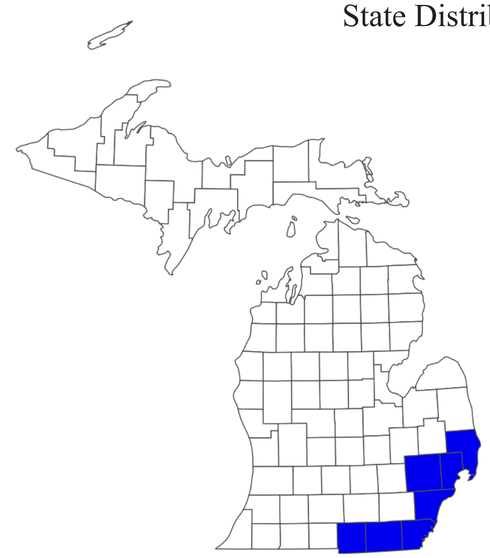
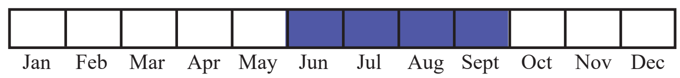
Paetulunio fabalis Lea — Rayed Bean

Male (top) and female (bottom) rayed bean. Photos by Kurt Stepntiz

State Distribution



Best Survey Period



Status: Federal and State Endangered

Global and State Rank: G2 (Imperiled) / S1 (Critically Imperiled)

Family: Unionidae (Pearly mussels)

Synonyms: *Eurynia* (*Micromya*) *fabalis* Lea, *Lemiox fabalis* Lea, *Ligumia* (*Micromya*) *fabalis* Lea, *Margarita* (*Unio*) *fabalis* Lea, *Margaron* (*Unio*) *fabalis* Lea, *Micromya lapillus* Say, *Micromya fabalis* Lea, *Micromya fabale* Lea, *Unio capillus* Say, *Unio donacopsis* De Gregorio, *Unio fabalis* Lea, *Unio lapillus* Say, *Villosa fabalis* Lea (MolluscaBase 2026)

Total Range: The rayed bean is sporadically distributed in the drainages of the St. Lawrence, Ohio and Tennessee Rivers. While it was historically found frequently from Ontario to Alabama and Illinois to New York, only a few populations are currently known to exist. It is presumed to be extirpated (SX) throughout much of its former range, including Alabama, Kentucky, and Virginia. It is possibly extirpated (SH) in Illinois and listed as critically imperiled (S1) throughout the rest of its range. An estimated 70% of formerly occupied streams no longer support viable populations. It is now confirmed in only 34 streams and 1 lake in seven states and one Canadian providence, including the Black River (Mill Creek), Pine River, Belle River, Clinton River, and River Raisin in Michigan (NatureServe 2026).

State Distribution: Historically, the rayed bean was found in many rivers in southeastern Michigan. It was reported from the Clinton River in Oakland County, the Belle and Pine Rivers in St. Clair County, the lower Huron River in Monroe County, and the River Raisin in Lenawee County. Spent shells have also been found in the St. Joseph River in Hillsdale County, Lake St. Clair in Wayne County, and Lake Erie in Monroe County. In the past 25 years, however, rayed bean have been found only in the Huron, St. Clair, Clinton, and River Raisin watersheds along the southeastern portion of the state (Wayne, St. Clair, Oakland, Lenawee, Macomb, and Monroe Counties; MNFI 2026).

Recognition: The rayed bean is a small mussel with a thick shell, usually under 38 mm (1.5 in) in length. The shell is elliptical and rounded in shape with varying degrees of inflation. There is sexual dimorphism in rayed bean, with males tapering posteriorly to a point and females having a more rounded posterior end. Beaks are wide and low but tend to end in a point. Beak sculpture consists of two or three heavy ridges that disappear after the first year of growth. The exterior is light yellow or tan to dark green or olive, with heavy, dark green, wavy, and continuous rays that cover much of the shell. The nacre (inside of shell) is white to whitish blue, often iridescent posteriorly. Rayed bean have large, triangular pseudocardinal teeth and heavy, short lateral teeth (Cummings and Mayer 1992, Burch 1994, Watters et al. 2009, Mulcrone and Rathbun 2020).

Similar species include the lilliput (*Toxolasma parvum*), purple lilliput (*T. lividum*), ellipse (*Venustaconcha ellipsiformis*), and rainbow (*Cambarunio iris*). However, the lilliput and purple lilliput are without rays, have a broader more inflated beak, and tend to have a thinner shell. The nacre of purple lilliput is usually purple. Ellipse and rainbow are much larger relative to their age and thinner shelled. Rainbow are also typically lighter than rayed bean, with a yellower shell.

Best Survey Time: The best time to survey for this species is the first week of June through the end of September during periods of low water level and turbidity. The rayed bean is typically found buried deep in the sediment, sometimes tangled in the roots of aquatic plants, making it difficult to detect during visual surveys. Due to the small size of this species targeted surveys using modified methods (e.g. higher search effort per unit area, careful excavation and close visual inspection of excavated substrate) are required to reliably detect live individuals and shells.

Habitat: The rayed bean occurs in multiple habitat types, including small, shallow rivers and lakes. In rivers, these mussels are typically found in and around riffles, where they are buried deep in sand, gravel, or both. They have also been found in locations with mixtures of silt, gravel, and sand substrates, despite silt typically being considered unsuitable habitat (Ford et al. 2024). Rayed bean often live near aquatic vegetation and can be found in roots when plants are pulled (Ortmann 1919). The rayed bean is also found in slow flowing rivers and along the shallow, wave-swept shores of lakes, including Lake Erie, where it is associated with western islands (La Rocque 1967, Ohio River Valley Ecosystem Team 2002, Mulcrone and Rathbun 2020).

Biology: Rayed bean can live for about 15 years (USFWS 2024). The exact breeding season of the rayed bean is not known, although females bearing eggs have been found in May (Ortmann 1919). Males release sperm into the water column which is then filtered out by females to fertilize their eggs. As a bradytictic species, female rayed bean hold glochidia (the parasitic larval stage of mussels) internally over the winter for release in the spring (Ortmann 1909). Female rayed bean have specialized mantel tissue that is displayed to attract potential fish hosts (Williams et al. 2008). While more studies are needed, potential fish hosts include the Tippecanoe darter (*Etheostoma tippecanoe)*, rainbow darter (*E. caeruleum*), greenside darter (*E. blennioides*), mottled sculpin (*Cottus bairdii*), and largemouth bass (*Micropterus salmoides*; White et al. 1996, Strayer and Jirka 1997, Woolnough 2002, Butler 2003).

Studies in the lab suggest the glochidia attachment lasts for 7-14 days (Woolnough 2002). After completing this "parasitic" stage (referred to as parasitic despite no harm done to the fish host), the rayed bean remains relatively sessile on the river bottom. Some juvenile mussels use an elastic thread that is secreted by a gland in the soft tissue, known as the byssus, to attach to pebbles, sticks, and other solid objects to avoid displacement. While most mussels lose the byssus after the first year of life, a few, including the rayed bean, retain it as an anchor as adults (Haag 2012). Rayed bean grow quickly in their first three years, during which female characteristics appear and after which growth rates slow. As a filter feeder, rayed bean siphon water and extract particulate organic matter, algae and diatoms from the river currents, although they can also obtain food from sediments (Vaughn et al. 2008).

Conservation/Management: Like other freshwater mussels, rayed bean face many threats and have experienced significant declines. Particularly in the southern portion of the lower peninsula, expanding urbanization, agricultural activity, and the introduction of zebra (*Dreissena polymorpha*) and quagga mussels (*D. bugensis*) contribute to declines in mussel species richness and abundance (Morris and Burridge 2006). Urbanization and agricultural practices lead to the removal of natural land cover, increasing pollution runoff and erosion, resulting in reduced water quality and increased siltation. Increased siltation often leads to a buildup of fine sediment on the substrate, reducing flow rates and dissolved oxygen below, resulting in rayed bean death (Watson et al. 2001, Morris and Burridge 2006). Freshwater mussels are also sensitive to pollutants that can enter river systems via runoff, such as ammonia (Wang et al. 2007), chlorine (Valenti et al. 2006), and heavy metals, including copper (Valenti et al. 2006, March et al. 2007, Wang et al. 2007). Glochidia and juvenile mussels are also sensitive to increases in salinity, primarily due to runoff of salts used for clearing roads in the winter (Pandolfo et al. 2012). Eutrophication of water bodies, caused by increased nutrient inputs and resulting in increased algal and plant growth, can lead to decreased dissolved oxygen levels, impacting mussels, their host fish, or both.

While sensitive to changes in water chemistry, mussels are also sensitive to physical habitat changes, such as those caused by impoundments and channelization. Impoundments greatly alter river processes by altering flow regimes, decreasing habitat heterogeneity, altering the flow of nutrients and sediments, preventing host fish movement, and isolating mussel populations (Neves et al. 1997, Watters 2000). Dams also lead to altered temperatures and channel characteristics downstream, potentially altering habitats enough to lead to mussel extirpation (Ohio River Valley Ecosystem Team 2002). In addition, channelization also drastically alters riverine environments, impacting erosion rates, channel depth, and riparian characteristics (i.e., plant species, community structure; Hartfield 1993, Neves et al. 1997, Watters 2000)

Zebra mussels, introduced to the Great Lakes area in the late 1980s, grow in large groups on solid surfaces, including on the shells of native mussels. If a native mussel has too many zebra mussels attached, it may impact reproduction, movement, and feeding, eventually leading to death of the native mussel (Mackie 1991). Zebra and quagga mussels also act as competitors; as efficient filter feeders, combined with their large numbers, they can limit food availability for native species (Baker and Levinton 2003). Another invasive species, the common carp (*Cyprinus carpio*), can have adverse effects on rayed bean by uprooting plants to feed on fauna located on the substrate of a river. This feeding strategy not only reduces roots, in which the rayed bean may be found, but can also increase turbidity and sedimentation (Dextrase et al. 2003, Morris and Burridge 2006).

Research Needs: Targeted surveys are needed to better understand the historical and current distribution of rayed bean, especially due to their small size and difficulty in detecting individuals. By understanding how rayed bean distributions change over time, a deeper understanding of the threats and pressures facing rayed bean could be gained. In addition, targeting suitable habitats for surveys may result in finding previously unknown populations, particularly as they are hard to detect due to their size and burying behavior. Increased surveys will further refine our understanding of rayed bean habitat, enabling targeted management. In addition, further life history study is needed to better identify the breeding phenology and which fish species are used as hosts for the rayed bean.

Selected References

Baker, S.M. and J.S. Levinton. 2003. Selective feeding by three native North American freshwater mussels implies food competition with zebra mussels. Hydrobiologia 505: 97-105.

Burch, J.B. 1994. Mollusk: Species Accounts. Pages 395-410 in D.C. Evers, ed. Endangered and

Threatened Wildlife of Michigan. University of Michigan Press, Ann Arbor, Michigan.

Butler, R.S. 2003. Status assessment for the rayed bean, *Villosa fabalis*, occurring in the Mississippi River and Great Lakes systems. Unpublished report prepared by the Ohio River Valley Ecosystem Team Mollusk Subgroup, Asheville, North Carolina, March 2003.

Cummings, K.S. and C.A. Mayer. 1992. Field Guide to Freshwater Mussels of the Midwest. Illinois Natural History Survey. Manual 5. Champaign, Illinois.

Dextrase, A.J., S.K. Staton, and J.L. Metcalfe-Smith. 2003. National Recovery Strategy for species at risk in the Sydenham River: An ecosystem approach. National Recovery Plan No. 25. Recovery of Nationally Endangered Wildlife (RENEW). Ottawa, Ontario.

Ford, D.F., J. Grabarkiewicz, A. Benshoff, D.A. Foltz Ii, M. Kriege, and J. Spaeth. 2024. Population demographic data from four populations of the federally endangered rayed bean, *Paetulunio* (*Villosa*) *Fabalis* (Mollusca: Unionidae). Freshwater Mollusk Biology and Conservation 27: 1-7.

Haag, W.R. 2012. North American Freshwater Mussels: Natural History, Ecology, and Conservation. Cambridge University Press, New York, New York.

Hartfield, P.W. 1993. Headcuts and their effect on freshwater mussels. Pages 131-141 in: K.S. Cummings, A.C. Buchanan, and L.M. Koch, eds. Conservation and Management of Freshwater Mussels. Proceedings of a UMRCC Symposium, October 1992, St. Louis, Missouri. Upper Mississippi River Conservation Committee, Rock Island, Illinois.

La Rocque, A.C. 1967. Pleistocene mollusca of Ohio. Ohio Division of Geological Survey Bulletins. Volume 62, Parts 1-4.

Ohio River Valley Ecosystem Team. 2002. Status Assessment Report for the Rayed Bean, *Villosa fabalis*, Occurring in the Mississippi River and Great Lakes Systems (U.S. Fish and Wildlife Service Regions 3, 4, and 5, and Canada). U.S. Fish and Wildlife Service, Asheville, North Carolina.

Mackie, G.L. 1991. Biology of the exotic zebra mussel, *Dreissena polymorpha*, in relation to native bivalves and its potential impact in Lake St. Clair. Hydrobiologia 219: 251-68.

March, F.A., F.J. Dwyer, T. Augspurger, C.G. Ingersoll, N. Wang, and C.A. Mebane. 2007. An evaluation of freshwater mussel toxicity data in the derivation of water quality guidance and standards for copper. Environmental Toxicology and Chemistry 26: 2066-74.

Michigan Natural Features Inventory (MNFI). 2026. Michigan Natural Heritage Database, Lansing, Michigan.

Morris, T.J. and M. Burridge. 2006. Recovery Strategy for Northern Riffleshell (*Epioblasma torulosa rangiana*), Snuffbox (*Epioblasma triquetra*), Round Pigtoe (*Pleurobema sintoxia*), Mudpuppy Mussel (*Simpsonaias ambigua*) and Rayed Bean (*Villosa fabalis*) in Canada. [Proposed]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa, Ontario.

Mulcrone, R.S. and J.E. Rathbun. 2020. Pocket Field Guild to the Freshwater Mussels of Michigan. 2nd edition. Michigan Department of Natural Resources, Lansing Michigan.

Molluscabase. 2026. MolluscaBase [web application]. LifeWatch Belgium, Flanders Marine Institute, NatureServe, Ostend, Flanders. https://www.molluscabase.org/index.php. (Accessed: February 25, 2026)

NatureServe: An online encyclopedia of life [web application]. 2026. Arlington, Virginia, USA:

Association for Biodiversity Information. Available: http://www.natureserve.org/. (Accessed: February 25, 2026).

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. Pages 43-85 in: G.W. Benz and D.E. Collins, eds. Aquatic fauna in peril: the southeastern perspective, March-April 1994, Chattanooga, Tennessee. Special Publication 1, Southeast Aquatic Research Institute, Chattanooga, Tennessee.

Ortmann, A.E. 1909. The breeding season of Unionidae in Pennsylvania. Nautilus 22: 91-95, 99-103.

Ortmann, A.E. 1919. Monograph of the naiades of Pennsylvania. Part III. Systematic account of the genera of the naiades. Annals Carnegie Museum 8: 222-365.

Pandolfo, T.J., W.G. Cope, G.B. Young, J.W. Jones, D. Hua, and S.F. Lingenfelser. 2012. Acute effects of road salts and associated cyanide compounds on the early life stages of the unionid mussel *Villosa iris*. Environmental Toxicology and Chemistry 31: 1801-6.

Strayer, D.L. and K.J. Jirka. 1997. The Pearly Mussels of New York State. New York State Museum Memoir 26. The University of the State of New York. 113 pp.

U.S. Fish and Wildlife Service (USFWS). 2024. Recovery plan for four species of freshwater mussels: Rayed bean (*Villosa fabalis*), sheepnose (*Plethobasus cyphyus*), snuffbox (*Epioblasma triquetra*), and spectaclecase (*Cumberlandia monodonta*). Bloomington, Minnesota. 16 pp.

Valenti, T.W., D.S. Cherry, R.J. Currie, R.J. Neves, J.W. Jones, R. Mair, and C.M. Kane. 2006. Chlorine toxicity to early life stages of freshwater mussels (Bivalvia: Unionidae). Environmental Toxicology and Chemistry 25: 2512-18.

Vaughn, C.C., Nichols, S.J., and Spooner, D.E. 2008. Community and foodweb ecology of freshwater mussels. Journal of North America Benthological Society 27: 409-23.

Wang, N., C.G. Ingersoll, I.E. Greer, D.K. Hardesty, C.D. Ivey, J.L. Kunz, W.G. Brumbaugh, F.J. Dwyer, A.D. Robers, T. Augspurger, C.M. Crane, R.J. Neves, and M.C. Barnhart. 2007. Assessing contaminant sensitivity of early life stages of freshwater mussels (Unionidae): Chronic toxicity testing of juvenile mussels with copper and ammonia. In Presentation at the 5 th biennial Freshwater Mollusk Conservation Society Symposium, Little Rock, Arkansas.

Watters, G.T. 2000. Freshwater mollusks and water quality: effects of hydrologic and instream habitat alterations. Pages 261-274 in: P.D. Johnson and R.S. Butler, eds. Freshwater Mollusk Symposium Proceedings-Part II: Proceedings of the First Symposium of the Freshwater Mollusk Conservation Society, March 1999, Ohio Biological Survey, Columbus, Ohio.

Watters, G.T., M.A. Hoggarth, and D.H. Stansbery. 2009. The Freshwater Mussels of Ohio. The Ohio State University Press, Columbus, Ohio.

Watson, E.T., J.L. Metcalfe-Smith, and J. Di Maio. 2001. Status of the Mudpuppy Mussel, *Simpsonaias ambigua*, in Canada. COSEWIC Status Report, Ontario.

Williams, J.D., A.E. Bogan, and J.T. Garner. 2008. Freshwater Mussels of Alabama & the Mobile Basin in Georgia, Mississippi & Tennessee. University of Alabama Press, Tuscaloosa, Alabama.

White, L.R., B.A. McPheron, and J.R. Atauffer, Jr. 1996. Molecular genetic identification tools for the unionids of French Creek, Pennsylvania. Malacologia 38: 181-202.

Woolnough, D.A. 2002. Life history of endangered freshwater mussels of the Sydenham River, southwestern Ontario, Canada. MS Thesis, University of Guelph, Ontario.

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