Conservation Assessment

for

The Rabbitsfoot (Quadrula cylindrica) Say, 1817

USDA Forest Service, Eastern Region

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EXECUTIVE SUMMARY

The Rabbitsfoot *Quadrula cylindrica* (Say, 1817) is a medium-sized rectangular mussel that inhabits small to medium sized rivers. *Quadrula cylindrica* can be distinguished from other mussels because of its elongate, rectangular shape and the presence of large pustules on the shell surface. The historical range of this species includes the Ohio River System, (including the Tennessee and Cumberland rivers) and the Mississippi River System from Northern Louisiana north to Missouri and western Oklahoma. *Quadrula cylindrica* is not listed by the U. S. Fish and Wildlife Service as threatened or endangered, although it is recognized as threatened and endangered by several states.

Quadrula cylindrica is tachytictic (glochidia do not over-winter in the marsupium).

Three species of cyprinids have been found to be suitable hosts for *Q. cylindrica.* Factors considered detrimental to the persistence of this species are pollution, siltation and habitat perturbation such as gravel mining an in particular the construction of new impoundments. Additional information regarding life history and genetic variation in *Q. cylindrica* should be obtained prior to initiation of captive breeding and re-introduction or translocation projects.

Quadrula cylindrica (Say, 1817) Rabbitsfoot

SYNONYMY

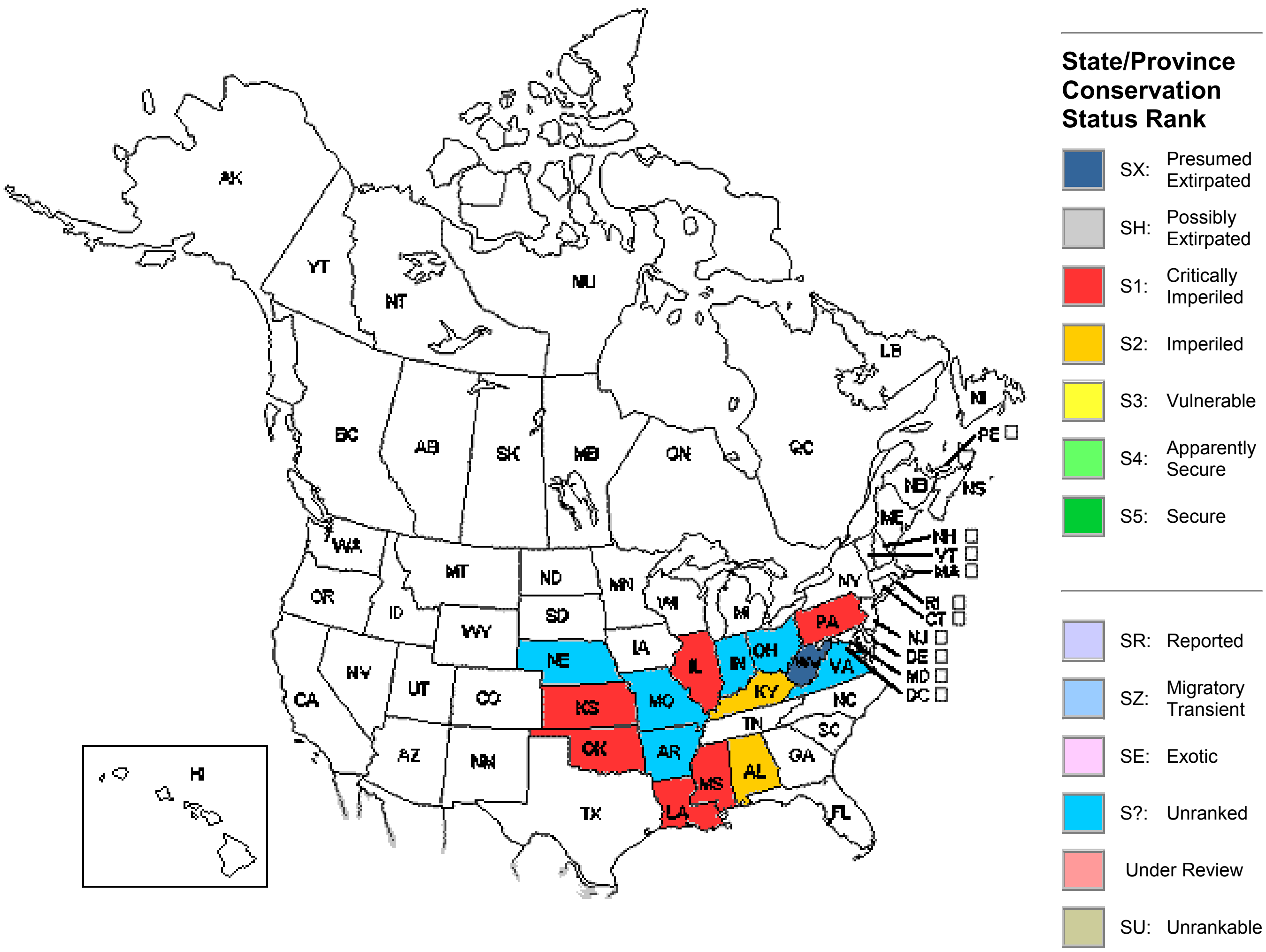
Unio cylindricus Say, 1817; Say, 1817: pl. 4, fig. 3
Unio (*Eurynia*) *solenoides* var. *cylindrica* Say, 1817; Rafinesque, 1820:298
Mya cylindricus (Say, 1817); Eaton, 1826:219
Margarita (*Unio*) *cylindricus* (Say, 1817); Lea, 1836:17
Unio (*Theliderma*) *cylindrica* (Say, 1817); Swainson, 1840:271, fig. 54c
Margaron (*Unio*) *cylindricus* (Say, 1817); Lea, 1852c, 23
Orthonymus cylindricus (Say, 1817); Agassiz, 1852:48
Quadrula cylindrica (Say, 1817); Lewis, 1870:218
Quadrula(*Quadrula*) *cylindrica* (Say, 1817); Simpson, 1900a:773
Quadrula cylindrica cylindrica (Say, 1817); Oesch, 1984:91
Unio naviformes Lamarck, 1819; Lamarck, 1819:75
Unio rugosus (Barnes, 1823); Chenu, 1859:138 [misidentification]
Unio cylindricus var. *strigillatus* B. H. Wright, 1898; B. H. Wright, 1898c:6; Johnson, 1967b:9, pl. 3, fig. 2
Quadrula (*Orthonymus*) *cylindrica strigillata* (Wright, 1898); Frierson, 1927:51
Quadrula cylindrica strigillata (Wright, 1898); Goodrich, 1913:93

Type Locality: Wabash River

DISTRIBUTION

The Ohio River System, including the Tennessee and Cumberland rivers and the Mississippi River System from Northern Louisiana north to Missouri and western Oklahoma. Alabama (S2), Arkansas (S?), Illinois (S1), Indiana (S?), Kansas (S1), Kentucky (S2), Louisiana (S1), Mississippi (S1), Missouri (S?), Nebraska (S?), Ohio (S?), Oklahoma (S1), Pennsylvania (S1), Virginia (S?), West Virginia (SX).

Figure 1. Distribution of *Quadrula cylindrica*.



DESCRIPTION

An elongate, rectangular shell, the valves are thickened and somewhat inflated. The beaks are offset to the anterior, and are elevated above the hinge. The posterior ridge is usually well defined. The ventral margin is straight to slightly curved. The periostracum ranges from yellow to shades of brown, and often has numerous dark green streaks, blotches and chevrons over most of the surface. The shell surface is covered in tubercles, knobs and pustules. Parmalee and Bogan (1998) indicate sub-specific level differences in shell sculpture within this species. The nacre is usually white, although some have been observed with pink nacre (Wright, 1898). The glochidia of *Quadrula cylindrica* are described by Yeager and Neves (1986) as sub-circular with a truncated dorsal hinge line and a mean length and height of 0.22 mm and 0.22 mm respectively.

LIFE HISTORY AND ECOLOGY

Quadrula cylindrica is typically found in small to medium sized rivers of moderate current with clear, relatively shallow water and a mixture of sand and gravel substrates. Yeager and Neves (1986) determined that this species is tachytictic, and spawns and releases glochidia from May to July. In a detailed examination of the life history of *Q. cylindrica* they noted that the formation of intermediate gametic phases in the winter and their rapid maturation in the spring differed from other tachytictic (short-term brooding) species which exhibit a gradual gametogenisis which often contain mature ova in the winter. Three species of minnows have been determined to be suitable hosts for *Q. cylindrica*: *Cyprinella galctura*, *Cyprinella spiloptera*, and *Hybopsis amblops*. Of these three potential hosts *C. galactura* produced the most transformed juvenile mussels.

STATUS

The two recognized subspecies of *Quadrula cylindrica* were treated separately by Williams et al. (1993). *Quadrula c. cylindrica* is listed as threatened, whereas *Q. c. strigillata* is listed as endangered. Indiana and Ohio list *Q. c. cylindrica* as a state endangered species, whereas Kentucky considers it threatened. Tennessee and Virginia list *Q. c. strigillata* as state endangered. The states of Illinois and Kansas lists *Qualdrula cylindrica* as a state endangered species. The state of Missouri applied the rank of S1 (critically imperiled) to *Q. c. cylindrica*. The species was considered rare throughout its range by Cummings and Mayer (1992) and it is difficult to obtain an feeling for its historical abundance throughout its range. Museum records show collections have been made within the last five years in Alabama, Illinois, Kentucky and Ohio. Reasons for the decline of freshwater mussels in North America are still not well understood, and the interaction of a variety of factors appears to have confounded attempts to precisely identify causal relationships. Probable causes for the decline were listed by van der Schalie (1938), Fuller (1974), Bogan (1993) and Williams et al. (1993), and include habitat modification and degradation, the introduction of exotic bivalves. *Q. cylindrica* is not a commercially valuable species and so, is not threatened by over-harvesting. The rabbitsfoot is typically found in clean, swiftly flowing water. In order to maintain it's current distribution efforts should be directed at preventing further degradation by reducing siltation and preventing the construction of new impoundments in existing habitat. The completion of the life cycle of *Q. cylindrica* is dependent on the presence of a suitable fish host. Maintenance of host species populations in rivers inhabited by *Q. cylindrica* is critical for the long-term survival of this species. *Cyprinella galactura*, the most likely host fish examined to date, is generally common throughout its range.

Limiting Factors:

Approximately 67% of freshwater mussel species are vulnerable to extinction or are already extinct (NNMCC, 1998). Factors implicated in the decline of freshwater bivalves include the destruction of habitat by the creation of impoundments, siltation, gravel mining, and channel modification; pollution and the introduction of non-native species such as the Asiatic clam and the Zebra Mussel.

Zebra Mussels:

The introduction of consequent spread of *Dreissena polymorpha* in the mid to late 1980's has severely impacted native mussel populations in the Lower Great Lakes region (Schlosser et al. 1996). Adverse effects on unionid mussels stem primarily from the attachment of *D. polymorpha* the valves native mussels. In sufficient numbers, *D. polymorpha* can interfere with feeding, respiration, excretion, and locomotion (Haag et al. 1993, Baker and Hornbach 1997). It has been estimated that the introduction of *D. polymorpha* into the Mississippi River basin has increased the extinction rates of native freshwater mussels from 1.2% of species per decade to 12% per decade.

Native mussels have shown differential sensitivity to *D. polymorpha* infestations. Mackie et al. (2000) stated that smaller species with specific substrate requirements and few hosts and were long-term brooders were more susceptible than larger species with many hosts, that were short-term brooders. *Quadrula cylindrica* has a tendency to maintain approximately half of its shell exposed above the substrate; this particular trait that may make it susceptible to *D. polymorpha*, by providing a suitable substrate for veligers to settle. One factor in *Q. cylindrica's* favor would that it prefers fast flowing streams which might reduce its risk of colonization by *D. polymorpha* which seem to be more abundant in more lentic environments.

Siltation:

Accumulation of sediments has long been implicated in the decline of native mussels. Fine sediments can adversely affect mussels in several ways they can interfere with respiration, feeding efficiency by clogging gills and overloading cilia that sort food. It can reduce the supply of food by interfering with photosynthesis. Heavy sediment loads can also smother juvenile mussels. In addition, sedimentation can indirectly affect mussels by affecting their host fishes (Brim-Box and Mossa, 1999). Strayer and Fetterman (1999) have suggested that fine sediments may be more harmful to mussels in lower gradient streams where sediments can accumulate. It is unclear what the direct effect of sedimentation is on *Q. cylindrica*, although it's preference for clear, fast flowing streams and gravel substrates may indicate sensitivity to siltation.

Pollution:

Chemical pollution from domestic, agricultural, and domestic sources were responsible for the localized extinctions of native mussels in North America throughout the 20th century (Baker, 1928, Bogan, 1993). According to Neves et al. (1997) the eutrophication of rivers was a major source of unionid decline in the 1980's, while Havlik and Marking (1987) showed that many types of industrial and domestic substances: heavy metals, pesticides, ammonia, and crude oil were toxic to mussels.

Dams/Impoundments:

Impoundments whether for navigational purposes or for the generation of power can dramatically affect the habitat of freshwater mussels. Impoundments alter flow, temperature, dissolved oxygen, substrate composition (Bogan, 1993). In addition, they can isolate freshwater mussels from their host fishes thereby disrupting the reproductive cycle. Changes in water temperature can suppress or alter the reproductive cycle and delay maturation of glochidia and juvenile mussels (Fuller, 1974, Layzer et al. 1993). The riffle environment, which is the preferred habitat of *Q. cylindrica* would be seriously altered by the creation of new impoundments on those rivers where it still occurs. Bates (1962) noted a dramatic change in the fauna of the Tennessee River after impoundment and the formation of the Kentucky Reservoir. *Quadrula cylindrica* was among the taxa that were found prior to impoundment but were found in low numbers post impoundment. Bates (1962) also noted an absence of recruitment in the pre-impoundment fauna.

POPULATION BIOLOGY AND VIABILITY

As with other headwater inhabiting species of mussel, the combination of river impoundments and the ecological requirements of *Q. cylindrica* predict a series of isolated populations in the headwater streams throughout the species range. To date no genetic survey has been conducted on this species, and such information would be a valuable resource for constructing a species wide management plan that would preserve existing genetic variability of existing populations of *Q. cylindrica.* Such studies would also provide an opportunity to test the validity of the two currently named subspecies *Q. c. cylindrica* and *Q. c. strigillata*. A phylogenetic analysis of the genus *Quadrula* indicates that *Q. cylindrica* is closely related to *Q. metanevra* (J. Serb, pers. com.) and that single individuals of the two subspecies of *Q. cylindrica* exhibited 1.4% sequence divergence.

SPECIAL SIGNIFICANCE OF THE SPECIES:

Aside from its unique morphology, this species has no special significance. Genetic analysis places this species within the genus *Quadrula* (J. Serb, pers. com.).

MANAGEMENT RECOMMENDATIONS

Plans for the conservation of North American freshwater mussels have generally taken one of two approaches:

1.) the preservation of existing populations and allow the mussels to re-invade historical ranges naturally and

2.) the active expansion of the existing ranges by re-introducing mussels through translocation from "healthy" populations or from captive rearing programs (NNMCC, 1998). The second strategy is the more pro-active, and may ultimately prove to be effective, however several important factors should not be over-looked. Before translocations or re-introductions occur it should be established that conditions at the re-introduction site are suitable for the survival of mussels. Mussel translocation projects have had mixed success (Sheehan et al. 1989, Cope and Waller, 1995). Re-introducing mussels into still contaminated or otherwise un-inhabitable habitat is a waste of resources and can confound attempts to obtain unbiased estimates of the survival of species after re-introduction. Additionally, the genetic variation across and within populations should be assessed prior to the initiation of a reintroduction/ translocation scheme (Lydeard and Roe, 1998). Evaluation of the genetic variation is crucial to establishing a captive breeding program that maintains the maximal amount of variation possible and avoid excessive inbreeding (Templeton and Read, 1984) or outbreeding depression (Avise and Hamrick, 1996).

Additional information about the life-history variation across populations of *Q. cylindrica* would also prove important to assess prior to initiating a translocation project. Differences in the timing of various aspects of reproduction such as the release of gametes by males and the movement of eggs into the demibranchs of females are critical for successful reproduction as is the presence of a suitable host fish. The number of host fishes used by this species across its range is still poorly known.

REFERENCES

Avise, J.C. and J.L. Hamrick. 1996. Conservation genetics: case histories from nature. Chapman and Hall, New York.

Baker, F.C. 1928. The fresh water mollusca of Wisconsin. Part II: Pelycepoda. Bulletin 70, Wisconsin Geological and Natural History Survey: 495 pp.

Baker, S. M. and D. J. Hornbach. 1997. Acute physiological effects of zebra mussel (Dreisenna polymorpha) infestation on two unionid mussels, *Actinonaias ligamentina* and *Amblema plicata*. Can. J. Fish. Aquat. Sci. 54: 512-519.

Bates, J.M. 1962. The impact of impoundment on the mussel fauna of Kentucky Reservoir, Tennessee River. Am. Midl. Nat. 68:232-236.

Bogan, A. E. 1993. Freshwater bivalve extinctions (Mollusca: Unionoida): A search for causes. *Am. Zool.* **33:** 599-609.

Brim-Box, J.M. and J. Mossa. 1999. Sediment, land use, and freshwater mussels: prospects and problems. J. N. Am. Benthol. Soc. 18: 99-117.

Cope, W.G. and D.L. Waller. 1995. Evaluation of freshwater mussel relocation as a conservation and management strategy. Regulated Rivers: Research and Management. 11: 147-155.

Cummings, K.S. and C.A. Mayer. 1992. Field guide to the freshwater mussels of the midwest. Illinois Natural History Survey, manual 5.

Fuller, S.L.H. 1974. Clams and mussels (Mollusca: Bivalvia) In: Pollution Ecology of Freshwater Invertebrates. (Eds. C.W. Hart Jr. and S.L.H Fuller). Academic Press, New York.

Haag, W.R., D.J. Berg, D.W. Garton, and J.L. Ferris. 1993. Reduced survival and fitness in native bivalves in response to fouling by the introduced zebra mussel (*Dreisenna polymorpha*) in western Lake Erie. Can. J. Fish. Aquat. Sci. 50: 13-19.

Havlik, M.E. and L.L. Marking. 1987. Effects of contaminants on naiad molluscs (Unionidae): a review. U.S. Fish and Wildlife Service, Resource Publication 164: 20p.

Layzer, J.B. M.E. Gordon, and R.M. Anderson. 1993. Mussels: the forgotten fauna of regulated rivers. A case study of the Caney Fork River. Regulated Rivers: research and management 8:63-71.

Lydeard, C. and K.J. Roe. 1998. Phylogenetic systematics: the missing ingredient in the conservation of freshwater unionid bivalves. 23: 16-17.

Mackie, G.L., D. Zanatta, J.L. Metcalf-Smith, J. Di Maio, and S.K. Staton. 2000. Toward developing strategies for re-habilitating/re-establishing Unionidae populations in southwestern Ontario. Final Report to the Endangered Species Recovery Fund.

National Native Mussel Conservation Committee. 1998. National Strategy for the conservation of native freshwater mussels. J. Shellfish Res. 17:1419-1428.

NatureServe. 2003. NatureServe Explorer: An online encyclopedia of life [web application]. Version 1.8. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: July 9, 2003).

Neves, R.J., A.E. Bogan, J.D. Williams, S. A. Ahlstedt and P.W. Hartfield. 1997. Status of aquatic mollusks in the southeastern United States: A downward spiral of diversity. Pp. 43-85. In: G.W. Benz and D.E. Collins, eds. *Aquatic fauna in peril: the southeastern perspective*. Special publication 1, Southeast Aquatic Research Institute, Lenz Design and Communication, Decatur, Georgia.

Parmalee, P.W. and A.E. Bogan. 1998. The freshwater mussels of Tennessee. The University of Tennessee Press, Knoxville.

Sheehan, R.J. R.J. Neves, and H.E. Kitchel. 1989. Fate of freshwater mussels transplanted to formerly polluted reaches of the Clinch and North Fork Holston Rivers, Virginia. Journal of Freshwater Ecology. 5: 139-149.

Schlosser, D. W., T. F. Nalepa, and G. L. Mackie. 1996. Zebra mussel infestation of unionid Bivalves (Unionidae) in North America. Amer. Zool. 36: 300-310.

Strayer, D.L. and A.R. Fetterman. 1999. Changes in the distribution of freshwater mussels (Unionidae) in the Upper Susquehanna River basin, 1955-1965 to 1996-1997. Am. Midl. Nat. 142:328-339.

Templeton, A.R. and B. Read. 1984. Factors eliminating inbreeding depression in a captive heard of Speke's gazelle (*Gazella spekei*). Zoo. Biol. 3:177-199.

Van der Schalie, H. 1938. Contributing factors in the depletion of naiades in eastern United States. Basteria 3(4): 51-57.

Yeager, B.L. & R.J. Neves. 1986. Reproductive cycle and fish hosts of the rabbit's foot mussel, *Quadrula cylindrica strigillata* (Mollusca: Unionidae) in the Upper Tennessee River drainage. American Midland Naturalist 116(2):329-340.

Williams, J. D., Warren, M. L. Jr., Cummings, K. S., Harris, J. L., and Neves, R. J. 1993. Conservation status of the freshwater mussels of the United States and Canada. *Fisheries* 18: 6-22.

Wright, B.H. 1898. New Unionidae. The Nautilus 12:5-6.