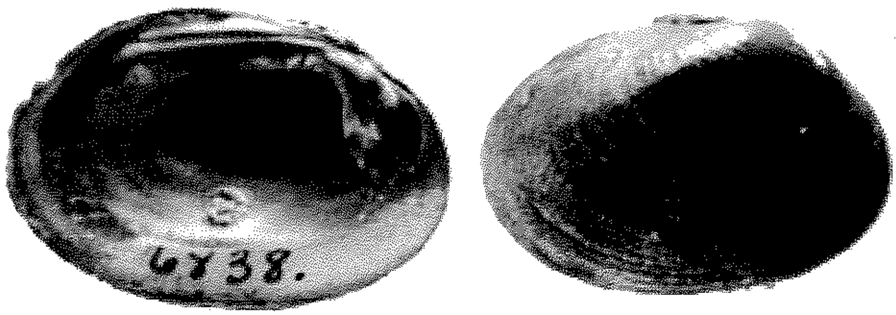
Roe
2002

# *Conservation Assessment* *for* *The Purple Lilliput (Toxolasma lividus) Rafinesque, 1831*




## *USDA Forest Service, Eastern Region*

2002

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## EXECUTIVE SUMMARY

The Purple Lilliput, *Toxolasma lividus* Rafinesque, 1831 is a small, dark mussel that is found in small to medium sized rivers. *Toxolasma lividus* can be distinguished from other mussels its size by its robust hinge teeth and from other members of *Toxolasma* by its purple nacre. The historical range of *T. lividus* includes the Ohio River system, including the Tennessee and Cumberland Rivers as well as the White and Arkansas rivers. Specimens reported from outside the Tennessee River System in Alabama may be range extensions.

*Toxolasma lividus* is currently not listed by the U. S. Fish and Wildlife Service as threatened or endangered, although it is listed by several states. *Toxolasma lividus* is a dioecious species, it brooding habit is bradytictic: spawning occurs in the summer, and the larvae are released the following spring. Two species of *Lepomis* have been determined to be suitable hosts for this species.

Factors considered detrimental to the persistence of many species of freshwater mussels include pollution, siltation and habitat perturbation such as gravel mining or the construction of impoundments. Additional information regarding the affects of these and other potential threats to *T. lividus* is needed. Studies to determine the suitability of other fishes as hosts should be undertaken prior to initiation of captive breeding and re-introduction or translocation projects.

*Toxolasma lividus* Rafinesque, 1831 Purple Lilliput

## SYNONOMY

*Toxolasma lividus* Rafinseque, 1831; Rafinesque, 1831:2
*Toxolasma livida* Rafinseque, 1831; Morrison, 1969:24
*Toxolasma lividum* Rafinseque, 1831; Ortmann,, 1918:573
*Toxolasma lividum lividum* Rafinseque, 1831; Stansbery, 1972:46
*Toxolasma lividus lividus* Rafinseque, 1831; Stansbery, 1976a:48
*Unio glans* Lea, 1831; Lea, 1831:82, pl. 18, fig. 12
*Margarita* (*Unio*) *glans* (Lea, 1831); Lea, 1836:28
*Margaron* (*Unio*) *glans* (Lea, 1831); Lea, 1852c:31
*Lampsilis* (*Carunculina*) *glans* (Lea, 1831); Simpson, 1900a:565
*Eurynia* (*Carunculina*) *glans* (Lea, 1831); Ortmann, 1912a:339
*Carunculina glans* (Lea, 1831); Ortmann, 1910:119
*Carunculina glans glans* (Lea, 1831); Stansbery, 1970:18
*Toxolasma glans* (Lea, 1831); Valentine and Stansbery, 1971:29
*Toxolasma glans glans* (Lea, 1831); Stansbery, 1971:14
*Toxolasma lividus glans* (Lea, 1831); Stansbery, 1976a:48
*Unio moestus* Lea, 1841; Lea, 1841b:82, Lea, 1842b:244, pl. 26, fig. 60
*Margaron* (*Unio*) *moestus* (Lea, 1841); Lea, 1852c:31
*Lampsilis moestus* (Lea, 1841); Simpson, 1900a:565
*Lampsilis moesta* (Lea, 1841); Simpson, 1914:156
*Carunculina moesta* (Lea, 1841); Ortmann, 1921:89
*Carunculina glans moesta* (Lea, 1841); Stansbery, 1970:18

**Type locality**: Rockcastle River [Kentucky]

## DISTRIBUTION

Ohio River Drainage including the Tennessee and Cumberland Rivers. The White River Drainage in Missouri and Arkansas and tributaries of the Arkansas River in Arkansas and Oklahoma. There are some museum records that indicate that the range of *T. lividus* extends further south in Alabama in to the Mobile River Basin. This may be the result of unintentional introduction of glochidia infested fishes or the result of dispersal via the Tennessee-Tombigbee Waterway.

## DESCRIPTION

A small but very solid shell. The valves are inflated and elliptical with a rounded anterior and a sharply pointed posterior. The ventral margin is rounded in females to somewhat straight in males. The posterior ridge is low and rounded. Beaks are only slightly elevated above the hinge line. The periostracum ranges from dark brown to black in color, and is smooth except for growth lines. The nacre is a dark purple that lightens towards the margins. Members of this genus tend to have well-developed hinge teeth for shells this size. The glochidia are described by Ortmann (1921) as subovate in shape.

## LIFE HISTORY AND ECOLOGY

This species is reported from the headwaters of small to medium sized rivers. They have been collected from various substrates including sand, mud, and gravel. Like other members of this genus *Toxolasma lividus* seems to adapt to lentic environments as many have been found in the Wheeler Reservoir in the Tennessee River Drainage (Tennessee Valley Authority, 1986). Laboratory infestations have indicated that *Lepomis cyanellus* and *Lepomis megalotis* are suitable hosts for this species. Females of *T. lividus* display a "caruncle" or fleshy, fingerlike growth immediately below the branchial opening during breeding season. It is thought this mantle modification may serve to attract a suitable host fish. This species is a long-term brooder (bradytictic) (Heard and Guckert, 1970). Gravid females have been collected in September (Neves, 1991).

## STATUS

*Toxolasma lividus* is listed as a species of special concern by Williams et al. (1993). This species is listed as endangered in Illinois, Kentucky, Michigan and Ohio (Cummings and Mayer, 1992) and Virginia. The state of Indiana considers *T. lividus* a species of special concern and assigned it a rank of G1 (critically imperiled) and S2 (imperiled in the state), whereas the state of Missouri assigned it G2 (imperiled globally) S2. Based on museum records the rankings given this species by various state agencies appear accurate. Although the species range of *Toxolasma lividus* covers a fairly broad area, it is found sporadically throughout that range. 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. *Toxolasma lividus* is not a commercially valuable species and so, is not threatened by over-harvesting. Although the *T. lividus* has been found in lotic environments it is more 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 impoundments of existing habitat. The completion of the life cycle of *T. lividus*, like all unionoids is dependent on the presence of a suitable fish host. Host suitability studies conducted to date indicate that two widespread centrarchids are suitable hosts.

## LIMITING FACTORS

Approximately 67% of freshwater mussel species are vulnerable to extinction or are already extinct (National Native Mussel Conservation Committee, 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. *Toxolasma lividus* tends to be found in small to medium sized rivers which 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. This species tends to be found in rocky and gravel substrates, although it does seem to do well in impounded rivers, which tend to have silty substrates. It is unclear if *T. lividus* is more susceptible to siltation than other mussels.

### 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. It is unclear what the effect of pollution is on *T. lividus*.

### 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). Although as noted by Gordon and Layzer (1989) *T. lividus* prefers riffle and headwater environments, it has also appears to have adapted well to at least some impoundments Drainage (Tennessee Valley Authority, 1986).

## POPULATION BIOLOGY AND VIABILITY

The combination of river impoundments and the ecological requirements of *T. lividus* predict a series of isolated populations in the headwater streams throughout the species range. Museum records imply that populations west of the Mississippi River are isolated from the Ohio River populations. 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 *T. lividus*.

## SPECIAL SIGNIFICANCE OF THE SPECIES

There is no special significance of this species.

## 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 *T. lividus* 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. Further investigation aimed at more definitively identifying host fishes across the ranges of many species is advised.

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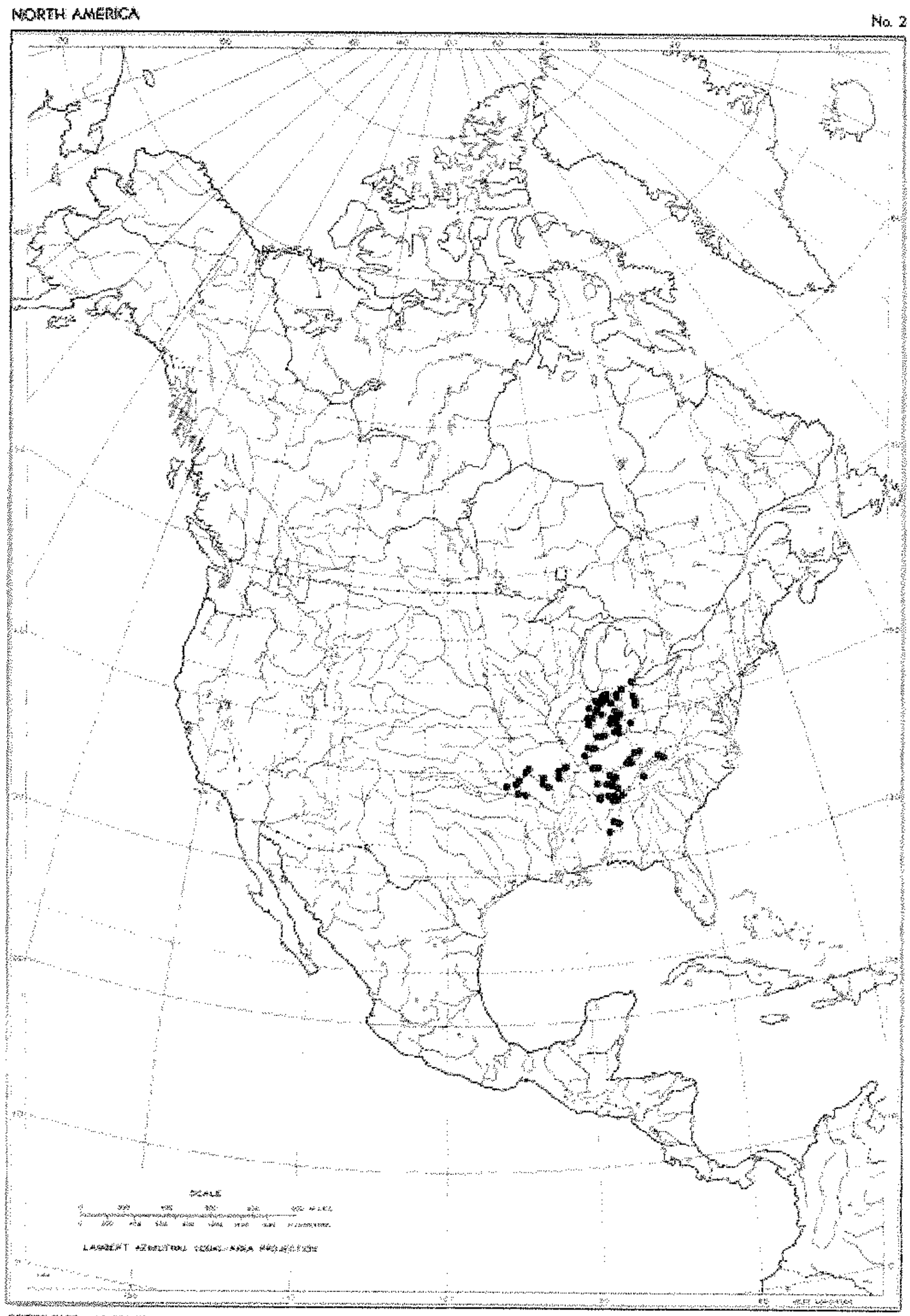
## APPENDIX

**Figure 1.** *Distribution of Toxolasma lividus by county based on museum records.*



***Toxolasma lividus*** - (Rafinesque, 1831)
Purple Lilliput
**Other Related Names:** *Carunculina glans* (I. Lea, 1831) ;*Carunculina lividus* (Rafinesque, 1831) ;*Toxolasma lividum* Rafinesque, 1831
**Unique Identifier:** ELEMENT_GLOBAL.2.119668
**Element Code:** IMBIV43030
**Informal Taxonomy:** Animals, Invertebrates - Mollusks - Freshwater Mussels

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| Kingdom | Phylum | Class | Order | Family | Genus |
|---|---|---|---|---|---|
| Animalia | Mollusca | Bivalvia | Unionoida | Unionidae | Toxolasma |

**Genus Size:** C - Small genus (6-20 species)

**Check this box to expand all report sections:** ☐

Concept Reference

**Concept Reference:** Turgeon, D.D., J.F. Quinn, Jr., A.E. Bogan, E.V. Coan, F.G. Hochberg, W.G. Lyons, P.M. Mikkelsen, R.J. Neves, C.F.E. Roper, G. Rosenberg, B. Roth, A. Scheltema, F.G. Thompson, M. Vecchione, and J.D. Williams. 1998. Common and scientific names of aquatic invertebrates from the United States and Canada: Mollusks. 2nd Edition. American Fisheries Society Special Publication 26, Bethesda, Maryland: 526 pp.
**Concept Reference Code:** B98TUR01EHUS
**Name Used in Concept Reference:** *Toxolasma lividus*
**Taxonomic Comments:** The spelling *Toxolasma lividus* follows Turgeon et al. (1998). Through misinterpretations of species identities and synonomy, *Toxolasma* has been considered to contain two to eight species (e.g., Johnson, 1970; Burch, 1975; Turgeon et al. 1988; Turgeon et al, 1998). Examination of museum vouchers indicate that there may be as many as 15 species. These recent publications have been little more than species lists and present no explanation for the synonomies. The last such work to do so was Ortmann and Walker (1922) which mistakenly synonymized *Toxolasma lividus* under *Carunculina moesta* (Lea, 1841). In recent works, *C. moesta* has been interpreted as a junior synonym of *Carunculina glans* (Lea, 1834). However, Pilsbry and Rhoads (1896), Ortmann (1918), and Ortmann and Walker (1922) indicate that *lividus* and *glans* are not the same shell and probably represent different species. As such, *Toxolasma lividus* would represent the species found within the Cumberlandian region. The entire genus needs to be revised and should include an examination of the affinities between *glans* and *lividus* and between populations of *lividus* in the Cumberland and Tennessee river systems. The relationship between *T. lividus* and purple-nacred *Toxolasma* in the Alabama River system is similarly unclear.

Conservation Status

## NatureServe Status

**Global Status:** G2
**Global Status Last Reviewed:** 25Nov2007
**Global Status Last Changed:** 21Aug1997
**Rounded Global Status:** G2 - Imperiled
**Reasons:**
If interpreted as a Cumberlandian endemic, declining numbers and loss of occurrences have rendered this species quite rare. If lumped with *Toxolasma glans*, the species would have a considerably wider, although still sporadic distribution with relatively low densities at many sites. Because of the possible catastrophic implications if more Cumberlandian occurrences are lost, the species should be

considered a Cumberlandian endemic until the systematic problems can be rectified.
**Nation:** United States
**National Status:** N2

| U.S. & Canada State/Province Status | |
|---|---|
| United States | Alabama (S2?), Arkansas (S2), Georgia (SH), Illinois (S1), Indiana (S2), Kentucky (S1), Michigan (S1), Missouri (S2), North Carolina (SX), Ohio (S1), Oklahoma (SH), Tennessee (S1S2), Virginia (S1) |

## Other Statuses

**IUCN Red List Category:** NE - Not evaluated

**American Fisheries Society Status:** Special Concern (01Jan1993)

## NatureServe Conservation Status Factors

**Global Abundance:** Unknown
**Global Abundance Comments:** Assuming a restricted interpretation of the species (i.e., Cumberlandian endemic), the species is quite rare but widely scattered through the region. It has only rarely been found in any surveys during the last 5 years.

**Estimated Number of Element Occurrences:**6 - 20
**Estimated Number of Element Occurrences Comments:**If distinct from *Toxolasma glans* then a 20 or more occurrences appears justified due to severe loss of habitat and present rarity. If *Toxolasma lividus* and *Toxolasma glans* are lumped together, then a classification of 80 or more occurrences would be appropriate. In the Maumee River drainage, it is rare and very sporadic in the headwater lakes of the St. Joseph River (Indiana/Ohio) (Grabarkiewicz and Crail, 2006). In Illinois, it is now restricted to the Little Wabash and Vermilion Rivers where it is sporadic but was formerly known from the Embarras River and Wabash River tributaries and Wabash River (Cummings and Mayer, 1997). In Missouri, it is known only in southern Missouri in a few sites (Oesch, 1995). In Arkansas, it is known from the Ouachita River system in South Fourche La Fave River, Poteau River, Illinois River but always in low population numbers (Harris and Gordon, 1997); also historically in the Cache River (Christian et al., 2005). In Tennessee, it was found throughout the upper Tennessee River system, including the Powell, Clinch, Emory, Holston, French Broad, Tellico, Little Pigeon, and Little Rivers, as well as the main channel of the Tennessee River below Knoxville. It was also found in the Duck and Elk Rivers and occurred in the Caney Fork, Stones and Harpeth Rivers and numerous tributaries of the Cumberland River system in Tennessee (Parmalee and Bogan, 1998). A recent study of the North Fork Holston River in Virginia (Jones and Neves, 2007) did not find this species and is likely extirpated there or is extremely rare. It was recently collected in the Middle Fork North Branch Vermillion River in Illinois and Jordan Creek in Indiana (Szafoni et al., 2000). In Indiana, Harmon (1989) reported it from seven of 12 sites surveyed in Graham Creek in the southeast portion of the state; as well as from Sugar Creek (east fork White River drainage) in central Indiana (Harmon, 1992) (most weathered shells but some living and fresh dead) and Tippecanoe River (Cummings and Berlocher, 1990). It can still be found in Wabash River tributaries in Indiana (Fisher, 2006). In Ohio it is nearly extirpated (Watters, 1995) occurring in a few sites in the Little Miami and St. Josephs drainages as well as the Maumee drainage (Grabarkiewicz and Crail, 2006). In Kentucky, it is sporadic in the Green River and upper Cumberland River below Cumberland Falls (Cicerello and Schuster, 2003). In a 2004 survey of 24 sites in the Choctawhatchee, Yellow, and Conecuh-Escambia River drainages in southern Alabama, Pilarczyk et al. (2006) found this species (although acknowledged some confusion as to which species of *Toxolasma* it should be listed as) at 16 sites (including just over the border in Eightmile Creek in Florida). It is known from the Clinton River drainage in Michigan (Strayer, 1980).

**Global Short Term Trend:** Declining (decline of 10-30%)
**Global Short Term Trend Comments:** Numbers and occurrences have, and continue to, declined drastically since 1979 in the Cumberlandian region. This species is listed as endangered in Illinois, Kentucky, Michigan and Ohio and is also considered rare in Indiana and Missouri. The species is extirpated in North Carolina in the French Broad River where it formerly occurred (LeGrand et al., 2006). In Virginia it is likely extirpated from the North Fork Holston (Jones and Neves, 2006) and Clinch Rivers (VA NHP, pers. comm., 2007). Outside the Cumberlandian region, if considered the same species, it is secure, however, although it has a fairly wide range, it is considered to occur only sporadically within the range.

**Global Long Term Trend:** Moderate decline (decline of 25 - 50%)
**Global Long Term Trend Comments:** In North Carolina, it was recorded from Hot Springs on the French Broad River, Madison Co. but Johnson (1970) suggested these specimens may be *Villosa vanuxemensis* (Bogan, 2002). Branson (1984) postulated on the occurrence of this species (as *Toxolasma glans*) in Oklahoma based on presence in the Spring and Elk Rivers in nearby Missouri, but today no evidence of the species can be found.

**Global Inventory Needs:** Determine extent of existing populations, continue surveys, and assess potential reintroduction sites.

**Global Protection:** None. No occurrences appropriately protected and managed

**Global Protection Comments:** No site appears to be protected in any way.

**Global Protection Needs:** All populations should receive protection through acquisition, easement, registry, and working with local, state, and federal government agencies on issues relating to development, water quality, river designation, etc. Watershed management with particular emphasis on control of acid coal mine run-off and agricultural induced siltation is critical.

**Degree of Threat:** Moderate and imminent threat

**Threat Scope:** Moderate

**Threat Severity:**Moderate

**Threat Immediacy:** Moderate

**Threats:** It is impacted by chemical and organic pollution, siltation from agriculture and clear-cutting, channel alteration and inundation, and acid coal mine run-off. Cattle wading in small streams have destroyed considerable habitat formerly used by this species. Roe (2002) lists the following threats: invasion of competetive zebra mussels (limited threat due to habitat preference), siltation, pollution (agricultural, domestic, industrial) (effect unclear on this species), dams and impoundments (although this species adapts better to impoundments than others).

**Fragility:** Unknown

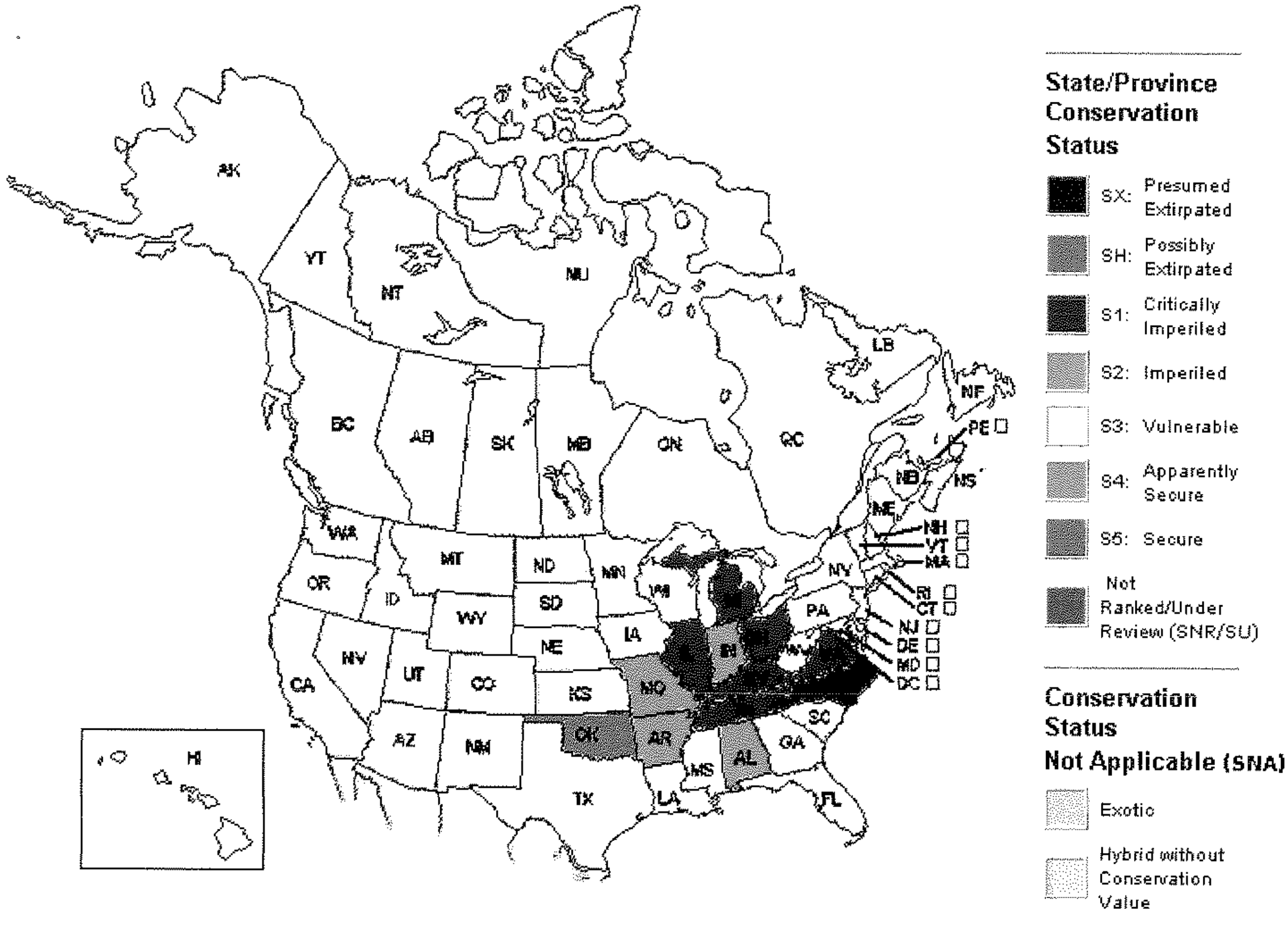
**Fragility Comments:** Sensitive to pollution, siltation, habitat perturbation, inundation, and loss of glochidial hosts.

**Environmental Specificity:** Narrow to moderate.

**Environmental Specificity Comments:** Although the *T. lividus* has been found in lotic environments it is more typically found in clean, swiftly flowing water.

Distribution

**U.S. States and Canadian Provinces**




**Endemism:** endemic to a single nation

| U.S. & Canada State/Province Distribution | |
|---|---|
| United States | AL, AR, GA, IL, IN, KY, MI, MO, NC, OH, OK, TN, VA |

**Range Map**
No map available.

**Global Range:** 5000-20,000 square km (about 2000-8000 square miles)

**Global Range Comments:** Because of the uncertainty of the distinctness of *Toxolasma lividus* vs. *Toxolasma glans*, it is not clear just what the current distribution of *T. lividus* encompasses. Both forms have suffered considerable declines in range. As a whole, the species occupied the Ohio River Drainage including the Tennessee and Cumberland Rivers; the White River Drainage in Missouri and Arkansas and tributaries of the Arkansas River in Arkansas and Oklahoma; as well as some museum records that indicate that the range of *T. lividus* extends further south in Alabama in to the Mobile River Basin. In the Cumberland River basin, it is known to occur sporadically in less than ten tributary streams (e.g., Little South Fork Cumberland River, Buck Creek: see Schuster et al., 1989). In the Tennessee River basin, it occurs in small, disjunct populations in the Duck, Elk, Paint Rock, and North Fork Holston rivers. The *glans* form is more widely distributed, although still sporadic and in greatly reduced numbers: Kentucky, Ohio, Indiana, Illinois, Michigan, Ozark Plateaus in southern Missouri, nothern Arkansas, and northern Oklahoma. Recent collections of a similar *Toxolasma* from the Ouachita mountains in Arkansas may represent a different species. Historically in the Poteau River and tributaries, Arkansas/Oklahoma (Vaughn and Spooner, 2004). Branson (1984) suggested it might occur in Oklahoma based on close proximity in southern Arkansas and Missouri, but could document no occurrences. Harris (1994) found the species in the uppermost reaches of the Poteau River in Arkansas close to the Oklahoma border and a subsequent survey of the same river further downstream in Oklahoma did not yield any specimens (Vaughn and Spooner, 2004). Although it once occurred just over the border in the Clinch River in Virginia, it does not appear to reach as far northeast as West Virginia. There is a record from the H. Athearn collection from Lookout Creek in Georgia (H. Athearn Collection).

| U.S. Distribution by County (based on available natural heritage records) | |
|---|---|
| | |

| State | County Name (FIPS Code) |
|---|---|
| AL | Colbert (01033), Jackson (01071), Lauderdale (01077), Lawrence (01079), Limestone (01083), Madison (01089), Marshall (01095) |
| IL | Pope (17151), Vermilion (17183), White (17193) |
| IN | Adams (18001), Allen (18003), Bartholomew (18005), Benton (18007), Boone (18011), Carroll (18015), De Kalb (18033), Decatur (18031), Delaware (18035), Fountain (18045), Fulton (18049), Hamilton (18057), Hancock (18059), Henry (18065), Huntington (18069), Jefferson (18077), Jennings (18079), Kosciusko (18085), Madison (18095), Marshall (18099), Martin (18101), Miami (18103), Posey (18129), Pulaski (18131), Putnam (18133), Randolph (18135), Rush (18139), Shelby (18145), Steuben (18151), Tippecanoe (18157), Vermillion (18165), Wabash (18169), White (18181), Whitley (18183) |
| KY | Adair (21001), Allen (21003), Butler (21031), Casey (21045), Christian (21047), Clinton (21053), Cumberland (21057), Green (21087), Jackson (21109), Laurel (21125), Lincoln (21137), Logan (21141), McCracken (21145), McCreary (21147), Muhlenberg (21177), Ohio (21183), Pendleton (21191), Pulaski (21199), Rockcastle (21203), Russell (21207), Shelby (21211), Spencer (21215), Todd (21219), Warren (21227), Wayne (21231) |
| MI | Monroe (26115), Oakland (26125), Tuscola (26157) |
| MO | Bollinger (29017), Butler (29023), Douglas (29067), Greene (29077), Jasper (29097), Madison (29123), McDonald (29119), Newton (29145), Oregon (29149), Ripley (29181), Shannon (29203), St. Francois (29187), Stone (29209), Taney (29213), Wayne (29223), Webster (29225) |
| OH | Hancock (39063), Warren (39165), Williams (39171) |
| TN | Franklin (47051), Giles (47055), Grundy (47061), Marshall (47117), Maury (47119), Monroe (47123) |
| VA | Russell (51167), Scott (51169), Smyth (51173) |

| U.S. Distribution by Watershed (based on available natural heritage records) | |
|---|---|
| Watershed Region | Watershed Name (Watershed Code) |
| 04 | Clinton (04090003), Raisin (04100002), St. Joseph (04100003), Blanchard (04100008) |
| 05 | Little Miami (05090202), Licking (05100101), Upper Green (05110001), Upper Wabash (05120101), Mississinewa (05120103), Eel (05120104), Middle Wabash-Deer (05120105), Tippecanoe (05120106), Middle Wabash-Little Vermilion (05120108), Vermilion (05120109), Sugar (05120110), Lower Wabash (05120113), Little Wabash (05120114), Upper White (05120201), Driftwood (05120204), Flatrock-Haw (05120205), Upper East Fork White (05120206), Muscatatuck (05120207), Lower East Fork White (05120208), Rockcastle (05130102), Upper Cumberland-Lake Cumberland (05130103), South Fork Cumberland (05130104), Red (05130206), Salt (05140102), Lower Ohio-Bay (05140203) |
| 06 | North Fork Holston (06010101), Lower Little Tennessee (06010204), Upper Clinch (06010205), Wheeler Lake (06030002), Upper Elk (06030003), Lower Elk (06030004), Pickwick Lake (06030005), Upper Duck (06040002), Lower Tennessee (06040006) |
| 07 | Whitewater (07140107) |
| 08 | Upper St. Francis (08020202) |
| 11 | James (11010002), Bull Shoals Lake (11010003), North Fork White (11010006), Current (11010008), Lower Black (11010009), Eleven Point (11010011), Spring (11070207), Elk (11070208) |

## Ecology & Life History

**Basic Description:** A freshwater mussel

**General Description:** Shell small, solid, relatively heavy for size, thinner posteriorly, elliptical to ovate-elliptical or subrhombodial, inflated; anterior margin evenly rounded; ventral margin flatly convex; posterior margin bluntly pointed to vaguely biangulate, point near posterio-ventral junction with a slightly convex margin obliquely sloped towards dorsum in males, point supermedial to midline with truncated margin sloping anterio-ventrally to a sharply rounded junction with ventral margin, posterior margin rounded in young shells; dorsal margin flatly convex to almost straight posteriorly, slightly convex anteriorly; anterio-dorsal junction may be smooth to slightly angular; beaks well developed, rather full, moderately elevated above dorsal margin, sculpted by relatively heavy concentric ridges; posterior ridge subangulate and elevated near beaks to low and flattened posteriorly, double, termini at posterior point; posterior point concave, a radial swelling from the beak to the posterio-ventral junction may be present in females; periostracum rather rough, greenish to olive-brown or black, subshiny, may be obscurely rayed with minute lines. Pseudocardinal teeth rather small, heavy, subcompressed to triangular, elevated, serrated, double in left valve, posterior tooth taller than anterior tooth, single in right valve, triangular, small lamellae may develop anterior and posterior to contiguous sulci; interdentum very short, relatively narrow; lateral teeth relatively long, slightly curved to straight; anterior muscle scars small, distinct, impressed; pallial line not impressed; posterior muscle scars lightly impressed, confluent; beak cavity moderately developed but not deep; nacre purple, leadened or bluish in shell cavity, may be paler along periphery of shell, nacre rarely white, iridescent posteriorly.

**Diagnostic Characteristics:** Several species that occur within the Cumberlandian region may be confused with TOXOLASMA LIVIDUM. TOXOLASMA PARVUM does not get as big or as high, has a thinner shell, always has a white nacre which mat be somewhat silvery due to the iridescense (LIVIDUM when white is more of a porcelain white, similar to the nacre of VILLOSA TRABALIS [Conrad, 1834]), and always exibits female shell morphology (it's a hermaphroditic species). TOXOLASMA is more elliptically shaped, being not as tall, has a yellowish periostracum, and has a paler nacre which often has a yellowish overcast. VILLOSA VANUXEMII (Lea, 1838) tends to be taller; has a very shiny nacre which may be salmon or purple (often with reddish overtones) with a brownish cast in the shell cavity; the posterior margin of the female is acutely truncated and often exibits an indentation just below the posterior point; may have some wavy, greenish capillary rays across a brown periostracum; and has a rounded posterior ridge. If LIVIDUM and GLANS are conspecific, T. PARVUM and VILLOSA LIENOSA (Conrad, 1834) are probably the only species which might be mistaken for "LIVIDUM". Height: 28mm.

**Reproduction Comments:** This species generally has been considered a long-term brooder. Graved females ahve been reported from May until July. However, indicative of these records, Hoeh (personal communication) has found some Michigan populations to function as short-termed brooders and to produce multiple broods per year. Glochidia are held in echtobranchous marsupia. Hill (1986) determined *Lepomis cyanellus* (green sunfish) and *Lepomis megalotis* (longear sunfish) to serve as glochidial hosts.

**Ecology Comments**
No specific studies have considered this species. Densities estimate were presented in Jenkinson (1988).

**Habitat Type:** Freshwater

**Non-Migrant:** N

**Locally Migrant:** N

**Long Distance Migrant:** N

**Mobility and Migration Comments:** This species is probably rather sessile with only limited movement through the substrate. Passive downstream movement may occur when mussels are displaced from the substrate during floods. Major dispersal occurs when glochidia are encysted on their hosts.

**Riverine Habitat(s):** CREEK, High gradient, Low gradient, MEDIUM RIVER, Riffle

**Special Habitat Factors:** Benthic

**Habitat Comments:** This species can inhabit fine-particle substrates and also sand, gravel, or cobbles and boulders in riffles or flats immediatly above riffles (Gordon, 1989). This species is reported from the headwaters of small to medium sized rivers. They have been collected from various substrates including sand, mud, and gravel. Like other members of this genus *Toxolasma lividus* seems to adapt to lentic environments as many have been found in the Wheeler Reservoir in the Tennessee River Drainage (Roe, 2002). It is often the first species encountered in headwater areas. It generally occurs at depths < 1 m. It very rarely is encountered in a big river habitat or reservoirs (Gordon and Lazer, 1989).

**Adult Food Habits:** Detritivore

**Immature Food Habits:** Parasitic

**Food Comments:** Larvae (glochidia) of freshwater mussels generally are parasitic on fish and display varying degrees of host specificity. No specific tropic studies have been conducted on this species. General literature claims that mussels are filter-feeders which remove phytoplankton from the water column. These assumptions appear to be based on casual observations of mussels in situ and a few examinations of rectal contents. Baker (1928) speculated that detritus was the primary energy source. This has been substantiated by James (1987) and correlates well with microhabitats observed in the field. This suggests that mussels may occupy a variety of guilds such as postulated for the Sphaeriidae (see Lopez and Layzer, 1989).

**Phenology Comments:** Little is known concerning the phenology of mussels other than when eggs/glochidia are held in the branchial marsupia. Being poikilotherms, activity levels would expectly be greatly reduced during cold-temperature months.

**Length:** 5.1 centimeters

Economic Attributes Not yet assessed ?

Management Summary ?

**Stewardship Overview:** 1) Maintain high quality T. LIVIDUS habitat, consisting of riffle areas of streams with good water quality. 2)

Monitor and regulate land use upstream to prevent siltation of streams. 3) Physical modifications to streams such as dredging and impoundment should be avoided, as should biological modifications to natural fish communities in areas where the species may occur.

**Restoration Potential:** Upgrading of water quality undoubtedly will help in the recovery of the species. Dredging for sand and gravel as well as channel modifications in good mussel habitats should be halted, as well as any management schemes which would alter the natural fish population, particularly sunfish.

**Preserve Selection & Design Considerations:** Streams or tributaries with good water quality would probably make the best preserve areas for the species. Acquisition of land on either side of a creek would help ensure that pollutant/siltation runoff to the stream would be minimal, although land use practices should be monitored in the entire watershed to minimize siltation.

**Management Requirements:** Requirements include the maintenance of flowing water in riffle areas with suitable water quality. Stream modifications such as dredging and impoundment should be avoided, as well as any modifications to the natural fish communities in areas where the species may occur.

Construction, mining, and agricultural activities in stream watersheds should be closely monitored in order to minimize siltation and acid runoff to streams. Point sources should be closely checked to insure compliance with discharge permit regulations.

**Monitoring Requirements:** Because T. LIVIDUS is most often reported from shallow water habitats, wading and hand picking specimens from the substrate is probably the most effective sampling method. Care must be taken to thoroughly search the substrate, since the species is relatively small and could easily be overlooked.

**Biological Research Needs:** Determine habitat preferences and environmental tolerances, tolerances to various pollutants and siltation, and reproductive biology/glochidial hosts. Determine systematic relationship between the nominal forms LIVIDUS (Cumberland River drainage), MAESTUM (Tennessee River drainage), and GLANS (portions of Ohio and Mississippi river systems).

## Population/Occurrence Delineation

**Group Name:** FRESHWATER MUSSELS

**Use Class:** Not applicable

**Minimum Criteria for an Occurrence:** Occurrences are based on some evidence of historical or current presence of single or multiple specimens, including live specimens or recently dead shells (i.e., soft tissue still attached and/or nacre still glossy and iridescent without signs of external weathering or staining), at a given location with potentially recurring existence. Weathered shells constitute a historic occurrence. Evidence is derived from reliable published observation or collection data; unpublished, though documented (i.e. government or agency reports, web sites, etc.) observation or collection data; or museum specimen information.

**Mapping Guidance:** Based on the separation distances outlined herein, for freshwater mussels in STANDING WATER (or backwater areas of flowing water such as oxbows and sloughs), all standing water bodies with either (1) greater than 2 km linear distance of unsuitable habitat between (i.e. lotic connections), or (2) more than 10 km of apparently unoccupied though suitable habitat (including lentic shoreline, linear distance across water bodies, and lentic water bodies with proper lotic connections), are considered separate element occurrences. Only the largest standing water bodies (with 20 km linear shoreline or greater) may have greater than one element occurrence within each. Multiple collection or observation locations in one lake, for example, would only constitute multiple occurrences in the largest lakes, and only then if there was some likelihood that unsurveyed areas between collections did not contain the element.

For freshwater mussels in FLOWING WATER conditions, occurrences are separated by a distance of more than 2 stream km of unsuitable habitat, or a distance of more than 10 stream km of apparently unoccupied though suitable habitat. Standing water between occurrences is considered suitable habitat when calculating separation distance for flowing water mussel species unless dispersal barriers (see Separation Barriers) are in place.

Several mussel species in North America occur in both standing and flowing water (see Specs Notes). Calculation of separation distance and determination of separation barriers for these taxa should take into account the environment in which the element was collected. Juvenile mussels do not follow this pattern and juveniles are typically missed by most standard sampling methods (Hastie and Cosgrove, 2002; Neves and Widlak, 1987), therefore juvenile movement is not considered when calculating separation distance.

**Separation Barriers:** Separation barriers within standing water bodies are based solely on separation distance (see Separation Distance-suitable, below). Separation barriers between standing water bodies and within flowing water systems include lack of lotic connections, natural barriers such as upland habitat, absence of appropriate species specific fish hosts, water depth greater than 10 meters (Cvancara, 1972; Moyle and Bacon, 1969) or anthropogenic barriers to water flow such as dams or other impoundments and high waterfalls.

**Separation Distance for Unsuitable Habitat:** 2 km

**Separation Distance for Suitable Habitat:** 10 km

**Alternate Separation Procedure:** None

**Separation Justification:** Adult freshwater mussels are largely sedentary spending their entire lives very near to the place where they first successfully settled (Coker et al., 1921; Watters, 1992). Strayer (1999) demonstrated in field trials that mussels in streams occur chiefly in flow refuges, or relatively stable areas that displayed little movement of particles during flood events. Flow refuges conceivably allow relatively immobile mussels to remain in the same general location throughout their entire lives. Movement occurs with the impetus of some stimulus (nearby water disturbance, physical removal from the water such as during collection, exposure conditions during low water, seasonal temperature change or associated diurnal cycles) and during spawning. Movement is confined to either vertical movement burrowing deeper into sediments though rarely completely beneath the surface, or horizontal movement in a distinct path often away from the area of stimulus. Vertical movement is generally seasonal with rapid descent into the sediment in autumn and gradual reappearance at the surface during spring (Amyot and Downing, 1991; 1997). Horizontal movement is generally on the order of a few meters at most and is associated with day length and during times of spawning (Amyot and Downing, 1997). Such locomotion plays little, if any, part in the distribution of freshwater mussels as these limited movements are not dispersal mechanisms. Dispersal patterns are largely speculative but have been attributed to stream size and surface geology (Strayer, 1983; Strayer and Ralley, 1993; van der Schalie, 1938), utilization of flow refuges during flood stages (Strayer, 1999), and patterns of host fish distribution during spawning periods (Haag and Warren, 1998; Watters, 1992). Lee and DeAngelis (1997) modeled the dispersal of freshwater into unoccupied habitats as a traveling wave front with a velocity ranging from 0.87 to 2.47 km/year (depending on mussel life span) with increase in glochidial attachment rate to fish having no effect on wave velocity.

Nearly all mussels require a host or hosts during the parasitic larval portion of their life cycle. Hosts are usually fish, but a few exceptional species utilize amphibians as hosts (Van Snik Gray et al., 2002; Howard, 1915) or may metamorphose without a host (Allen, 1924; Barfield et al., 1998; Lefevre and Curtis, 1911; 1912). Haag and Warren (1998) found that densities of host generalist mussels (using a variety of hosts from many different families) and displaying host specialists (using a small number of hosts usually in the same family but mussel females have behavioral modifications to attract hosts to the gravid female) were independent of the densities of their hosts. Densities of non-displaying host specialist mussels (using a small number of hosts usually in the same family but without host-attracting behavior) were correlated positively with densities of their hosts. Upstream dispersal of host fish for non-displaying host specialist mussels could, theoretically, transport mussel larvae (glochidia) over long distances through unsuitable habitat, but it is unlikely that this occurs very often. D. Strayer (personal communication) suggested a distance of at least 10 km, but a greater distance between occurrences may be necessary to constitute genetic separation of populations. As such, separation distance is based on a set, though arbitrary, distance between two known points of occurrence.
**Date:** 18Oct2004
**Author:** Cordeiro, J.
**Notes:** Contact Jay Cordeiro (jay_cordeiro@natureserve.org) for a complete list of freshwater mussel taxa sorted by flow regime.

Population/Occurrence Viability — Not yet assessed

U.S. Invasive Species Impact Rank (I-Rank) — Not yet assessed

Authors/Contributors

**NatureServe Conservation Status Factors Edition Date:** 06Mar2007
**NatureServe Conservation Status Factors Author:** Cordeiro, J. (2007); Gordon, M. (1992); Whittaker, J. C. (1994)
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**Management Information Edition Author:** DIANE LAURITSEN
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**Element Ecology & Life History Author(s):** Cordeiro, J. (2007); GORDON, M. E. (1991)

Zoological data developed by NatureServe and its network of natural heritage programs (see **Local Programs**) and other contributors and cooperators (see **Sources**).

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**Citation for data on website including Watershed and State Distribution maps:**
NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: July 7, 2008 ).

**Citation for Bird Range Maps of North America:**
Ridgely, R.S., T.F. Allnutt, T. Brooks, D.K. McNicol, D.W. Mehlman, B.E. Young, and J.R. Zook. 2003. Digital Distribution Maps of the Birds of the Western Hemisphere, version 1.0. NatureServe, Arlington, Virginia, USA.

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