



Species Action Plan: Eastern Pearlshell (*Margaritifera margaritifera*)

Purpose: This plan provides an updated five-year blueprint for the actions needed to attain near-term and, ultimately, long-term goals for the conservation and recovery of the state endangered Eastern Pearlshell. The action plan is a living document and will be updated, as needed, to reflect progress toward those goals and to incorporate new information as it becomes available.

Goal: The goal of this plan is to provide guidance for the maintenance, augmentation, and protection of extant populations of Eastern Pearlshell in the Commonwealth and to ensure sufficient distribution to adequately secure the species' Pennsylvania range. The long-term recovery goal is to increase viable, reproducing, and protected populations of Eastern Pearlshell and ultimately, to remove the Eastern Pearlshell from the list of Pennsylvania endangered species (58 Pa. Code §75.1).

Natural History

Taxonomy: Class Bivalvia, Order Unionoida, Family Unionidae (unionids), Eastern Pearlshell (*Margaritifera margaritifera*, Linnaeus 1758). Nomenclature follows Williams et al. (2017) et seq.

Description: Linnaeus first described the Eastern Pearlshell in 1758. Strayer and Jirka (1997) describe the shell characteristics as “elongate, subelliptical to arched, thick (but often cracking when dried).” Shell size reaches up to 152 mm (Ortmann 1919). Ortmann (1919) described the Pennsylvanian specimens (from the vicinity of Rene Mont) as the largest specimens ever recorded for that time. Bogan (2005, correspondence) further noted that shell specimens are “somewhat inflated, somewhat cylindrical in cross-section, often becoming arctuate in older specimens.” Beak sculpture consists of longitudinal ridges, sometimes broken (Bogan 2005, correspondence). Periostracum dark brown to blackish, without rays. Pseudocardinal teeth are strong; however, lateral teeth nearly or entirely absent. The Eastern Pearlshell’s nacre color varies from pearly white, to sometimes with pink or with purple tones. Pits are present where the mantle muscle attaches to the shell. These pits, when examined closely, have a trailing edge not unlike a shooting star.



Figure 1. Eastern Pearlshell (*Margaritifera margaritifera*), Photo credit: PFBC (Kyle Clark).

Habitat: The Eastern Pearlshell is found in clean, low nutrient, calcium-poor, fast-flowing areas of small creeks to medium-



sized rivers where often it is the only mussel species (Smith 1976).

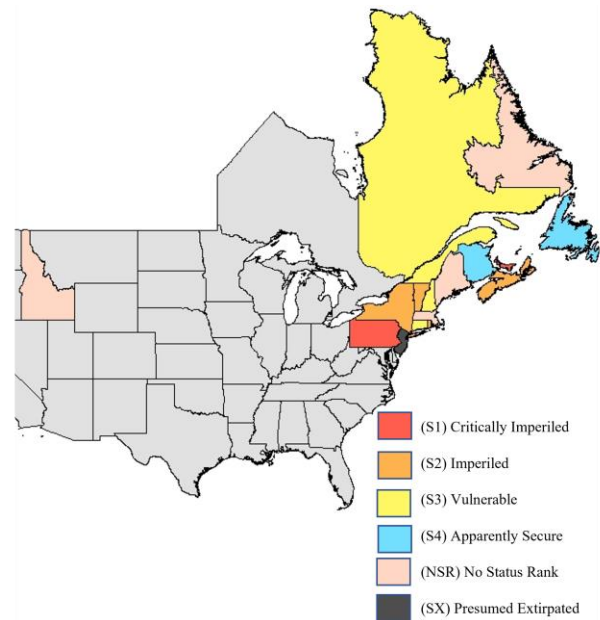
Life History: The Eastern Pearlshell has been described as the longest living invertebrate known and Bauer (1987) reported specimens > 100 years old. The Eastern Pearlshell is a short-term brooder (tachytictic), spawning annually during mid-June through August (Hastie and Young 2003; Young and Williams 1984). Conner (1909) noted that the Pennsylvania breeding season occurred during June and August. Hastie and Young (2003) reported glochidia being released into the water column beginning mid-July and tapering off around the beginning of September. The Eastern Pearlshell uses salmonid species as its host, including Rainbow Trout (*Oncorhynchus mykiss*), Brown Trout (*Salmo trutta*) and Brook Trout (*Salvelinus fontinalis*). These salmonid species are found within the historic range of the Eastern Pearlshell and are stocked by the Pennsylvania Fish and Boat Commission (PFBC). Specific salmonid host fish-use by Pennsylvania’s Eastern Pearlshell has not been determined. The Eastern Pearlshell diet is unknown, but presumed to be bacteria, detritus, phytoplankton, and zooplankton..

Distribution and Status

National Distribution: The Eastern Pearlshell is a Holarctic species found on the North American, Asian, and European continents. Large populations remain in northern Russia (Varzuga River) and

declining populations – with little to no recruitment – remain in Western Europe.

The North American distribution of Eastern Pearlshell includes Atlantic Slope basins that range from Labrador south to Pennsylvania. In the United States, this species is distributed from Maine to Pennsylvania. New York tributaries to Lake Ontario are considered the western extent of the species range and Pennsylvania’s Delaware River basin the southern extent (NatureServe 2022) (Figure 2).



Eastern Pearlshell (*Margaritifera margaritifera*)

Figure 2. Eastern Pearlshell national range and conservation status (NatureServe 2022).

Pennsylvania Distribution: Historically, the Eastern Pearlshell’s Pennsylvania range probably included a large portion of the Schuylkill River basin including Pine Creek,



Cold Run, Hosensock Creek, Indian Run, Locust Creek, Neifert Creek, Panther Creek, Pine Creek (Maiden Creek), Maiden Creek, Quakake Creek, Still Creek, and Bear Creek. Presently, only two populations are known to exist in that basin.

The Eastern Pearlshell is also likely to have historically occupied portions of the Delaware River mainstem and tributaries. Live specimens were collected from the upper Delaware River mainstem in 2000 (Lellis 2000, unpublished data). Additional populations may occur in other under-surveyed river basins (e.g., northern portions of the Susquehanna River basin) or under surveyed stream reaches (e.g., West Branch Delaware River) or tributaries.

The Eastern Pearlshell will be considered for delisting when 80% of the historically occupied streams contain three distinct naturally reproduced year classes (PABS Bivalve Committee listing criteria) and a minimum number of individuals in each stream. A minimum number will be determined after analysis of occupied streams. Historical populations can include yet-undiscovered populations. Populations that contain at least three distinct year classes and a minimum number of individuals will be considered viable. A viable population is defined as a naturally reproducing population large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural environmental changes (Soule 1980).

Management Status

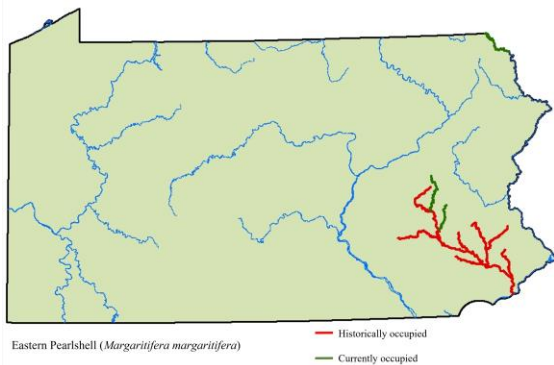


Figure 2. Eastern Pearlshell historical and extant occupied watersheds in Pennsylvania.

Pennsylvania Legal Status: Endangered (58 Pa. Code §75.1).

State Rank: S1 – Critically Imperiled (assessed 2014)

Global Status: G4 – Apparently Secure (assessed 2011)

Historical streams have been visited by PFBC (unpublished data) and the Western Pennsylvania Conservancy (Walsh 2016). Comprehensive assessments of historical streams have been restricted due to limited permissions from landowners and staff availability.

Population trends:

Two populations in the Schuylkill River basin appear stable while the Delaware River population status is unknown.



Threats

Despite its stable status in Pennsylvania, historical threats have resulted in a decline or have restricted the species range within known occupied streams (e.g., Ortmann 1909). Due to the historical and recent distribution of Eastern Pearlshell over several physiographic provinces along the Delaware River, qualitative uncertainty ranges were used to measure the scope of threats facing this species. The following broad threats categories follow Salafsky et al. (2008).

Existing and possible future threats to the Eastern Pearlshell include the following:

- 1) Agriculture and aquaculture:
Non-point source pollution from agricultural activities, particularly the introduction of nitrogen and phosphorus that contribute to stream and river eutrophication and sedimentation, has the potential to adversely affect mussel habitat or alter biological functioning within the stream or river. Sediment can clog the gills of mussels, affect filter-feeding of mussels, and decouple host fish from mussels during critical life stages (see Brim Box and Mossa 1999).
- 2) Energy production and mining:
Historically, portions of the Schuylkill River region were heavily mined for anthracite coal. The time of Ortmann's 1919 publication was near the peak production of coal. A few streams which may have historically contained Eastern Pearlshell were probably destroyed by mine-related pollution.
- 3) Transportation and service corridors
 - a. Roads and railroads: Bridge projects on streams and rivers with Eastern Pearlshell populations may result in temporary or permanent habitat alteration, mussel mortality via direct impacts (e.g., crushing) or indirect impacts (e.g., sediment deposition), and mortality associated with relocating mussels out of harm's way.
 - b. Utility and service lines: The threats associated with pipeline crossings could be locally severe; however, severity is reduced when stream crossings are accomplished using directional boring methods. Directional boring is preferred where feasible despite risks associated with inadvertent returns. Inadvertent returns may lead to the smothering of mussels or the choking of interstitial spaces or host fish habitat.
- 4) Natural systems modifications: The operation of upper Delaware River dams (e.g., Pepacton Reservoir on the East Branch Delaware River and Cannonsville Reservoir on the West Branch Delaware River) has the potential to alter habitat and persistence of Pennsylvania Eastern Pearlshell in the mainstem Delaware River. Both reservoirs serve as major water supplies to New York City and the dams are operated to maintain water



supply as well as to meet a minimum mainstem flow target at Montague (river mile 246.8). Proposals to revise release of water from two other impoundments on the Mongaup and Lackawaxen Rivers (located upstream of Montague) may affect the quantity of water available at the known Eastern Pearlshell locations.

5) Invasives and other problematic species and genes

a. Invasive non-native/alien species:

The correlation between North American enigmatic mussel declines and the non-native Asian Clam (*Corbicula fluminea*), is under study.

The spread of the diatom alga didymo (*Didymosphenia geminata*) into Eastern Pearlshell waterways is the most immediate invasive species threat to the Eastern Pearlshell.

Didymo is currently known from the upper Delaware River mainstem where Eastern Pearlshell has been collected. Proliferation of didymo could result in the loss of general mussel-related ecosystem services (water filtration) because of the burial of mussels beneath didymo mats or loss of mussel reproductive capacity due to changes in host fish populations or behaviors.

b. Problematic native species:

Predation may also threaten the continued existence of the Eastern Pearlshell in the Commonwealth. Shells of the species have been found in raccoon middens along occupied streams and the species is

presumably consumed by other mammals such as muskrats and minks. While predation is not thought to be a significant threat to healthy mussel populations, it could limit Eastern Pearlshell persistence or recovery or contribute to the local extirpation of mussel populations already depleted by other factors (Neves and Odum 1989).

The extent to which freshwater mussels, including Eastern Pearlshell, are vulnerable to native molluscan and non-molluscan diseases or pathogens is becoming better known (e.g., Richard et al. 2022).

6) Pollution

a. Industrial and military effluents:

Risks associated with industrial accidents or spills exist although the scope and severity of this particular risk is unpredictable. A single catastrophic pollution event could destroy a Pennsylvania stream or river population. Mussels in general are particularly vulnerable to pH alterations, sodium, chlorides, ammonia, nickel, and other constituents with varying life stages (e.g., glochidia, juveniles) being particularly sensitive. The scope and severity of these constituents may vary throughout the Eastern Pearlshell's range depending upon the nature of the effluent.



- b. Agricultural and forestry effluents: Increased sedimentation remains a threat to mussels, host fish, substrate integrity, and overall water quality. Mussels that depend upon direct interactions with the host, or the host and their conglomerates, risk being decoupled during this critical life stage. Host fish that rely on clean swept substrates for critical life stages are also at risk in streams that suffer from excess sedimentation.
- 7) Climate change and severe weather:
- a. Major shifts or alteration of water quantity, quality, and temperature can have severe effects on freshwater mussels (PFBC 2022). Abnormally high or low flows that disrupt mussel reproduction at key periods, such as fertilization and glochidia release, are likely to decouple male-female gamete interactions or result in host fish behavioral changes that decouple the transfer of larvae to hosts. Habitat alterations are anticipated with predicted increasing storm intensities and associated flooding or via fluctuations in wetted widths associated with drought conditions. These oscillations are likely to result in increased channel instability and bank failure contributing to habitat loss or degradation. Climate change may have a particularly deleterious effects on mussel populations given the Eastern Pearlshell and its hosts affinity for cold water streams (e.g., Hastie et al. 2003; Galbraith et al. 2010). Eastern Pearlshell and their hosts are particularly vulnerable to elevated water temperatures and large flood events associated with an increase in precipitation.
- b. Droughts: As aquatic animals, mussels are extremely sensitive to drought conditions which lower water levels, dewater formerly wetted channels, desiccate mussels, increase water temperatures, occlude mussels, and contribute knock-on effects such as toxicity via low dissolved oxygen levels, elevated temperatures, and concentrated pollutants.
- c. Temperature extremes: Extreme temperatures are anticipated to have a direct effect on freshwater mussel communities (e.g., Galbraith and Vaughn 2010). Mussels rely on thermal cues for feeding and reproduction and disruptions to these cues can result in decreased fecundity, brood abortion, increased parasite loads, or asynchronous timing of larval release with the presence of obligate host fish (PFBC 2022).
- d. Policy: Climate change policy that calls for drainage “improvement” or flood control measures have the potential to further altered flow patterns during the year, (flooding and drought), contribute to stream bank failure and riverbed destabilization,



erratic temperatures, and perhaps demands to alter reservoir flow discharges to maintain downstream sport fisheries needs in direct competition with endangered species management.

Conservation and Recovery

Conservation and Recovery Goal: The goal of this plan is to implement actions that maintain, augment, protect and enhance extant populations of Eastern Pearlshell in the Commonwealth and ensure sufficient distribution to adequately secure the species and allow its removal from the Pennsylvania list of endangered, threatened and candidate species (58 Pa. Code §75.1).

In general, PFBC encourages the use of the online Pennsylvania Conservation Explorer environmental review tool and Conservation Opportunity Areas tool to restore degraded habitats and facilitate watershed-level water quality enhancements. Habitat conservation and protection in the form of riparian restoration via tree-plantings, land acquisition, or easements are encouraged; however, instream habitat management for Eastern Pearlshell, in places where it is physically present, is generally discouraged. Where Eastern Pearlshell habitat is limited, and there are no known occurrences, active trout habitat restoration projects are encouraged to create conditions that may facilitate continued species recovery and range expansion.

Schuylkill River

- 1) Protect, conserve, and enhance existing Eastern Pearlshell populations in the Schuylkill River basin
 - a. Maintain water volume and flow
 - i. Provide Pennsylvania Department of Conservation of Natural Resources (DCNR) with minimum streamflow recommendations.
 - b. Develop and implement long-term monitoring plan for sites established by Walsh (2016)
 - c. Identify current age structure (shell thin-sectioning)
 - d. Identify degraded habitat in occupied portions of the Schuylkill drainage
 - i. Conduct additional desktop and ground truth analyses
 - ii. Coordinate with partners (e.g., County Conservation Districts) and begin landowner outreach
 - iii. Complete restoration plans
 - e. Implement restoration projects
 - f. Maintain current PFBC trout stocking within Schuylkill River basin
 - i. Using PFBC hatchery trout, identify Eastern Pearlshell glochidial transformation rates on trout species.

Delaware River

- 1) Protect, conserve, and enhance existing Delaware River population



- a. Continue to work with Federal and state government agencies to develop flow recommendations that are protective of Eastern Pearlshell
- b. Encourage the development of regulations and policies that would reduce the introduction and spread of aquatic invasive species

Areas tool), identify areas where habitat restoration efforts would benefit Eastern Pearlshell

Threat Mitigation

- 1) Identify and mitigate microscopic threats to Eastern Pearlshell (e.g., diseases, pathogens)
- 2) Conduct DNA testing to address genetic concerns
- 3) Maintain existing habitats and facilitate genetic connectivity, where feasible

Long-term Monitoring

- 1) Continue long-term monitoring at sites established by Walsh (2016).

Propagation, Augmentation, Reintroduction, and Habitat Restoration

- 1) Propagation
 - a. Determine feasibility of establishing an Eastern Pearlshell propagation program at a PFBC facility
 - b. Develop Eastern Pearlshell propagation techniques
- 2) Augmentation
 - a. PFBC will work to identify Pennsylvania streams suitable for Eastern Pearlshell augmentation utilizing PFBC or other hatchery-propagated mussels.
- 3) Habitat Restoration
 - a. Using existing data and tools (e.g., Conservation Opportunity

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