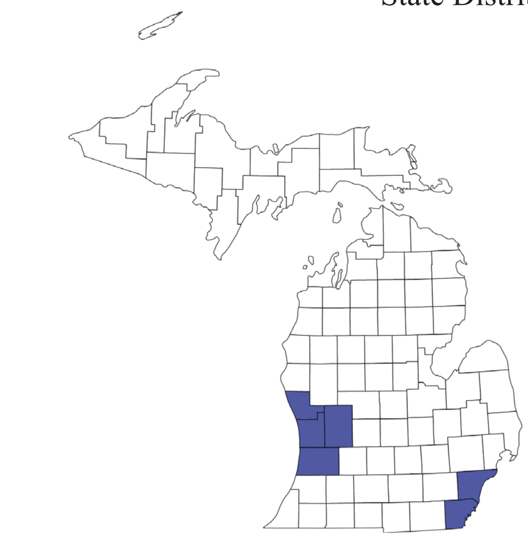
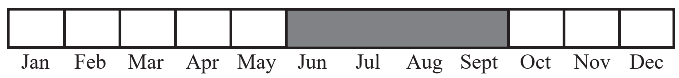
Truncilla donaciformis Lea — Fawnsfoot


Photo by Kurt Stepnitz

State Distribution



Best Survey Period



Status: State endangered

Global and state ranks: G5/S1

Family: Unionidae

Synonyms: *Unio donaciformis* Lea, *Unio zigzag* Lea, *Unio nervosa* Rafinesque*, Unio nervosus* Rafinesque, *Margarita donaciformis* Lea, *Margarita zigzag* Lea, *Plagiola nervosa* Rafinesque, *Margaron donaciformis* Lea, *Margaron zigzag* Lea, *Plagiola donaciformis* Lea, *Amygdalonaias donaciformis* Lea, *Unio zig-zag* var. *illius* De Gregorio (Watters et al. 2009).

Range: The global range of fawnsfoot includes the United States east of the Rocky Mountains and west of the Appalacian Mountains, and the southern portion of Ontario, Canada. The Mississippi River, Mobile River, and Great Lakes Drainages have historically been a stronghold for the species. Its status is most secure in Tennessee where its state conservation rank is secure (S5) and in Illinois, Missouri, Kentucky, and Mississippi where its state conseration rank is apparently secure (S4). The fawnsfoot is imperiled in three states in the western portion of its range and critically imperiled in five states and Ontario in the eastern and northern portions of its range.

State distribution: Fawnsfoot has been documented in the southwestern portion of the lower peninsula of Michigan in the Kalamazoo, Macatawa, Grand, and Muskegon River watersheds, as well as in Lake St. Clair, the Detroit River, Lake Erie, and in Lake Erie tributary rivers near the coast of the southeastern lower peninsula. Very few recent records exist for the species in Michigan. It has been documented in Michigan only six times (as shell or live) from 2000 to 2023, with occurrences in the Grand River, Kalamazoo River, River Raisin, Lake Erie, the Detroit River, and Lake St. Clair (Michigan Natural Features Inventory 2023, GBIF 2023). Live individuals (2) were documented in the Lower Kalamazoo River in 2000 (Sherman-Mulcrone and Mehne 2001), although targeted surveys throughout the range of fawnsfoot have not been done.

Fawnsfoot populations in Lake St. Clair, the Detroit River, and Lake Erie within Michigan have likely been extirpated due to negative impacts from zebra mussels among other factors. None were found in

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95 sites surveyed in Lake St. Clair between 1998 and 2001 (Zanatta et al. 2002); one live fawnsfoot was found in a 2003 survey of the Lake St. Clair delta (in Canada) (Metcalfe-Smith et al. 2004); none were found in a survey of 22 sites in the Detroit River around Belle Isle, Stony Island, and Fox Island in 2007; empty shells (up to 65 per site) were found in a survey of 10 sites in Lake St. Clair near the outlet into the Detroit River in 2008 (Badra 2009); none were found in 49 sites sampled in Lake St. Clair, the Detroit River, Lake Erie, and the Niagara River in 2011-2012 (Zanatta et al. 2015); and only one shell was found at one of 56 sites surveyed in the Detroit River in 2019 (Keretz 2021). Just south of the Michigan border live individuals (128) were documented at four sites in Maumee Bay, Ohio in 2010 (Bryan et al. 2013).

Recognition: Fawnsfoot is one of the smaller sized unionid mussels with a maximum length of 5 cm (2 inches). Its outline is somewhat oval and often rounded on the anterior end and pointed on the posterior end. The shell is rather inflated in cross section as opposed to compressed. The beak, also known as the umbo, is located slightly anterior to the midline of the shell. The ratio of the height of the shell compared to the length is approximately 2:3 or 3:5. The shell is thick and heavy for its size. Color of the shell can range from light to dark green, yellow to tan, tan to brown, and variations in between. Against this background there are often repeating patterns of darker green or brown W's and V's, and/or green rays. The green rays, if present, can be broad or very fine. Beak sculpture consists of several fine double-looped ridges. The lateral and cardinal teeth are well developed. The nacre of the shell is typically white. Male and female shells have nearly the same morphology with the females having a less elongate outline.

Similar species include deertoe (*Truncilla truncata*), which typically has a sharply angled posterior ridge, is more square in outline, and has a larger maximum size. Male snuffbox (*Epioblasma triquetra*) can also resemble fawnsfoot. Shells of male snuffbox are more inflated and the posterior point of the shell is located close to the ventral margin of the shell (below the midline) rather than near the midline of the shell as in fawnsfoot.

Best survey time: The best time of year to survey for fawnsfoot is typically the first week of June through the last week of September. Fawnsfoot and other unionid mussel species burrow deeper into the stream or lake bottom as temperatures get colder in the Fall, making them more difficult to detect during surveys. Periods of high water levels and turbity after rain should be avoided to help ensure detection rates are high.

Habitat: Fawnsfoot occurs in medium to large rivers and the Great Lakes nearshore area. It is most often found in firm sand and gravel substrates (Watters 2009). In Lake St. Clair, fawnsfoot occurred in substrate composed of cobble, gravel, pebble, sand, and silt (Badra 2009).

Biology: Fawnsfoot belongs to a family of native freshwater mussels called the Unionidae. Unionids are primarily filter feeders but also obtain food from the sediment. They eat phytoplankton, zooplankton, bacteria, fine organic detritus, and other microscopic particles (Vaughn et al. 2008). Though there are some reports of hermaphroditic species in the Unionidae, fawnsfoot has separate sexes. Eggs are fertilized within the female in the summer months then develop into larvae, called glochidia. These glochidia are brooded within marsupial gills of female mussels until they are ready to be released. In some species, the glochidia overwinter within the female mussel (bradytictic), while in other species they are released in the fall (tachytictic). Fawnsfoot are likely bradytictic (Parmalee and Bogan 1998) and females are gravid in July and August (Ortman 1919).

Glochidia must attach to the gills or fins of a fish host when they are released in order to survive and develop into the adult mussel form. In contrast, the larvae (veligers) of Dreissenids (zebra and quagga mussels) and Corbiculids (Asian clams) are free-swimming and therefore aren't reliant on fish hosts for their reproduction. Without the proper species of fish co-occurring with the unionid mussel population, glochidia do not survive and reproduction cannot occur. Some species of mussel are specialists and have only a few species of fish known to act as hosts, others are generalists and are known to utilize a dozen or more different host species. Glochidia do not harm fish hosts. There are two main benefits to having fish as hosts. The fish host provides a stable environment for the glochidia to grow. Also, glochidia are transported with their host fish until they transform into the adult form and drop off the fish. This allows unionid mussels, which are otherwise mostly sedentary, to migrate to new habitats and exchange genes among populations. Fawnsfoot are known to successfully utilize only two host fish species, freshwater drum (*Aplodinotus grunniens*) and sauger (*Sander canadensis*) (Freshwater Mussel Host Database 2017). Freshwater drum inhabit the Great Lakes coast and migrate upstream into Great Lakes tributary rivers. Sauger is much less common than freshwater drum and is state listed as endangered in Michigan.

Some species of unionid mussels use structures resembling minnows or other fish prey to lure in potential host fish when glochidia are ready to be released. For example, the lures of species in the *Lampsilis* genus resemble minnows, complete with an eye spot and fringes that look like fins. The female mussel extends and moves the lure in an undulating motion. When the potential host fish bites the lure, glochidia are released and have improved chances of attaching to their fish host. Fawnsfoot, along with some other species of unionid mussels, release packets of glochidia called conglutinates to lure in host fish. The conglutinates of fawnsfoot have been described as being white in color and fragile (Utterback 1916). Maximum lifespan of fawnsfoot is around seven years.

Conservation/Management: Fawnsfoot populations in Michigan have declined due to several factors including invasive species, habitat alteration (e.g. dredging and channelization), point and non-point source inputs, and altered stream flows/hydrologic regimes (i.e. dams/impoundments and increased flashiness). None has had as dramatic an impact on the species as the spread of zebra mussels (*Dreissena polymorpha*) and quagga mussels (*Dreissena bugensis*). These non-native dreissenid mussels were introduced to Michigan in the late 1980s and have spread throughout the Great Lakes (except Lake Superior), connecting waterways, Great Lakes tributary rivers, and many inland lakes in the Lower Peninsula. Dreissenid mussels must attach to a solid substrate with byssal threads to survive. They often attach to the shells of native mussels in great enough numbers that they prevent them from feeding, moving, and reproducing, eventually causing mortality (Mackie 1991; Haag et al. 1993). Zebra mussels are present throughout the entire range of fawnsfoot in Michigan and remain a threat to the continued presence of the species in the state.

The lower reaches of rivers and Great Lakes coastline that fawnsfoot tends to inhabit are subjected to the cumulative effect of upstream point and non-point impacts including agricultural and urban run-off, industrial waste, and herbicides and pesticides used to treat aquatic habitats. Certain components of some herbicides and pesticides, like copper and surfactants, are harmful to unionid mussels. Unionid mussels are particularly sensitive to heavy metals such as copper and cadmium (Newton 1995, Keller and Zam 1991), chlorides (e.g. road salt, Gibson 2018), and ammonia (Newton 2003).

More severe fluctuations in precipitation due to climate change have led to altered stream flows and hydrologic regimes, bringing higher peak flows during heavier rain events and lower minimum flows during more severe dry periods. This increase in stream flashiness has led to more erosion and scouring of stream bottoms that negatively impacts unionid mussels. Ongoing conversion of land from more natural cover types such as forest, wetlands, and fields to more impervious cover types such as agriculture, residential, commercial, and paved has led to faster inflow of precipitation into streams and rivers, as well as increased surface runoff of nitrogen, ammonia, chlorides, heavy metals, and other substances harmful to native mussels and other stream life. Maintaining and restoring naturally vegetated riparian corridors along rivers and streams can help mediate impacts of increased stream flashiness and surface runoff on native mussels and their habitats.

The range of unionid mussels is determined in part by the range and movements of their fish host species. The ranges of freshwater drum and sauger, the only known hosts for fawnsfoot, naturally limit the potential range of this species. However, barriers to the movement and migration of these fish species further limit the potential for fawnsfoot populations to be reestablished. Removing barriers and improving fish passage in Michigan, such as removing obsolete dams, can improve connectivity of mussel populations, allowing for migration to new habitats and transportation of mussels between populations via host fish movement. Gene flow (interbreeding) among populations prevents negative impacts from inbreeding and genetic isolation of populations (Watters 1996; Haag 2012). Alteration of stream flows with dams or other in-stream structures can lead to scouring of substrates used by mussels. Poor stream crossings, such as culverts that are too small or that are perched above stream water level, can also interfere with fish passage, as well as increase erosion and create flooding hazards. The construction of dams and impoundments on large rivers in the southern U.S. has caused or contributed to the extinction of at least twelve native mussel species over the past century (pp. 331-334 in Haag 2012) and is one of the of the major impacts to Michigan's native mussel fauna. However, the natural range of fawnsfoot, for the most part, does not include the middle and upper reaches of rivers that have been most severely altered by dams and impoundments.

Due to their decline from impacts and rarity in Michigan fawnsfoot may soon be extirpated from the state unless management action is taken. Targeted surveys to assess the status of remaining populations in Michigan and the wider Great Lakes portion of its range are needed to inform development of a species recovery plan and conservation action. One potential conservation strategy is to develop a propagation program to augment and reestablish populations. A number of factors need to be addressed in the development of such a program including: determining if there are a sufficient number of live individuals in Michigan and the Great Lakes portion of its range to form brood stock for propagation (e.g. Maumee Bay, Ohio [Bryan et al. 2013]); assessing potential genetic implications of propagating individuals from outside the Great Lakes if there is insufficient abundance within; and determining if there are sites with high enough habitat quality, freshwater drum and/or sauger abundance, and relatively low risk from current impacts to augment and reestablish fawnsfoot populations (Patterson et al. 2018).

Research needs: Surveys targeting the historical range of fawnsfoot in Michigan are needed to assess the current status of past occurrence records, as well as search for new occurrences that have not previously been documented. Due to the small size of the species extra care must be taken during surveys to ensure shells and live individuals are not being overlooked. The movement of its host fish species, the freshwater drum, into and through Great Lakes tributary rivers is necessary for the long-term viability of fawnsfoot in Michigan. Assessing the availability of its host fish in its historical and current range may help focus efforts to remove barriers to fish passage.

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