidt, 1982), and Collins River (Herb Athearn, personal communication 1985).

As a result of this survey, live and fresh-dead specimens of *Pegias fabula* were found only in the upper North Fork Holston River above Nebo, Virginia (Fig. 2), Little South Fork Cumberland River at Kidds Ford Crossing, Kentucky (Fig. 3), Horse Lick Creek, Kentucky (Fig. 4), and Cane Creek at Sweetgum, Tennessee (Fig. 5).

Sampling in the upper North Fork Holston at seven sites produced six specimens of *Pegias fabula* (three live, one fresh-dead, and two relicts) at route 622 bridge above Nebo. The single female collected was gravid. A total of 10 square-meter quadrat samples was taken to determine density estimates; however, no specimens were found (Ap-pendix A).

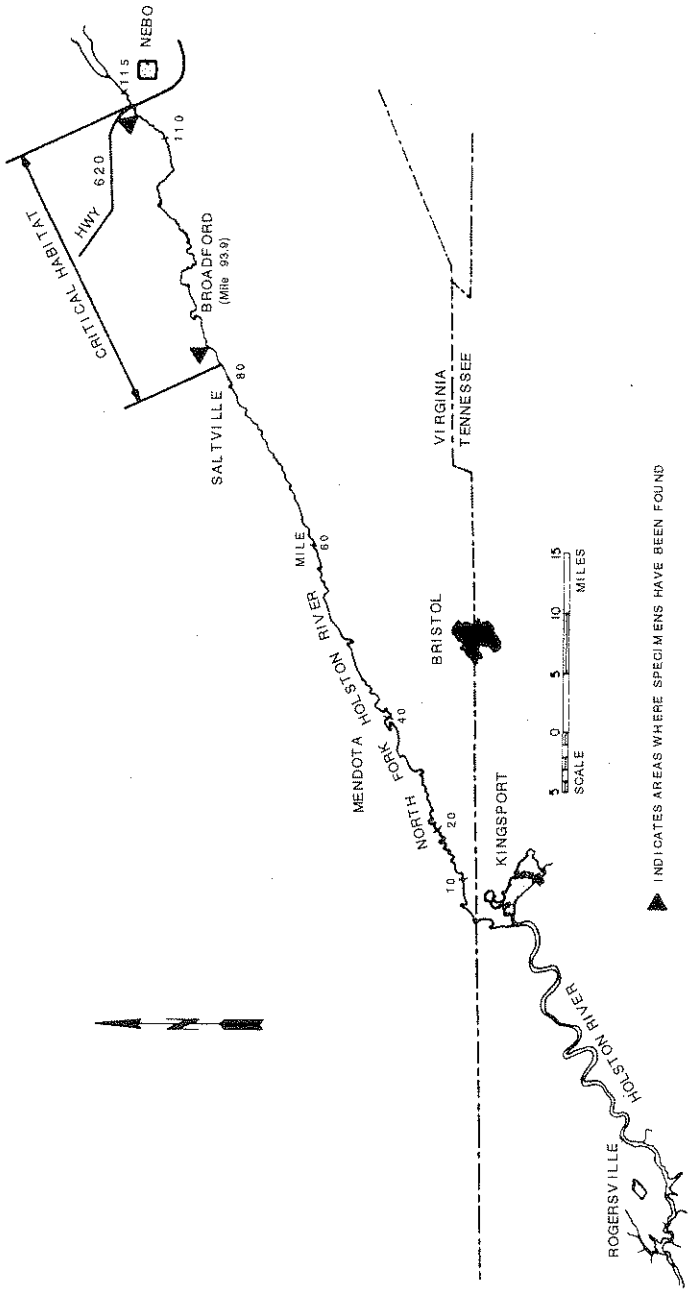

FIG. 2. North Fork Holston River - locations where *Pegias fabula* was found.

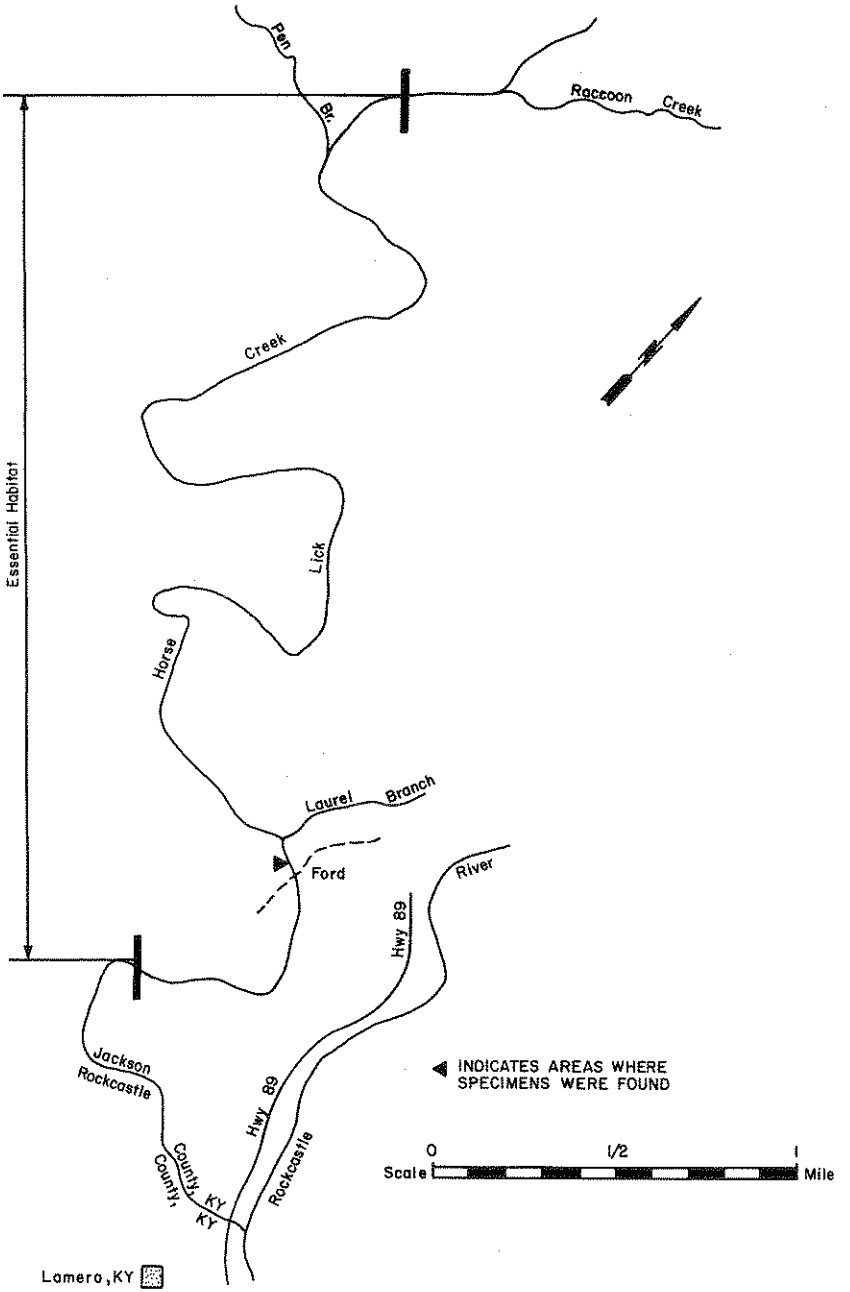

FIG. 3. Horse Lick Creek - locations where *Pegias fabula* was found.

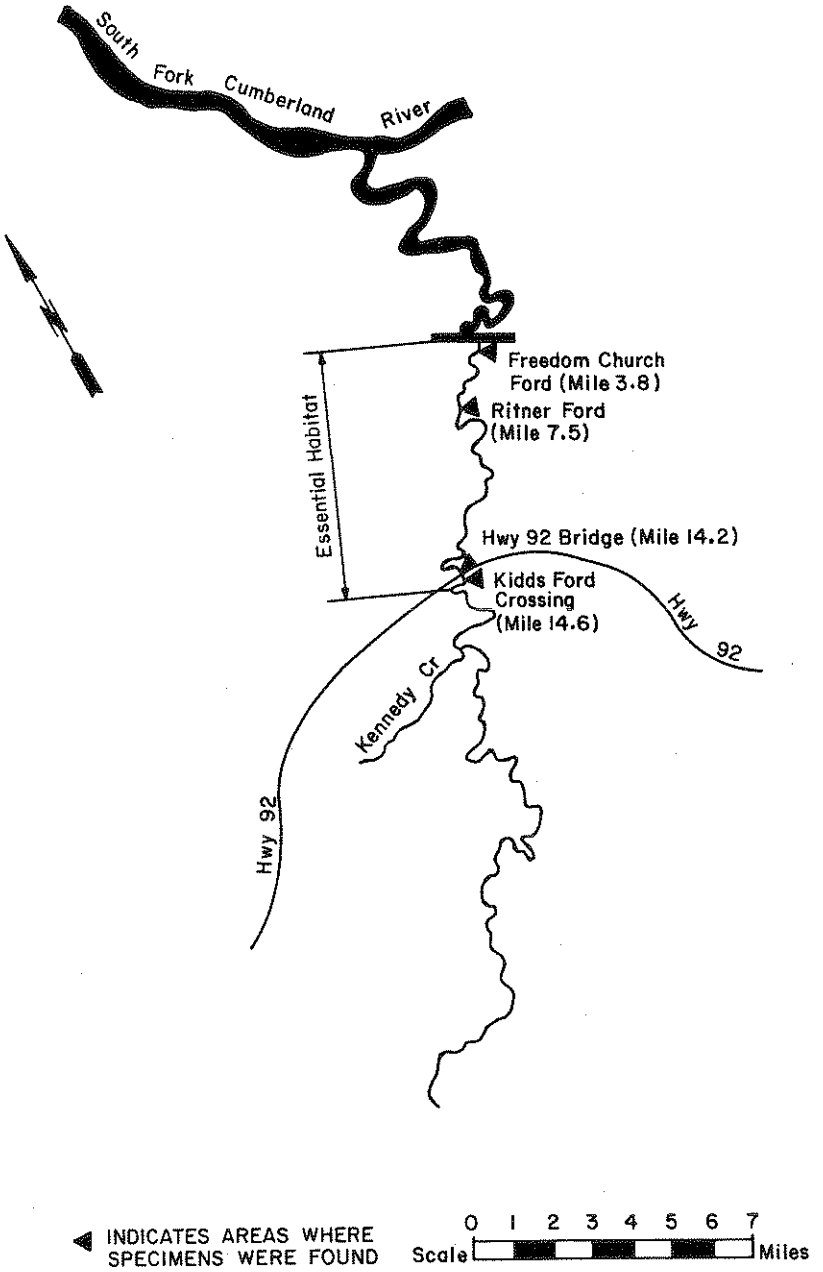

FIG. 4. Little South Fork Cumberland River - locations where *Pegias fabula* was found.

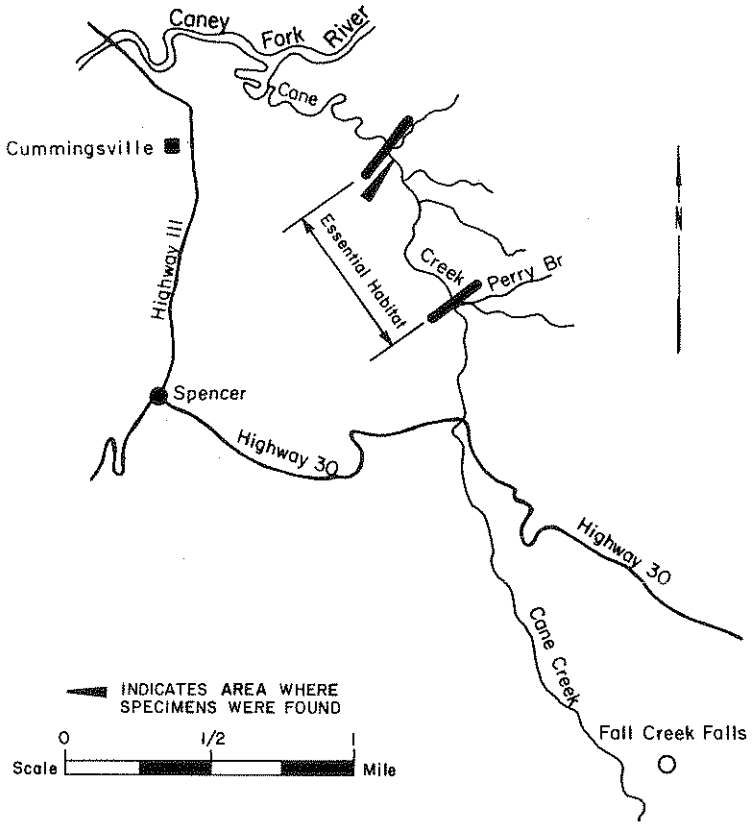

FIG. 5. Cane Creek – locations where *Pegias fabula* was found.

The Little South Fork Cumberland River was sampled at four sites in 1984 and 1985, including Kidds Ford Crossing, route 92 bridge, aged at six years by counting annual growth rests on the external surface of the shell. This suggests both specimens had reproduced successfully within the last six to eight years. The large number of live specimens found in Horse Lick Creek and Cane Creek is probably an indication that both creeks support reproducing populations.

Since the completion of this status survey three additional locations have been discovered for the species. In May 1986, during a survey of the freshwater mussel fauna in the Big South Fork Cumberland River, a large number of individuals (20 live, 18 fresh-dead) were found at mile 52.7 upstream from Oil Well Branch in McCreary County, Kentucky (Steve Bakaletz, personal communication). This is the first report of this species from the Big South Fork. Bakaletz reported find-

ing specimens under large slab rocks in clean swept riffles. This species was reported also from the upper Clinch River, approximately one-half mile downstream from route 639 bridge crossing in Tazewell County, Virginia (Dr. Richard Neves, personal communication). The single live specimen was collected in February 1987 by graduate students conducting a mussel survey of the area. This species was found in clean swept rubble and gravel habitat. The last report of this species occurrence in the Clinch was a single subfossil specimen collected in 1968 (Stansbery, 1976). One fresh-dead specimen was collected in the upper Little Tennessee River by Richard Biggins, USFWS, Ashville, North Carolina, who was collecting with the author and Mark Gordon, Tennessee Technological University, Cookville, Tennessee in 1990. This is the first report of the species in the upper Little Tennessee River.

CONCLUSIONS

Populations of *Pegias fabula* in the upper North Fork Holston River appear to have changed little since the 1970s; however, this small population is largely limited to one site. Given the small stream size of the upper North Fork and its remote location, potential problems appear to be limited to increased logging, oil and gas exploration, and overcollecting. Muskrat predation is probably not a problem since this species is often found under large rocks and is generally inaccessible to this predator. Recent conversations with Jerry Fouse, Virginia Commission of Game and Inland Fisheries, revealed no Federal project permits have been issued for activities that would affect the upper North Fork Holston.

Extant populations in the Cumberland River drainage (Horse Lick Creek, Little South Fork Cumberland River, and Cane Creek) are also situated in remote, mountainous terrain away from urban development. However, Horse Lick Creek and the Little South Fork Cumberland River may be impacted by activities associated with coal mining. Silt and acid mine drainage from strip mining, deep mining, abandoned mined lands, and oil and gas exploration could cause major changes in both watersheds within the next few years. Horse Lick Creek, located in Daniel Boone National Forest, presently contains the largest population of the species. The creek is considered one of Kentucky's outstanding resource waters; however, strip mining is already in progress in the Clover Bottom area of the watershed. All known locations for Pe*gias fabula* occur downstream from mined areas. Increased mining and/or acid water runoff could seriously impact

these populations. Although no Federal projects are identified in the Horse Lick Creek watershed, logging, oil and gas exploration, and overcollecting are considered potential problems.

Approximately 16 km of the lower Little South Fork Cumberland River is designated Kentucky State wild river. When this portion of the river was searched for *Pegias fabula,* large numbers of mussels were observed dead. Sherri Evans of the Kentucky Division Water Resources (personal communication) reported acid water and silt from active and abandoned strip mines enter the Little South Fork along the lower portions of the river. She also noted leakage from settling ponds filled with silt during this survey. Lick Creek, a tributary stream located at Ritner Ford, was covered with a white substance which was later identified as aluminum flocculent. No fish or aquatic invertebrates were observed in this creek. Rust colored "yellow boy" from mine sites in the watershed was observed in smaller streams. Recently, new strip mines have been approved for the Little South Fork watershed (Evans, personal communication). Increased strip mining (silt and acid water runoff) is considered an imminent threat to this species in the Little South Fork. No Federal projects are identified in the watershed, but logging, oil and gas exploration, and overcollecting are considered additional potential problems.

Pegias fabula populations in Cane Creek appear restricted to the lower five km of the creek above the impounded backwaters of the Caney Fork River (Center Hill Reservoir). Mussel habitat is extremely limited in the stream because of impoundment, the predominance of large round boulders typical of mountain streams, and the absence of gravel and sand shoals. Because of its restricted distribution and limited habitat in Cane Creek, road and bridge construction and overcollecting are considered major problems for the species.

Essential Habitat

Habitats considered essential for the continued survival of *Pegias fabula* are those areas where the species presently occurs: upper North Fork Holston River, Horse Lick Creek, lower Little South Fork Cumberland River, and Cane Creek. A more detailed description of each area is presented below:

North Fork Holston River - above Saltville (NFHRM 85), upstream to county route 620 bridge crossing at Nebo (NFHRM 111.6), Smyth County, Virginia (Fig. 2).

Horse Lick Creek - at unnamed ford (HLCM 2.0), Jackson and Rockcastle Coun-

ties, Kentucky, upstream to below mouth of Raccoon Creek (HLCM 5.3), Jackson County, Kentucky (Fig. 3).

Little South Fork Cumberland River - from Freedom Church Ford (LSFCRM 3.8), upstream to Kidds Ford Crossing (LSFCRM 14.6) upstream from route 92 bridge, Wayne and McCreary Counties, Kentucky (figure 4).

Cane Creek - at Sweetgum off county road 4251, shoal upstream of swinging bridge, to mouth of Perry Branch near Cane Creek Church, Van Buren County, Tennessee (Fig. 5).

MANAGEMENT AND RECOVERY

Management and recovery of *Pegias fabula* are almost totally dependent on funding available through State and Federal agencies. Actions deemed necessary or essential for the continued survival of the species are presented in recovery plans of other federally listed endangered mussel species. Recovery actions considered essential for the survival of this species are listed below in order of priority:

1. Immediate protection of all existing populations to include any new populations discovered.
2. Identify present and foreseeable threats to the species and its habitat, and work to eliminate them.
3. Conduct life history studies and determine host fish species.
4. Investigate the use of an artificial culture medium for mass propagation.
5. Identify potential transplant sites in streams within the species historical range.
6. Transplant juveniles or infected host fish into selected stream reaches.
7. Develop and implement a program to monitor the success of transplants, and evaluate recovery.

LITERATURE CITED

AHLSTEDT, S.A. 1981. The molluscan fauna of the Duck River between Normandy and Columbia Dams in central Tennessee. *Bulletin of the American Malacological Union for 1980,* 47: 60-62.

AHLSTEDT, S.A. 1981. The molluscan fauna of Copper Creek (Clinch River system) in southwestern Virginia. *Bulletin of the American Malacological Union for 1981,* 48: 4-6.

AHLSTEDT, S.A. 1983. The molluscan fauna of the Elk River in Tennessee and Alabama. *American Malacological Bulletin,* 5(1): 43-50.

AHLSTEDT, S.A. 1991a. Twentieth Century changes in the freshwater mussel fauna of the Clinch River (Tennessee and Virginia). *Walkerana,* 5(13): 73-122.

AHLSTEDT, S.A. 1991b. Cumberlandian Mollusk Conservation Program. Activity 1: Mussel surveys in six Tennessee Valley streams. *Walkerana,* 5(13): 123-160.

AHLSTEDT, S.A. & BROWN, S.R. 1980. The naiad fauna of the Powell River in Virginia and Tennessee (Bivalvia: Unionacea). *Bulletin of the American Malacological Union, 1979,* 46: 40-43.

BATES, J.M. & DENNIS, S.D. 1978. The mussel fauna of the Clinch River, Tennessee and Virginia. *Sterkiana,* 69-70: 3-23.

BLANKENSHIP, S. 1971. Notes on *Alasmidonta fabula* (Lea) in Kentucky (Unionidae). *The Nautilus,* 85(2):60-61.

BLANKENSHIP, S. & CROCKETT, D.R. 1972. Changes in the freshwater mussel fauna of Rockcastle River at Livingston, Kentucky. *Transactions of the Kentucky Academy of Science,* 33: 37-39.

BOGAN, A. & PARMALEE, P. 1983. Tennessee's rare mollusks, In: Tennessee's rare wildlife, Final Report: Tennessee Heritage Program of the Department of Conservation. June 1979. University of Tennessee, Knoxville. 360 pp.

CLARKE, A.H. 1981. The Tribe Alasmidontini (Unionidae: Anodontinae), Part I: *Pegias, Alasmidonta,* and *Arcidens. Smithsonian Contributions to Zoology,* (326): 101 pp.

CLARKE, A.H. & BERG, C.O. 1959. The freshwater mussels of central New York. *Cornell University Agricultural Experimental Station Memoir,* 307: 1-79.

DENNIS, S.D. 1981. Mussel fauna of the Powell River, Tennessee and Virginia. *Sterkiana,* 71: 1-7.

DENNIS, S.D. 1985. *Distributional analysis of the freshwater mussel fauna of the Tennessee River system, with special reference to possible limiting effects of siltation.* Dissertation, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, U.S.A. 171 pp.

Di STEFANO, R.J. 1984. Freshwater mussels (Bivalvia: Unionidae) of Horse Lick Creek, Rockcastle River, Kentucky. *The Nautilus,* 98(3): 110-113.

HARKER, D.F. Jr., WARREN, M. L. Jr., CAMBURN, K.E., CALL, S.M., FALLO, G.J. & WIGLEY, P. 1980. Aquatic biota and water quality survey of the upper Cumberland River Basin. Kentucky Nature Preserve Commission Technical Report, Frankfort, Kentucky. 679 pp.

LEA, I. 1838. Description of new freshwater and land shells. *Transactions of the American Philosophical Society,* n.s., 6: 1-154, pls. 1-24.

LEA, I. 1840. Description of new freshwater and land shells. *Proceedings of the American Philosophical Society,* 1: 284-289.

MORRISON, J.P.E. 1956. Family relationships in the North American fresh water mussels. *American Malacological Union, Annual Report, 1955,* 22: 16-17.

NEVES, R.J., PARDUE, G.B., BENFIELD, E.F. & DENNIS, S.D. 1980. An evaluation of endangered mollusks in Virginia. Final Report for Virginia Commission of Game and Inland Fisheries, Project No. E-F-1. Richmond, Virginia. 140 pp.

NEVES, R.J. & ZALE, A. 1982. Freshwater mussels (Unionidae) of Big Mocassin Creek, southwestern Virginia. *The Nautilus,* 96(2): 52-54.

ORTMANN, A.E. 1913-14. Studies in najades. *The Nautilus,* 27(8): 88-91; 28(2): 20-22; 28(3): 28-34; 28(4): 41-47; 28(5): 65-69; 28(9): 106-108.

ORTMANN, A.E. 1918. The nayades (freshwater mussels) of the upper Tennessee drainage, with notes on synonymy and distribution. *Proceedings of the American Philosophical Society,* 57(6): 521-626, 1 map.

ORTMANN, A.E. 1925. The naiad fauna of the Tennessee River system below Walden Gorge. *American Midland Naturalist,* 9(8): 321-373, 1 map.

SCHMIDT, J. 1982. *The freshwater mussels of the Stones River above J. Percey Priest Reservoir, Tennessee.* Master's Thesis, Tennessee Technological University, Cookeville, Tennessee, U.S.A. 65 pp.

SIMPSON, C.T. 1900. Synopsis of the naiades, or pearly freshwater mussels. *Proceedings of the United States National Museum,* 22: 501-1044, pl. 18 (No. 1205).

SIMPSON, C.T. 1914. *A descriptive catalogue of the naiades, or pearly freshwater mussels.* Bryant Walker, Detroit, Michigan, 1540 pp.

STANSBERY, D.H. 1972. The mollusk fauna of the North Fork Holston River at Saltville, Virginia. *American Malacological Union, Inc., Bulletin, 1971,* 38: 45-46.

STANSBERY, D.H. 1973. A preliminary report on the naiad fauna of the Clinch River

in the southern Appalachian Mountains of Virginia and Tennessee (Mollusca: Bivalvia: Unionidae). *American Malacological Union, Inc., Bulletin, 1972,* 39: 20-22.

STANSBERY, D.H. 1976. Status of endangered fluviatile mollusks in central North America: *Pegias fabula* (Lea, 1838). Ohio State University Research Foundation Report to the Department of the Interior, United States Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, 6 pp.

STANSBERY, D.H. & CLENCH, W.J. 1974. The Pleuroceridae and Unionidae of the North Fork Holston River above Saltville, Virginia. *The American Malacological Union, Inc., Bulletin, 1973,* 40: 33-36.

STANSBERY, D.H. & CLENCH, W.J. 1978. The Pleuroceridae and Unionidae of the upper South Fork Holston River in Virginia. *Bulletin of the American Malacological Union, 1977,* 44: 75-78.

STARNES, L.B. & BOGAN, A. 1982. Unionid Mollusca (Bivalvia) from Little South Fork Cumberland River, with ecological and nomenclatural notes. Brimleyana, North Carolina State Museum of Natural History at Raleigh. No. 8: 101-119.

STARNES, L.B. & STARNES, W.C. 1980. Discovery of a new population of *Pegias fabula* (Lea) (Unionidae). *The Nautilus,* 94(1): 5-6.

THOMPSON, Y. 1985. *The mussel fauna of the Rockcastle River system, Kentucky (Bivalvia: Unionidae).* Master's Thesis. Eastern Kentucky University, Richmond, Kentucky, U.S.A. 52 pp.

WILSON, C.B. & CLARK, H.W. 1914. *The mussels of the Cumberland River and its tributaries.* United States Bureau of Fisheries, Document No. 781. 63 pp.

APPENDIX A

TABLE A-1. Location of collecting sites and number of mussel specimens found. Species marked with an asterisk (*) are endangered.

Tennessee River Drainage

Little River - tributary to upper Clinch River at mile 299.6 downstream from route 19 bridge crossing at Wardell, Tazewell County, Virginia. September 14, 1985.

No live or relict mussels found.

Little River - tributary to upper Clinch River at route 610 bridge crossing above Greens Chapel, Tazewell County, Virginia. September 14, 1985.

Villosa iris - 4

Upper Clinch River - upstream from route 639 bridge crossing near Cliffield, Tazewell County, Virginia. September 13, 1985.

Fusconaia barnesiana - 46
Lampsilis fasciola - 1
Medionidus conradicus - 49
Villosa iris - 399
Sphaerium - common
Numerous young *Villosa iris*

Upper Clinch River - at route 640 bridge crossing upstream from Cedar Bluff,

Tazewell County, Virginia. September 15, 1985.

Fusconaia barnesiana - 2
Lampsilis fasciola - 1
Medionidus conradicus - 9
Villosa iris - 119
Villosa vanuxemensis - 1
Sphaerium - common

Upper Clinch River - downstream from Taylor Mill Dam, Tazewell County, Virginia. September 13, 1985.

Fusconaia barnesiana - 4
Villosa iris - 11

Middle Fork Holston River - downstream from bridge at Chilhowee, Smyth County, Virginia. September 10, 1985.

Elliptio dilatata - 20
**Epioblasma florentina walkeri* - 5
Fusconaia barnesiana - 2
Lampsilis fasciola - 2
Lexingtonia dolabelloides - 2
Medionidus conradicus - 2
Pleurobema oviforme - 6
Ptychobranchus subtentum - 4
Villosa iris - 5
Villosa vanuxemensis - 73

Laurel Creek - tributary to upper North Fork Holston River at route 91 bridge crossing, 2.7 miles upstream from mouth, Tazewell County, Virginia. September 11, 1985.

Villosa iris - 2

North Fork Holston River - at river mile 85.2 above Saltville, Smyth County, Virginia. September 11, 1985.

Fusconaia barnesiana - 1
Medionidus conradicus - 4
Toxolasma lividus - 2 relicts
Villosa vanuxemensis - 1

North Fork Holston River - at river mile 93.3 upstream from mouth of Laurel Creek, Smyth County, Virginia. September 11, 1985.

Actinonaias pectorosa - 35
Alasmidonta viridis - 2
Fusconaia barnesiana - 27
**Fusconaia cor* -32

Lampsilis fasciola - 47
Lexingtonia dolabelloides - 217
Medionidus conradicus - 68
Pleurobema oviforme - 1
Ptychobranchus fasciolaris - 19
Ptychobranchus subtentum - 17
Villosa iris - 101
Villosa vanuxemensis - 85

North Fork Holston River — at river mile 96.1 off route 42 near unnamed island, Smyth County, Virginia. September 9, 1985.

Actinonaias pectorosa - 2
Fusconaia barnesiana - 1
Lampsilis fasciola - 2
Lexingtonia dolabelloides - 4
Ptychobranchus fasciolaris - 1
Ptychobranchus subtentum - 11

North Fork Holston River - at bridge one-fourth mile southwest of Chatham Hill, Smyth County, Virginia. September 11, 1985.

Fusconaia barnesiana - 2
Lampsilis fasciola - 2
Medionidus conradicus - 1
Villosa iris - 9
Villosa vanuxemensis - 9

North Fork Holston River - at mouth of McDonald Branch Creek downstream from Nebo, Smyth County, Virginia. September 11, 1985.

No mussels observed.

North Fork Holston River - downstream from route 622 bridge above Nebo, Smyth County, Virginia. September 12, 1985.

Medionidus conradicus - 8
Pleurobema oviforme - 27
Pegias fabula - 3 live, 1 fresh-dead, 2 relict
Villosa iris - 48
Sphaerium - common

Quantitative sampling

1. *Pleurobema oviforme* - 1
   Villosa vanuxemensis - 3
   Sphaerium - 7
2. *Sphaerium* - 1
3. *Fusconaia barnesiana* - 2
   Sphaerium - 1
4. *Fusconaia barnesiana* - 1
   Villosa iris - 1

Villosa vanuxemensis - 1
5. *Villosa vanuxemensis* - 1
6. *Villosa iris* - 1
Villosa vanuxemensis - 1
Sphaerium - 1
7. *Sphaerium* - 3
8. *Fusconaia barnesiana* - 1
9. *Fusconaia barnesiana* - 1
10. *Villosa iris* - 2
Villosa vanuxemensis - 1
Sphaerium - 5

North Fork Holston River - at route 610 bridge crossing downstream from Groseclose store, Bland County, Virginia. September 12, 1985.

Fusconaia barnesiana - 9
Villosa vanuxemensis - 36
Sphaerium - abundant

Wallen Creek - tributary to upper Powell River approximately two miles downstream from Thompson Mill Dam off route 665, Lee County, Virginia. April 23, 1985.

Fusconaia barnesiana - 1
Medionidus conradicus - 2
Villosa iris - 18
Villosa vanuxemensis - 3

Wallen Creek - off route 665 downstream from Thompson Mill Dam, Lee County, Virginia. April 23, 1985.

No mussels observed.

Valley Creek - tributary to upper Watauga River, at junction of creek and Watauga River, Watauga County, North Carolina. February 4, 1986.

No mussels observed.

Watauga River - at Foscoe, Watauga County, North Carolina. February 4, 1986.

No mussels observed.

Watauga River - one-half mile downstream from Foscoe, Watauga County, North Carolina. February 4, 1986.

No mussels observed.

Watauga River - one mile downstream from junction of route 105 and county road 1112. February 4, 1986.

No mussels observed.

Watauga River - at bridge approximately one mile below Valle Crucis, Watauga

County, North Carolina. February 4, 1986.

No mussels observed.

Watauga River - at junction of Cane Creek and Watauga River, Watauga County, North Carolina. February 4, 1986.

No mussels observed.

Blue Water Creek - at route 72 bridge crossing near Elgin, Lauderdale County, Alabama. March 5, 1986.

No mussels observed.

Blue Water Creek - at route 71 bridge crossing, Lauderdale County, Alabama. March 5, 1986.

No mussels observed.

Blue Water Creek - at route 64 bridge crossing, Lauderdale County, Alabama. March 5, 1986.

No mussels observed.

Cumberland River Drainage

Collins River - at Shellsford Bridge, Warren County, Tennessee. June 20, 1984.

Pleurobema gibberum - 27
Villosa iris - 53

Collins River - near Irving College, Warren County, Tennessee. June 20, 1984.

Pleurobema gibberum - 12
Villosa iris - 23

Cane Creek - tributary to the Caney Fork River at Perry Branch near Cane Creek Church, Van Buren County, Tennessee. March 4, 1986.

Villosa iris - 21

Cane Creek - tributary to the Caney Fork River at shoal immediately upstream of swinging bridge at Sweetgum, off route 4251, Van Buren County, Tennessee. March 4, 1986.

Alasmidonta marginata - 1
Medionidus conradicus - 1 relict
Pegias fabula - 4 live, 2 fresh-dead, 2 relict
Pleurobema gibberum - 2 fresh-dead
Villosa iris - 20 (common)

Fishing Creek - tributary to Cumberland River downstream from route 70

bridge crossing, Pulaski County, Kentucky. September 27, 1985.

No mussels observed.

Fishing Creek - upstream from route 635 bridge crossing, Pulaski County, Kentucky. April 20, 1985.

No mussels observed.

Rockcastle River - one mile downstream from Livingston, Rockcastle County, Kentucky. September 24, 1985.

Actinonaias pectorosa - 2
Amblema plicata - 1 relict
Cyclonaias tuberculata - 2 relict
Elliptio dilatata - 11
Lampsilis ovata - 1
Ligumia recta - 4
Tritogonia verrucosa - 1

Rockcastle River - downstream from route 490 bridge crossing, one mile southeast of Lamero, Rockcastle and Laurel Counties, Kentucky. September 24, 1985.

Actinonaias ligamentina - 2
Actinonaias pectorosa - 3
Amblema plicata - 6
Elliptio dilatata - 14 (numerous)
Fusconaia subrotunda - 2
Lampsilis fasciola - 2
Lampsilis ovata - 3
Lasmigona costata - 3
Ligumia recta - 2
Potamilus alatus - 1
Ptychobranchus fasciolaris - 5
Tritogonia verrucosa - 2
Villosa iris - 1

Rockcastle River - two miles upstream from Horse Lick Creek off route 89 at canoe launch, Jackson and Laurel Counties, Kentucky. September 25, 1985.

Actinonaias pectorosa - 1
Elliptio dilatata - 3
Lampsilis ovata - 1
Ligumia recta - 1
Medionidus conradicus - 5
Pegias fabula - 1 relict
Ptychobranchus fasciolaris - 1
Ptychobranchus subtentum - 1
Villosa taeniata - 13

Skegg Creek - tributary to Rockcastle River upstream from Interstate 75 bridge

crossing, Rockcastle and Laurel Counties, Kentucky. September 27, 1985.

No mussels observed.

Horse Lick Creek - tributary to Rockcastle River approximately two miles upstream from mouth, Rockcastle and Jackson Counties, Kentucky. September 24, 1985, and December 17, 1985.

Alasmidonta marginata - 1
Actinonaias pectorosa - 1
Elliptio dilatata - 19
Lampsilis ovata - 1
Lasmigona costata - 1
Medionidus conradicus - 8
Pegias fabula - 7 live, 1 fresh-dead, 2 relict
Ptychobranchus fasciolaris - 1
Ptychobranchus subtentum - 2
Toxolasma lividus - 1
Villosa iris - 22

Quantitative sampling

1. *Corbicula fluminea* - 3
2. *Corbicula fluminea* - 4
3. *Alasmidonta viridis* - 1
   Villosa taeniata - 1
   Sphaerium - 12
   Corbicula fluminea - 20
4. *Sphaerium* - 1
   Corbicula fluminea - 6
5. *Corbicula fluminea* - 14
6. *Corbicula fluminea* - 9
7. *Corbicula fluminea* - 3
8. *Corbicula fluminea* - 1
9. No mussels
10. No mussels

Roundstone Creek - tributary to Rockcastle River at Sinks, Rockcastle County, Kentucky. September 25, 1985.

Elliptio dilatata - 1 relict
Lampsilis fasciola - 1 relict
Villosa iris - 1 relict
**Villosa trabalis* - 2 relicts
Corbicula fluminea - abundant

Roundstone Creek - downstream from railroad bridge at Hummel, Rockcastle County, Kentucky. September 24, 1985.

Lampsilis ovata - 1 relict
Lampsilis fasciola - 1
**Villosa trabalis* - 1 relict

Towne Creek - tributary to Roundstone Creek near Hummel Road bridge, Rockcastle County, Kentucky. September 25, 1985.

Alasmidonta viridis - 1 relict
Villosa iris - 3 relicts
Corbicula fluminea - abundant

Pittman Creek - at route 1247 bridge crossing near Elihu, Pulaski County, Kentucky. September 13, 1984.

No mussels observed.

Pittman Creek - at route 769 bridge crossing at Alcalde, Pulaski County, Kentucky. September 13, 1984.

No mussels observed.

Pittman Creek - at route 192 bridge crossing at Ruth, Pulaski County, Kentucky. September 13, 1984.

No mussels observed.

Pittman Creek - tributary to Cumberland River at route 39 bridge crossing near Somerset, Pulaski County, Kentucky. September 14, 1984.

No mussels observed.

Pittman Creek - at route 452 bridge crossing near Pulaski, Pulaski County, Kentucky. September 14, 1984.

No mussels observed.

Buck Creek - upstream from route 80 bridge crossing at Stab, Pulaski County, Kentucky. November 14, 1984.

Lampsilis fasciola - 1
Lampsilis ovata - 1
Villosa iris - 3 relicts
**Villosa trabalis* - 2 relicts

Buck Creek - below highway to bridge crossing at Briary Creek, Pulaski County, Kentucky. November 13, 1984.

Lampsilis fasciola - 1 relict
Lampsilis ovata - 1 fresh-dead, 1 relict
Medionidus conradicus - 1 relict
Obovaria subrotunda - 1 fresh-dead
Potamilus alatus - 1 fresh-dead
**Villosa trabalis* - 1 relict

Buck Creek - downstream from route 39 bridge crossing above Bobtown, Pulaski

County, Kentucky. November 13, 1984.

Lampsilis ovata - 3 relicts
Potamilus alatus - 2 relicts
**Villosa trabalis* - 2 relicts

Buck Creek - downstream from route 461 bridge crossing, Pulaski County, Kentucky. September 26, 1985.

Elliptio dilatata - 3
Epioblasma brevidens - 1
Lampsilis fasciola - 3
Lampsilis ovata - 2
Medionidus conradicus - 1
Obovaria subrotunda - 1
Potamilus alatus - 2
Ptychobranchus fasciolaris - 2
Villosa iris - 11
**Villosa trabalis* - 5 fresh-dead, 4 relicts

Little South Fork Cumberland River - at river mile 14.6 located upstream of route 92 bridge crossing at Kidd's Ford Crossing, Wayne and McCreary Counties, Kentucky. November 15, 1984, and April 20, 1985.

Alasmidonta marginata - 2 fresh-dead
Elliptio dilatata - 2 fresh-dead
Fusconaia barnesiana - 1 fresh-dead
Lampsilis fasciola - 2 fresh-dead, 1 relict
Lampsilis ovata - 1 fresh-dead
Lasmigona costata - 2 fresh-dead
Medionidus conradicus - 1 fresh-dead, 1 relict
Obovaria subrotunda - 14 fresh-dead
Pegias fabula — 3 live, 72 fresh-dead and relict
Pleurobema oviforme - 1 live, 11 fresh-dead, 1 relict
Potamilus alatus - 2 fresh-dead
Ptychobranchus fasciolaris - 3 fresh-dead
Ptychobranchus subtentum - 7 fresh-dead, 2 relict
Toxolasma lividus - 13 fresh-dead, 1 relict
Villosa iris - 7 fresh-dead
Villosa taeniata - 2 fresh-dead, 11 relict
**Villosa trabalis* - 11 fresh-dead, 2 relict

Kennedy Creek - approximately 100 yards upstream from mouth of creek draining into Little South Fork Cumberland River, Wayne County, Kentucky. April 18, 1985.

Pegias fabula - 3 relicts
Pleurobema oviforme - 2 fresh-dead
**Villosa trabalis* - 1 fresh-dead

Kennedy Creek - off route 92 at unnamed ford, Wayne County, Kentucky. April 18, 1985, and April 19, 1985.

No mussels observed.

Little South Fork Cumberland River - at Ritner Ford, river mile 7.5, Wayne and McCreary Counties, Kentucky. November 14, 1985.

Alasmidonta marginata - 1 fresh-dead
Alasmidonta viridis - 1 fresh-dead, 2 relict
Elliptio dilatata - 3 fresh-dead, 2 relict
Lampsilis fasciola - 1 live, 4 fresh-dead, 1 relict
Lampsilis ovata - 1 fresh-dead
Leptodea fragilis - 1 fresh-dead
Medionidus conradicus - 3 fresh-dead, 6 relict
Obovaria subrotunda - 3 fresh-dead
Pegias fabula - 47 fresh-dead and relict
Pleurobema oviforme - 1 fresh-dead
Potamilus alatus - 2 fresh-dead
Ptychobranchus fasciolaris - 2 fresh-dead
Ptychobranchus subtentum - 1 live, 2 fresh-dead, 3 relict
Toxolasma lividus - 3 fresh-dead, 8 relict
Villosa iris - 2 live, 3 fresh-dead, 4 relict
Villosa taeniata - 5 fresh-dead, 8 relict
**Villosa trabalis* - 1 fresh-dead, 2 relict

Quantitative sampling: Ten square-meter quadrat samples taken produced no live mussels.

Little South Fork Cumberland River - at Freedom Church Ford, river mile 3.8, Wayne and McCreary Counties, Kentucky. November 14, 1985.

Elliptio dilatata - 1 fresh-dead
Lampsilis fasciola - 1 fresh-dead
Medionidus conradicus - 1 relict
Pegias fabula - 5 relicts
Ptychobranchus subtentum - 3 fresh-dead
Villosa iris - 2 fresh-dead
Villosa taeniata - 2 fresh-dead

Little South Fork Cumberland River - upstream from route 92 bridge crossing at river mile 14.2, Wayne and McCreary Counties, Kentucky. November 15, 1984.

Alasmidonta marginata - 1 relict
Lampsilis fasciola - 1 relict
Leptodea fragilis - 1 fresh-dead
**Pegias fabula* - 1 fresh-dead, 1 relict
Pleurobema oviforme - 1 relict
Potamilus alatus - 1 fresh-dead
Ptychobranchus subtentum - 1 relict
Toxolasma lividus - 1 fresh-dead
Villosa taeniata - 1 fresh-dead