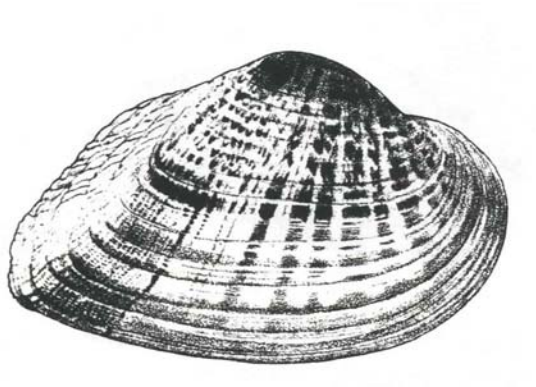
Conservation Assessment

The Snuffbox, *Epioblasma triquetra* (Rafinesque, 1820)



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Executive Summary:

The Snuffbox, *Epioblasma triquetra* (Rafinesque, 1820) is a small triangular freshwater mussel; it is the most widely distributed member of the genus *Epioblasma*, and like the other members of that genus is found in small to medium sized, swiftly flowing rivers in shallow riffles with rubble and gravel substrates that are silt-free. *E. triquetra* can be distinguished from all of its congeners quite readily, the shell is thick and inflated, the periostracum is yellow to yellowish brown or green with dark green blotches that are broken into triangular or chevron shapes, and the nacre is iridescent white. The historical range of *E. triquetra* includes the Great Lakes system and the Mississippi River system from western New York west to Nebraska and eastern Kansas, south to northern Alabama and Mississippi. *E. triquetra* is now thought to persist in only 40% of its historical range, and is considered to be extinct in Iowa, Kansas, New York and Mississippi. *Epioblasma triquetra* is currently not listed by the U. S. Fish and Wildlife Service as threatened or endangered, however the Nature Conservancy has assigned *E. triquetra* a global rank of G3 (rare and uncommon globally).

Epioblasma triquetra is a dioecious species, it brooding habit is bradytictic: spawning occurs in the summer, and the larvae are released the following spring. Several fish hosts have been identified for this species. The long-term survival of this species is dependent upon healthy populations of host fishes and the presence of suitable habitat. Factors considered detrimental to the persistence of this species are pollution, siltation and habitat perturbation such as gravel mining or the construction of new impoundments. Additional information regarding life history and genetic variation in *E. triquetra* should be obtained prior to initiation of captive breeding and re-introduction or translocation projects.

Epioblasma triquetra (Rafinesque, 1820) Snuffbox

Synonymy:

Truncilla triqueter Rafinesque, 1820; Rafinesque, 1820:300, pl. 81, figs. 1-4
Unio triqueter (Rafinesque, 1820); Short and Eaton, 1831:79
Truncilla (*Truncilla*) *triquetra* Rafinesque, 1820; Simpson, 1900a:517
Truncilla triquetra Rafinesque, 1820; Scammon, 1906:283
Dysnomia triquetra (Rafinesque, 1820); Danglade, 1922:5
Dysnomia (*Truncillopsis*) *triquetra* (Rafinesque, 1820); Ortmann and Walker, 1922:65
Plagiola (*Truncillopsis*) *triquetra* (Rafinesque, 1820); Johnson, 1978:248, pl. 1, pl. 10, figs. 1-4
Plagiola triquetra (Rafinesque, 1820); Oesch, 1984:232
Unio triangularis Barnes, 1823; Barnes, 1823:272, pl. 13, figs. 17a,b
Mya triangularis (Barnes, 1823), Eaton, 1826:221
Margaron (*Unio*) *triangularis* (Barnes, 1823), Lea, 1836:18
Margaron (*Unio*) *triangularis* (Barnes, 1823), Lea, 1852c:23
Unio cuneatus Swainson, 1823, Swainson, 1823b:112
Unio formosus Lea,1831; Lea, 1831:111, pl. 16, fig. 41
Unio triangularis var. *longisculus* De Gregorio, 1914; De Gregorio, 1914:40, pl. 4, fig. 5
Unio triangularis var. *pergibosus* De Gregorio, 1914; De Gregorio, 1914:40, pl. 4, fig. 4

The taxonomy of the genus *Epioblasma* has been particularly confusing and readers are referred to Bogan (1997) for a discussion and resolution to this problem.

Type Locality: Falls of the Ohio

Distribution:

Great Lakes system including tributaries of Lakes Huron, St. Clair, Michigan and Erie. Mississippi River system from western New York west to Nebraska and eastern Kansas, south to northern Alabama and Mississippi.

Description:

A generally small and triangular shaped mussel. The shells are thick, and inflated. Beaks are anterior to the middle of the shell and elevated above the hinge line. Posterior ridge is

sharply defined. The ventral margin is mostly straight in females and slightly curved in males. In females, the region of the shell that corresponds to the marsupium is raised to form a prominent ridge, which can project past the ventral edge of the anterior half of the shell. The periostracum ranges from yellowish to yellowish brown or green with dark green rays that are broken into many triangular or chevron-shaped blotches. The surface is smooth, except for growth lines. The nacre is white. The glochidium of *E. triquetra* are is described by Hoggarth (1999) as depressed subelliptical. The average length and height are 214 and 211 µm respectively. The ventral edge of the valve is covered with blunt irregularly shaped micropoints, and several supernumerary hooks (Hoggarth, 1999).

Life History and Ecology:

This species are typically found living in gravel substrates, in shallow (< 1m), swiftly flowing water. They have also been reported in mud, silt, sand and bedrock substrates (Parmalee, 1967, Baker, 1928). They are typically deeply buried (Baker, 1928, Hickman, 1937). They are described as bradytictic (Baker, 1928). Females are gravid from September to May. Glochidia may be present from mid September, and glochidial release occurs by late May (Ortmann, 1919). Five species of fishes have been determined to be suitable hosts via laboratory infections, they are: *Nocomis biguttatus*, *Cottus caroline*, *C. hypselurus*, *Fundulus olivaceous*, *Percina caprodes*, and *P. maculata* (Hill, 1986; Sherman, 1993; Yeager et al., 1995; Hilegas et al., 1997; and Barnhart et al., 1998).

Status:

Epioblasma triquetra is described as threatened by Williams et al. (1993). The snuffbox is widely distributed but rare throughout much of its range. It is listed as a Federal Candidate (Category 2) for listing by the USFWS. It is considered endangered in Illinois, Indiana, Wisconsin, Missouri and Michigan, and threatened in Ohio. Usually found in riffles, this species is distributed in large rivers as well as small ones, and has been recovered from pools as well as lakes (Gordon and Layzer, 1989). This species has been considered uncommon in much of the Midwest since the middle of the last century (Goodrich and van der Schalie, 1944; Murray and Leonard, 1962; Parmalee, 1967). 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. *Epioblasma triquetra* is not a commercially valuable species and so, is not threatened by over-harvesting. Although the snuffbox has been found in pond environments it's predominantly 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 impoundments of existing habitat. The completion of the life cycle of *E. triquetra* is dependent on the presence of a suitable fish host. Maintenance of host species populations in rivers inhabited by *E. triquetra* is critical for the long-term survival of this species.

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, few

hosts and were long-term brooders were more susceptible than larger species with many hosts, that were short-term brooders. *Epioblasma triquetra* has several traits that indicate it may be susceptible to *D. polymorpha*, it is small and is a long-term brooder. One factor in *E. triquetra*'s favor would be its habit of remaining almost entirely buried below the substrate might reduce its risk of colonization by *D. polymorpha*.

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. Because of its burrowing habit, *E. triquetra* is probably sensitive 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. The overall reduction in the range *of E. triquetra* indicates that it is adversely affected by poor water quality.

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 habitat, which is the preferred habitat of *E. triquetra* would be seriously altered by the creation of new impoundments on those rivers where it still occurs.

Population Biology and Viability:

The combination of river impoundments and the ecological requirements of *E. triquetra* 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, such information would be a valuable resource for constructing a species wide management plan that would preserve existing genetic variability of existing populations of *E. triquetra*. In the United States, *E. triquetra* is believed to persist in 37 of the 99 streams for which historical records are available. In Canada, *E. triquetra* was until recently considered to have been extirpated; the last confirmed record of a live specimen was from the Sydeham River in 1973 (Watson et al. 2001). Intensive surveys conducted from 1997-1999 have since yielded live specimens from the Sydeham River and "fresh" shells were also found on the Ausable and Thames rivers as well (Watson et al. 2001).

Special Significance Of The Species:

Of all North American freshwater mussels the genus *Epioblasma* is the most endangered. Of the approximately 25 species, 14 are considered to already be extinct and the status of the remaining taxa is uncertain, or threatened. *Epioblasma triquetra* is the most widely distributed member of the genus, which may in part be responsible for its persistence whereas other species in the genus have been extirpated. Because the members of this genus prefer high-gradient silt-free streams they are generally considered to be more sensitive to human mediated disturbances than many other native mussels. The remaining populations of *E. triquetra* are small and fragmented, and the potential for their loss due to catastrophic accidents, such as chemical spills such as the one which occurred on the Clinch River in 1998 is possible (USGS, 2000). If efforts are not made to preserve this species, it is conceivable that *Epioblasma* may be the first genus of North American unionid mussel to go extinct.

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.) to actively expand 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 *E. triquetra* 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. Variation of host fishes across the ranges of many species 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 (Dreissena polymorpha) infestation on two unionid mussels, *Actinonaias ligamentina* and *Amblema plicata*. Can. J. Fish. Aquat. Sci. 54: 512-519.

Barnhart, C., Riusech, F. & M. Baird. 1998. Hosts of salamander mussel (*Simpsonaias ambigua*) and snuffbox (*Epioblasma triquetra*) from the Meramec River system, Missouri. Triannual Unionid Report (16): 34.

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

Bogan, A. E. 1997. A resolution of the nomenclatural confusion surrounding *Plagiola* Rafinesque, *Epioblasma*, and *Dysnomia* Agassiz (Mollusca: Bivalvia: Unionidae). Malacological Review 30:77-86.

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.

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.

Goodrich, C. and van der Schalie, H. 1944. A revision of the Mollusca of Indiana. American Midland Naturalist 32: 257-326.

Gordon, M.E. and J.B. Layzer. 1989. Mussels (Bivalvia: Unioniodea) of the Cumberland River. Review of life histories and ecological relationships. Biological Report 89(15) U. S. Fish and Wildlife Service.

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 (*Dreissena 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.

Hickman, M.E. 1937. A contribution to Mollusca of east Tennessee. M.S. Thesis. University of Tennessee, Knoxville.

Hill, D.M. 1986. Cumberlandian Mollusks Conservation Program, activity 3: Identification of fish hosts. Office of Natural Resources and Economic Development, Tennessee Valley Authority, Knoxville. 57 pp.

Hillegass, K.R. & M.C. Hove. 1997. Suitable fish hosts for glochidia of three freshwater mussels: strange floater, ellipse, and snuffbox. Triannual Unionid Report (13): 25

Hoggarth, M.A. 1999. Descriptions of some of the glochidia of the Unionidae (Mollusca: Bivalvia). Malacologia 41: 1-118.

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.

Murray, H. D. and Leonard, A. B. 1962. Handbook of unionid mussels in Kansas. Univ. Kans. Mus. Nat. Hist. Misc. Pub. 28: 1-184.

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

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.

Ortmann, A.E. 1919. A monograph of the naiades of Pennsylvania. Part III: Systematic account of the genera and species. Mem. Carnegie Mus. 8: xvi-384, 21 pls.

Parmalee, P. 1967. The fresh-water mussels of Illinois. Ill. State Museum Pop. Sci. Ser. 8: 1-108.

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.

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.

Sherman, R.A. 1993. Glochidial release and reproduction of the snuffbox mussel, Epioblasma triquetra; timing in southern Michigan. (Abstract). Bulletin of the North American Benthological Society 10(1): 197.

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.

USGS. 2000. *Certus NRDA Injury Asessment Report*: Qualitatative and quantitative assessment of the freshwater mussel fauna of the upper Clinch River at Cedar Bluff, Virginia, following a chemical truck spill. Prepared for the U.S. Fish and Wildlife Service, Virginia Field Office. Prepared by Steve Ahlstedt, Knoxville, TN, August, April-June, 2000.

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

Watson, E. T., J. L. Metcalf-Smith, and J. DiMaio. 2001. COSEWIC Report on the Snuffbox *Epioblasma triquetra*. NWRI Contribution No. 00-141.

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.

Yeager, B.L., and C.F. Saylor. 1995. Fish hosts for four species of freshwater mussels (Pelecypoda: Unionidae) in the Upper Tennessee River drainage. American Midland Naturalist 133(1):1-6.

Figure 1. Distribution of *Epioblasma triquetra* by county, based on museum records.

NORTH AMERICA

No. 2

GOODE BASE MAP SERIES

Prepared by Henry M. Leppard