Species Status Assessment

Common Name: Northern riffleshell **Date Updated:** 1/16/2024

Scientific Name: *Epioblasma torulosa rangiana* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Epioblasma torulosa rangiana has recently been found live in New York State. Previously, this species had been recorded only from the Allegheny River and Conewango Creek a few kilometers south of the New York-Pennsylvania boarder. Strayer & Jirka (1997) speculate that this species most certainly lived in the New York portions of these streams at one time. Range wide, Epioblasma species have declined sharply, with rangiana only occupying 5% of its former range (NatureServe 2013). E. torulosa rangiana should be sought in the riffles of the Allegheny River, Cassadaga Creek, Conewango Creek, and French Creek and in the Niagara-Erie basin. This species was removed from the New York Species of Greatest Conservation list in 2015 but should be reinstated as a High Priority Species of Greatest Conservation Need (HPSGCN) based on this recent finding.

E. torulosa rangiana belongs to the subfamily Ambleminae and the tribe Lampsilini, which includes 17 extant and 6 likely extirpated New York species of the genera Actinonaias, Epioblasma, Lampsilis, Leptodea, Ligumia, Obovaria, Potamilus, Ptychobranchus, Toxolasma, Truncilla, and Villosa (Haag 2012; Graf and Cummings 2011).

I. Status

a. Current legal protected Status

i. **Federal:** Endangered **Candidate:** No

ii. **New York:** Endangered

b. Natural Heritage Program

i. **Global:** G1 – Critically imperiled

ii. **New York:** S1 – Critically imperiled **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Critically Endangered (2000)

-Northeast Regional SGCN: Yes (2023)

-Midwest Regional SGCN: Yes

- Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Endangered (2010)

Status Discussion:

This small freshwater mussel is restricted to two rivers in southern Ontario. Since the original COSEWIC assessment (2000), a small, possibly reproducing population was discovered in the Ausable River although only 16 live individuals, including one juvenile, have been found over the last 10 years. Recruitment is occurring at several sites along the Sydenham River and the population appears to be stable, but the perceived recovery could be due to increased sampling effort over the past 12 years. The main limiting factor is the availability of shallow, silt-free riffle habitat. Both riverine populations are in areas of intense agriculture and urban and industrial development, subject to siltation and pollution. Only four populations in the world, including the two in Canada, show signs of recruitment (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Declining	Declining		Endangered	(blank)
Northeastern US	Yes	Declining	Declining			Yes
New York	Yes	Unknown	Unknown		Endangered	No
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Unknown	Unknown	2005-2024	Endangered, S2	Yes
Vermont	No	N/A	N/A			No
Ontario	Yes	Choose an item.	Choose an item.		Endangered, S1	(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

In both the short and long term this species has declined between 70% and 90%, with only four reproductively viable populations still existing (NatureServe 2013).

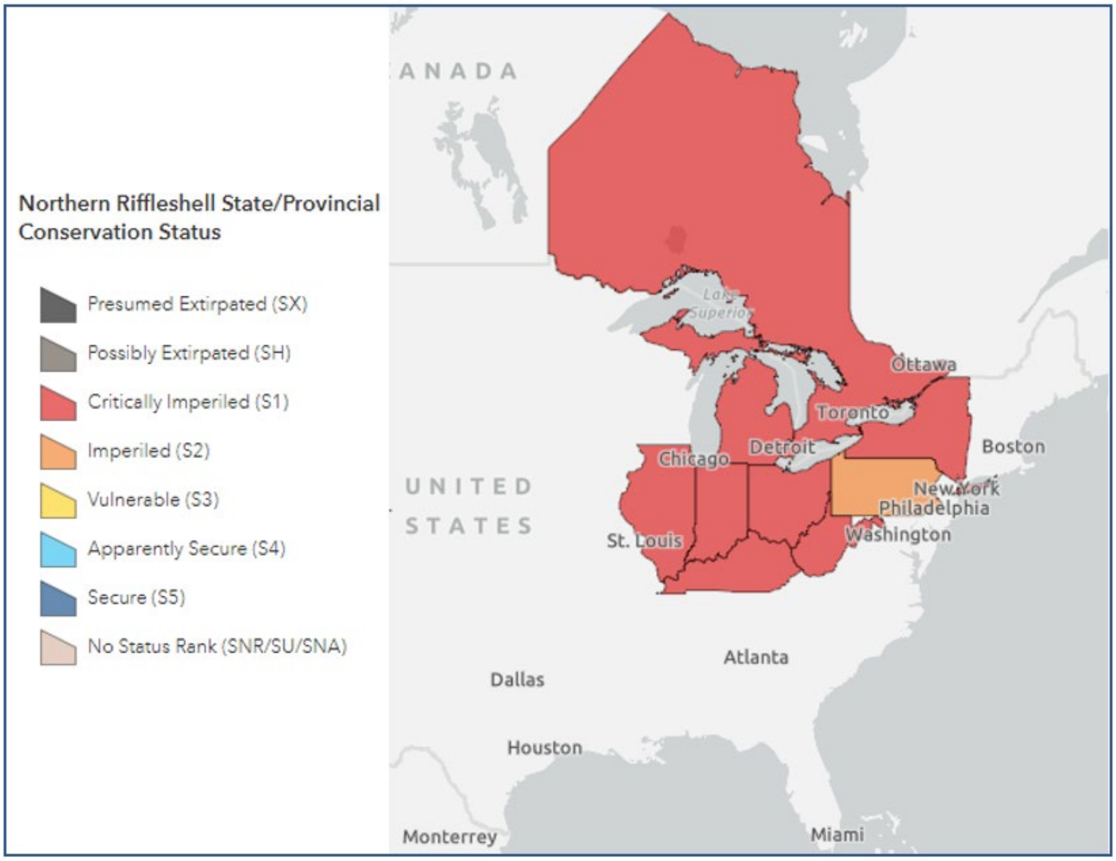

Figure 1. Northern riffleshell distribution and status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

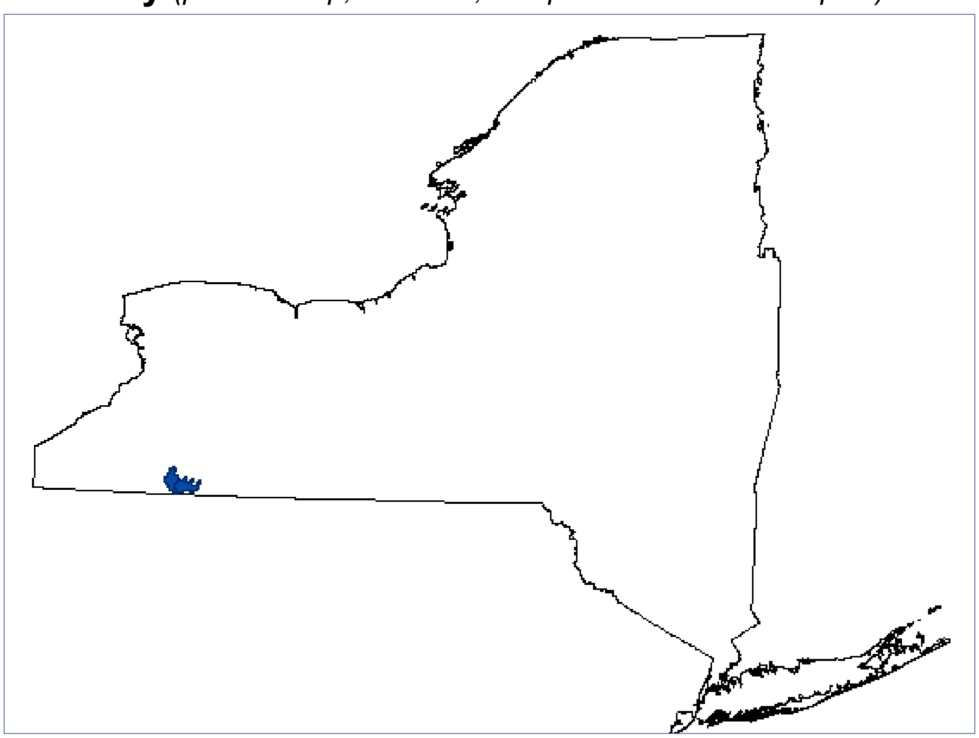

Figure 2. Records of northern riffleshell in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
Pre-1995	______	______	______
1995-2004	______	______	______
2005-2014	______	______	______
2015- 2023	______	1	0.1%

Table 1. Records of northern riffleshell in New York.

Details of historic and current occurrence:

2024: In 2016, as part of a mitigation, E. torulosa rangiana were relocated from Hunter Station, PA salvage to the Allegheny River in the Seneca Nation. E. torulosa rangiana were documented live at one year post relocation. In a separate occurrence, a single male E. torulosa rangiana was found in the Allegheny River near Olean during a remediation project survey. This occurrence was not associated with the downstream Seneca Nation reintroduction.

E. torulosa rangiana was widespread in the Allegheny basin of Pennsylvania, nearly to New York. In the early 1900's this species was collected from the Allegheny River "near the New York boundary (presumably near Warren) and from Conewango Creek a few kilometers south of the New York border. Although E. torulosa rangiana has never been reported from New York, due to the close proximity of the Pennsylvania populations, it is likely that this species may have lived in New York portions of these streams at some point (Strayer and Jirka 1997).

This species has recently been found live in New York's Allegheny basin. This species was not found in Cassadaga and Conewango Creeks (Strayer and Jirka 1997) during recent surveys by The Nature Conservancy (2009). Since the time of the historic records, the mussel fauna of lower Conewango Creek in New York was destroyed and much of the lower Allegheny River in New York has been impounded by the Kinzua Dam (Strayer and Jirka 1997). This species is also known from western Lake Erie and some of its tributaries, so there is a remote chance that this species may be found in the Niagara-Erie basin in New York (Strayer and Jirka 1997).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	450 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type: Medium River

b. Geology: Moderately Buffered

c. Temperature: Warm

d. Gradient: Low Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
Yes	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

E. torulosa ragniana is found in large creeks to large rivers in swift current and shallow riffles (Metcalfe-Smith 2005, Cummings and Mayer 1992, Watters et al. 2009, Strayer and Jirka 1997). Suitable substrates include coarse sand and gravel with some cobble to firmly packed fine gravel (Metcalfe-Smith 2005). Although it is known form Lake Erie, it is not a pond or lake species. The Lake Erie specimens apparently occurred in areas with sufficient wave-action to approximate stream conditions (Watters et al. 2009).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	Choose an item.	Choose an item.	Yes	Yes	Choose an item.

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, E. torulosa ragniana species must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable habitat, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as cited in NatureServe 2013).

This species is thought to be bradytictic, with females gravid from September to the following June. Individuals may live to 15 years old. Glochidia transformation has been confirmed on mottled sculpin (Cottus bairdi), bluebreast darter (Etheostoma camurum), rainbow darter (Etheostoma caeruleum), banded darter (Etheostoma zonale), and brown trout (Salmo trutta) (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

General threats to mussels that are likely relevant range wide:

Impoundments – Range wide
Range wide, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Agricultural Runoff
Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry 2013), indicating that runoff is a major threat to resident mussel populations.

Species that have a mantle modified to attract host fish are thought to rely on the visual acuity of their fish hosts to facilitate transfer of glochidia from the female to the host. For such species, this indicates that increases in turbidity associated with runoff may in interfere with reproduction and be especially detrimental to the species (Nedeau 2008).

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Treated and Untreated Wastewater

Recent studies show that mussel richness and abundance decreases with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals also originate from municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012).

Runoff from Developed Land

Developed lands are likely sources runoff containing metals and road salts.
Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991; Liquori & Insler 1985; Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Invasive Species

Invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugenis*) have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997; Watters et al. 2009). En masse, Dreissenids outcompete native mussels by removing food and oxygen from the water. They can also reduce reproductive success by filtering native mussel male gametes from the water column. They can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994). In addition, ammonia from Asian clam die offs has been shown to be capable of exceeding acute effect levels of some mussel species (Cherry et al. 2005). Didymo (*Didymosphenia geminata*), a filamentous diatom, can form extensive mats that can smother stream bottom and occlude habitat for mussels (Spaulding & Elwell 2007).

Sea lamprey control treatments

Climate Change

The NatureServe Climate Change Vulnerability Index has been used in several states to help identify species that are particularly vulnerable to the effects of climate change. In West Virginia's assessment, *E. torulosa rangiana* is ranked as “moderately vulnerable” to climate change, while the populations within Pennsylvania are ranked as “highly vulnerable” to climate change (2013) and in Michigan, the species was ranked as “extremely vulnerable” to climate change (Hoving, et al. 2013).

Global climate change is expected (among other disruptions) to cause an increase in surface water temperatures. Although many species are tolerant of warm water, higher water temperatures may be an added stress for some. Increased water temperatures may also increase algal growth, which could result in reductions in dissolved oxygen levels at night (Morris & Burridge 2006). Galbraith et al. (2010) recently showed how regional climate patterns coupled with changing local water regimes and management strategies have shifted mussel populations from thermally sensitive species to thermally tolerant species.

In addition, warmer stream temperatures due to the combined effects of land use, such as removal of shaded buffers, and climate change may contribute to the loss of coldwater fisheries and *mussel* populations in some watersheds (Nedeau 2008). Temperature induced changes in fish communities could have a profound influence on the availability of hosts for freshwater mussels. Mussels that inhabit small streams and rivers and rely on fish adapted for cooler water might be most affected by climate change (Nedeau 2008).

Habitat Modifications
Ecosystem modifications, such as in-stream work associated with canal, navigational channel, or flood control dredging, bridge replacements, gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting “dredge” had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000). Seasonal draw downs of water bodies have been shown to impact unionid age distributions (Richardson et al. 2002).

Levees and flood walls confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999; Yeager 1993; Nedeau 2008).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓__ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

New York State Environmental Conservation Law, § 11-0535. 6 NYCRR Part 182: Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern; Incidental Take Permits.

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the

NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussels habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York’s mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Assess if this species does or has ever existed in New York.

- Assess the need and opportunity for relocation/reintroduction efforts. Conduct relocation or reintroduction where adequate sources can be identified and appropriate stream conditions exist (water quality, habitat, host species etc.).

- Following any reintroduction efforts, develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley & Tank 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Establish a protocol whereas DEC staff work closely with state and local highway departments to reduce impacts to native mussels during maintenance and construction projects.

- Replace culverts that disrupt aquatic habitat connectivity to allow for passage of small fish species.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g. point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	

Table 2. (need recommended conservation actions for northern riffleshell).

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.

- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

VII. References

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
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Latest revision	January 16, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Paper pondshell **Date Updated:** 1/16/2024

Scientific Name: *Utterbackia imbecillis* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Utterbackia imbecillis belongs to the subfamily Unioninae, diagnosed by the presence of subtriangular glochidia with large, medial hooks, and the tribe Anodontini, which includes 16 extant and one likely extirpated New York species of the genera Alasmidonta, Anodonta, Anodontoides, Lasmigona, Pyganodon, Simpsonaias, Strophitus, and Utterbackia (Haag, 2012; Graf and Cummings, 2011). U. imbecillis is the only member of the Utterbackia genus. The species name imbecillis comes from the Latin word meaning feeble or weak; most likely describing the thin, fragile shell of U. imbecillis (Watters et al., 2009).

U. imbecillis generally prefers muddy/silty habitats with relatively slow moving water (NatureServe 2013; Watters et al., 2009). In New York this species is currently found in four streams in the Oswego and Mid-Ontario basins, and in the Erie Canal from Orleans county to Wayne county (Mahar & Landry, 2013). Historically, U. imbecillis was also found in the Alleghany, Mohawk, and upper Hudson basins (Strayer & Jirka, 1997). The New York state rank for U. imbecillis has recently been updated from historic to imperiled/vulnerable reflecting its rarity and continued presence in the state.

In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al.2000). While population trends in New York are unknown, based on sparse historical information, it is assumed that they too are declining due to a myriad of environmental stressors.

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** None, Proposed Special Concern (2019)

b. Natural Heritage Program

i. **Global:** G5 - Secure

ii. **New York:** S2S3 – Imperiled / Vulnerable **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Least Concern (2012)

-Northeast Regional SGCN: No (2023)

Status Discussion:

This species is very widespread with many populations across much of U.S. (edge of range states less common) and also into Mexico. It is stable or increasing, and is tolerant of a wide range of habitat conditions (NatureServe, 2013). Previously considered historic in New York, it was found during surveys in 2011 and 2012.

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Stable	Stable			(blank)
Northeastern US	Yes	Choose an item.	Choose an item.			No
New York	Yes	Choose an item.	Choose an item.		Proposed Special Concern	Yes
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	(blank)	(blank)		S4	No
Vermont	No	N/A	N/A			No
Ontario	Yes	Choose an item.	Choose an item.		S2	(blank)
Quebec	Yes	Choose an item.	Choose an item.		S1S2	(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

Trends for New York populations are difficult to determine as most historic data comes from opportunistic naturalist collections, as opposed to more comprehensive baseline surveys. For example, mussels were documented for the first time in 50 of the 106 streams surveyed to date by the Southern Lake Ontario mussel inventory project (Mahar & Landry, 2013). This is because many of these streams had never before been surveyed for mussels, not because mussel distribution has dramatically increased. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al.2000). Based on New York's Natural Heritage S-rank, sparse historical data, and the plight of North America's freshwater mussels, it is assumed that trends are declining due to a myriad of environmental stressors.

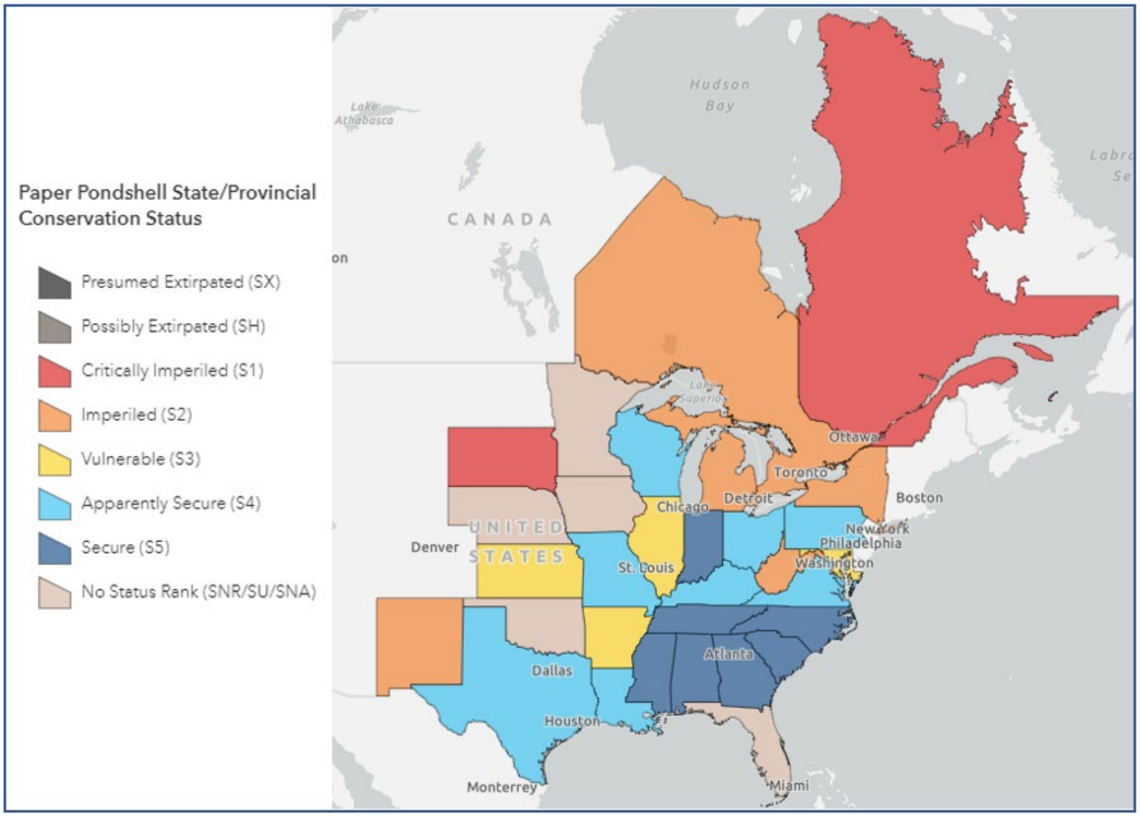

Figure 1. Paper pondshell status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

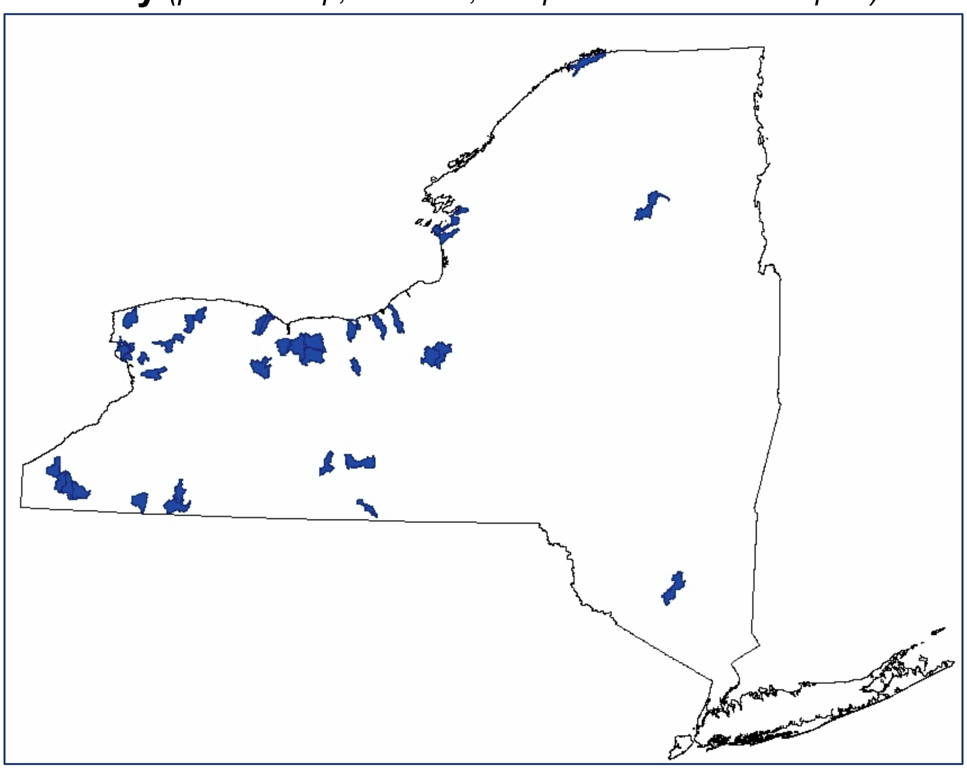

Figure 2. Records of paper pondshell in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
	_______	_______	_______
	_______	_______	_______
	_______	_______	_______
Total	_______	27	2%

Table 1. Records of paper pondshell in New York.

Details of historic and current occurrence:

2024: U. imbecillis has been found in 36 of 1802 HUC 12 watersheds (2.0%) and 27 waterbodies in New York.

In New York, records for U. imbecillis are few and scattered. They include: Chautauqua Lake (1895) and its outlet; Erie Canal from Pittsford to Macedon (1959); Irondequoit Creek (1891); Seneca Lake near Geneva; Clyde River near Marengo, and Seneca River at the north end of Cayuga Lake (1970); Onondaga County (1887); Oswego River (1895); Mohawk River (1868); Brown's Tract Pond; and Raquette Lake (Strayer & Jirka, 1997). This distribution is remarkable for its wide extent and erratic character, which unlike distributions of other unionoids, does not closely follow drainage patterns other than the central part of the Erie Canal (Strayer & Jirka, 1997). Strayer and Jirka (1997) show no records for this species after 1970, and no positive records are found in the New York Natural Heritage Program elements of occurrence database (2013).

Since 1970, U. imbecilis has been known from five New York State waterbodies (Figure 2).

In the Oswego basin, this species has been found live in Red Creek (Palmyra) and Pond Brook, an outflow of Junius Ponds, both in Wayne County, and Catharine Creek Canal in Schuyler County. In the Mid Lake Ontario basin, it has been found live in Red Creek (Wolcott) and First Creek, also both in Wayne County. A total of 57 fresh shells were found at 13 Erie Canal locations between Ridgeway, Orleans Co. and Macedon, Wayne County, with the majority of the shells (32) found at a single site in Macedon (Mahar & Landry, 2013).

No evidence of U. imbecillis was found in the Lower Genesee basin and the only occurrences of this species in the West Lake Ontario basin were from the Erie Canal (Mahar & Landry, 2013). This species was not detected in the recent Allegheny basin and Susquehanna basin mussel surveys (The Nature Conservancy, 2009; Harman & Lord, 2010).

Live U. imbecillis were found in Spicer Creek (Niagara River Tributary, Grand Island, 2 specimens) in 2011, and in Lake Ontario watershed: 2 in Twelve Mile Creek (Niagara Co.) and one in the Black River Bay in 2012 (Burlakova, Karatayev et al. unpublished data).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	500 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. **Size/Waterbody Type:** Headwater/Creek to Small River

b. **Geology:** Moderately Buffered

c. **Temperature:** Transitional Cool to Warm

d. **Gradient:** Low to Low-Moderate Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

U. imbecillis is most typically found in soft substrates in quiet waters of ponds, lakes, and sluggish mud-bottomed pools and backwaters of creeks and rivers (Strayer & Jirka, 1997; Cummings & Mayers, 1992; Metcalfe-Smith et al., 2005; McMurray et al., 2012; Watters et al., 2009). It is commonly found in artificial waters (e.g., canals, impoundments, boat basins, retention ponds, old phosphate pits) (NatureServe 2013; Watters et al., 2009). This species seems to be tolerant of moderately poor water and habitat quality (muddy substrates). Such substrates have become more prevalent with increased eutrophication (NatureServe, 2013).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

U. imbecillis is thought to be hermaphroditic with both gametes maturing simultaneously in the same individual. Hermaphroditism affords benefits when population densities are low; under such conditions, females may switch to self-fertilization to ensure that recruitment continues (Watters et al., 2009).

This species is also one only of 2-3 unionid species capable of direct development, meaning there is no need for a host fish, at least under certain conditions (NatureServe, 2013). Metamorphosis in the absence of host parasitism has been confirmed, although in the laboratory, fish-reared juveniles were found to be in more robust physiological condition than their counterparts that metamorphosed without a host fish (Dickinson and Sietman, 2008 and Fisher and Dicmock, 2006as cited in NatureServe, 2013).

Although this species may be able to develop without a fish host, it also can complete its life cycle in the usual way (Strayer & Jirka, 1997). U. imbecillis is a host generalist (Watters et al., 2009) and has more identified hosts, including three amphibians, than any other unionid (Watters et al., 2009). Known fish hosts, not including exotic aquaria fish, include: rock bass (Ambloplites rupestris), spotfin shiner (Cyprinella spiloptera), greenthroat darter (Etheostoma lepidum), banded killifish (Fundulus diaphanus), channel catfish (Ictalurus punctatus), green sunfish (Lepomis cyanellus), pumpkinseed (Lepomis gibbosus), bluegill (Lepomis macrochirus), longear sunfish (Lepomis megalotis), largemouth bass (Micropterus salmoides), golden shiner (Notemigonus crysoleucas), yellow perch (Perca flavescens), black crappie (Pomoxis nigromaculatus), and creek chub (Semotrilus atromaculatus) (Watters et al., 2009). Amphibian hosts include tiger salamander (Ambystoma tigrinum), bullfrog tadpole (Rana catesbeiana), and northern leopard frog tadpole (Rana pipens) (Watters et al., 2009). Other potential hosts include: mosquitofish (Gambusia affinus) and warmouth (Lepomis gulosus) (Watters et al., 2009).

These characteristics may make U. imbecillis an unusually good colonizer among unionoids and may free it to some extent from the constraint of dispersing within drainage basins (Strayer & Jirka, 1997).

This species has an opportunistic life history strategy. This strategy is often characterized by short life span, early maturity, high fecundity achieved soon after maturation, and, to a lesser extent, moderate to large body size. Species in this group have the fastest growth rates and highest reproductive effort. Nearly all opportunistic species are long-term brooders. This life history strategy is considered an adaptation for rapid colonization and persistence in disturbed and unstable but productive habitats (Haag, 2012).

U.imbecillis is a short lived species and rarely lives for more than five years. The species is bradytictic, with gravid females present from April through September in Ohio (Watters et al., 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as sited in NatureServe 2013).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Pollution	Household Sewage & Urban Waste Water (waste water treatment effluent, sewer and septic overflows)
2. Natural System Modifications	Dams & Water Management/Use (Lowering of water table from agriculture, etc…, causing drying of habitat)

3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (die offs from unknown disease)

Agricultural Runoff
Several streams that host *U. imbecillis* populations, including Red Creek in Wolcott, Pond Brook, and the Erie Canal, flow through heavily agricultural areas and are likely impacted by associated siltation, nutrient and pesticide loading. In addition, just upstream of the site where live specimens were found, First Creek flows through a golf course and likely receives pesticide and fertilizer runoff from this source (New York State Landcover, 2010). Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis, 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in western and central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry, 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag, 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag, 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al., 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag, 2012).

Fertilizer run-offs are also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag, 2012). In addition, ammonia adsorbs to sediment particles, resulting in higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom, 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al., 2012).

Runoff from Developed Land
All five of New York waterbodies that are known to currently host *U. imbecillis* populations are intermittently bordered by an interstate highways, state routes, and/or local roads and lawns (New York State Landcover, 2010), and likely receive runoff containing metals and road salts from these sources. Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam, 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen, 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al., 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991; Liquori & Insler 1985; Pandolfo et al., 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al., 2007).

Treated Wastewater

Red Creek in Wolcott receives treated effluent from the village of Red Creek Regional Wastewater Treatment Plant (SPDES, 2011). It is also possible that raw sewage enters the Erie Canal from illegal dumping by recreational boats. Recent studies show that mussel richness and abundance decrease with increased proximity to sewage effluent (Wildenberg, 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al*.,* 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al*.,* 1978). Endocrine disrupters from pharmaceuticals also are present in municipal sewage effluents and are increasingly common rivers and lakes (Haag, 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag, 2012). It should be noted that in the Susquehanna basin, Harmon & Lord (2010) found no evidence that wastewater treatment plants were responsible for reductions in mussel species of greatest conservation need.

Habitat Modifications
Ecosystem modifications, such as in-stream work associated with, canal dredging bridge replacements, gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge, 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting “dredge” had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy, 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge, 2000).

Based on the number of fresh shells found, it is thought that the majority of New York’s *U. imbecillis* populations reside in the Erie Canal system. Habitat modification threats present in the Erie Canal include maintenance dredging by the NY Canal Corporation and seasonal water draw downs. Seasonal draw downs of water bodies have been shown to impact unionid age distributions (Richardson et al. 2002) and it is likely that the Erie Canal water draw downs have negative impacts on the *U. imbecillis* population. During spring mussel surveys of the Erie Canal, it is not uncommon to find hundreds of fresh shells of multiple species, including *U. imbecillis,* and multiple age classes, many containing desiccating flesh, along the exposed canal banks and bed (Mahar & Landry, 2013). This antidotal evidence suggests seasonal draw downs have a large impact on these populations.

Invasive Species
Invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugenis*) have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka, 1997; Watters et al., 2009). This threat is of particular concern to the *U. imbecillis* populations in the Erie Canal. En masse, Dreissenids outcompete native mussels by efficiently filtering food and oxygen from the water. They reduce reproductive success by filtering native mussel male gametes from the water column and they can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS, 1994).

Lamprey Control
U. imbecillis populations are found in several stream that are regularly scheduled for sea lamprey control treatment. These streams include Red Creek and Catharine Creek in the Lake Ontario drainage.

In New York, tributaries harboring larval sea lamprey (*Petromyzon marinus*), are treated periodically with lampricides (TFM or TFM/Niclosamide mixtures) by Fisheries and Oceans Canada and the U.S. Fish and Wildlife Service to reduce larval populations (Sullivan and Adair 2014) or by NYSDEC. Niclosamide was originally developed as a molluscicide. While unionid mortality is thought to be minimal at TFM concentrations typically applied to streams to control sea lamprey larvae (1.0 –1.5 × sea lamprey MLC), increases in unionid mortality were observed when exposed to the niclosamide mixture, indicating that mussels may be at risk when the mixture is used in control operations. Treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard, 2006).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: ✓ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussels habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York’s mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c)of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Priority conservation efforts for this species should focus on, but not be limited to, the Erie Canal, especially between Pittsford and Macedon/Palmyra (Mahar & Landry, 2013).

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley & Tank, 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Enforce No Discharge Zone, and promote the proper discharge of sewage by recreational boaters on the Erie Canal.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to unionids at multiple life stages, and therefore needs to be addressed (Gillis, 2012).

- Establish a protocol whereas DEC staff work closely with state and local highway departments to reduce impacts to native mussels during maintenance and construction projects.

- Replace culverts that disrupt aquatic habitat connectivity to allow for passage of small fish species.

- Within the Great Lakes and Champlain watersheds, lamprey control efforts should consider specific, potentially adverse, impacts to native freshwater mussels when determining methods, including selection of lampricide formulations and concentrations.
  Lampricide treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard, USGS 2006).

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g. point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	

Table 2. (need recommended conservation actions for paper pondshell).

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.

- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	February 25, 2014 (Samantha Hoff)
Latest revision	January 16, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Piedmont groundwater amphipod **Date Updated:**

Scientific Name: *Stygobromus tenuis tenuis* **Updated by:**

Class: Malacostraca

Family: Crangonvctidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

The Piedmont groundwater amphipod is a regionally endemic subspecies of *Stygobromus tenuis,* and may also be referred to as the slender stygobromid. Its distribution ranges from central Connecticut southwestward to the Maryland peninsula with a large disjunction occurring between New York and Maryland. The distribution and status of this species in New York are unknown; it has not been reported in the state since the mid-20th century. This tiny crustacean occurs in shallow groundwater habitats including wells, seeps, and springs, therefore groundwater contamination and loss of wetlands are likely threats to populations.

I. Status

a. Current legal protected Status

i. **Federal:** Not listed **Candidate:** No

ii. **New York:** Not listed; SGCN

b. Natural Heritage Program

i. **Global:** G4T4

ii. **New York:** SNR **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List:

-Northeast Regional SGCN:

Status Discussion:

The Piedmont groundwater amphipod is a rare, regionally endemic subspecies with six known historic localities in Connecticut, Massachusetts, and Maryland (NatureServe 2013). Although it has a fairly large range, there is a large disjunction between populations.

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Unknown	Unknown			Choose an item.
Northeastern US	Yes	Unknown	Unknown			Choose an item.
New York	Yes	Unknown	Unknown			Yes

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
Connecticut	Yes	Unknown	Unknown		SC	Yes
Massachusetts	Yes	Unknown	Unknown		SC	Yes
New Jersey	No	Choose an item.	Choose an item.			Choose an item.
Pennsylvania	No	Choose an item.	Choose an item.			Choose an item.
Vermont	No	Choose an item.	Choose an item.			Choose an item.
Ontario	No	Choose an item.	Choose an item.			Choose an item.
Quebec	No	Choose an item.	Choose an item.			Choose an item.

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

None.

Trends Discussion *(insert map of North American/regional distribution and status):*

Short and long term trend information for the piedmont groundwater amphipod is not available. Individuals were found at two locations in Massachusetts in 1982, extending the range farther northwest than was previously. Surveys were also conducted in Canaan, Connecticut but no individuals were found at that time. Smith (1984) noted that these findings in MA are significant because the occupied habitat is unlike that described for the species anywhere else in its range. Historical records are from shallow groundwater environments near the coast in southern New England, New York, and Maryland, but there are no habitat descriptions for New York occurrences.

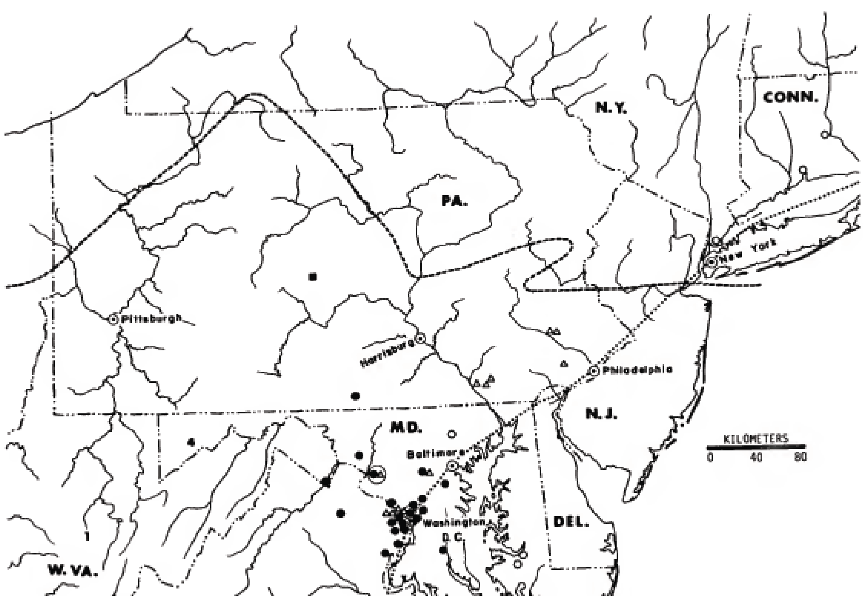

Figure 1. Distribution of *Stygobromus tenuis tenuis* in the eastern United States (Holsinger 1978). Open circles are *S.t. tenuis*, closed circles are *S.t. potamacus*.

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

Figure 3: (need map of records of Piedmont groundwater amphipod in New York).

Years	# of Records	# of Distinct Waterbodies/Locations	% of State
Pre-1995			
1995-2004			
2005-2014			
2015-2023			

Table 1: Records of Piedmont groundwater amphibod in New York.

Details of historic and current occurrence:

Historical records are from the High Allegheny Plateau, Lower New England Piedmont, and Great Lakes eco regions in the following five basins: Delaware, SE Lake Ontario, Lower Hudson-Long Island Bays, Susquehanna, and Upper Hudson River (NYSDEC 2005). The piedmont groundwater amphipod is an extremely rare endemic subspecies known from only six historic localities (NatureServe 2013).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Core	

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Caves and Tunnels

b. Spring

c. Headwater/Creek

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
Yes	No	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

The Piedmont groundwater amphipod is found in shallow groundwater habitats including wells, caves, small streams, seeps, and small springs (NatureServe 2013).

Individuals found recently in Massachusetts occurred in habitat unlike that described for this species elsewhere in its range; it was found in upland karst terrain, which is a limestone area with underground caverns and streams, and springs connected to deep aquifers in the extreme southern Taconic Mountains of southwestern Massachusetts (Smith 1984).

V. Species Demographics and Life History

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	Choose an item.	Choose an item.	Yes	Yes	Choose an item.

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Little is known about the life history of this species or most others in the genus *Stygobromus*. Holsinger (1978) reported that ovigerous females of other *Stygobromus* species are generally observed during the summer and fall months, and females lay a small number of eggs (1-2 per brood) into a ventral brood pouch (Holsinger 1978).

VI. Threats *(from NY 2015 SWAP or newly described)*

Threats to NY Populations	
Threat Category	**Threat**
Pollution	Household Sewage & Urban Waste Water
Pollution	Industrial & Military Effluents
Pollution	Agricultural & Forestry Effluents
Natural System Modifications	Dams & Water Management/Use
Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species
Natural System Modifications	Other Ecosystem Modifications (wetlands loss)

Because the distribution of the piedmont groundwater amphipod is unknown, the immediate threats remain unknown; however, water pollution from various sources and loss of wetlands are likely to be primary threats to this species. Lack of habitat management will endanger existing populations and habitat alteration due to sedimentation is a threat caused by any activities or development that disturb groundcover, potentially changing cave habitat, blocking recharge sites, or altering flow volume and velocity (Lewis 2001). Impoundments may also affect cave species by creating changes in stream flow that may cause siltation and drastic modification of pool habitats and riffles (Lewis 2001).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _____ **No:** ✓ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

Surveys of aquatic caves in waters that are part of its historic range are needed. If individuals are found, critical habitat needs and the impacts of modified flow regime on this species life cycle should also be evaluated (NYSDEC 2005).

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection): ***https://www.iucnredlist.org/resources/conservation-actions-classification-scheme***

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2: (need recommended conservation actions for Piedmont groundwater amphipod).

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2005) includes recommendations for the following actions for freshwater crustaceans, and for the Piedmont groundwater amphipod in particular.

Habitat monitoring:
____ Investigate the degree of alteration to natural flow regime of waters containing the species.
____ The immediate threats to these populations need to be determined.

Habitat research:
____ The critical habitat needs of both species need to be evaluated.

Life history research:
____ Investigate the impacts of modified flow regime on species life cycle.

Population monitoring:
____ Inventories need to be conducted in their respective historical ranges.

VII. References

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Originally prepared by	Samantha Hoff
Date first prepared	May 23, 2013
First revision	July 24, 2013 (Samantha Hoff)
Latest revision	Transcribed March 2024

Species Status Assessment

Common Name: Pimpleback **Date Updated:** 1/17/2024

Scientific Name: *Pustulosa pustulosa* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

The scientific name for Mapleleaf was recently changed from Quadrula pustulosa to Pustulosa pustulosa. P. pustulosa is thought to be extirpated in New York State. It has not been reported in New York in over 60 years (Strayer & Jirka, 1997). This species was removed from the New York Species of Greatest Conservation list in 2015.

P. pustulosa species belongs to the subfamily Ambleminae and the tribe Quadrulini, which includes two likely extirpated New York species of genus Quadrula (Haag 2012, Graf and Cummings 2011).

P.pustulosa usually lives in medium-sized to large rivers (Cummings & Mayer 1992) as well as in the Great Lakes (Clarke & Stansbery 1988). It occupies the entire Mississippi River drainage from Pennsylvania to the Dakotas all the way south to Texas (NatureServe 2013). Recent trends for the species nationwide are positive. Possible population increases of 10-25% are expected in the long term (NatureServe2013).

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** None

b. Natural Heritage Program

i. **Global:** S5 - Secure

ii. **New York:** SH - Historic **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Least Concern (2011)

-Northeast Regional SGCN: No (2023)

Status Discussion:

This species is a widespread and common in North America with stable populations throughout its range with the exception of perhaps the northeastern occurrences from New York to West Virginia. (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Choose an item.	Choose an item.			(blank)

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
Northeastern US	Yes	Choose an item.	Choose an item.			No
New York	Unknown	Extirpated	Extirpated		SH	No
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Choose an item.	Choose an item.		S1	Yes
Vermont	No	N/A	N/A			No
Ontario	Yes	Stable	Stable	2003-2013	S2	(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a 2009 to 2020 State Wildlife Grant funded project, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York where this species might be found. No regular surveys are being conducted for this species at this time. Regulatory surveys may be conducted in known or likely habitat as part of the project review process.

Trends Discussion *(insert map of North American/regional distribution and status):*

This species faces all of the normal threats posed to aquatic benthic macro invertebrates, yet the outlook for P. pustulosa is positive. Short term, their populations are expected to remain stable with the possibility of a 10-25% increase in the long term (NatureServe 2013).

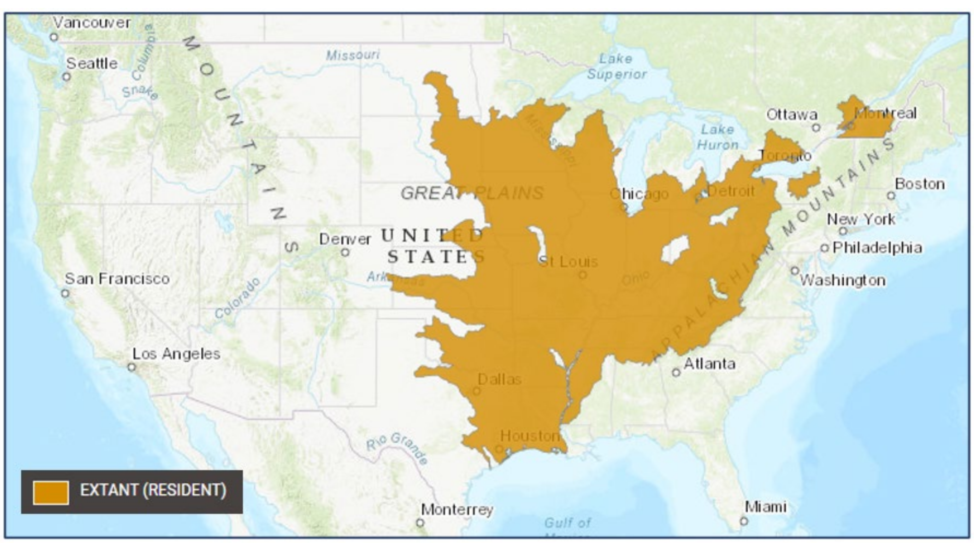

Figure 1. Pimpleback distribution (IUCN Redlist 2024)

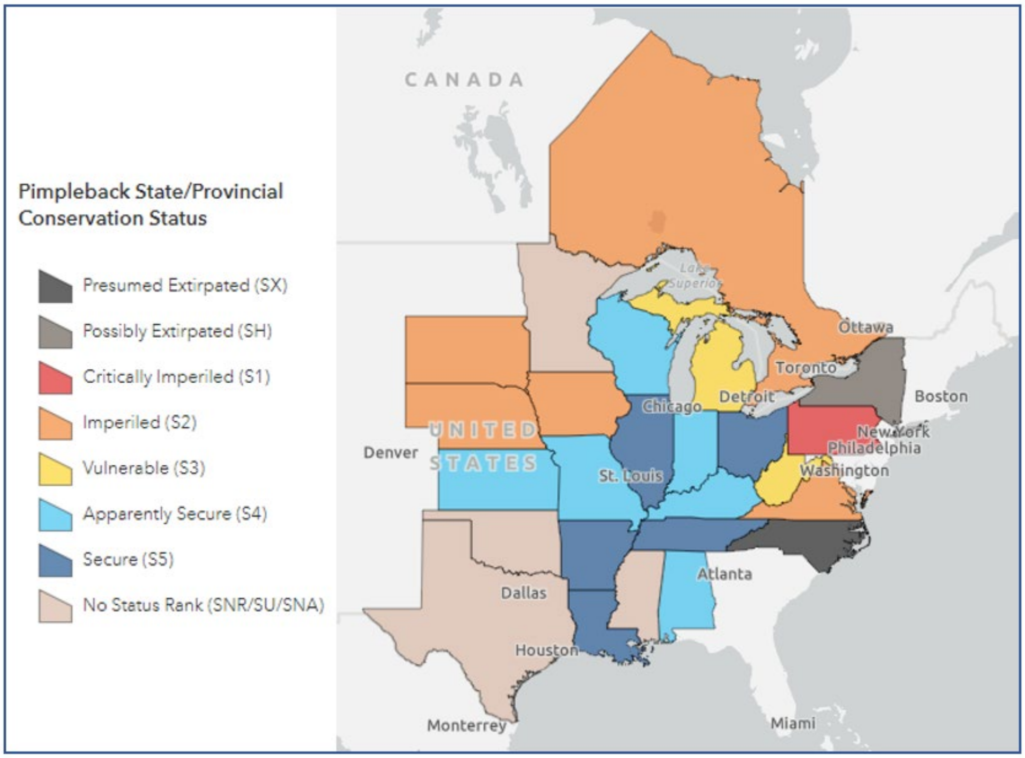

Figure 2. Pimpleback distribution and status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

Years	# of Records	# of Distinct Waterbodies	% of State
Pre-1995	____	2	2 of 56 HUC 8 watersheds
1995-2004	0	0	0
2005-2014	0	0	0
2015- 2023	0	0	0

Table 1. Records of pimpleback in New York.

Details of historic and current occurrence:

Several records from the first half of the 1900s document this species in the Niagara River, where it was likely not abundant. Specimens were also collected around 1920 from the Erie Canal at Pittsford. A questionable specimen also exists for the St. Lawrence River from 1906 (Strayer & Jirka 1997).

P. pustulosa has not been found in New York in over 60 years (Strayer & Jirka 1997, Mahar and Landry 2013, NY Natural Heritage Program 2013, The Nature Conservancy 2009, Harman and Lord 2010, White et al. 2011, NatureServe 2013). It is thought to be extirpated from the state.

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
0%	Peripheral	250 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. **Size/Waterbody Type:**

b. **Geology:**

c. **Temperature:**

d. **Gradient:**

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

Throughout its range, P. pustulosa has a generalized habitat preferences. This species and can maintain abundant and viable populations in shallow to deep sections of large reservoirs, and Lake Erie, as well as in large creeks to large-sized free-flowing rivers. It is rarely found as a stray in small creeks. It is usually found in moving water in a substrate consisting of coarse gravel, sand, silt, or mud (Cummings and Mayer 1992, McMurray et al. 2012, Metcalfe-Smith et al. 2005, Parmalee & Bogan, 1998, Watters et al. 2009).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Unknown	No	No	Unknown	Unknown	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, P. pustulosa must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable habitat, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as cited in NatureServe 2013).

P. pustulosa is believed to be tachytictic, with eggs present in May, glochidia developing from May to July and glochidia released by late August. Glochidia have only been documented to transform on catfishes. Known hosts include black bullhead (Ameiurus melas), brown bullhead (Ameiurus nebulosus), channel catfish (Ictalurus punctatus), and flathead catfish (Pylodictis olivaris). Additional potential hosts include white crappie (Pomoxis annularis), and shovelnose sturgeon (Scaphirhynchus platorynchus) (Watters et al. 2009). This species can live for over 45 years (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

General threats to mussels that are likely relevant range wide:

P. pustulosa is also a commercially valuable species. In addition to the following range wide threats, overharvest may also be a concern.

Impoundments – Range wide
Range wide, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Agricultural Runoff

Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Treated and Untreated Wastewater

Recent studies show that mussel richness and abundance decreases with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals also originate from municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012).

Runoff from Developed Land

Developed lands are likely sources runoff containing metals and road salts.
Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal

to glochidia and juvenile mussels (Keller & Zam 1991; Liquori & Insler 1985; Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Invasive Species

Invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugenis*) have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997; Watters et al. 2009). En masse, Dreissenids outcompete native mussels by removing food and oxygen from the water. They can also reduce reproductive success by filtering native mussel male gametes from the water column. They can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994). In addition, ammonia from Asian clam die offs has been shown to be capable of exceeding acute effect levels of some mussel species (Cherry et al. 2005). Didymo (*Didymosphenia geminata*), a filamentous diatom, can form extensive mats that can smother stream bottom and occlude habitat for mussels (Spaulding & Elwell, 2007)

Climate Change

Global climate change is expected (among other disruptions) to cause an increase in surface water temperatures. Although many species are tolerant of warm water, higher water temperatures may be an added stress for some. Increased water temperatures may also increase algal growth, which could result in reductions in dissolved oxygen levels at night (Morris & Burridge 2006). Galbraith et al. (2010) recently showed how regional climate patterns coupled with changing local water regimes and management strategies have shifted mussel populations from thermally sensitive species to thermally tolerant species.

In addition, warmer stream temperatures due to the combined effects of land use, such as removal of shaded buffers, and climate change may contribute to the loss of coldwater fisheries and *mussel* populations in some watersheds (Nedeau, 2008). Temperature induced changes in fish communities could have a profound influence on the availability of hosts for freshwater mussels. Mussels that inhabit small streams and rivers and rely on fish adapted for cooler water might be most affected by climate change (Nedeau, 2008).

Habitat Modifications

Ecosystem modifications, such as in-stream work associated with canal, navigational channel, or flood control dredging, bridge replacements, gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000). Seasonal draw downs of water bodies have been shown to impact unionid age distributions (Richardson et al. 2002).

Levees and flood walls confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999; Yeager 1993; Nedeau 2008).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: ✓ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York’s mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Assess the need and opportunity for relocation/reintroduction efforts. Conduct relocation or reintroduction where adequate sources can be identified and appropriate stream conditions exist (water quality, habitat, host species etc.).

- Historical evidence of multiple New York State extirpated species exists for the Niagara River. These species include: *Epioblasma triquetra, Lampsilis teres, Lampsilis abrupta, Obovaria olivaria, Potamilus capax*, *Pustulosa pustulosa*, *Quadrula quadrula, Simpsonaias ambigua, and possibly Truncilla donaciformis,*. To assess the potential for future reintroduction efforts, a pilot program relocating common species to suitable sections of the Niagara River should be initiated and its results assessed, to gage the possible success of reintroduction efforts for extirpated species in this waterbody.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley & Tank 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Following any reintroduction efforts, develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Update wastewater treatment facilities in Buffalo to eliminate combined sewer outflows.
- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant

Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Within the Great Lakes watersheds, lamprey control efforts should consider specific, potentially adverse, impacts to native freshwater mussels when determining methods, including selection of lampricide formulations and concentrations. Lampricide treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard 2006).

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g. point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2. (need recommended conservation actions for pimpleback).

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between Alasmidonta varicosa and Alasmidonta marginata and, if occurring, evaluate the potential threat to A. varicosa population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:
Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

VII. References

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	
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Species Status Assessment

Common Name: Pink heelsplitter **Date Updated:** 1/16/2024

Scientific Name: *Potamilus alatus* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Potamilus alatus belongs to the subfamily Ambleminae and the tribe Lampsilini, which includes 17 extant and 6 likely extirpated New York species of the genera Actinonaias, Epioblasma, Lampsilis, Leptodea, Ligumia, Obovaria, Potamilus, Ptychobranchus, Toxolasma, Truncilla, and Villosa (Haag 2012; Graf and Cummings 2011). P. alatus is one of two species of the genus Potamilus that have been found in New York (Strayer and Jirka 1997).

P. alatus is found in the Mississippi River system as well as in the Great Lakes drainage and the upper St. Lawrence River. In New York's it is currently found in 21 waterbodies in the Lower Genesee, West Lake Ontario (Mahar & Landry 2013), east Lake Ontario (Black River Bay, Burlakova et al. unpublished), Finger Lakes (White et al. 2011), Erie (Mahar & Landry 2013, NY Natural Heritage Program 2013), and Lake Champlain basins (NY Natural Heritage Program 2013, White et al. 2011), and in the Erie Canal (Mahar & Landry 2013). Its habitat ranges from quiet waters of lakes and canals to riffles of creeks and rivers (Watters et al. 2009).

Although rare and ranked as "Imperiled" in New York, this edge of range species is considered secure throughout its range. In North America, approximately 2/3 to 3/4 of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al. 2000). While population trends in New York are unknown, based on sparse historical information it is assumed that they too are declining due to a myriad of environmental stressors.

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** None, Proposed Special Concern (2019)

b. Natural Heritage Program

i. **Global:** G5 - Secure

ii. **New York:** S2 - Imperiled **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Least Concern (2015)

-Northeast Regional SGCN: No

-American Fisheries Society Status: Currently Stable (1993)

Status Discussion:

This species is widespread throughout central North America and is considered stable and secure throughout its range, although some Canadian occurrences are declining, as are occurrences at the edge of the range of the species (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Stable	Stable	2015		(blank)
Northeastern US	Yes	Declining	Declining			No
New York	Yes	Choose an item.	Choose an item.		Proposed Special Concern, S2	Yes
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Choose an item.	Choose an item.		S4	No
Vermont	Yes	Declining	Declining		Endangered, S2	Yes
Ontario	Yes	Declining	Declining	2003-2013	S3	(blank)
Quebec	Yes	Declining	Declining		S1	(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

Trends for New York populations are difficult to determine as most historic data comes from opportunistic naturalist collections, as opposed to more comprehensive baseline surveys. For example, mussels were documented for the first time in 50 of the 106 streams surveyed to date by the Southern Lake Ontario mussel inventory project (Mahar & Landry 2013). This is because many of these streams had never before been surveyed for mussels, not because mussel distribution has dramatically increased. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al. 2000). Based on New York's Natural Heritage S-rank, sparse historical data, and the plight of North America's freshwater mussels, it is assumed that trends are declining due to a myriad of environmental stressors.

Figure 1. Pink heelsplitter distribution (IUCN Redlist 2024)

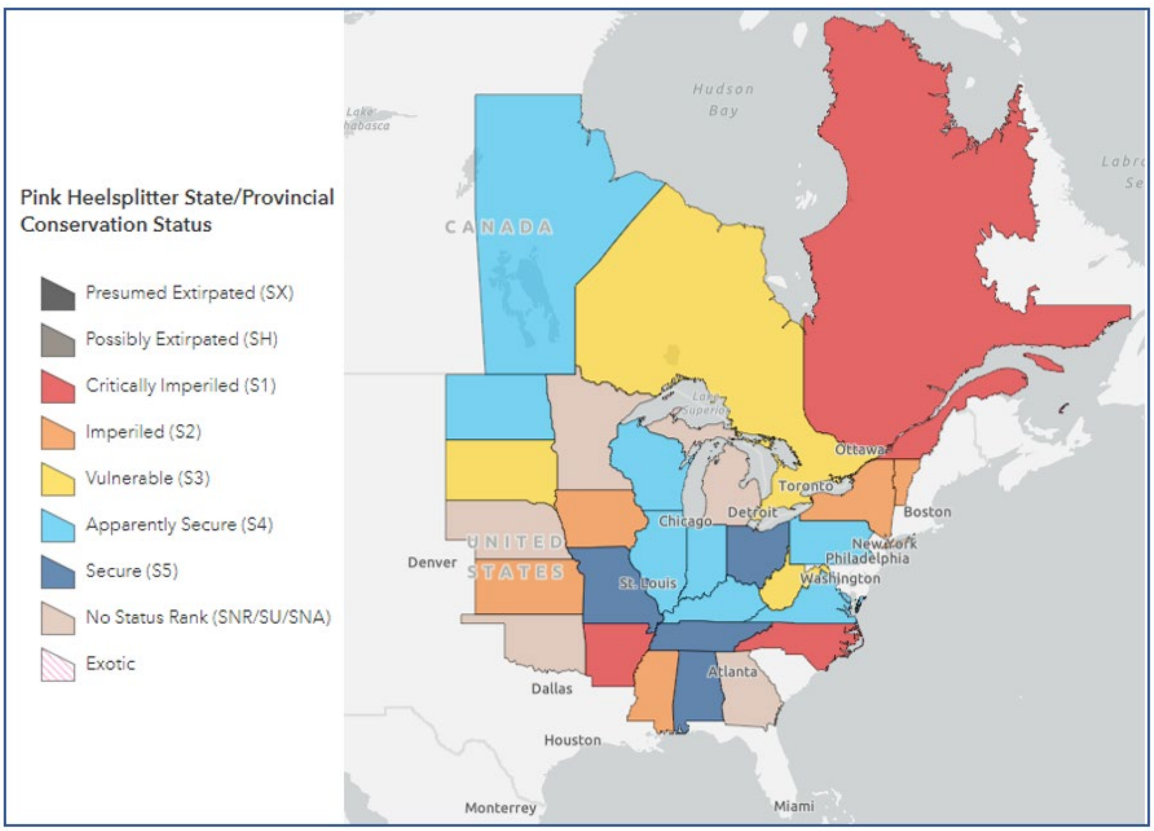

Figure 2. Pink heelsplitter status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

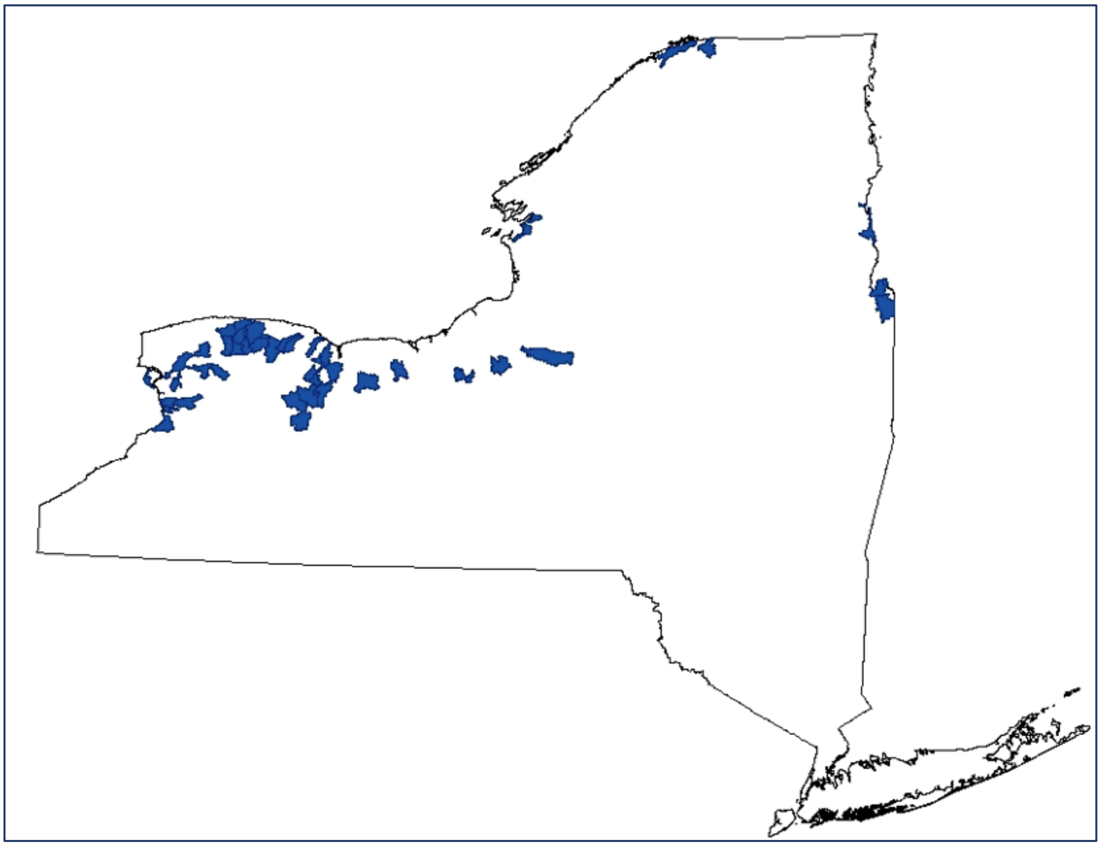

Figure 3. Records of pink heelsplitter in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
Total		21	2.3%

Table 1. Records of pink heelsplitter in New York.

Details of historic and current occurrence:

2024: P. alatus has been found in 21 waterbodies and 41 of New York' s1802 HUC 12 watersheds (2.3%).

In New York, P. alatus has been found at many sites from Buffalo to Oneida Lake as well as in Lake Champlain and its larger tributaries, and from Canandaigua Lake at Vine Valley. The few historical records from the Albany area probably represent recent range extensions through the Erie or Champlain canals (Strayer & Jirka 1997).

Since 1970, P. alatus is has been found in 17 New York State waterbodies.

In the Lower Genesee basin, this species has been found live in Black Creek, Honeoye Creek, and the Genesee River. In the West Lake Ontario basin, it was found live in Johnson Creek and as shells in Oak Orchard Creek (Mahar & Landry 2013). In the Finger Lakes basin, it has been found in Canandaigua Lake at Vine Valley (White et al. 2011). In the Erie basin it has been found live in Tonawanda Creek (Mahar & Landry 2013) and Cayuga Creek, and fresh shells were found in Lake Erie (Athol Springs), Niagara River and Buffalo River (NY Natural Heritage Program 2013). In the Lake Champlain basin, live mussels were found in Putnam Creek Delta, Poultney River, the Mettawee River at Whitehall (NY Natural Heritage Program 2013), and in Lake Champlain at Crown Point (White et al. 2011). P. alatus has also been collected from the Lake Ontario's Black River Bay (Mahar & Landry 2013). In the Erie Canal, live specimens were found from Gasport to Albion and over 300 shells, including many fresh dead and juveniles, have been found from Gasport to Macedon, and in the Seneca River at Baldwinsville (Mahar & Landry 2013).

Waterbodies with greatest P. alatus abundance include the Poultney River with 42 live, include Honeoye Creek with 38 live, Johnson Creek with 22 live, Black River Bay with 15 live, and the Erie Canal (Mahar & Landry, 2013, NY Natural Heritage Program).

Recent surveys did not find P. alatus in the Mid Lake Ontario basin, except where the Erie Canal passes through the watershed (Mahar & Landry 2013). However it has been found in East Lake Ontario basin, in the Black River Bay in 2012 (Burlakova et al., in preparation). Although P. alatus has not been reported from the St. Lawrence or its tributaries in northern New York, it may turn up in these waters (Strayer & Jirka 1997).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	525 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type: Small to Medium River

b. Geology: Moderately Buffered

c. Temperature: Transitional Cool to Warm

d. Gradient: Low Gradient to Moderate-High Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

P. alatus is especially common in quiet backwaters in silty sand and mud. It is widespread in shallow lake habitat, impoundments, canals, and medium to large rivers (Cummings & Mayer 1992; Metcalfe-Smith et al. 2005; NatureServe 2013; Strayer & Jirka 1997; Watters et al. 2009). Although less common, it can also be found in riffles of creeks and rivers (Strayer & Jirka 1997).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, P. alatus must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable habitat, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as cited in NatureServe 2013).

P. alatus is bradytictic, with glochidia overwintering in the female. Ortmann (1919) believed this species bred year round, with overlapping broods. He found gravid females from June to October and again from May to July (Watters et al., 2009). The only known glochidial host for P. alatus is the freshwater drum (Aplodinotus grunniens)(Brady et al. 2004; Sietman et al. 2009; NatureServe, 2013; Watters et al. 2009). The life span of this species is approximately 15 years (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations

Threat Category	Threat
1. Human Intrusions & Disturbance	Work & Other Activities (bridge projects and other instream work)
2. Natural System Modifications	Other Ecosystem Modifications (levees and flood walls, channelization, dredging, impassable culverts)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (zebra mussels)
4. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers, sediment)
5. Pollution	Household Sewage & Urban Waste Water (road runoff of salts and metals, other regulated discharges)
6. Pollution	Household Sewage & Urban Waste Water (waste water treatment effluent, sewer and septic overflows)
7. Climate Change & Severe Weather	Droughts
8. Natural System Modifications	Dams & Water Management/Use (lowering of water table from agriculture, etc…, causing drying of habitat)
9. Climate Change & Severe Weather	Storms & Flooding (extreme storms)
10. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (die offs from unknown disease)
11. Invasive & Other Problematic Species & Genes/Pollution?	Invasive Non-Native/Alien Species (lampricide)

Agricultural Runoff

The bulk of New York's *P. alatus* population is found in the Genesee River basin (Honeoye Creek, Black Creek), in the Southwest Lake Ontario basin (Johnson Creek, Oak Orchard Creek), and the Erie Canal, all highly agricultural areas, bordered by to some extent by cultivated cropland (NYS Landcover 2010). Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Treated and Untreated Wastewater

Several known *P. alatus* sites are located near areas of known combined sewer outflows as well as the permitted discharge of treated wastewater. These areas include sites on the Niagara River and the Erie Canal, with CSOs near Lockport and Medina and treated wastewater discharge from Rochester and several smaller municipalities along the Erie Canal (Combined Sewer Overflow 2013, SPDES 2007). Illegal dumping of sewage from recreational boats in the Erie Canal may also a concern. Recent studies show that mussel richness and abundance decreases with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals also originate from municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012). It should be noted that in the Susquehanna Basin, Harman and Lord (2010) found no evidence that wastewater treatment plants were responsible for reductions in mussel species of greatest conservation need.

Runoff from Developed Land

All 17 of New York waterbodies that host *P. alatus* populations are intermittently bordered by interstate highways, state routes, and/or local roads and lawns, and receive runoff containing metals and road salts from these sources (Gillis 2012). In particular, populations in the Buffalo River and Lake Erie receive urban runoff from Buffalo and its suburbs. In addition, Erie Canal populations receive urban storm water runoff from multiple municipalities including Lockport, Medina, Albion, Brockport, Spencerport, and Rochester (New York State Landcover 2010). Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen 1992), suggesting that EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991, Liquori & Insler 1985, Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels.

Recent studies have shown that copper can significantly alter *P. alatus'* thermal tolerance (Pandolfo et al. 2010) and that *P. alatus* has thermal thresholds that allow for burrowing (Block 2013), suggesting that exposure to heavy metals can impact survival. These threats would be exacerbated by the anticipated thermal tolerances problems associated with climate change, as mussel populations shift towards less diversity and more abundant thermally tolerant species (Gailbraith et al. 2010, Pandolfo et al. 2010). This may be a concern for *P. alatus* in the Buffalo and Rochester regions, as well as in communities that fall along the Erie Canal.

Invasive Species

In the Erie Canal, zebra and quagga mussels (*Dreissena bugenis*) and Asian clams (*Corbicula*) have been found in large numbers (Mahar and Landry 2013). Invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugenis*) have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997; Watters et al. 2009). En masse, Dreissenids outcompete native mussels by removing food and oxygen from the water. They can also reduce reproductive success by filtering native mussel male gametes from the water column. They can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994). In addition, ammonia from Asian clam die offs has been shown to be capable of exceeding acute effect levels of some mussel species (Cherry et al. 2005). These invasives may be a threat to populations in Lake Erie, Lake Ontario, the Erie Canal, Oak Orchard Creek, and along Lake Champlain. Outside New York State, the *P. alatus* population in the Ottawa River has been threatened by zebra mussels (Schueler & Karstad 2007).

Sea lamprey control treatments

Pultney River and in tributaries to Lake Ontario.

Habitat Modifications

Ecosystem modifications, such as in-stream work associated with, canal dredging bridge replacements, gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000).

Based on the number of fresh shells found and live individuals found, it is thought that a significant portion of New York's *P. alatus* populations reside in the Erie Canal system. In addition to those habitat modifications previously mentioned, threats to the Erie Canal populations include maintenance dredging by the NY Canal Corporation and seasonal water draw downs. Seasonal draw downs of water bodies have been shown to impact unionid age distributions (Richardson et al. 2002) and it is likely that the Erie Canal water draw downs have negative impacts on *P. alatus* populations. During spring mussel surveys of the Erie Canal, it is not uncommon to find hundreds of fresh shells of multiple species, including *P. alatus,* and multiple age classes, many containing desiccating flesh along the exposed canal banks and bed (Mahar & Landry 2013). This antidotal evidence suggests seasonal draw downs have a large impact on these populations.

Impoundments – Range wide

Across its range, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves.

The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓_ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussels habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York’s mussel resources occur within Class C and D waters (see species specific streams in threats/management discussion) An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Priority conservation efforts for this species should focus on, but not be limited to, the Poultney River between the New York border and Whitehall, Honeoye Creek between Rush and the confluence with the Genesee River, Johnson Creek in the town of Carlton, and the Erie Canal between Medina and Spencerport.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley & Tank 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted. Update wastewater treatment facilities in Buffalo, Lockport, and Medina to eliminate combined sewer outflows.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Enforce No Discharge Zone, and promote the proper discharge of sewage by recreational boaters on the Erie Canal.

- Establish a protocol whereas DEC staff work closely with state and local highway departments to reduce impacts to native mussels during maintenance and construction projects.

- Establish a protocol whereas DEC staff work closely the New York State Canal Corps to reduce impacts to native mussels during maintenance, construction and dredging projects.

- Replace culverts that disrupt aquatic habitat connectivity to allow for passage of small fish species.

- Within the Great Lakes and Champlain watersheds, lamprey control efforts should consider specific, potentially adverse, impacts to native freshwater mussels when determining methods, including selection of lampricide formulations and concentrations.
  Lampricide treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard 2006).

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g., point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) -
https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions

Action Category	Action
1.	
2.	

Table 2. (need recommended conservation actions for pink heelsplitter).

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	February 26, 2014 (Samantha Hoff)
Latest revision	January 16, 2024 (Amy Mahar)

<u>Species Status Assessment</u>

Common Name: Pink mucket **Date Updated:** 1/17/2024

Scientific Name: *Lampsillis abrupta* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Lampsilis abrupta not been seen in New York for over 100 years and is thought to be extirpated in the state. A single New York State specimen was taken from the Niagara River in 1906. Although removed from the accepted range of this species, Strayer & Jirka (1997) tentatively accept this record as legitimate. This species was removed from the New York Species of Greatest Conservation list in 2015.

L. abrupta belongs to the subfamily Ambleminae and the tribe Lampsilini, which includes 17 extant and 6 likely extirpated New York species of the genera Actinonaias, Epioblasma, Lampsilis, Leptodea, Ligumia, Obovaria, Potamilus, Ptychobranchus, Toxolasma, Truncilla, and Villosa (Haag 2012; Graf and Cummings 2011). This species is listed as state and federally endangered and is ranked by The Natural Heritage Program as historic in New York and as imperiled throughout its range. According to recent trends L. abrupta populations are a steep decline (NatureServe 2013).

I. Status

a. Current legal protected Status

i. **Federal:** Endangered **Candidate:** ____

ii. **New York:** Endangered

b. Natural Heritage Program

i. **Global:** G1G2 – Critically imperiled/Imperiled

ii. **New York:** SH - Historic **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Vulnerable (2012)

-Northeast Regional SGCN: Watchlist (2023)

- American Fisheries Society Status: Endangered (1993)

Status Discussion:

The overall range of this once very widespread species has diminished, but this species has always been considered rare and it seems to be surviving and reproducing in sections of river that have been altered by impoundments. More dramatic has been the decline in area of occupancy (probably greater than 30%) as it continues to be found in historical sites but often only in very low numbers. Although currently known from a few dozen localities, most are represented by very few individuals and have poor viability. If populations west of the Mississippi River prove to be a different species, the conservation status will need to be reevaluated (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Declining	Declining			(blank)
Northeastern US	Unknown	Choose an item.	Choose an item.			Yes
New York	Unknown	Extirpated	Extirpated		SH	No
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Unknown	Extirpated	Extirpated		SH	Yes
Vermont	No	N/A	N/A			No
Ontario	No	N/A	N/A			(blank)
Quebec	No	N/A	N/A			(blank)

Column options

Present?: Yes; No; Unknown; No data; (blank) or Choose an Item

Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item

SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a 2009 to 2020 State Wildlife Grant funded project, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York where this species might be found. No regular surveys are being conducted for this species at this time. Regulatory surveys may be conducted in known or likely habitat as part of the project review process.

Trends Discussion *(insert map of North American/regional distribution and status):*

Species has declined in numbers between 30% - 50% over the short and long term. These trends are expected to continue since very few populations are currently reproductively viable.

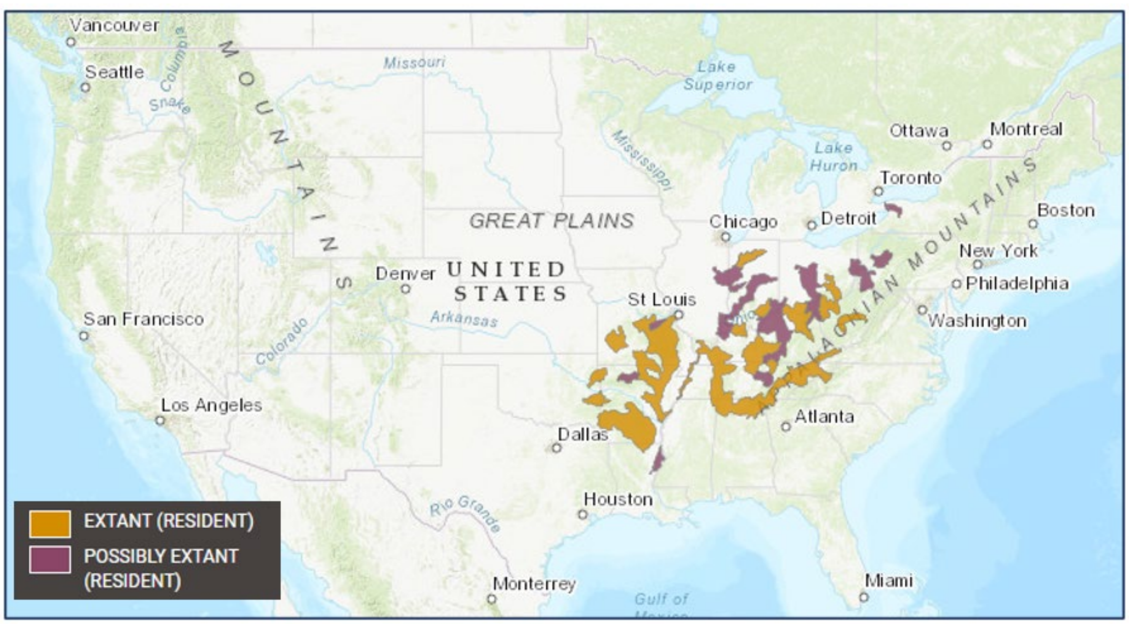

Figure 1. Pink mucket distribution (IUCN Redlist 2024)

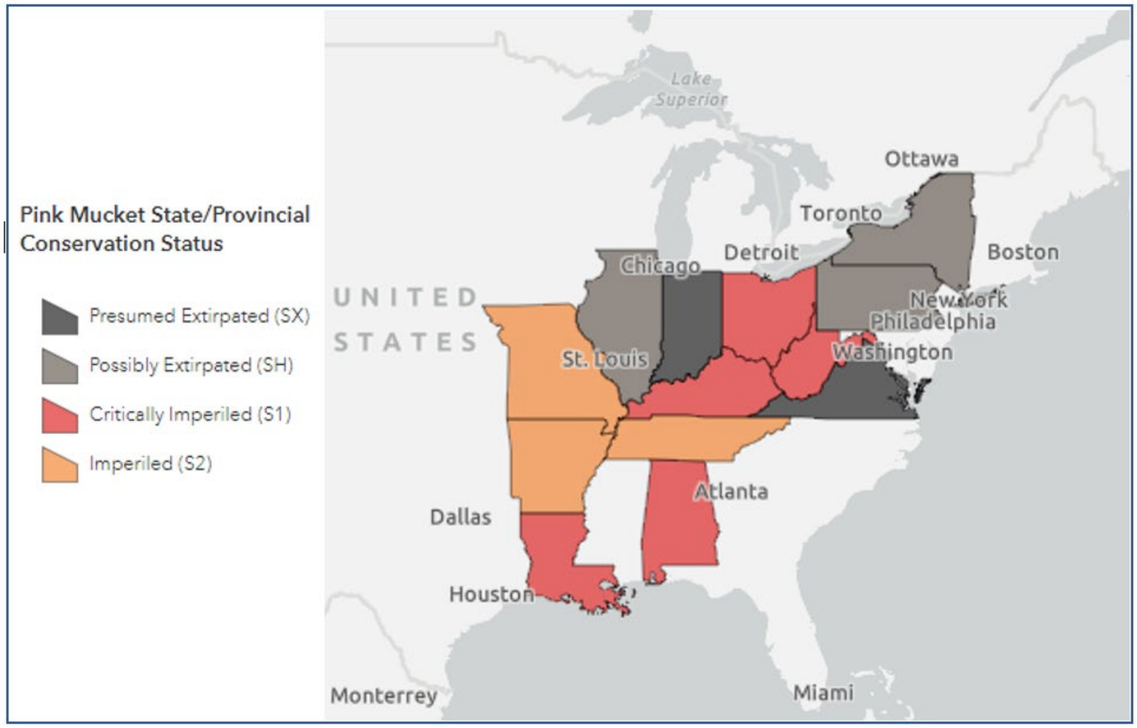

Figure 2. Pink mucket distribution status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

Years	# of Records	# of Distinct Waterbodies	% of State
Pre-1995	1	1	1 of 56 HUC 8 watersheds
1995-2004	0	0	0
2005-2014	0	0	0
2015- 2023	0	0	0

Table 1. Records of pink mucket in New York.

Details of historic and current occurrence:

Only a single specimen of this species has been found in NYS; from the Niagara River in 1906. Although removed from the accepted range of this species, Strayer & Jirka (1997) tentatively accept this record as legitimate.

Despite recent survey efforts, this species has not been found in New York in over 100 years (Strayer & Jirka 1997, Mahar and Landry 2013, New York Natural Heritage Program 2013, The Nature Conservancy 2009, Harman and Lord 2010, White et al. 2011, NatureServe 2013). Strayer and Jirka (1997) speculate that if it still lives in New York, it may be found in the Niagara River above the falls.

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
0%	Peripheral	700 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type:

b. Geology:

c. Temperature:

d. Gradient:

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

Found in waters with strong currents, rocky or boulder substrates, with depths up to about 1 m, but is also found in deeper waters with slower currents and sand and gravel substrates (Gordon & Layzer 1989; USFWS 1985; NatureServe 2013).

L. abrupt is found in medium to large rivers (Watters et al. 2009, McMurray et al. 2012), although is occasionally reported from large creeks and small rivers (Williams et al. 2008). It has been able to survive and reproduce in impoundments with river-lake conditions but never in standing pools of water (USFWS 1985). It occurs in swift current in sandy mud, sand, gravel, cobble substrates (Parmalee and Bogan 1998, Cummings and Mayer 1992, Watters et al. 2009, McMurray et al 2012), but has also been found in rocky substrates (NatureServe 2013).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Unknown	No	No	Unknown	Unknown	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, this species must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. L. abrupta females possess a mantle flap with an eyespot which may serve to attract host fish (USFWS 1985; NatureServe 2013). After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable substrate, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as cited in NatureServe 2013).

This species is a long-term breeder (bradytictic) becoming gravid in August. Glochidia are found in females in September, and are discharged the following June (Ortmann 1912; 1919). Glochidial transformation has been confirmed on largemouth bass (Micropterus salmoides), smallmouth bass (Micropterus dolomieui), spotted bass (Micropterus punctulatus) and walleye (Stizostedion vitreum) (Watters et al. 2009). Additional potential hosts may be sauger (Stizostedion canadense) and freshwater drum (Aplodinotus grunniens) (Fuller 1974). Individuals may live for 25 years (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats within New York are irrelevant considering live *L. abrupta* hasn't been observed in nearly a century. However, threats do exist that would restrict the re-colonizing of New York habitats.

General threats to mussels that are likely relevant range wide:

Impoundments – Range wide
Range wide, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Agricultural Runoff
Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry 2013), indicating that runoff is a major threat to resident mussel populations.

Species such as *L. abrupta* that have a mantle modified to attract host fish are thought to rely on the visual acuity of their fish hosts to facilitate transfer of glochidia from the female to the host. For such species, this indicates that increases in turbidity associated with runoff may in interfere with reproduction and be especially detrimental to the species (Nedeau 2008).

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Treated and Untreated Wastewater
Recent studies show that mussel richness and abundance decreases with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals also originate from municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012).

Runoff from Developed Land

Developed lands are likely sources runoff containing metals and road salts.
Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991; Liquori & Insler 1985; Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Invasive Species
Invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugenis*) have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997; Watters et al. 2009). En masse, Dreissenids outcompete native mussels by removing food and oxygen from the water. They can also reduce reproductive success by filtering native mussel male gametes from the water column. They can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994). In addition, ammonia from Asian clam die offs has been shown to be capable of exceeding acute effect levels of some mussel species (Cherry et al. 2005). Didymo (*Didymosphenia geminata*), a filamentous diatom, can form extensive mats that can smother stream bottom and occlude habitat for mussels (Spaulding & Elwell 2007)

Climate Change
Global climate change is expected (among other disruptions) to cause an increase in surface water temperatures. Although many species are tolerant of warm water, higher water temperatures may be an added stress for some. Increased water temperatures may also increase algal growth, which could result in reductions in dissolved oxygen levels at night (Morris & Burridge 2006). Galbraith et al. (2010) recently showed how regional climate patterns coupled with changing local water regimes and management strategies have shifted mussel populations from thermally sensitive species to thermally tolerant species.

In addition, warmer stream temperatures due to the combined effects of land use, such as removal of shaded buffers, and climate change may contribute to the loss of coldwater fisheries and *mussel* populations in some watersheds (Nedeau 2008). Temperature induced changes in fish communities could have a profound influence on the availability of hosts for freshwater mussels. Mussels that inhabit small streams and rivers and rely on fish adapted for cooler water might be most affected by climate change (Nedeau 2008).

Habitat Modifications
Ecosystem modifications, such as in-stream work associated with canal, navigational channel, or flood control dredging, bridge replacements, gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000). Seasonal draw downs of water bodies have been shown to impact unionid age distributions (Richardson et al. 2002).

Levees and flood walls confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999; Yeager 1993; Nedeau 2008).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓__ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

New York State Environmental Conservation Law, § 11-0535. 6 NYCRR Part 182: Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern; Incidental Take Permits.

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any "protected stream", its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York's mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Assess the need and opportunity for relocation/reintroduction efforts. Conduct relocation or reintroduction where adequate sources can be identified and appropriate stream conditions exist (water quality, habitat, host species etc).

- Evidence of historic occurrence of multiple New York State extirpated mussel species exists for the Niagara River. These species include: *Epioblasma triquetra, Lampsilis teres, Lampsilis abrupta, Obovaria olivaria, Potamilus capax*, *Pustulosa pustulosa*, *Quadrula quadrula, Simpsonaias ambigua, and possibly Truncilla donaciformis*. To assess the potential for future reintroduction efforts, a pilot program relocating common species to suitable sections of the Niagara River should be initiated and its results assessed to gage the possible success of reintroduction efforts for extirpated species in this waterbody.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley & Tank 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Following any reintroduction efforts, develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Update wastewater treatment facilities in Buffalo to eliminate combined sewer outflows.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Within the Great Lakes watersheds, lamprey control efforts should consider specific, potentially adverse, impacts to native freshwater mussels when determining methods, including selection of lampricide formulations and concentrations. Lampricide treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard 2006).

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g., point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2. (need recommended conservation actions for pink mucket).

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.

- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Date first prepared	June 2013
First revision	
Latest revision	January 17, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Plain pocketbook **Date Updated:** 1/16/2024

Scientific Name: *Lampsillis cardium* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Lampsilis cardium belongs to the subfamily Ambleminae and the tribe Lampsilini, which includes 17 extant and 6 likely extirpated New York species of the genera Actinonaias, Epioblasma, Lampsilis, Leptodea, Ligumia, Obovaria, Potamilus, Ptychobranchus, Toxolasma, Truncilla, and Villosa (Haag 2012; Graf and Cummings 2011). L. cardium is one of seven species of the genus Lampsilis that have been found in New York (Strayer and Jirka 1997).

Although the NYS CWCS (2006) combines L. ovata and L. cardium under the L. ovata listing, almost all New York material is “L. cardium,” with only specimens from the Allegheny River basin classified as “L. ovata” (Strayer and Jirka 1997, The Nature Conservancy 2009). Additionally, NY Natural Heritage Program (2013), NatureServe (2013) and most recent species reference guides (Watters et al. 2009, Cummings and Mayer 1992, Parmalee and Borgan 1998) regard L. ovata and L. cardium as separate species. For the purpose of this assessment, L. ovata as described in the NYS CWCS will be divided into L. ovata and L. cardium.

Since 1970, L. cardium has been found in 19 New York waterbodies. In New York, it has been found in the Lower Genesee, Oswego, Erie (Mahar and Landry 2013), Allegheny (The Nature Conservancy 2009), Champlain (Strayer and Jirka 1997), Hudson, and St. Lawrence basins (NY Natural Heritage Program 2013). L. cardium is present in creeks, rivers, ponds, and lakes. It tolerates many substrates and water flows (Watters et al. 2009).

In New York, L. cardium is ranked as imperiled/vulnerable, and as secure throughout its range (NatureServe 2013). In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993, Stein et al., 2000). While population trends in New York are unknown, it is assumed that they too are declining, due to a myriad of environmental stressors.

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** None

b. Natural Heritage Program

i. **Global:** G5 - Secure

ii. **New York:** S2S3 - Imperiled/ Vulnerable **Tracked by NYNHP?:** No

Other Ranks:

-IUCN Red List: Least Concern (2015)

-Northeast Regional SGCN: No (2023)

- American Fisheries Society Status: Special Concern (1993)

Status Discussion:

This species can be found in the entire upper Mississippi River drainage from northern Arkansas and Tennessee, north to Minnesota and Wisconsin, and from New York west to eastern Kansas; as well as the Winnipeg, Red, and Nelson River systems of central Canada. It is also found throughout the Great Lakes- St. Lawrence system except most of Lake Superior. It is considered stable throughout the majority of its wide range (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Stable	Stable			(blank)
Northeastern US	Yes	Stable	Stable			No
New York	Yes	Choose an item.	Choose an item.			Yes
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Choose an item.	Choose an item.		S4	No
Vermont	No	N/A	N/A			No
Ontario	Yes	Stable	Stable	2003-2013	S4	(blank)
Quebec	Yes	Choose an item.	Choose an item.		S3S4	(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

Trends for New York populations are difficult to determine as most historic data comes from opportunistic naturalist collections, as opposed to more comprehensive baseline surveys. For example, mussels were documented for the first time in 50 of the 106 streams surveyed to date by the Southern Lake Ontario mussel inventory project (Mahar and Landry 2013). This is because many of these streams had never before been surveyed for mussels, not because mussel distribution has dramatically increased. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al. 2000). Based on New York's Natural Heritage S-rank, sparse historical data, and the plight of North America's freshwater mussels, it is assumed that trends are declining due to a myriad of environmental stressors.

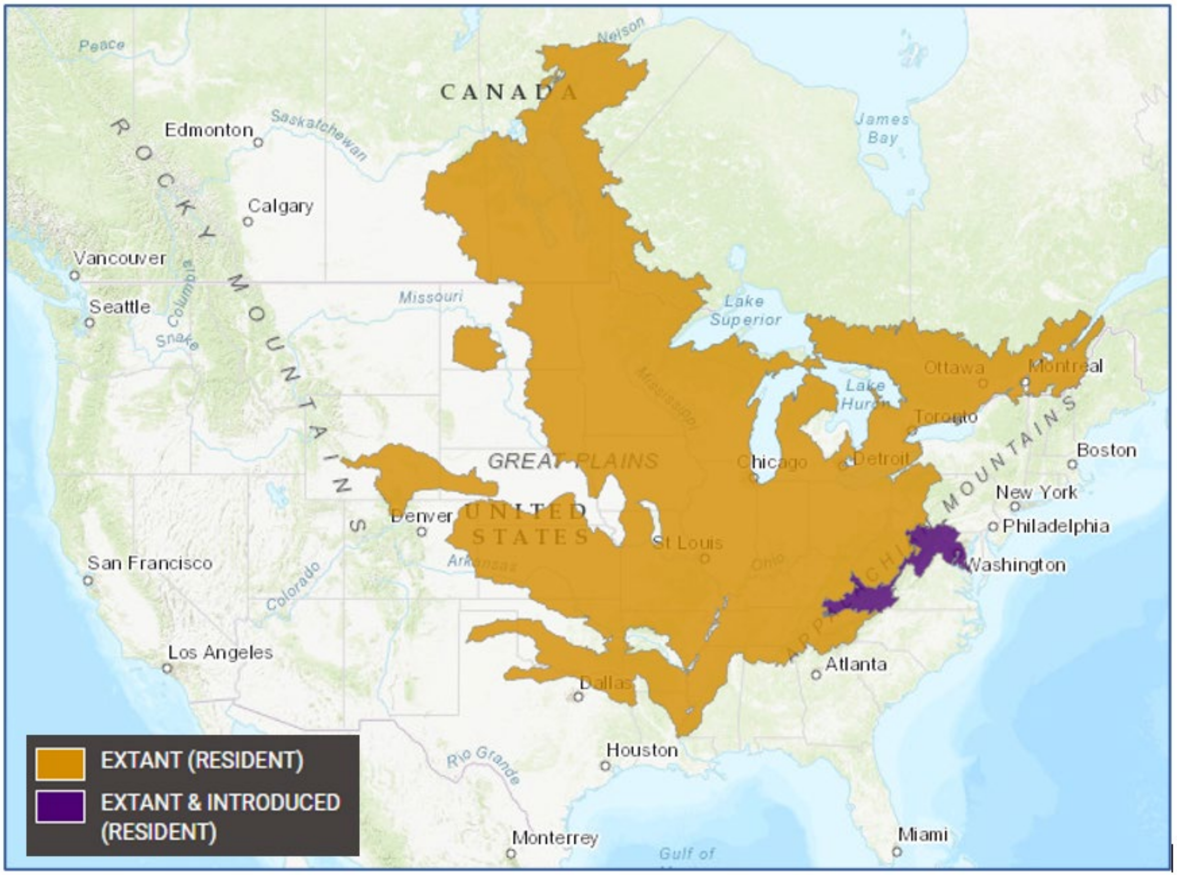

Figure 1. Plain pocketbook distribution (IUCN Redlist 2024)

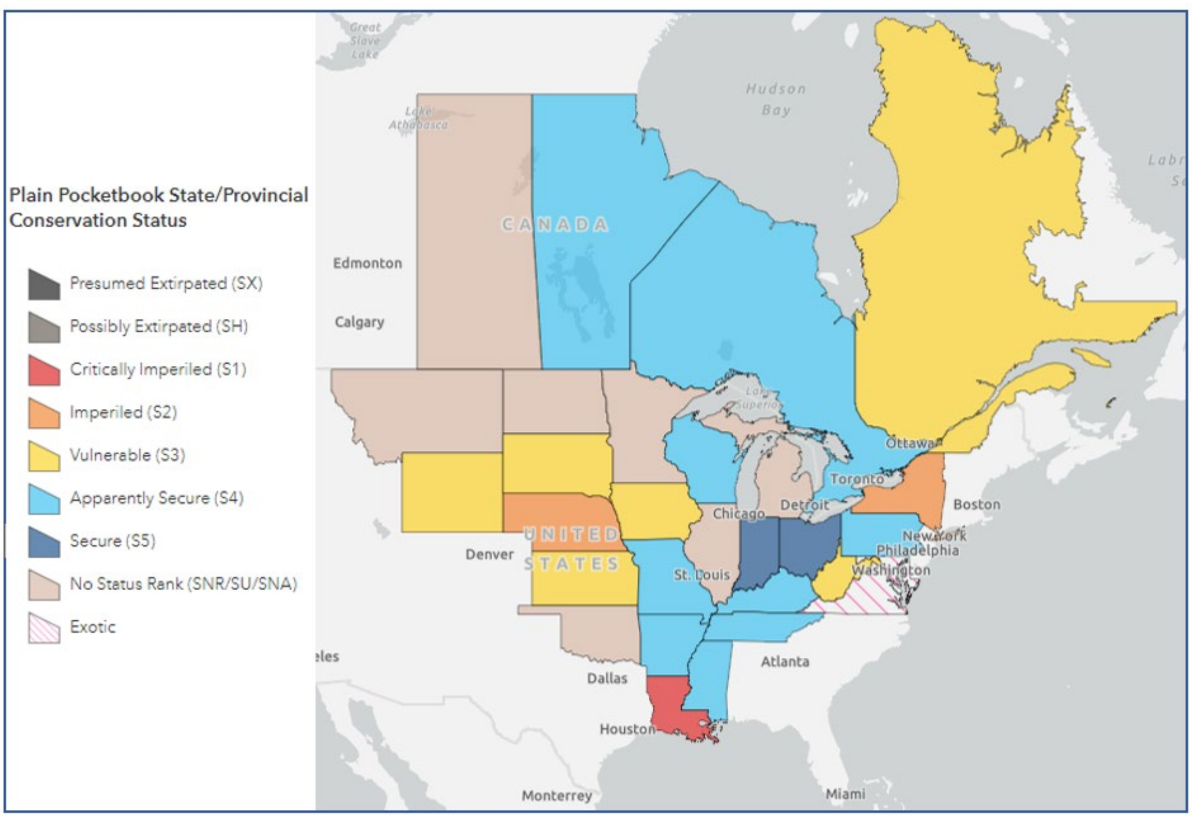

Figure 2. Plain pocketbook status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

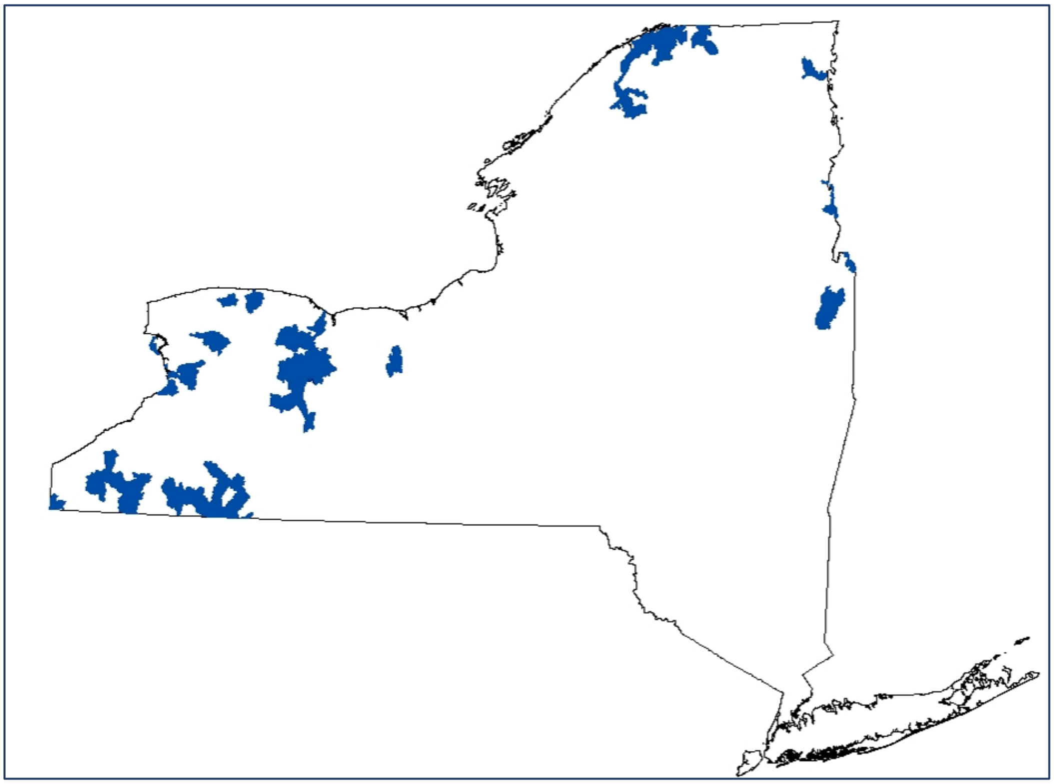

Figure 3. Records of plain pocketbook in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
	_______	_______	_______
	_______	_______	_______
	_______	_______	_______
Total	_______	44	3.6%

Table 1. Records of plain pocketbook in New York.

Details of historic and current occurrence:

2024: L. cardium has been found in 44 waterbodies and 65 of New York's 1802 HUC 12 watersheds (3.6%).

In New York, L. cardium has been found in many sites in the Allegheny, Erie-Niagara, Genesee, Oswego, and Champlain basins as well as a few places in the St. Lawrence River basin and the upper Hudson basin (Strayer and Jirka 1997).

L. cardium was found at 48 of 105 sites surveyed in the Allegheny basin. L. cardium was distributed throughout the Upper Allegheny and Conewango sub-basins but at relatively low numbers. L. cardium were considered viable at 21 of the sites where they were found. During this survey effort, a total of 405 L. cardium were found in Oswayo Creek, Olean Creek, Allegheny River, Conewango Creek, Cassadaga Creek (The Nature Conservancy 2009). This species is also present in Red House Brook (Mahar and Landry 2013). In addition, recent records exist for French Creek (Strayer and Jirka 1997), where it was found live in 2013 (Burlakova, Karatayev, unpublished data).

In the Lower Genesee basin, L. cardium has been found in Black Creek, Conesus Creek, Genesee River, Honeoye Creek. In the Oswego basin, this species was found in Canandaigua Outlet (Mahar and Landry 2013). In the Erie basin, L. cardium was collected from Cayuga Creek (Natural Heritage Program 2013) and from 4 of 38 sites surveyed in the Tonawanda Creek watershed (Marangelo and Strayer 2000, NY Natural Heritage Program 2013, Mahar and Landry 2013). Records from the St. Lawrence River basin include Raquette River, Grass River (Strayer and Jirka 1997), Salmon River, and Little Salmon River (NY Natural Heritage Program 2013). In addition, Strayer and Jirka (1997) report records in the southern Champlain basin (likely the southern end of Lake Champlain and the Lake Champlain Canal), as well as sites in the Hudson basin (Hudson River and possibly 1 – 2 tributaries) near the entrance of the Champlain Canal.

Streams of greatest L. cardium abundance include the Genesee River with 1261 live, Honeoye Creek with 352 live (Mahar and Landry 2013), the Allegheny River upstream of Olean, and Oswayo Creek (The Nature Conservancy 2009). As expected, L. cardium was not found in recent Susquehanna basin survey (Mahar and Landry 2019, Harman and Lord 2010).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	550 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type: Medium River

b. Geology: Moderately Buffered

c. Temperature: Warm to Transitional Cool

d. Gradient: Low to Moderate-High Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

Watters et al. (2009) notes that L. cardium is widespread in creeks, rivers, ponds, and lakes and tolerates many substrates and water flows. However, other sources state only that this species is found in flowing water, with moderate to strong current, and stable substrates of mud, silt, sand, or gravel (McMurry et. al. 2012; Cummings and Mayer 1992; Metcalfe-Smith et al. 2005, Parmalee and Bogan1998).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, L. cardium must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable substrate, they will burrow into the substrate, where they may remain for several years (Watters et al 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC 2003 in NatureServe 2013).

Specimens older than 30 years of age are rare. Sexual maturity may be reached at about 4 years of age (Watters et al. 2009). L. cardium has been reported to have either a single brood per year, with spawning occurring in July and August and glochidia released in April or May of the following year or to have two broods per year with egg-bearing or gravid females occurring from July through October and again from May to July (Watters et al. 2009).

Most of the known hosts for L. cardium are centrarchids. Glochidia transformation has been confirmed on tiger salamander (Ambystoma tigrinum ssp.), green sunfish (Lepomis cyanelllus), pumpkinseed (Lepomis gibbosus), bluegill (Lepomis macrochirus), smallmouth bass (Micropterus dolomieu), largemouth bass (Micropterus salmoides), yellow perch (Perca flavescens), white crappie (Pomoxis annularis), black crappie (Pomoxis nigromaculatus), and walleye (Sander vitreus) (Watters et al. 2009). Based on infestation, sauger (Sander canadensis) is a potential host (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Human Intrusions & Disturbance	Work & Other Activities (bridge projects and other instream work)
2. Natural System Modifications	Other Ecosystem Modifications (levees and flood walls, channelization, dredging, culverts)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (zebra mussels)
4. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers, sediment)
5. Pollution	Household Sewage & Urban Waste Water (road runoff of salts and metals, other regulated discharges)
6. Pollution	Household Sewage & Urban Waste Water (waste water treatment effluent, sewer and septic overflows)
7. Climate Change & Severe Weather	Droughts
8. Natural System Modifications	Dams & Water Management/Use (lowering of water table from agriculture, etc…, causing drying of habitat)
9. Climate Change & Severe Weather	Storms & Flooding (extreme storms)
10. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (die offs from unknown disease)

Agricultural Runoff

Many known New York State *L. cardium* habitats are found in areas potentially subject to agricultural runoff. Although primarily a forested watershed, agriculture is present in the valleys adjacent to the Allegheny River and its tributaries near Olean, Allegany, Portville, and adjacent to Cassadaga and Conewango Creeks. The Lower Genesee basin is primarily agricultural with large and often continuous blocks of cultivated cropland adjacent to the Genesee River and Honeoye Creek near *L. cardium* habitat. Hay and pasture lands are more prevalent adjacent to Black Creek, Tonawanda Creek, Salmon River, Little Salmon River, Raquette River, and Grass River, as well as some adjacent agriculture in the Lake Champlain watershed (New York State Landcover 2010). Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar and Landry 2013), indicating that runoff is a major threat to resident mussel populations.

Species such as *L. cardium L. ovata* that have a mantle modified to attract host fish are thought to rely on the visual acuity of their fish hosts to facilitate transfer of glochidia from the female to the host. This indicates that increases in turbidity associated with runoff may in interfere with reproduction and be especially detrimental to the species (Nedeau 2008).

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting in higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Runoff from Developed Land

The habitat of *L. cardium* receives storm water runoff from the cities of Olean and Salamanca, and the villages of Allegany and Portville, either directly to the Allegheny River or through tributaries. Cassadaga Creek receives Jamestown's urban runoff via the Chadokoin River. Known habitat in Cayuga Creek receives runoff from Buffalo's suburbs, the Genesee River receives runoff from Geneseo, and the Grass River receives runoff from Massena. In addition, all 19 New York waterbodies that host *L. cardium* populations are intermittently bordered by interstate highways, state routes, and/or local roads (New York State Landcover, 2010). These developed lands are likely sources runoff containing metals and road salts. Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller and Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner and Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller and Zam 1991; Liquori and Insler 1985; Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Treated and Untreated Wastewater

The habitat of *L. cardium* receives treated wastewater from Olean and Portville, either directly to the Allegheny River or through tributaries. Cassadaga Creek receives treated effluent from the city of Jamestown sewage treatment plant. Geneseo releases treated effluent into *L. cardium* habitat in the Genesee River. In the St. Lawrence River basin, Salmon River receives wastewater from Fort Covington and Grass River receives effluent from Massena. In addition combined sewer outflow (CSO) outfalls from the cities of Massena (Grass River, Raquette River) and Potsdam (Raquette River) may be found in the vicinity of *L. cardium* sites ("Combined Sewer

Overflow" 2012). Both Fort Ann and Whitehall release treated effluent to known habitat in the Champlain Canal (SPDES 2007). Recent studies show that mussel richness and abundance decrease with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals are also present in municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012). It should be noted that in the Susquehanna Basin, Harman and Lord (2010) found no evidence that wastewater treatment plants were responsible for reductions in mussel species of greatest conservation need.

Flood Control Projects
Large stretches of *L. cardium* habitat are within the leveed portions of the Allegheny River (in Olean and Portville), Olean Creek (in Olean), and Oswayo Creek (in Portville) ("New York State Flood Protection" 2013). These structures confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999; Yeager 1993; Nedeau 2008).

Habitat Modifications
Ecosystem modifications, such as isolated occurrences of flood control channel dredging, instream work associated with bridge replacement, or gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000).

Invasive Species
Invasive zebra mussels (*Dreissena polymorpha*) pose a potential threat to *L. cardium* populations in Cassadaga and Conewango Creeks, where they are present in the lower reaches. Chautauqua Lake's connection to Cassadaga Creek, Chadakoin Creek, is the main source of this exotic invasive (The Nature Conservancy 2009), which has been repeatedly cited as a threat to native mussel populations (Strayer and Jirka 1997; Watters et al. 2009). En masse, Dreissenids outcompete native mussels by efficiently filtering food and oxygen from the water. They reduce reproductive success by filtering native mussel male gametes from the water column and they can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994). Although zebra mussels will continue to cause problems for Chautauqua Lake, they currently appear to have minimal impact downstream. However, precautions should be taken to avoid invasions by zebra mussels to upstream locations,

especially the headwater lakes in the Cassadaga system. Monitoring for zebra mussels in these lakes may provide early detection of this invader (The Nature Conservancy 2009).

Climate Change
Global climate change is expected (among other disruptions) to cause an increase in surface water temperatures in southern Ontario. Although many species are tolerant of warm water, higher water temperatures may be an added stress for some. Increased water temperatures may also increase algal growth, which could result in reductions in dissolved oxygen levels at night (Morris and Burridge 2006). Galbraith et al. (2010) recently showed how regional climate patterns coupled with changing local water regimes and management strategies have shifted mussel populations from thermally sensitive species to thermally tolerant species.

Impoundments – Range wide
Across its range, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery and King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓_ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York's mussel resources occur within Class C and D waters (see species specific streams in threats/management discussion) An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Priority conservation efforts for this species should focus on, but not be limited to, Honeoye Creek between Rush and the confluence with the Genesee River, the Genesee River, especially between the Mt. Morris dam and Geneseo, Oswayo Creek, and the Allegheny River upstream of Olean.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, salts from entering these aquatic systems.

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Establish a protocol whereas DEC staff work closely with Flood control management to reduce or impacts to native mussels during maintenance flood control projects.

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g. point and nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

- Within the Great Lakes and Champlain watersheds, lamprey control efforts should consider specific, potentially adverse, impacts to native freshwater mussels when determining methods, including selection of lampricide formulations and concentrations.
  Lampricide treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard 2006).

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	

Table 2. (need recommended conservation actions for plain pocketbook).

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
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Latest revision	January 16, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Pocketbook **Date Updated:** 1/16/2024

Scientific Name: *Lampsillis ovata* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Lampsilis ovata belongs to the subfamily Ambleminae and the tribe Lampsilini, which includes 17 extant and 6 likely extirpated New York species of the genera Actinonaias, Epioblasma, Lampsilis, Leptodea, Ligumia, Obovaria, Potamilus, Ptychobranchus, Toxolasma, Truncilla, and Villosa (Haag 2012; Graf and Cummings 2011). L. ovata is one of seven species of the genus Lampsilis that have been found in New York (Strayer and Jirka 1997).

Although the NYS CWCS (2006) combines L. ovata and L. cardium under the L. ovata listing, almost all New York material is "L. cardium," with only specimens from the Allegheny River basin classified as "L. ovata" (Strayer and Jirka 1997; The Nature Conservancy 2009). Additionally, NY Natural Heritage Program (2013), NatureServe (2013) and most recent species reference guides (Watters et al. 2009, Cummings and Mayer 1992, Parmalee and Borgan 1998) regard L. ovata and L. cardium as separate species. For the purpose of this assessment, L. ovata as described in the NYS CWCS will be divided into L. ovata and L. cardium.

Since 1970, L. ovata has been found in five New York waterbodies. This species is considered a large creek or riverine species, usually found in strong currents, occasionally in riffles (Watters et al. 2009, Cummings and Mayer 1992, Parmalee and Borgan 1998).

In New York, L. ovata is ranked as imperiled, although it is secure throughout its range (NatureServe 2013). In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al., 2000). While population trends in New York are unknown, it is assumed that they too are declining, due to a myriad of environmental stressors.

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** None, Proposed Special Concern (2019)

b. Natural Heritage Program

i. **Global:** G5 - Secure

ii. **New York:** S2 - Imperiled **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Least Concern (2015)

-Northeast Regional SGCN: No (2023)

-Midwest Regional SGCN: Watch List (Assessment priority)

-American Fisheries Society Status: Special Concern (1993)

Status Discussion:

The range includes the Interior Basin: the Mississippi and Ohio drainages, St. Lawrence drainage from Lake Superior to the Ottawa River and Lake Champlain, Hudson Bay drainage; Atlantic slope: Potomac River system in Maryland. This extensive range includes various forms, subspecies and possibly valid species as the taxonomy of this species complex is convoluted, but regardless, most forms are considered common and stable throughout the range except some portions of Illinois and Ohio (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Stable	Stable	1997-2013		(blank)
Northeastern US	Yes	Stable	Stable			No
New York	Yes	Stable	Stable			Yes
Connecticut	No	Choose an item.	Choose an item.			No
Massachusetts	No	Choose an item.	Choose an item.			No
New Jersey	No	Choose an item.	Choose an item.			No
Pennsylvania	Yes	Stable	Stable		S2S3	Yes
Vermont	Yes	Declining	Declining		Endangered, S2	Yes
Ontario	Yes	Stable	Stable			(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

Trends for New York populations are difficult to determine as most historic data comes from opportunistic naturalist collections, as opposed to more comprehensive baseline surveys. For example, mussels were documented for the first time in 50 of the 106 streams surveyed to date by the Southern Lake Ontario mussel inventory project (Mahar & Landry 2013). This is because many of these streams had never before been surveyed for mussels, not because mussel distribution has dramatically increased. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al.2000). Based on New York's Natural Heritage S-rank, sparse historical data, and the plight of North America's freshwater mussels, it is assumed that trends are declining due to a myriad of environmental stressors.

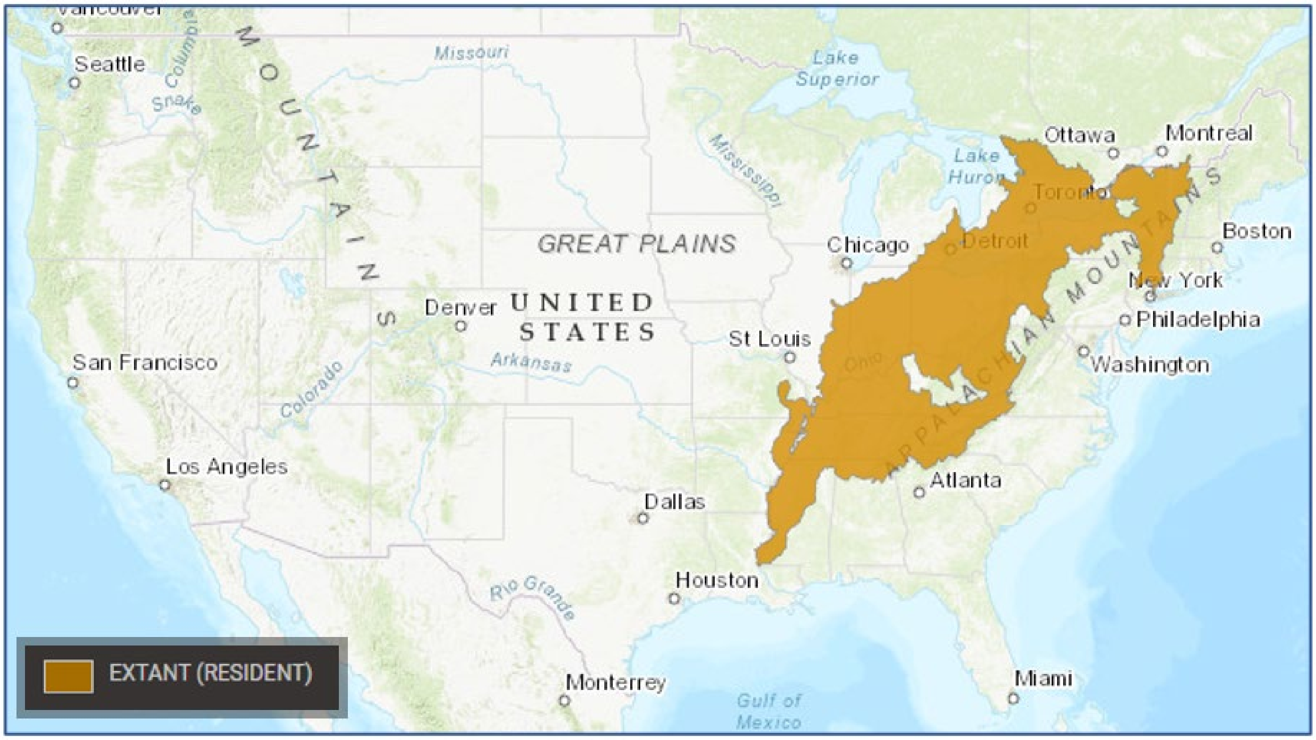

Figure 1. Pocketbook distribution (IUCN Redlist 2024)

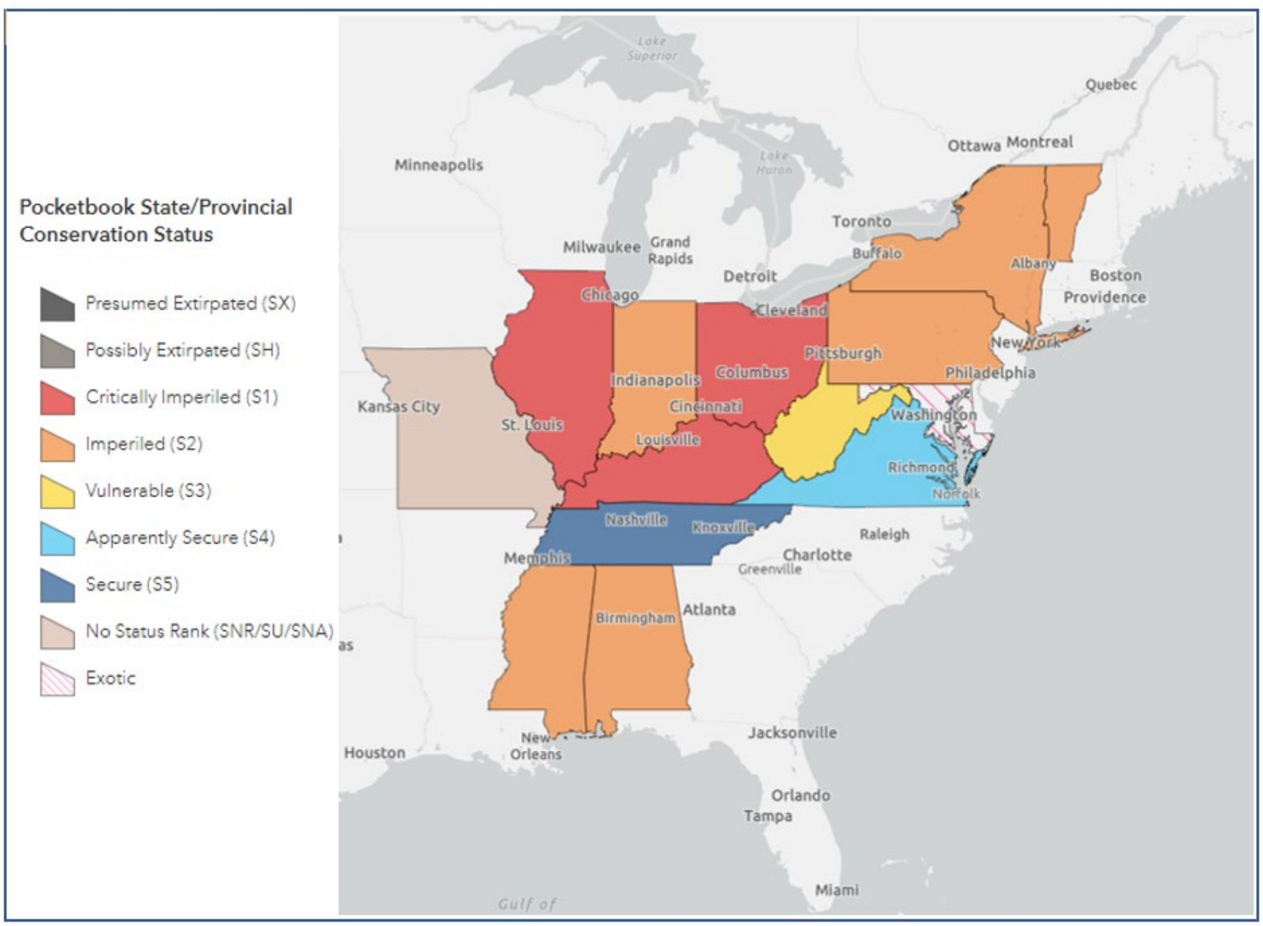

Figure 2. Pocketbook status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

Figure 3. Records of pocketbook in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
	_______	_______	_______
	_______	_______	_______
	_______	_______	_______
Total	_______	10	0.9%

Table 1. Records of pocketbook in New York.

Details of historic and current occurrence:

2024: L. ovata has been found in 10 waterbodies and 17 of New York's 1802 HUC 12 watersheds (0.9%).

In New York, L. ovata has been found in many sites in the Allegheny basin (Strayer & Jirka 1997).

Since 1970, L. ovata has been found in five New York waterbodies.

A total of 286 L. ovata were found at 36 of 105 sites surveyed in the Allegheny basin. The greatest catches (up to 7 per hour) were in the Allegheny River near and upstream of Olean. L. ovata was also found in Olean Creek, Oswayo Creek, Conewango Creek, and Cassadaga Creek, where it was present at relatively low numbers. L. ovata populations were considered viable at 18 of the sites where they were found (The Nature Conservancy 2009).

Also in the Allegheny watershed, Strayer & Jirka (1997) noted a recent occurrence in French Creek. L. ovata are known to be present in the French Creek watershed (Crabtree personal communication 2008), therefore, this referenced occurrence is thought be L. ovata.

Based on shell morphology (where documentation has been available, such as in recent surveys of the Erie and Southern Lake Ontario basins) and location, mussels found throughout the remainder of New York are assumed to be L. cardium and have been classified as such for the purpose of this assessment.

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	330 km

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type: Medium to Small River

b. Geology: Moderately Buffered

c. Temperature: Transitional Cool to Warm

d. Gradient: Low Gradient to Low-Moderate Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

L. ovata is considered a large creek or riverine species, usually found in strong currents, occasionally in riffles (Watters et al. 2009, Cummings and Mayer 1992, Parmalee and Borgan 1998). However, in Tennessee, it has been found to adapt well to impoundments, and may be found at depths between 2 and 20 feet (Parmalee and Borgan 1998). It occurs in substrates of sandy mud, coarse sand and gravel, and cobble, although it seems to thrive on a stable substrate composed of a high percentage of mud and silt (Watters et al. 2009, Cummings and Mayer 1992, Parmalee and Borgan 1998).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, L. ovata must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable habitat, they will burrow into the substrate, where they may remain for several years (Watters et al 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC 2003 in NatureServe 2013).

The reproductive biology of L. ovata is thought to be similar to that of L. cardium (Watters et al. 2009). It is bradytictic, with glochidia developing from August to the following May (Ortmann 1919). The glochidial host is not known (NatureServe 2013), although Watters et al. (2009) notes that records of potential hosts for this species may be confused with those for L. cardium. Specimens rarely reach 20 years old (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Human Intrusions & Disturbance	Work & Other Activities (bridge projects and other instream work)
2. Natural System Modifications	Other Ecosystem Modifications (levees and flood walls, channelization, dredging, impassable culverts)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (zebra mussels)

4. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers, sediment)
5. Pollution	Household Sewage & Urban Waste Water (road runoff of salts and metals, other regulated discharges)
6. Pollution	Household Sewage & Urban Waste Water (waste water treatment effluent, sewer and septic overflows)
7. Climate Change & Severe Weather	Droughts
8. Natural System Modifications	Dams & Water Management/Use (lowering of water table from agriculture, etc…, causing drying of habitat)
9. Climate Change & Severe Weather	Storms & Flooding (extreme storms)
10. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (die offs from unknown disease)

Agricultural Runoff

New York's largest populations of *L. ovata* are found in the Allegheny River upstream of Olean, with additional viable populations between Olean and Salamanca (The Nature Conservancy 2009). Although primarily a forested watershed, agriculture is present in the valleys adjacent to the Allegheny River and its tributaries near Olean, Allegany, Portville, and adjacent to Cassadaga and Conewango Creeks. Additionally, the French Creek watershed is highly agricultural (New York State Landcover 2010). Aquatic habitat lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry 2013), indicating that runoff is a major threat to resident mussel populations.

Species such as *L. ovata* that have a mantle modified to attract host fish are thought to rely on the visual acuity of their fish hosts to facilitate transfer of glochidia from the female to the host. For such species, this indicates that increases in turbidity associated with runoff may in interfere with reproduction and be especially detrimental to the species (Nedeau 2008).

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting in higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Runoff from Developed Land

The habitat of *L. ovata* receives storm water runoff from the city of Olean and the village of Portville, either directly to the Allegheny River or through tributaries. Cassadaga Creek receives Jamestown's urban runoff via the Chadokoin River. All five New York waterbodies that host *L. ovata* populations are intermittently bordered by interstate highways, state routes, and/or local roads (New York State Landcover, 2010). These developed lands are likely sources runoff containing metals and road salts. Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991; Liquori & Insler 1985; Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Treated Wastewater

The habitat of *L. ovata* receives treated wastewater from the city of Olean and the village of Portville, either directly to the Allegheny River or through tributaries. Cassadaga Creek receives treated effluent from the city of Jamestown sewage treatment plant (SPDES 2007). Recent studies show that mussel richness and abundance decrease with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals are also present in municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012). It should be noted that in the Susquehanna Basin, Harman and Lord (2010) found no evidence that wastewater treatment plants were responsible for reductions in mussel species of greatest conservation need.

Flood Control Projects

Large stretches of *L. ovata* habitat are within the leveed portions of the Allegheny River, Olean Creek, and Oswayo Creek ("New York State Flood Protection" 2013). These structures confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999; Yeager 1993; Nedeau 2008).

Habitat Modifications
Ecosystem modifications, such as isolated occurrences of flood control channel dredging, instream work associated with bridge replacement, or gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting “dredge” had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000).

Invasive Species
Invasive zebra mussels (*Dreissena polymorpha*) pose a potential threat to *L. ovata* populations in Cassadaga and Conewango Creeks, where they are present in the lower reaches. Chautauqua Lake’s connection to Cassadaga Creek, Chadakoin Creek, is the main source of this exotic invasive (The Nature Conservancy 2009), which has been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997; Watters et al. 2009). Studies have shown that *L. ovata* are significantly stressed by zebra mussels (Baker & Hornbach 1997). En masse, Dreissenids outcompete native mussels by efficiently filtering food and oxygen from the water. They reduce reproductive success by filtering native mussel male gametes from the water column and they can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994). Although zebra mussels will continue to cause problems for Chautauqua Lake, they currently appear to have minimal impact downstream. However, precautions should be taken to avoid invasions by zebra mussels to upstream locations, especially the headwater lakes in the Cassadaga system. Monitoring for zebra mussels in these lakes may provide early detection of this invader (The Nature Conservancy 2009).

Climate Change
Global climate change is expected (among other disruptions) to cause an increase in surface water temperatures in southern Ontario. Although many species are tolerant of warm water, higher water temperatures may be an added stress for some. Increased water temperatures may also increase algal growth, which could result in reductions in dissolved oxygen levels at night (Morris & Burridge 2006). Galbraith et al. (2010) recently showed how regional climate patterns coupled with changing local water regimes and management strategies have shifted mussel populations from thermally sensitive species to thermally tolerant species.

Impoundments
Across its range, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: ✓ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussels habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York’s mussel resources occur within Class C and D waters (see species specific streams in threats/management discussion) An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c)of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Priority conservation efforts for this species should focus on, but not be limited to, the Allegheny River upstream of Olean and Portville, and Olean Creek.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, salts from entering these aquatic systems.

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis, 2012).

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g., point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2. (need recommended conservation actions for pocketbook).

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	February 26, 2014 (Samantha Hoff)
Latest revision	January 16, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Purplecap valvata **Date Updated:**

Scientific Name: *Valvata perdepressa* **Updated By:**

Class: Gastropoda

Family: Valvatidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

The purplecap valvata has a limited range, occurring only in Ontario, Illinois, Indiana, Michigan, Wisconsin, Ohio, Pennsylvania, and New York. It is ranked as S1 in Ontario and listed as a high priority for assessment by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). In New York, this species occurred historically in the NE Lake Ontario-St. Lawrence watershed. It was thought to have been extirpated but a single, fresh shell was collected from Lake Ontario in 2001 (D. Strayer, personal communication).

I. Status

a. Current legal protected Status

i. **Federal:** Not listed **Candidate:** No

ii. **New York:** Not listed

b. Natural Heritage Program

i. **Global:** G3

ii. **New York:** SNA **Tracked by NYNHP?:** Yes

Other Ranks:
-IUCN Red List:

-Northeast Regional SGCN:

American Fisheries Society (AFS): Vulnerable
COSEWIC – High priority for assessment

Status Discussion:

Purplecap valvata is ranked as Critically Imperiled in Ontario and SNR in Illinois, Michigan, Wisconsin, and New York. It is not ranked in the other states where it occurs or has occurred historically.

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Unknown	Unknown			Choose an item.

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
Northeastern US	Yes	Unknown	Unknown			Choose an item.
New York	Yes	Unknown	Unknown			Choose an item.
Connecticut	No	Choose an item.	Choose an item.			Choose an item.
Massachusetts	No	Choose an item.	Choose an item.			Choose an item.
New Jersey	No	Choose an item.	Choose an item.			Choose an item.
Pennsylvania	Yes	Unknown	Unknown		Not listed	No
Vermont	No	Choose an item.	Choose an item.			Choose an item.
Ontario	Yes	Declining	Declining		Not listed	Choose an item.
Quebec	No	Choose an item.	Choose an item.			Choose an item.

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

None.

Trends Discussion *(insert map of North American/regional distribution and status):*

Purplecap valvata was not detected in searches conducted during four survey periods from 1977 to 1985 by Jokinen (1992) or by Harmon and Berg (1971). It was found to be present in Lake Ontario in 2001 from a single fresh shell.

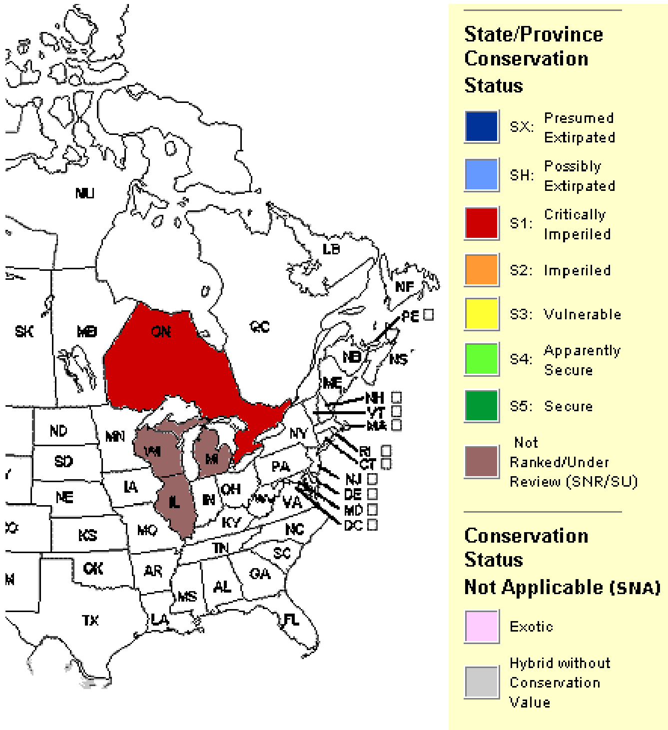

Figure 1: Conservation status of purplecap valvata in North America (NatureServe 2013)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

Years	# of Records	# of Distinct Waterbodies	% of State
Pre-1995	_______	_______	_______
1995-2004	_______	1	_______
2005-2014	_______	_______	_______
2015- 2023	_______	_______	_______

Table 1. Records of purplecap valvata in New York.

Details of historic and current occurrence:

Purplecap valvata is thought to have been extirpated from the NE Lake Ontario-St. Lawrence watershed (NYSDEC 2005).

A single, fresh shell complete with the operculum was found by Doug Carlson from Lake Ontario at Southwicks State Park in April 2001 (D. Strayer, personal communication).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY

1-25%	Peripheral	

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Lacustrine

b. Summer-stratified Monomictic Lake

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Stable	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

Purplecap valvata occur in lakes (NYSDEC 2005).

Aquatic gastropods are frequently used as bioindicators because they are sensitive to water quality and habitat alteration (Callil and Junk 2001, Salanki et al. 2003).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	Choose an item.	Choose an item.	Yes	Yes	Choose an item.

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

There is no specific life history information available for this species.

Most Gastropods belong to the clade Caenogastropoda, in which individuals mature slowly (requiring at least a year), are long-lived dioecious species with internal fertilization, and females generally attach eggs to firm substrates in late spring and early summer. Many species are narrow endemics associated with lotic habitats, often isolated in a single spring, river reach, or geographically restricted river basin (Johnson et al. 2013). In contrast, members of the clade Heterobranchia are hermaphroditic, mature quickly, and generally have shorter generation times (Johnson et al. 2013).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Residential & Commercial Development	Housing & Urban Areas (habitat loss/degradation)
2. Natural System Modifications	Dams & Water Management/Use (dams, channelization)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (New Zealand mud snail)
4. Pollution	Industrial & Military Effluents (metals)
5. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers)
6. Pollution	Household Sewage & Urban Wastewater (untreated sewage)
7. Climate Change & Severe Weather	Habitat Shifting & Alteration

Insufficient information to assess threats.
High imperilment rates among freshwater gastropods have been linked to alteration, fragmentation and destruction of habitat and introduction of non-indigenous species. Causes of habitat degradation and gastropod species loss include dams, impounded reaches, development of riparian areas, channelization, erosion, excess sedimentation, groundwater withdrawal and associated impacts on surface streams (flows, temperature, dissolved oxygen), multiple forms of pollution (salt, metals such as Cu, Hg, Zn, untreated sewage, agricultural runoff, pesticides/fertilizers), changes in aquatic vegetation, and invasion of exotic species (Johnson et al. 2013).

The New Zealand mud snail (*Potamopyrgus antipodarum*) is a highly invasive species that was introduced in Idaho in the 1980s. It can have devastating consequences to aquatic ecosystems, reducing or eliminating native snail species (Benson et al. 2013). This snail was found established in Lake Ontario in 1991 (Zaranko et al. 1997) and in Lake Erie in 2005 (Levri et al. 2007).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _x___ No:_____ Unknown:_____

If yes, describe mechanism and whether adequate to protect species/habitat:

The Protection of Waters Program provides protection for rivers, streams, lakes, and ponds under Article 15 of the NYS Environmental Conservation Law.

The Freshwater Wetlands Act provides protection for regulated wetlands greater than 12.4 acres in size under Article 24 of the NYS Conservation Law. The Adirondack Park Agency has the authority to regulate smaller wetlands within the Adirondack Park. The Army Corps of Engineers has the authority to regulate smaller wetlands in New York State, and the DEC has the authority to regulate smaller wetlands that are of unusual local importance. The Protection of Waters Program provides protection for rivers, streams, lakes, and ponds under Article 15 of the NYS Conservation Law.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

Basic biological information is lacking for most taxa of freshwater gastropods and there is a strong need for surveys and biological studies given the strong evidence of decline and extinction.

The following goals and recommended actions are provided in the NY Comprehensive Wildlife Conservation Strategy (NYSDEC 2005):

- Conduct surveys to determine distribution and population trends
- Identify habitat requirements for all life stages
- Develop specific plans for each listed species (or appropriate suite of species) that details status, threats, and actions necessary to reverse declines or maintain stable populations
- Develop fact sheets for each listed species for paper and online distribution

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2. Recommended conservation actions for purplecap valvata.

VII. References

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Salanki, J., A. Farkas, T. Kamardina, and K. S. Rozsa 2003. Molluscs in biological monitoring of water quality. Toxicology Letters 140-141: 403-410.

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Originally prepared by	Kimberley Corwin
Date first prepared	June 19, 2013
First revision	February 20, 214 (S. Hoff)
Latest revision	Transcribed March 2024

Species Status Assessment

Common Name: Rainbow **Date Updated:** 1/16/2024

Scientific Name: *Cambarunio iris* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Rainbow, previously Villosa iris, has been placed in the new genus *Cambarunio* by Watters (2018) and based on Kuehnl (2009). *Cambarunio dactylus* is recognized as a species distinct from *Villosa iris*. C. iris belongs to the subfamily Ambleminae and the tribe Lampsilini, which includes 17 extant and 6 likely extirpated New York species of the genera Actinonaias, Epioblasma, Lampsilis, Leptodea, Ligumia, Obovaria, Potamilus, Ptychobranchus, Toxolasma, Truncilla, and Villosa (Haag 2012, Graf and Cummings 2011). Iris refers the iridescent nacre characteristic of this species (Watters et al. 2009).

C.iris is typically a species of creeks and small rivers, but can sometimes occur in lakes and large rivers (Strayer and Jirka 1997). It prefers moving water and highly oxygenated waters (Strayer and Jirka 1997, Mahar and Landry 2013). Since 1970, this species has been found in 27 waterbodies. C.iris currently inhabits the lower Genesee, Lake Erie, West and Mid Lake Ontario, and the Oswego basins, as well as the Erie Canal and may occur in the Allegheny basin (Mahar and Landry 2013, NY Natural Heritage Program 2013). Portions of the New York range that have been recently surveyed show abundant populations of C.iris (Strayer and Jirka 1997).

In New York, C. iris is ranked as imperiled/vulnerable and in unranked globally (NatureServe 2024). In North America, approximately ⅔ to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993, Stein et al. 2000). While population trends in New York are unknown, it is assumed that they too are declining, due to a myriad of environmental stressors.

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** None

ii. **New York:** None, Proposed Special Concern (2019)

b. Natural Heritage Program

i. **Global:** GNR – No Status Rank

ii. **New York:** S2S3 – Imperiled /Vulnerable **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: No

-Northeast Regional SGCN: No (2023)

-Midwest Regional SGCN: Watch List (Assessment priority)

- Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Special Concern (2015)

-American Fisheries Society Status: Currently Stable (1993)

Status Discussion:

This species is found throughout the Tennessee, Cumberland, and Ohio River basins, the upper Mississippi River, and the St. Lawrence River system from Lake Huron to Lake Ontario including their tributaries and is considered stable in much of its range but is declining significantly in Canada (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Stable	Stable			(blank)
Northeastern US	Yes	Declining	Declining			No
New York	Yes	Unknown	Unknown		S2S3	Yes
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Declining	Declining		S3	Yes
Vermont	No	N/A	N/A			No
Ontario	Yes	Stable	Stable	2003-2013	Special Concern, S1	(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

Trends for New York populations are difficult to determine as most historic data comes from opportunistic naturalist collections, as opposed to more comprehensive baseline surveys. For example, mussels were documented for the first time in 50 of the 106 streams surveyed to date by the Southern Lake Ontario mussel inventory project (Mahar and Landry 2013). This is because many of these streams had never before been surveyed for mussels, not because mussel distribution has dramatically increased. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993, Stein et al.2000). Based on New York's Natural Heritage S-rank, sparse historical data, and the plight of North America's freshwater mussels, it is assumed that trends are declining due to a myriad of environmental stressors.

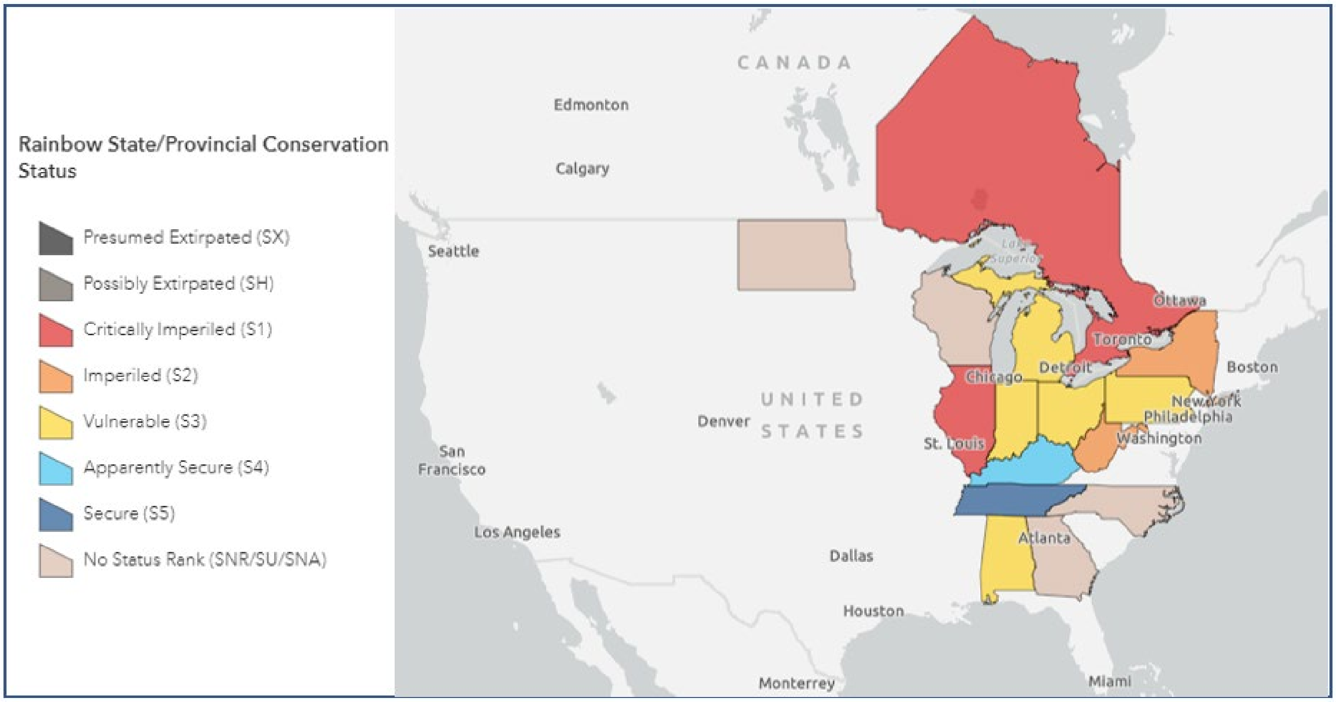

Figure 1. Rainbow distribution and status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

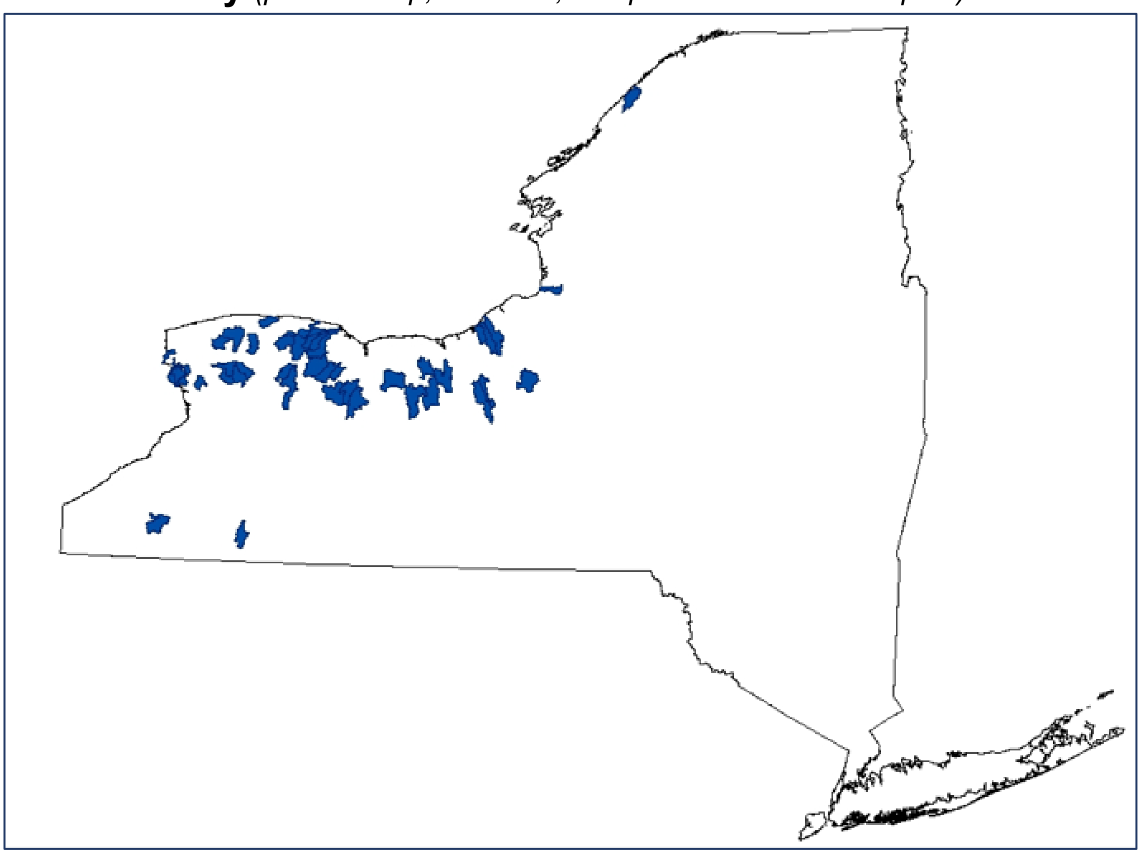

Figure 2. Records of rainbow in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
	_______	_______	_______
	_______	_______	_______
	_______	_______	_______
Total	_______	34	2.3%

Table 1. Records of rainbow in New York.

Details of historic and current occurrence:

2024: C. iris has been found in 34 waterbodies and 42 of New York's 1802 HUC 12 watersheds (2.3%).

In New York, C. iris has historically been found in the Erie-Niagara, lower Genesee, and Oswego basins, as well as in several small tributaries of southern basin of Lake Ontario. It has been found in Canandaigua, Seneca, Cayuga and Oneida Lakes, as well as the Niagara, Seneca and Oswego Rivers (Strayer and Jirka, 1997). In New York's Allegheny basin, it has been found only in the "outlet of Chautauqua Lake," and it is infrequent in the upper Allegheny basin in Pennsylvania. A single, indefinite record from the Mohawk River shows that C. iris may have used the Erie Canal to cross the Alleghenian Divide (Strayer and Jirka, 1997).

Since 1970, C. iris has been found in 27 New York State waterbodies (Figure 2).

As part of the Southern Lake Ontario mussel inventory, 423 live C. iris have been found to date (Mahar and Landry 2013). In the Lower Genesee basin, C. iris has been found in Honeoye Creek, Black Creek, and Black Creek's tributaries: Bigelow, Onion, and Spring Creeks. In the Oswego basin, this species has been found in both Canandaigua Outlet and Ganargua Creek. C. iris has been found in tributaries to Lake Ontario including East Branch of Eighteenmile Creek, Johnson Creek, Oak Orchard Creek, Sandy Creek, West Branch of Sandy Creek, East Branch of Sandy Creek, Moorman Creek, West Creek, Brockport Creek, Salmon Creek, Allen Creek, Sterling Creek, Sterling Valley Creek, and Ninemile Creek.

In the Erie basin, C. iris shells have been found in Tonawanda Creek and its tributary Beeman Creek (Mahar and Landry, 2013). Shells were found at six additional sites and live at a single site in the Tonawanda Creek basin (Marangelo and Strayer 2000). Fresh shells have been found in the Niagara River (NY Natural Heritage Program 2013).

Shells have also been found in the Erie Canal at Lyons (Mahar and Landry 2013). C. iris has been reported in the Grass River basin in northern New York, the first report of the species from this basin (Strayer and Jirka 1997). C. iris was not found in recent surveys of the Allegheny (The Nature Conservancy 2009) or Susquehanna basins (Harman and Lord 2010). However, recent NY Natural Heritage Program records show an element of occurrence for this species in Conewango Creek in the Allegheny basin. Strayer and Jirka (1997) note that in the parts of its New York range that have been recently surveyed, C. iris is still relatively common.

Waterbodies with greatest C. iris abundance include Honeoye Creek with 162 live, East Branch Eighteenmile with 65 live, and West Creek with 61 live individuals found during recent surveys (Mahar and Landry 2013).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	500 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. **Size/Waterbody Type:** Headwater/Creek to Medium River

b. **Geology:** Moderately Buffered

c. **Temperature:** Transitional Cool to Warm

d. **Gradient:** Low Gradient to Moderate-High Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
Yes	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

C.iris is typically thought of as a species of creeks and small rivers (Cummings and Mayer 1992, McMurray et al. 2012, Metcalfe-Smith et al. 2005, Strayer and Jirka 1997, Watters et al. 2009), however it also occurs in lakes (e.g. Canandaigua, Seneca, Cayuga, Oneida) and large rivers as well (e.g. Niagara, Seneca, Oswego) (COSEWIC 2006, NatureServe 2013, Strayer and Jirka 1997, Watters et al. 2009). It is often fairly abundant (Strayer and Jirka 1997).

This species is most commonly found in sandy cobble (Watters et al. 2009), coarse sand or gravel substrates (Cummings and Mayer 1992, McMurray et al. 2012, Metcalfe-Smith et al. 2005), in or near riffles and along the edges of emergent vegetation in moderate to strong current (Metcalfe-Smith et al. 2005, Parmalee and Bogan, 1998). It becomes most numerous in clean, well-oxygenated stretches at depths of less than three feet (Parmalee and Bogan 1998).

This species is considered a habitat specialist (NatureServe 2013).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, C. iris must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable habitat, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as sited in NatureServe 2013).

It has a periodic life history strategy, characterized by moderate to high growth rate, low to intermediate life span, age at maturity, and fecundity, but generally smaller body size than opportunistic species. Most species with this strategy are long-term brooders. This life history strategy is considered an adaptation to allow species to persist in unproductive habitats or habitats that are subject to large-scale, cylindrical environmental variation or stress (Haag 2012).

C.iris may reach approximately 15 years of age. The species is thought to be bradytictic, with gravid females reported from September to the following May (Watters et al. 2009). This species appears to be a host generalist. Glochidia have been found to transform on rock bass (Ambloplites rupestris), mottled sculpin (Cottus bairdi), streamline chub (Erimystax dissimilis), greenside darter (Etheostoma blennioides), rainbow darter (Etheostoma caeruleum), bluebreast darter (Etheostoma camurum), green sunfish (Lepomis cyanellus), striped shiner (Luxilus chrysocephalus), smallmouth bass (Micropterus dolomieu), largemouth bass (Micropterus salmoides), and yellow perch (Perca flavescens) (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Human Intrusions & Disturbance	Work & Other Activities (bridge projects and other instream work)
2. Natural System Modifications	Other Ecosystem Modifications (levees and flood walls, channelization, dredging, culverts)

3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (zebra mussels, rusty crayfish)
4. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers, sediment)
5. Pollution	Household Sewage & Urban Waste Water (road runoff of salts and metals, other regulated discharges)
6. Pollution	Household Sewage & Urban Waste Water (waste water treatment effluent, sewer and septic overflows)
7. Climate Change & Severe Weather	Droughts
8. Natural System Modifications	Dams & Water Management/Use (lowering of water table from agriculture, etc…, causing drying of habitat)
9. Climate Change & Severe Weather	Storms & Flooding (extreme storms)
10. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (die offs from unknown disease)

Agricultural Runoff

New York's southern Lake Ontario basin hosts the majority of the state's *V. iris* populations. Within this region, the majority of land use adjacent to *V. iris* streams is agriculture, including cultivated cropland or pasture/hay cultivation (New York State Landcover 2010). Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar and Landry 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag,2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer run-off is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting in higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Treated Wastewater

At least eight streams with populations of *V. iris* receive effluent from wastewater/sewage treatment plants either directly or through nearby tributaries. These include Oak Orchard (at Medina), Johnson Creek (at Lyndonville), West Branch of Sandy Creek (at Albion), East Branch of Sandy Creek (at Holly), Black Creek (at South Byron, Bergen, and North Byron), Honeoye Creek (at Honeoye Falls, Honeoye, and Lima), Ganargua Creek (at Farmington and Victor), and Canandaigua Outlet (at Shortsville, Phelps, and Clifton Springs) (SPDES 2007). Recent studies show that mussel richness and abundance decrease with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals are present in municipal sewage effluents and are increasingly common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012). It should be noted that in the Susquehanna Basin, Harman and Lord (2010) found no evidence that wastewater treatment plants were responsible for reductions in mussel species of greatest conservation need.

Runoff from Developed Land

All New York populations of *V. iris* are found in streams that are intermittently bordered by interstate highways, state routes, and/or local roads (New York State Landcover 2010). These sites are likely threatened by stormwater runoff containing metals, and road salts (Gillis 2012). Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller and Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner and Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al., 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller and Zam 1991; Liquori and Insler 1985, 2009; Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012)

Habitat Modifications

Ecosystem modifications, such as isolated occurrences of canal dredging, instream work associated with bridge replacement, and vegetation kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Since this species has been found in 27 waterbodies, such work, while devastating to individual populations, would not be expected to impact the species throughout its New York state range. Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000).

Lamprey Control

V. iris populations are found in several stream that are regularly scheduled for sea lamprey control treatment. These streams include Ninemile Creek, Sterling Creek, andSandy Creek in the Lake Ontario drainage.

In New York, tributaries harboring larval sea lamprey (*Petromyzon marinus*), are treated periodically with lampricides (TFM or TFM/Niclosamide mixtures) by Fisheries and Oceans Canada and the U.S. Fish and Wildlife Service to reduce larval populations (Sullivan and Adair 2014). Niclosamide was originally developed as a molluscicide. While unionid mortality is thought to be minimal at TFM concentrations typically applied to streams to control sea lamprey larvae (1.0 –1.5 × sea lamprey MLC), increases in unionid mortality were observed when exposed to the niclosamide mixture, indicating that mussels may be at risk when the mixture is used in control operations. Treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard 2006).

Impoundments - Range wide
Across its range, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery and King 1983, ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Outside of New York, the greatest threats occur in the Great Lakes portion of the range. This species has been lost from the lower Great Lakes and connecting channels largely due to impacts of the zebra mussel. Heavy loadings of sediment, nutrients and toxic substances from urban and agricultural sources have degraded mussel habitat throughout southern Ontario. *V. iris* is particularly sensitive to copper and ammonia (NatureServe 2013). Ammonia from Asian clam (*Corbicula fluminea*) die offs has been shown to be capable of exceeding acute effect levels of some mussel species, including *V. iris* (Cherry et al. 2005).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: ✓ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York’s mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Priority conservation efforts for this species should focus on, but not be limited to, Honeoye Creek, East Branch Eighteenmile Creek, and West Creek (Mahar and Landry 2013).

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley and Tank 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Establish a protocol whereas DEC staff work closely with state and local highway departments to reduce impacts to native mussels during maintenance and construction projects.

- Replace culverts that disrupt aquatic habitat connectivity to allow for passage of small fish species.

- Within the Great Lakes and Champlain watersheds, lamprey control efforts should consider specific, potentially adverse, impacts to native freshwater mussels when determining methods, including selection of lampricide formulations and concentrations.

Lampricide treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard 2006).

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g., point and nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	

Table 2. (need recommended conservation actions for rainbow).

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	February 26, 2014 (Samantha Hoff)
Latest revision	January 16, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Rayed bean **Date Updated:** 1/15/2024

Scientific Name: *Villosa fabalis* **Updated By:** Amy Mahar

Class:

Family:

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Villosa fabalis belongs to the subfamily Ambleminae and the tribe Lampsilini, which includes 17 extant and 6 likely extirpated New York species of the genera Actinonaias, Epioblasma, Lampsilis, Leptodea, Ligumia, Obovaria, Potamilus, Ptychobranchus, Toxolasma, Truncilla, and Villosa (Haag 2012, Graf and Cummings 2011). V. fabalis is in the genus Villosa meaning shaggy or rough, has evolved into a clade with many examples of smooth exteriors, including the rayed bean. The species name fabalis, meaning “faba” or “bean,” aptly describes its small, solid, bean-shape and size (Watters et al. 2009).

V. fabalis is most often found in high quality creeks or small rivers, in sand and gravel, often deeply buried among the roots of aquatic vegetation in and near riffles or along the river’s edge (Strayer and Jirka 1997, Metcalf-Smith et al. 2005, Watters et al. 2009, NatureServe 2013). However, this species has also been found in the Great Lakes, as well as some larger streams and rivers (Strayer and Jirka 1997). In New York this species is only present in six waterbodies in the Allegheny basin, where it was recently found in 19% of the sites that were surveyed (The Nature Conservancy 2009). V. fabalis is federally and state listed as an endangered species.

I. Status

a. Current legal protected Status

i. **Federal:** Endangered **Candidate:** No

ii. **New York:** Endangered

b. Natural Heritage Program

i. **Global:** G2 - Imperiled

ii. **New York:** S1 – Critically Imperiled **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Endangered (2012)

-Northeast Regional SGCN: Yes (2023)

-Midwest Regional SGCN: Yes

- Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Endangered (2010)

American Fisheries Society Status: Special Concern (1993)

Status Discussion:

This species is declining throughout its range to an extent where 78% of streams formerly occupied no longer contain viable populations. Distribution is greatly fragmented and only a small percentage of former populations are known to exist. Remaining V. fabalis populations are small and geographically isolated making them susceptible to a single catastrophic event and limiting potential for making natural repopulation or any genetic interchange between disjunct populations. Long-term viability of extant populations is questionable, particularly in the presence of introduced competitors (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Choose an item.	Choose an item.		Endangered	(blank)
Northeastern US	Yes	Choose an item.	Choose an item.			Yes
New York	Yes	Choose an item.	Choose an item.		Endangered	Yes
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Unknown	Unknown	2005-2014	Endangered, S1S2	Yes
Vermont	No	N/A	N/A			No
Ontario	Yes	Stable	Stable	2003-2013	Endangered, S1	(blank)
Quebec	No	Choose an item.	Choose an item.			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

Trends for New York populations are difficult to determine as most historic data comes from opportunistic naturalist collections, as opposed to more comprehensive baseline surveys. For example, mussels were documented for the first time in 50 of the 106 streams surveyed to date by the Southern Lake Ontario mussel inventory project (Mahar and Landry 2013). This is because many of these streams had never before been surveyed for mussels, not because mussel distribution has dramatically increased. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993, Stein et al. 2000). Based on New York's Natural Heritage S-rank, sparse historical data, and the plight of North America's freshwater mussels, it is assumed that trends are declining due to a myriad of environmental stressors.

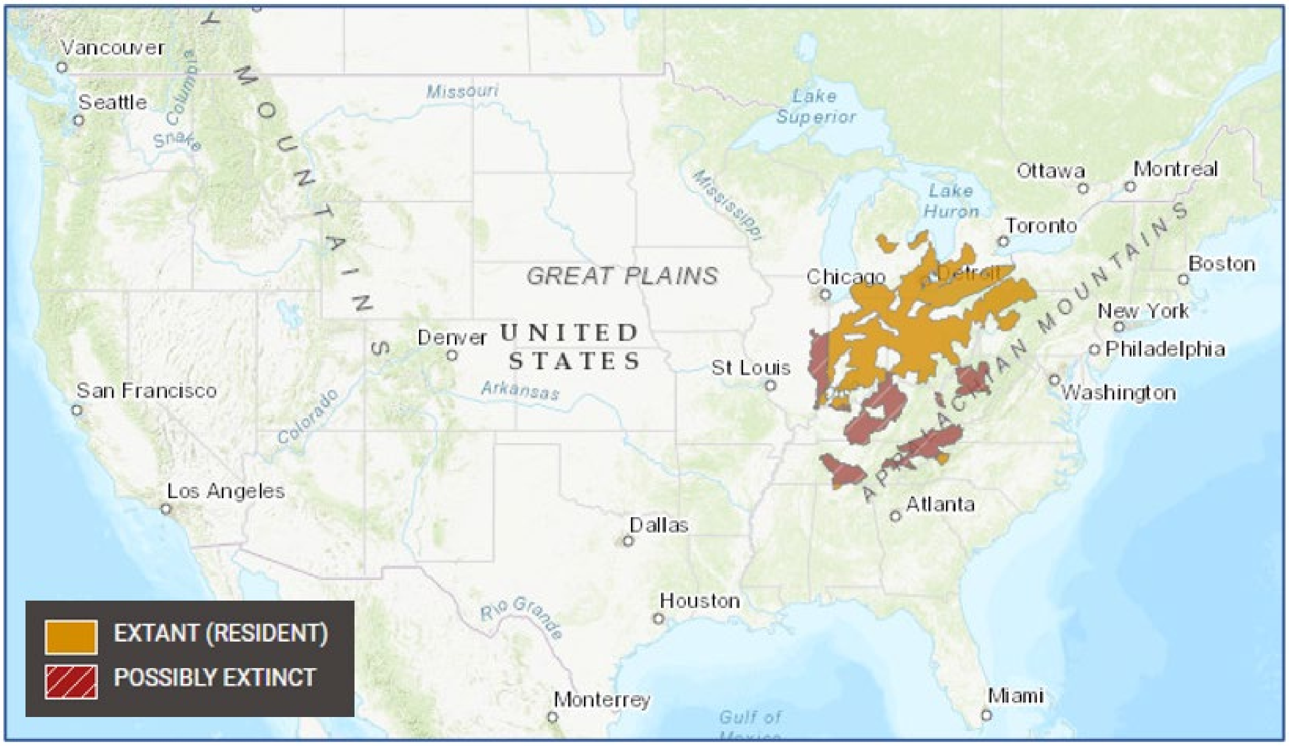

Figure 1. Rayed bean distribution (IUCN Redlist)

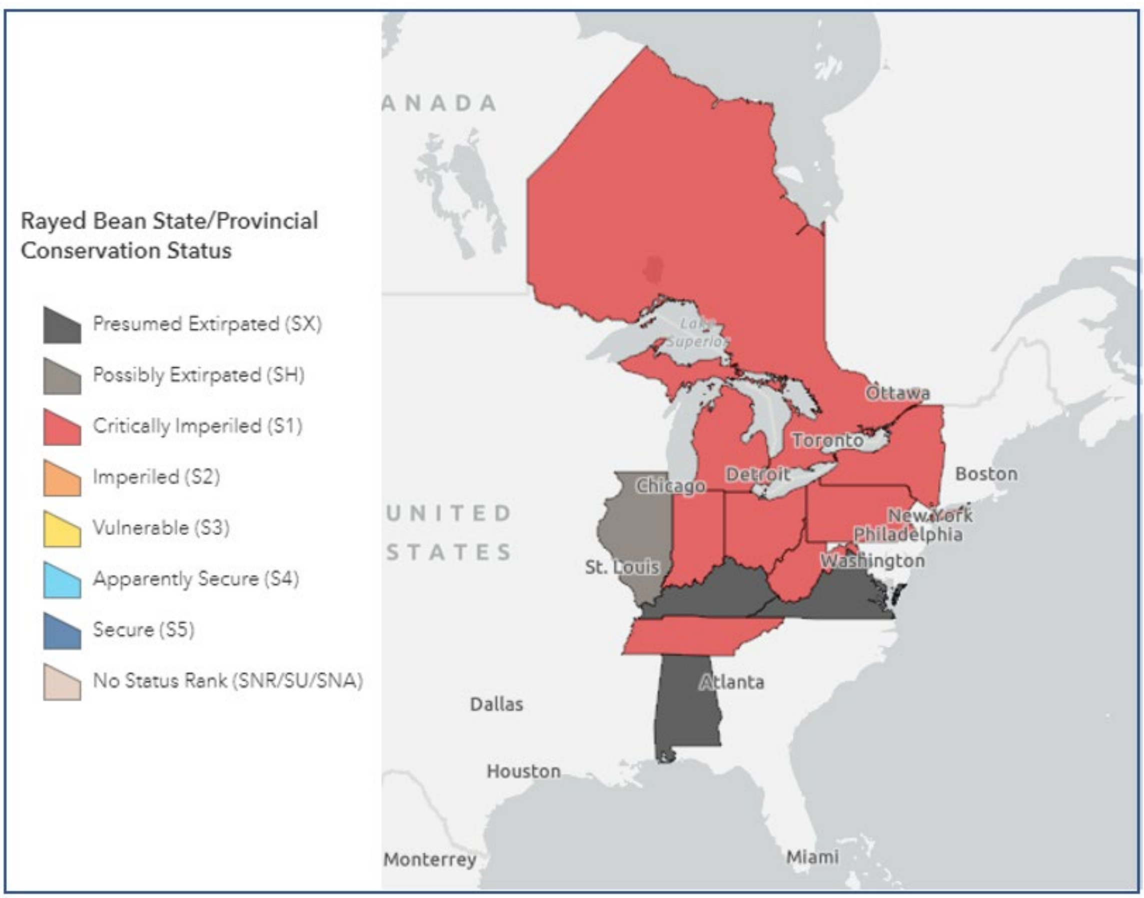

Figure 2. Rayed bean status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

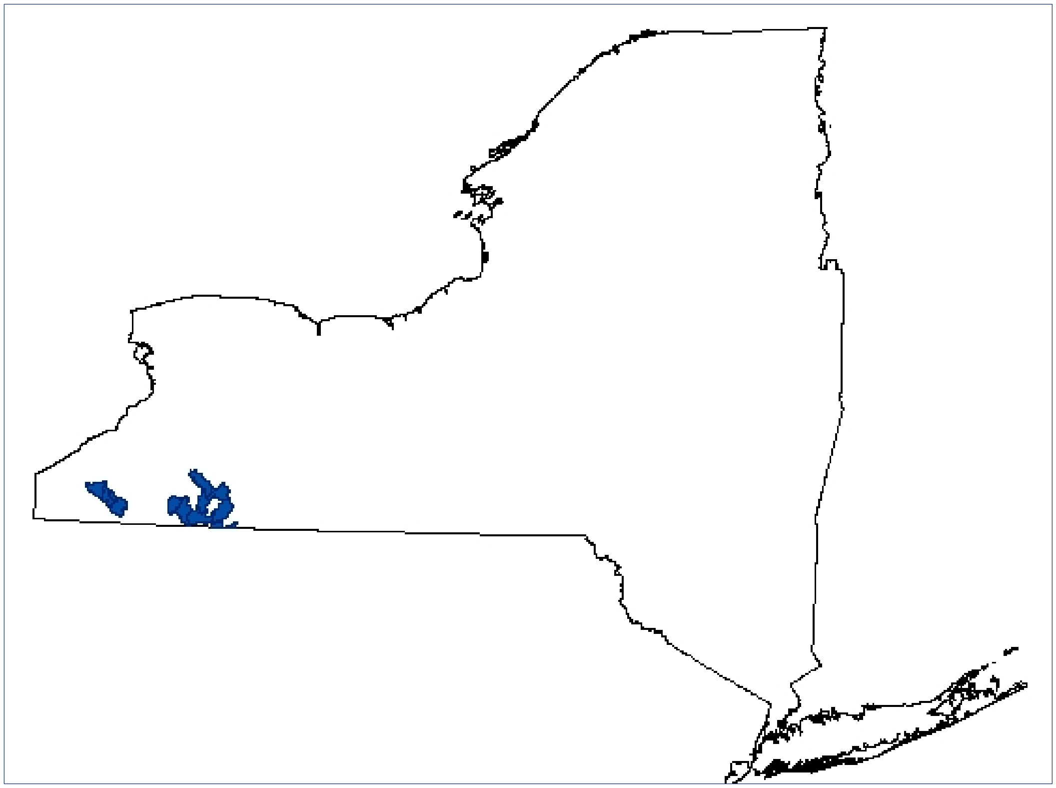

Figure 3. Records of rayed bean in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
	_______	_______	_______
	_______	_______	_______
	_______	_______	_______
Total	_______	9	0.6%

Table 1. Records of rayed bean in New York.

Details of historic and current occurrence:

2024: V. fabalis has been found in 9 waterbodies and 9 of New York's 1802 HUC 12 watersheds.

In New York, V. fabalis has been identified at several sites in the Allegheny basin. In addition, there is an old, questionable record of this species from the Chemung River. Later collectors did not report this species from the Susquehanna basin, so the record is probably erroneous. Nevertheless, some fish and mussels from the Interior Basin did enter the Susquehanna basin, so it is possible that V. fabalis does live in the western tributaries of the Susquehanna. Although V. fabalis is found in western Lake Erie and its tributaries, it has not yet been collected from the eastern part of the basin in Ontario, Pennsylvania, or New York (Strayer and Jirka 1997).

Since 1970, V. fabalis has been found in six New York State waterbodies (Figure 2). In a recent survey of the Allegheny basin, The Nature Conservancy found a total of 79 live V. fabalis at 20 of 105 sites surveyed. This species was found primarily in Olean and lower Ischua Creeks, mid-reaches of Cassadaga Creek, and Conewango Creek, and at lower numbers in the Allegheny River upstream of Olean to the confluence with Tunungwant Creek. The greatest catches (up to 3.3 per hr) were in upper Olean Creek, and populations were considered viable at 35% of the sites where V. favalis was found (The Nature Conservancy 2009). This species also occurs in Chautauqua Lake (Strayer and Jirka 1997).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	100 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type: Small to Medium River

b. Geology: Moderately Buffered

c. Temperature: Transitional Cool to Warm

d. Gradient: Low Gradient to Moderate-High Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
Yes	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

V.fabalis is most often found in high quality creeks or small rivers in sand and gravel, often deeply buried among the roots of aquatic vegetation in and near riffles or along the river's edge (Strayer and Jirka 1997, Metcalf-Smith et al. 2005, Watters et al. 2009, NatureServe 2013). This species also exists in larger rivers and is known to occur in the shallow wave-washed areas of glacial lakes (NatureServe 2013). In Lake Erie, it is generally associated with islands in the western portion of the lake.

V. fabalis are sensitive to pollution, eutrophication, siltation, habitat perturbation, inundation, and invasive species and loss of glochidial hosts (COSEWIC as sited in NatureServe 2013).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, V. fabalis must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable habitat, they will burrow into the substrate, where they may remain for several years (Watters et al 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal capability for V.fabalis is expected to be relatively limited as the three suspected fish hosts are darters and most darters have limited home ranges (Strayer and Jirka 1997, White et al. 1996, COSEWIC 2003 as cited in NatureServe 2013).

The glochidial fish hosts for V. fabalis have not been well studied, however they are thought to include Tippecanoe darter (Etheostoma tippecanoe) (Strayer and Jirka 1997, White et al. 1996). Additional potential hosts were found for Canadian populations including rainbow darter (Etheostoma caeruleum), greenside darter (Etheostoma blennioides), mottled sculpin (Cottus bairdii), and largemouth bass (Micropterus salmoides) (Woolnough 2003).

It has a periodic life history strategy, characterized by moderate to high growth rate, low to intermediate life span, age at maturity, and fecundity, but generally smaller body size than opportunistic species. Most species are long-term brooders. This life history strategy is considered an adaptation to allow species to persist in unproductive habitats or habitats that are subject to large-scale, cylindrical environmental variation or stress (Haag 2012).

V. fabalis is reported to be bradytictic, in that it holds glochidia overwinter for spring release (Ortmann 1909). Gravid females have been found in May, July, and August (Ortmann 1909, 1919). V. fabalis individuals may live for 11 years or more, with female characteristics becoming apparent in the shells as early as the second year (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Human Intrusions & Disturbance	Work & Other Activities (bridge projects and other instream work)
2. Natural System Modifications	Other Ecosystem Modifications (levees, channelization, dredging, culverts)
3. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers, sediment)
4. Pollution	Household Sewage & Urban Waste Water (road runoff of salts and metals, other regulated discharges)
5. Pollution	Household Sewage & Urban Waste Water (septic overflows)
6. Climate Change & Severe Weather	Droughts
7. Natural System Modifications	Dams & Water Management/Use (lowering of water table from agriculture, etc…, causing drying of habitat)
8. Climate Change & Severe Weather	Storms & Flooding (extreme storms)
9. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (die offs from unknown disease)
10. Invasive & Other Problematic Species & Genes	Problematic Native Species (beaver dams influencing hydrology)
11. Energy Production & Mining	Oil & Gas (hydraulic fracturing)

Agricultural Runoff

New York's largest populations of *V. fabalis* are found in the Allegheny basin, in the Allegheny River and its tributaries. Portions of these streams are bordered by agriculture, primarily in the Olean/Allegany area (New York State Landcover 2010). Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in western and central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar and Landry 2013), indicating that runoff is a major threat to resident mussel populations.

Although sedimentation is a natural process, poor land use practices, dredging, impoundments, and other activities accelerate erosion and increase sedimentation. Sediment that blankets a river bottom can suffocate mussels. Accelerated sedimentation may also reduce feeding and respiratory ability for *V .fabalis*, leading to decreased growth, reproduction, and survival (USFWS 2012).

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizers runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting in higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Runoff from Developed Land
Several *V. fabalis* populations, considered viable by The Nature Conservancy (2009), are located within the City of Olean and the Village of Allegany. These sites are likely impacted by storm water runoff from roads and lawns. Viable populations in Cassadaga Creek are bordered by roadways, and are potentially at risk from road runoff containing metals and road salts (New York State Landcover 2010). Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller and Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner and Pynnonen 1992), suggesting that U. S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller and Zam 1991, Liquori and Insler 1985, Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfolo et al. 2012).

Treated Wastewater
V. fabalis populations, considered viable by The Nature Conservancy (2009), are located within the City of Olean and are exposed to treated wastewater from the city of Olean and the village of Allegany either directly to the Allegheny River or through tributaries (SPDES 2007). Recent studies show that mussel richness and abundance decrease with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals are also present in from municipal sewage effluents and are increasingly common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012). It should be noted that in

the Susquehanna Basin, Harmon and Lord (2010) found no evidence that waste water treatment plants were responsible for reductions in mussel species of greatest conservation need.

Habitat Modifications
Ecosystem modifications, such as dredging, instream work associated with bridge replacement, gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000).

Flood Control Projects
Large stretches of *V. fabalis* habitat are within the leveed portions of the Allegheny River and Olean Creek (NYS Flood Protection 2013). Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. These structures confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999, Yeager 1993, Nedeau 2008).

Invasive Species
Based on the current distribution of zebra mussels (*Dreissena polymorpha*) in New York, only populations in Chautauqua Lake would likely be negatively impacted by the invasive mussels (iMapInvasives 2013). Zebra mussels have been repeatedly cited as a threat to native mussel populations (Strayer and Jirka 1997, Watters et al. 2009). En masse, Dreissenids outcompete native mussels by efficiently filtering food and oxygen from the water. They reduce reproductive success by filtering native mussel male gametes from the water column and they can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994).

Climate Change
In a recent assessment of the vulnerability of at-risk species to climate change in New York, Schesinger et al. (2011) ranked this species as "moderately vulnerable." This indicates that abundance and/or range extent within New York is likely to decrease by 2050.

Impoundments – Range wide
Across its range, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their

upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery and King 1983, ESI 1993c).

Adapted to living in flowing water, the *V. fabalis* cannot survive in the still water impounded behind dams. The rayed bean also depends on host fish as a means to move upstream. Because dams block fish passage, mussels are also prevented from moving upstream, which isolates upstream mussel populations from downstream populations, leading to small unstable populations more likely to die out (USFWS 2012).
In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓_ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

New York State Environmental Conservation Law, § 11-0535. 6 NYCRR Part 182: Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern; Incidental Take Permits

In February 2012, the U.S. Fish and Wildlife Service added the V. fabalis to the list of endangered species, giving the species full protection under the Endangered Species Act (ESA). The ESA provides protection against practices that kill or harm the species and requires planning for recovery and conservation actions.

Section 7(a) of the Federal Endangered Species Act, as amended, requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as Federally endangered or threatened. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR Part 402. Section 7(a)(4) requires Federal agencies to confer informally with the Service on any action that is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat. If a species is listed subsequently, Section 7(a)(2) requires Federal agencies to ensure that any activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of such a species or to destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Service.

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York's mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c)of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Priority conservation efforts for this species should focus on, but not be limited to, Olean Creek and Cassadaga Creek.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Although efforts to restore populations of *V. fabalis* in WV and KY have already begun, in NY, river system issues should first be addressed prior to restoration. Olean Creek might be an appropriate candidate stream for augmentation efforts due to *V. fabalis* presence, but has relatively low numbers. However, the Olean system, in particular the lower reaches, is highly modified with levees which protect the city of Olean, NY. Population augmentation efforts in these areas may be difficult, whereas greater opportunities for success may exist in areas which are currently *unihabtated* by *V. fabalis* (e.g., Conewango Creek and Allegheny River downstream of Olean, NY) (The Nature Conservancy 2009)

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Establish a protocol whereas DEC staff work closely with flood control management to reduce or impacts to native mussels during maintenance flood control projects.

- Establish a protocol whereas DEC staff work closely with state and local highway departments to reduce impacts to native mussels during maintenance and construction projects.

- Replace culverts that disrupt aquatic habitat connectivity to allow for passage of small fish species.

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account

for all contributing sources (e.g., point and nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) -
https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	

Table 2. Recommended conservation actions for rayed bean.

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.

- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

VII. References

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	February 26, 2014 (Samantha Hoff)
Latest revision	January 16, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Round hickorynut **Date Updated:** 1/17/2024

Scientific Name: *Obovaria subrotunda* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Obovaria subrotunda is thought to be extirpated in New York State. Only a single weathered shell of this species, from the Allegheny basin, has been found in the state. It has recently been suggested that this specimen may in fact be an example of Longsolid (Fusconaia subrotunda) (The Nature Conservancy 2009). This species was removed from the New York Species of Greatest Conservation list in 2015.

O. subrontunda belongs to the subfamily Ambleminae and the tribe Lampsilini, which includes 17 extant and 6 likely extirpated New York species of the genera Actinonaias, Epioblasma, Lampsilis, Leptodea, Ligumia, Obovaria, Potamilus, Ptychobranchus, Toxolasma, Truncilla, and Villosa (Haag 2012; Graf and Cummings 2011).

O. subrotunda inhabits medium-sized to large streams in sand and gravel in areas with moderate flow (Cummings & Mayer 1992). Its distribution includes the Ohio River system and drainages of Lake Erie and Lake St. Clair (Watters et al. 2009). This species is ranked by The Natural Heritage Program as historic in New York and apparently secure throughout its range.

I. Status

a. Current legal protected Status

i. **Federal:** Threatened (2023) **Candidate:** ________

ii. **New York:** Threatened?

b. Natural Heritage Program

i. **Global:** G4 – Apparently secure

ii. **New York:** SH - Historic **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Endangered (2015)

-Northeast Regional SGCN: Yes (2023)

-Midwest Regional SGCN: Yes

- Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Endangered (2013)

- American Fisheries Society Status: Special Concern (1993)

Status Discussion:

This is a wide-ranging species with thousands of individuals. It is starting to disappear from many areas where it formerly occurred. Declines are particularly evident in the last remaining population in Canada (Lake St. Clair) and other Great Lakes localities, as well as western Pennsylvania and New York (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Declining	Declining	1970 - present	Threatened	(blank)
Northeastern US	Yes	Declining	Declining	1970 - present		Yes
New York	Unknown	Extirpated	Extirpated		SH	No
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Declining	Declining		Endangered, S1	Yes
Vermont	No	N/A	N/A			No
Ontario	Yes	Declining	Declining	2003-2013	S1	(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a 2009 to 2020 State Wildlife Grant funded project, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York where this species might be found. No regular surveys are being conducted for this species at this time. Regulatory surveys may be conducted in known or likely habitat as part of the project review process.

Niagara River AOC surveys 2022-2023.

Trends Discussion *(insert map of North American/regional distribution and status):*

O. subrotunda has probably been eliminated from New York State (Strayer 1997) and is thought to be declining in numbers throughout its entire range (NatureServe 2013). In the short term this species has declined between 10% - 30% while in the long term it may have declined by as much as 50% (NatureServe 2013).

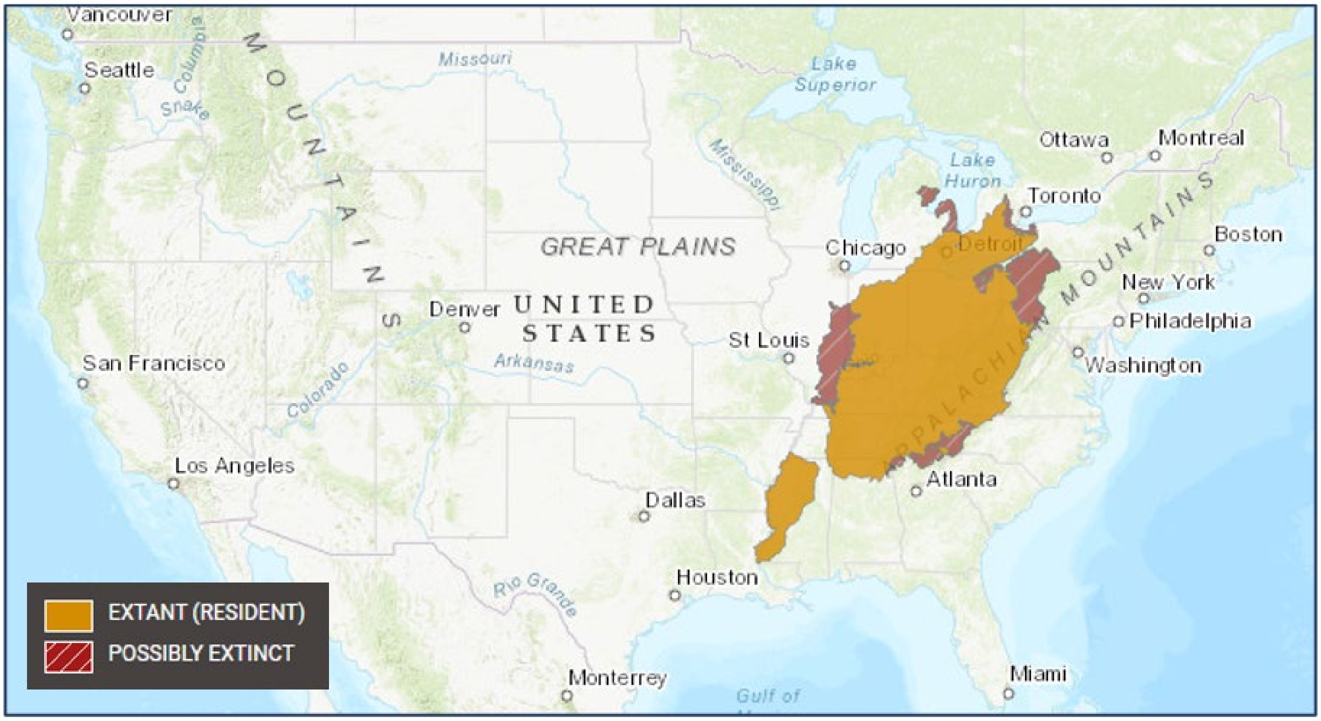

Figure 1. Round hickorynut distribution (IUCN Redlist 2024)

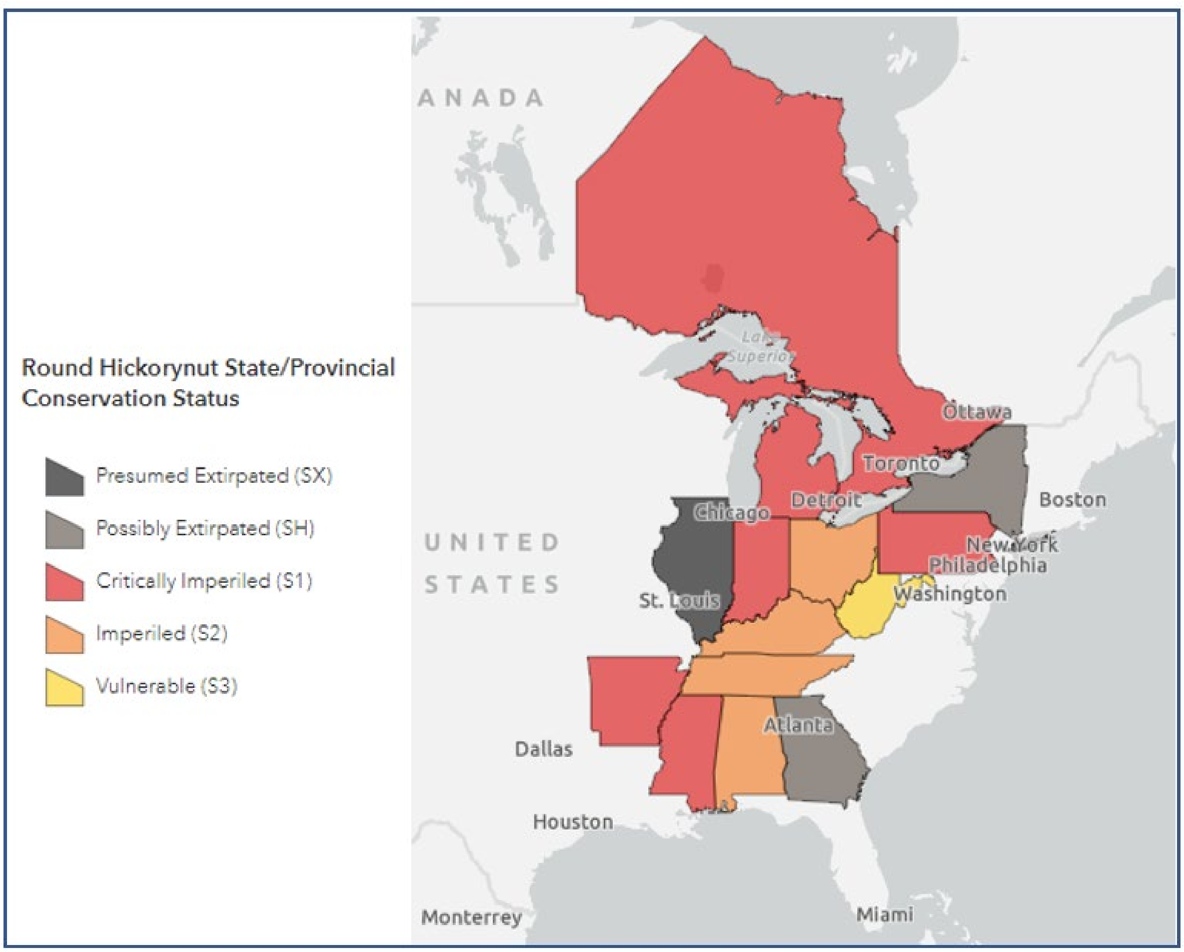

Figure 2. Round hickorynut distribution and status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

Years	# of Records	# of Distinct Waterbodies	% of State
Pre-1995	1	1	1 of 56 HUC 8 watersheds
1995-2004	0	0	0
2005-2014	0	0	0
2015- 2023	0	0	0

Table 1. Records of round hickorynut in New York.

Details of historic and current occurrence:

Only a single O. subrotunda specimen has been found in New York State. One broken, weathered shell of this species was collected in New York's Allegheny basin prior to 1970 (Strayer & Jirka 1997).

This species has not recently been found in New York (Strayer & Jirka 1997, Mahar and Landry 2013, NY Natural Heritage Program 2013, The Nature Conservancy 2009, Harman and Lord 2010, White et al. 2011, NatureServe 2013). However, F. subrotunda was recently found in Conewango Creek, near the area where the historic O. subrotunda specimen was collected (The Nature Conservancy 2009). Crabtree speculates that the historic specimen may have been a misidentified F. subrotunda, as these two species share many external characteristics.

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
0%	Peripheral	450 km

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type:

b. Geology:

c. Temperature:

d. Gradient:

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

This species is found in medium-sized to large streams and rivers in sand and gravel in areas with moderate flow (Cummings & Mayer 1992), but also occurs in Lake Erie and Lake St. Clair (COSEWIC 2003). It is typically found at depths of less than six feet (Parmalee & Bogan 1998). In Ohio, it is associated with a variety of flow regimes; sandy riffles and runs in Big Darby Creek system, slow-moving water in sandy mud in Shade River and Salt Creek (Watters et al. 2009; Ortmann 1919; and Van der Schalie 1938).

Lives in rivers, especially on sandy riffles as well as in Lakes Erie and St. Clair. In Michigan it occurs mainly in low-gradient, turbid, hydrologically unstable rivers (Strayer and Jirka 1997).

Deeper waters of medium-sized to large rivers with steady moderate flows and sand and gravel substrates, but tolerates turbid water and some clay; also found in Lake St. Clair (Metcalfe-Smith 2005).

Medium sized streams in sand and gravel in areas with moderate flow (Cummings and Mayer 1992).

Medium sized to large rivers with sand and gravel substrates with moderate flow, usually at depths of less than six feet (Parmalee and Bogan 1998)

This uncommon species occurs in a variety of habitats including riffles and runs, as well as slow moving water in sandy mud (Watters et al. 2009).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Unknown	No	No	Unknown	Unknown	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, this species must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable substrate, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as cited in NatureServe 2013).

This species is bradytictic with eggs present in September and present between late September and the following June (Watters et al. 2009). The host species for O. subrotunda is unknown (Watters et al. 2009), although the eastern sand darter might be a host for this mussel because the two species often co-occur (Strayer and Jirka 1997). Few individuals may live longer than 12 years (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

General threats to mussels that are likely relevant range wide:
Insufficient information to assess threats.

Impoundments – Range wide
Range wide, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Agricultural Runoff
Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Treated and Untreated Wastewater
Recent studies show that mussel richness and abundance decreases with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals also originate from municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012).

Runoff from Developed Land
Developed lands are likely sources runoff containing metals and road salts.
Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991; Liquori & Insler 1985; Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Invasive Species
Approximately 64% of historical records for *O. subrotunda* are from waters now infested with zebra mussels; this is probably the greatest threat to this species (COSEWIC, 2003).
Invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugenis*) have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997; Watters et al. 2009). En masse, Dreissenids outcompete native mussels by removing food and oxygen from the water. They can also reduce reproductive success by filtering native mussel male gametes from the water column. They can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994). In addition, ammonia from Asian clam die offs has been shown to be capable of exceeding acute effect levels

of some mussel species (Cherry et al. 2005). Didymo (*Didymosphenia geminata*), a filamentous diatom, can form extensive mats that can smother stream bottom and occlude habitat for mussels (Spaulding & Elwell, 2007)

Climate Change
Global climate change is expected (among other disruptions) to cause an increase in surface water temperatures. Although many species are tolerant of warm water, higher water temperatures may be an added stress for some. Increased water temperatures may also increase algal growth, which could result in reductions in dissolved oxygen levels at night (Morris & Burridge 2006). Galbraith et al. (2010) recently showed how regional climate patterns coupled with changing local water regimes and management strategies have shifted mussel populations from thermally sensitive species to thermally tolerant species.

In addition, warmer stream temperatures due to the combined effects of land use, such as removal of shaded buffers, and climate change may contribute to the loss of coldwater fisheries and *mussel* populations in some watersheds (Nedeau 2008). Temperature induced changes in fish communities could have a profound influence on the availability of hosts for freshwater mussels. Mussels that inhabit small streams and rivers and rely on fish adapted for cooler water might be most affected by climate change (Nedeau 2008).

Habitat Modifications
Ecosystem modifications, such as in-stream work associated with canal, navigational channel, or flood control dredging, bridge replacements, gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting “dredge” had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000). Seasonal draw downs of water bodies have been shown to impact unionid age distributions (Richardson et al. 2002).

Levees and flood walls confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999; Yeager 1993; Nedeau 2008).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: ✓ **No:** ____ **Unknown:** ____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any "protected stream", its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York's mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Conduct additional research to determine whether *O. subrotunda* ever existed within New York, or whether the voucher specimen for this occurrence was actually *Fusconaia subrotunda.*

- Assess the need and opportunity for relocation/reintroduction efforts. Conduct relocation or reintroduction where adequate sources can be identified and appropriate stream conditions exist (water quality, habitat, host species etc.).

- Following any reintroduction efforts, develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley & Tank 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Establish a protocol whereas DEC staff work closely with state and local highway departments to reduce impacts to native mussels during maintenance and construction projects.

- Replace culverts that disrupt aquatic habitat connectivity to allow for passage of small fish species.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account

for all contributing sources (e.g., point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2. Recommended conservation actions for round hickorynut.

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.

- Research potential interbreeding between Alasmidonta varicosa and Alasmidonta marginata and, if occurring, evaluate the potential threat to A. varicosa population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	
Latest revision	January 17, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Round pigtoe **Date Updated:** 1/16/2024

Scientific Name: *Pleurobema sintoxia* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Pleurobema sintoxia belongs to the subfamily Ambleminae and the tribe Pleurobemini, which includes four extant and one likely extirpated New York species in the genera Elliptio, Fusconaia, and Pleurobema (Haag 2012).). P. sintoxia is one of two species of the genus Pleurobema that have been found in New York (Strayer and Jirka 1997). In general, the shells of this tribe are unsculptured and larvae are brooded only in the outer demibranchs (with exceptions) (Graf and Cummings 2011). The genus name pleurobema, meaning step, refers to the ribs found between the shell annulae (Watters et al 2009).

In Strayer and Jirka's The Pearly Mussels of New York State (1997), this New York species is referred to as Pleurobema cordatum. However, P. cordatum is part of a complex of closely related species or ecophenotypes (P. cordatum; P. coccineum = P. sintoxia; P. plenum; P. rubrum = P. pyramidatum) that are found throughout the Ohio River drainage and in parts of the Mississippi and Great Lakes basins. These were widely regarded as intergrading ecophenotypes (e.g., Ortmann 1919), but more recently they have been recognized as distinct species (Stansbery and King 1983; Williams et al. 1993). Only the coccineum form (and its large lake ecophenotype form pauperculum) has been seen in New York (Strayer & Jirka 1997), while P. cordatum refers to a similar species not found in New York State. Both Watters et al. (2009) and Strayer and Jirka (1997) note that both P. coccineum and P. pauperculum fall under the species designation P. sintoxia. In addition, New York Natural Heritage Program refers to this New York species as P. sintoxia.

In New York, habitat for P. coccineum includes creeks and rivers of all sizes, but is especially frequent in large creeks and small- to medium-sized rivers (Strayer & Jirka 1997), The P. pauperculum ecophenotype lives in large lakes, rivers, and large streams and can be found in Lake Erie, the Niagara River, and the larger streams in the Allegheny basin (Strayer & Jirka 1997).

Impoundments have caused declines for this species across its range, with long term trends suggesting between 30% and 50% declines (NatureServe 2013). Although rare and ranked as "imperiled" in New York, this edge of range species is considered "apparently secure" throughout its range. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993, Stein et al.2000). While population trends in New York are unknown, based on sparse historical information it is assumed that they too are declining due to a myriad of environmental stressors.

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** None, Proposed Special Concern listing

b. Natural Heritage Program

i. **Global:** G4G5 – Apparently Secure / Secure

ii. New York: S2 - Imperiled **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Least Concern (2012)

-Northeast Regional SGCN: No (2023)

-Midwest Regional SGCN: Watchlist (Assessment priority)

- Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Endangered (2014)

-American Fisheries Society Status: Currently Stable (1993)

Status Discussion:

The large river P. sintoxia populations have become increasingly rare. Distribution is greatly fragmented but remains relatively wide, much as it was historically. Long-term viability of many populations is questionable, especially those in large rivers where zebra mussel populations are now established. Outside these areas the species appears to maintain stable populations (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Declining	Stable			(blank)
Northeastern US	Yes	Choose an item.	Choose an item.			No
New York	Yes	Unknown	Unknown		S2	Yes
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Unknown	Unknown		S3S4	Yes
Vermont	No	N/A	N/A			No
Ontario	Yes	Declining	Stable	2003-2013	Endangered, S1	(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

Trends for New York populations are difficult to determine as most historic data comes from opportunistic naturalist collections, as opposed to more comprehensive baseline surveys. For example, mussels were documented for the first time in 50 of the 106 streams surveyed to date by the Southern Lake Ontario mussel inventory project (Mahar & Landry 2013). This is because many of these streams had never before been surveyed for mussels, not because mussel distribution has dramatically increased. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al. 2000). Based on New York's Natural Heritage S-rank, sparse historical data, and the plight of North America's freshwater mussels, it is assumed that trends are declining due to a myriad of environmental stressors.

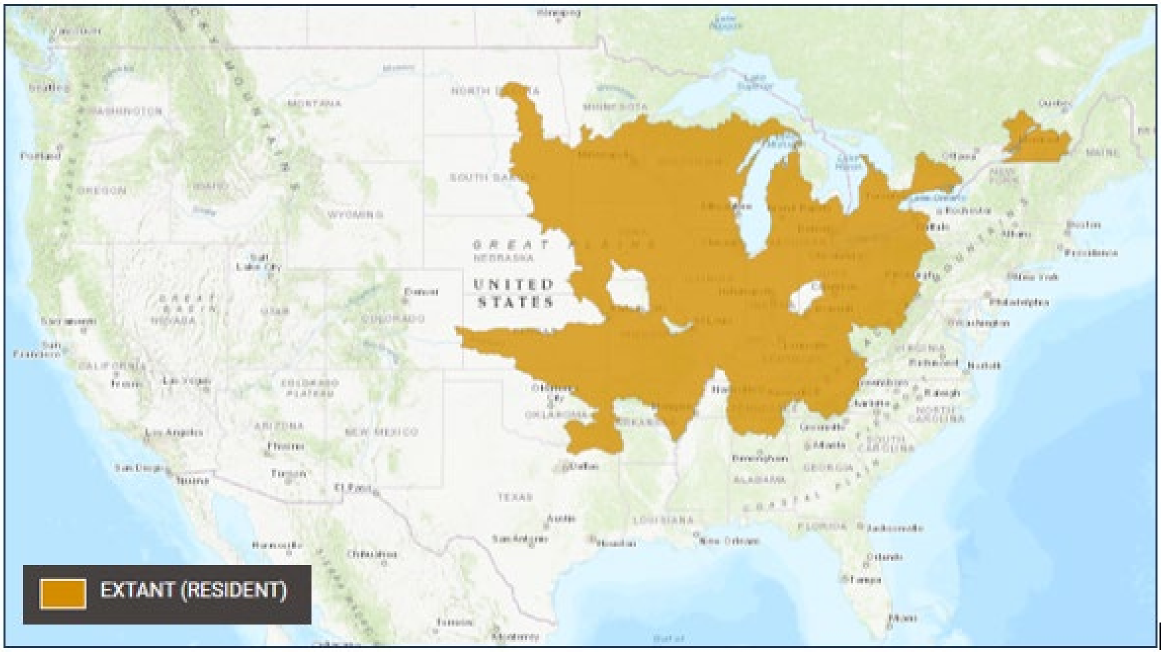

Figure 1. Round pigtoe distribution (IUCN Redlist 2024)

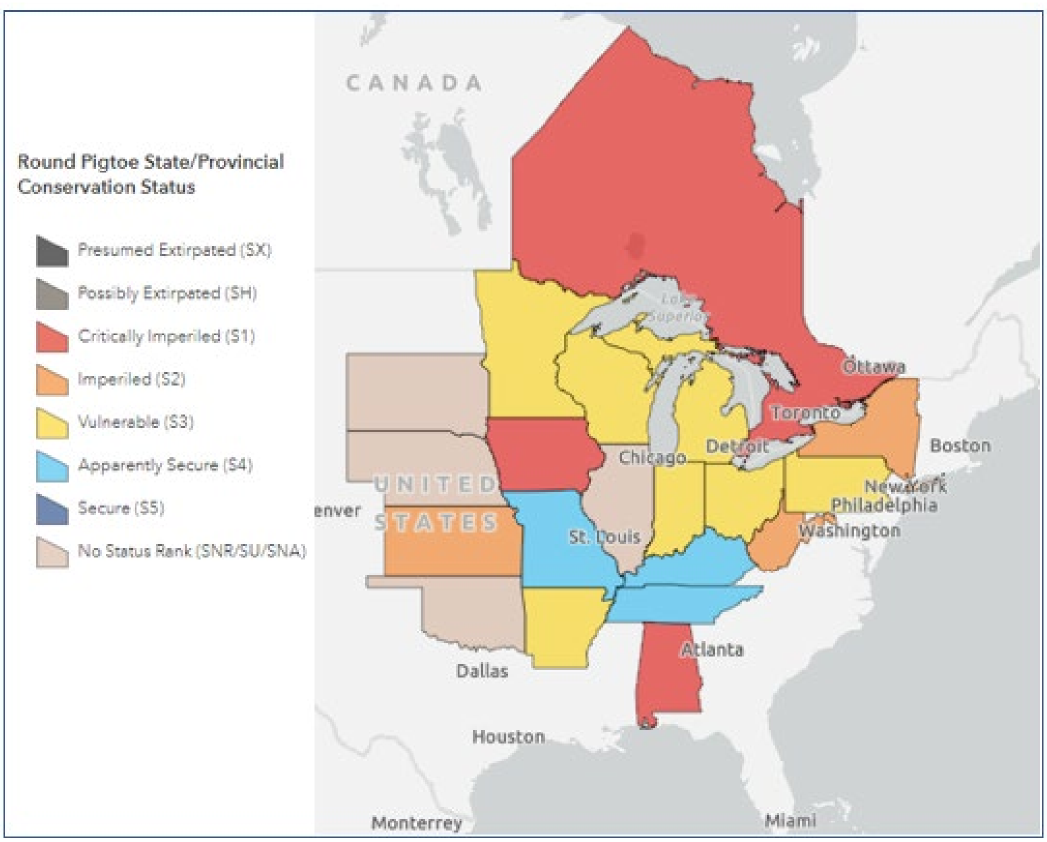

Figure 2. Round pigtoe status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

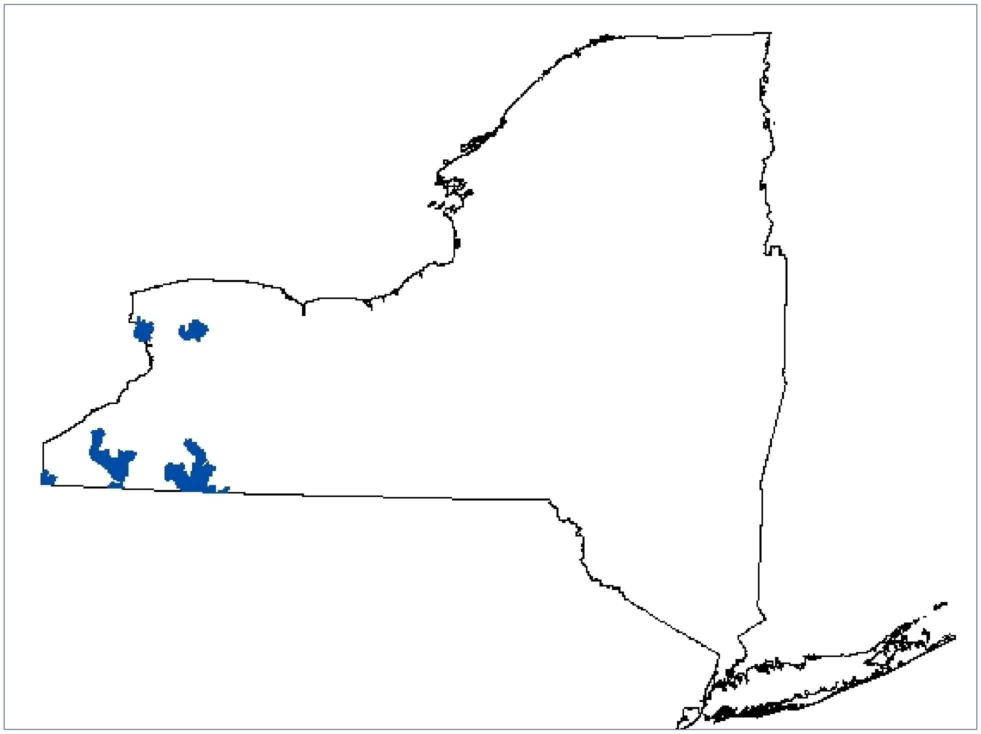

Figure 3. Records of round pigtoe in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
	_______	_______	_______
	_______	_______	_______
	_______	_______	_______
Total	_______	13	1.1%

Table 1. Records of round pigtoe in New York.

Details of historic and current occurrence:

2024: P. sintoxia has been found in 13 waterbodies and 20 of New York's 1802 HUC 12 watersheds (1.1%).

Historically, P. sintoxia was known from only a few sites in New York State: Lake Erie, the Niagara River, and larger streams in the Allegheny basin, including the Allegheny River, Cassadaga Creek, Conewango Creek, and French Creek. In the first half of the twentieth century, it had been recorded from Tonawanda Creek, but the museum specimens labeled as P. cordatum from Tonawanda Creek were confirmed to be Fusconaia flava, a common species in the waterbody (Strayer & Jirka 1997). There are two forms of this species that exist in New York. The coccineum form lives in the Allegheny basin, and its large lake ecophenotype form pauperculum lives in Lake Erie and the Niagara River (Strayer & Jirka 1997).

Since 1970, P. sintoxia has been found in eight New York State waterbodies. P. sintoxia is a common species in parts of its range, but it is uncommon at its New York localities, constituting only a few percent of the unionoid community (Strayer & Jirka 1997).

In a recent survey of the Allegheny basin, 223 live P. sintoxia were found throughout the Upper Allegheny and Conewango sub-basins at 37 of 105 survey sites. It was considered viable at 18 of the sites where it was found. The greatest catches (up to 7 per hour) were in the Allegheny River upstream of Olean, but patches of P. sintoxia were found in Conewango, Cassadaga, Olean, Ischua, and Oswayo Creeks (The Nature Conservancy 2009). As recently as 2005, recruitment was verified in Cassadaga Creek (NY Natural Heritage Program 2013). Also in the Allegheny basin, NY Natural Heritage Program notes P. sintoxia occurrences in French Creek (2013)), and three live individuals were found south-west of French Creek town in 2013 (Burlakova et al., unpublished data).

In addition, in 1990, one live adult and many recently dead shells, including young animals, were found at Beaver Island on the Niagara River, indicating that there is likely a good population at or near this site (NY Natural Heritage Program 2013)), and two live P. sintoxia were found there in 2011 (Burlakova, unpublished data). P. sintoxia may very well live in creeks tributary to Lake Erie and the Niagara River (Strayer & Jirka 1997).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	350 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type: Small to Medium River

b. Geology: Moderately Buffered

c. Temperature: Transitional Cool to Warm

d. Gradient: Low Gradient to Low-Moderate Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
Choose an item.	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

Although P. sintoxia is commonly cited as living in medium-sized to large rivers (McMurry et al. 2012; Metcalfe- Smith et al. 2005; Cummings & Mayer 1992; Watters et al. 2009), in New York, it may be found in creeks and rivers of all sizes, but is more likely to be found in large creeks and small- to medium-sized rivers (Strayer & Jirka 1997). Its large lake ecophenotype form pauperculum is found in the Great Lakes and the Niagara River (Strayer & Jirka 1997).

P. sintoxia may be found in a variety of substrates from mud and silt to gravel, cobble, and boulder (McMurry et al. 2012; Metcalfe-Smith et al. 2005; Cummings & Mayer 1992). Although most commonly found in moving water, it has been found in water depths of 1 inch to 5 feet in standing to moderately flowing water (Metcalfe-Smith et al. 2005; Watters et al. 2009). This species is somewhat sensitive to pollution, siltation, habitat perturbation, inundation, and loss of glochidial hosts (NatureServe 2013).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, P. sintoxia must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable habitat, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC in NatureServe 2013).

P. sintoxia specimens may reach nearly 30 years of age. This species is tachytictic, with eggs present in May and glochidia developed from May through July (Watters et al. 2009). Cyprinids are the most commonly reported hosts. Glochidia have been shown to transform on central stoneroller (Campostoma anomalum), spotfin shiner (Cyprinella spiloptera), bluegill (Lepomis macrochirus), southern redbelly dace (Phoxinus erythrogaster), northern redbelly dace (Phoxinus eos), and bluntnose minnow (Pimephales notatus) (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Human Intrusions & Disturbance	Work & Other Activities (bridge projects and other instream work)
2. Natural System Modifications	Other Ecosystem Modifications (levees and flood walls, channelization, dredging, impassable culverts)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (zebra mussels)
4. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers, sediment)
5. Pollution	Household Sewage & Urban Waste Water (road runoff of salts and metals, other regulated discharges)
6. Pollution	Household Sewage & Urban Waste Water (waste water treatment effluent, sewer and septic overflows)
7. Climate Change & Severe Weather	Droughts
8. Natural System Modifications	Dams & Water Management/Use (lowering of water table from agriculture, etc…, causing drying of habitat)
9. Climate Change & Severe Weather	Storms & Flooding (extreme storms)
10. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (die offs from unknown disease)

Agricultural Runoff

New York's largest populations of *P. sintoxia* have been found in the Allegheny River upstream of Olean. Although this watershed is primarily a forested landscape, cultivated cropland is present adjacent to the Allegheny River in portions of this area, as well as in streams with secondary *P. sintoxia* populations in the Conewango basin and French Creek (NYS Landcover 2010). Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012).

Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting in higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Runoff from Developed Land

All eight New York waterbodies that host *P. sintoxia* populations are intermittently bordered by interstate highways, state routes, and/or local roads (NYS Landcover 2010). It is likely that these sites are impacted by storm water runoff containing metals and road salts from roads and lawns (Gillis 2012). Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991, Liquori & Insler 1985, Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Treated and Untreated Wastewater

In the Niagara River, *P. sintoxia* habitat is located downstream of numerous City of Buffalo combined sewer outflow (CSO) outfalls (Combined Sewer Overflow 2013). In addition, *P. sintoxia* habitat receives storm water runoff and treated wastewater from the municipalities of Olean, Portville, Jamestown, and Buffalo (SPDES 2007). Recent studies show that mussel richness and abundance decrease with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals are also present in municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012). It should be noted that in the Susquehanna Basin, Harman and Lord (2010) found no evidence that wastewater treatment plants were responsible for reductions in mussel species of greatest conservation need.

Flood Control Projects

Flood walls and/or levees have been constructed near municipalities in the Upper Allegheny basin to confine the larger rivers and minimize flood damage. *P. sintoxia* has been found within or adjacent to stream reaches shaped by these flood control features in Olean on the Allegheny

River and in Portville on the Allegheny River and Oswayo Creek ("New York State Flood Protection" 2013). Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. These structures confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999; Yeager 1993; Nedeau 2008). In addition, such flood control projects often require periodic maintenance, including dredging which destroys habitat and kills resident mussels.

Other Habitat Modifications
In addition to channelization and regular channel dredging for maintenance of flood control structures, other ecosystem modifications such as instream work associated with bridge replacement, gravel removal, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000).

Invasive Species
Invasive mussels remain a threat to *P. sintoxia* populations in Niagara River and the Conewango basin. Invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugenis*) have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997; Watters et al. 2009). Native mussels have been effectively eliminated from the western basin of Lake Erie by these exotics. En masse, Dreissenids outcompete native mussels by efficiently filtering food and oxygen from the water. They reduce reproductive success by filtering native mussel male gametes from the water column and they can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994).

Zebra mussels are present in the lower reaches of Cassadaga and Conewango Creeks. Chautauqua Lake's connection to Cassadaga Creek through Chadakoin Creek, is the main source of this exotic invasive. Although zebra mussels will continue to cause problems for Chautauqua Lake, they currently appear to have minimal impact in the free-flowing, relatively shallow rivers downstream. However, precautions should be taken to avoid invasions by zebra mussels to upstream locations, especially the headwater lakes in the Cassadaga system. Monitoring for zebra mussels in these lakes may provide early detection of this invader (The Nature Conservancy 2009).

Climate Change
The NatureServe Climate Change Vulnerability Index has been used in several states to help identify species that are particularly vulnerable to the effects of climate change. While P. *sintoxia* vulnerability was not evaluated for New York, populations within Michigan are ranked as "highly vulnerable" to climate change (Hoving et al. 2013).

Impoundments – Range wide
Across its range, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear

increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, prevent movement by host fish, and effectively isolate mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓_ **No:**_____ **Unknown:**_____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussels habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York’s mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c)of this Section)may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Priority conservation efforts for this species should focus on, but not be limited to, the Allegheny River upstream of Olean.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley & Tank 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Establish a protocol where as DEC staff work closely with flood control management to reduce or impacts to native mussels during maintenance flood control projects.

- Establish a protocol whereas DEC staff work closely with state and local highway departments to reduce impacts to native mussels during maintenance and construction projects.

- Update wastewater treatment facilities in Buffalo to eliminate combined sewer outflows.

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g. point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2. Recommended conservation actions for round pigtoe.

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.

- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Date first prepared	June 2013
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Species Status Assessment

Common Name: Salamander mussel **Date Updated:** 1/15/2024

Scientific Name: *Simpsonaias ambigua* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Simpsonaias ambigua was thought to be extirpated in New York State until, in 2018, a recently dead, empty shell of this species was found in a tributary to Lake Erie. It is possible that unknown populations occur in Lake Erie, the Niagara River, and its tributaries (Strayer and Jirka 1997). This species was removed from the New York Species of Greatest Conservation list in 2015 but should be reinstated on the list based on this recent finding.

S. ambigua belongs to the subfamily Unioninae and the tribe Anodontini, which includes 16 extant and one likely extirpated New York species of the genera Alasmidonta, Anodonta, Anodontoides, Lasmigona, Pyganodon, Simpsonaias, Strophitus, and Utterbackia (Haag 2012; Graf and Cummings 2011). S. ambigua is the only representative of the genus Simpsonaias (Watters et al. 2009).

S. ambigua is widespread in the Mississippi and Great Lakes basins from Arkansas and Tennessee to Iowa and New York (Strayer and Jirka 1997). It is most commonly found in sand or silt under large, flat stones in areas of a swift current in medium to large rivers and lakes (Parmalee and Bogan 1998). As S. ambigua only uses the mudpuppy (Necturus maculosus) as its host, threats to the salamander are also threats to the mussel. The species as a whole has been on the slight decline in both abundance and range (NatureServe 2013). This species is ranked by The Natural Heritage Program as critically imperiled in New York and throughout its range.

I. Status

a. Current legal protected Status

i. **Federal:** Proposed Endangered (8/22/2023) **Candidate:** ____

ii. New York: None, Proposed Endangered (2019)

b. Natural Heritage Program

i. Global: G1G2 – Critically imperiled / Imperiled

ii. New York: S1 – Critically imperiled **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Vulnerable (2015)

-Northeast Regional SGCN: Yes (2023)

-Midwest Regional SGCN: Yes

- Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Endangered (2011)

- American Fisheries Society Status: Special Concern (1993)

-Species of Regional Northeast Conservation Concern (Therres 1999)

Status Discussion:

Although widely distributed and abundant in some areas, this species is still considered rare in all states where it is found and recently local extirpations have been occurring across nearly all of its range to the point where declines in areas of occupancy have occurred (NatureServe 2013). Reasoning for the status designation includes declining habitat quality from intense agriculture, urban development, and pollution from point and non–point sources. In addition, this mussel only uses the mudpuppy, a salamander, as its host; threats to the salamander are also threats to the mussel (COSEWIC 2011).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Declining	Declining	1999-2013		(blank)
Northeastern US	Yes	Declining	Declining			Yes
New York	Yes	Unknown	Unknown		S1	No
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Unknown	Unknown	2005-2014	Endangered, S1	Yes
Vermont	No	N/A	N/A			No
Ontario	Yes	Unknown	Stable	2003-2013	Endangered, S1	(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

This species is often overlooked due to its habitat, underneath flat rocks where mudpuppies prefer to inhabit. Specific intense searches for this species in known areas of inhabitance have led to the determination that they have been on the decline in the short term, at a rate of 10-30%. Many local known sites of abundance have been observed to have S. ambigua extirpated from the area. The long term trend for this species has been between stable populations to losses of up to 50% (Stansbery 1970; Clarke 1985; NatureServe 2013).

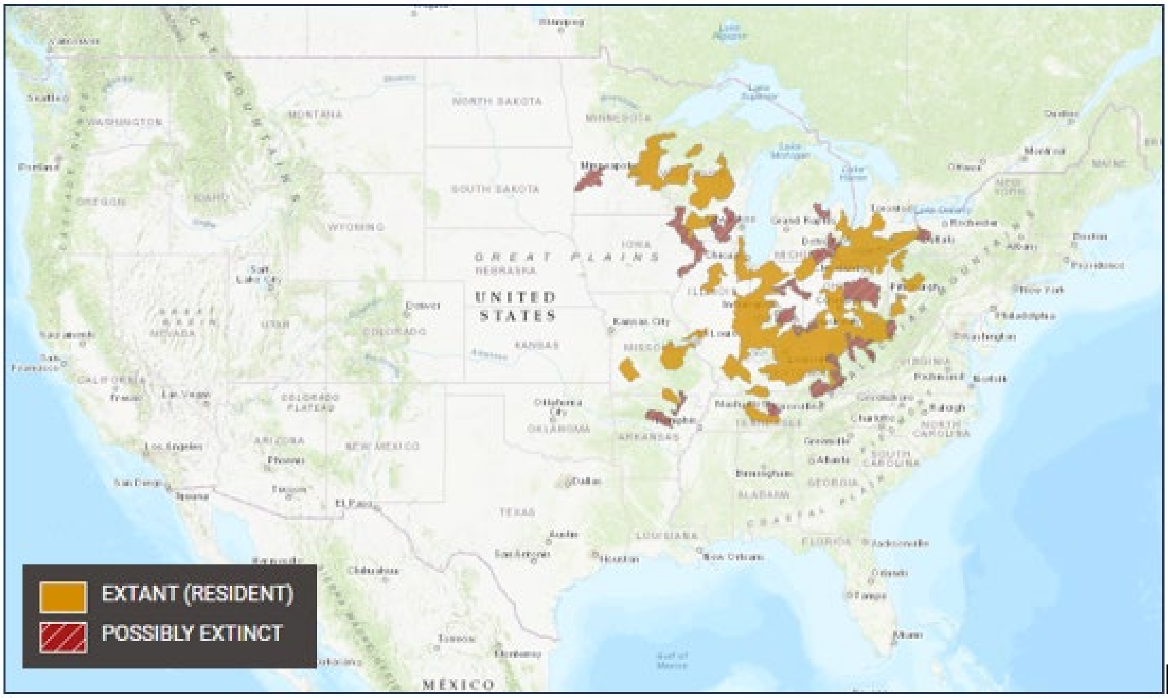

Figure 1. Salamander mussel distribution (IUCN Redlist 2024)

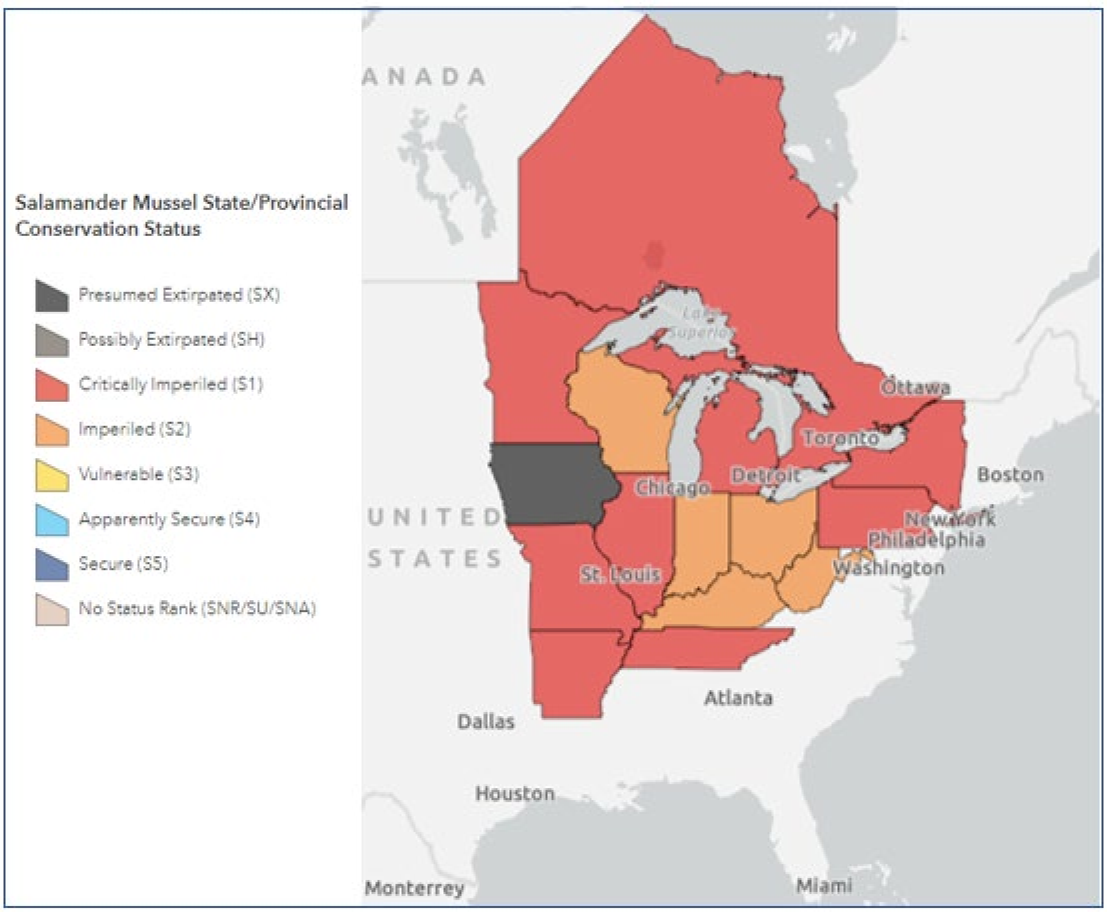

Figure 2. Salamander mussel status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

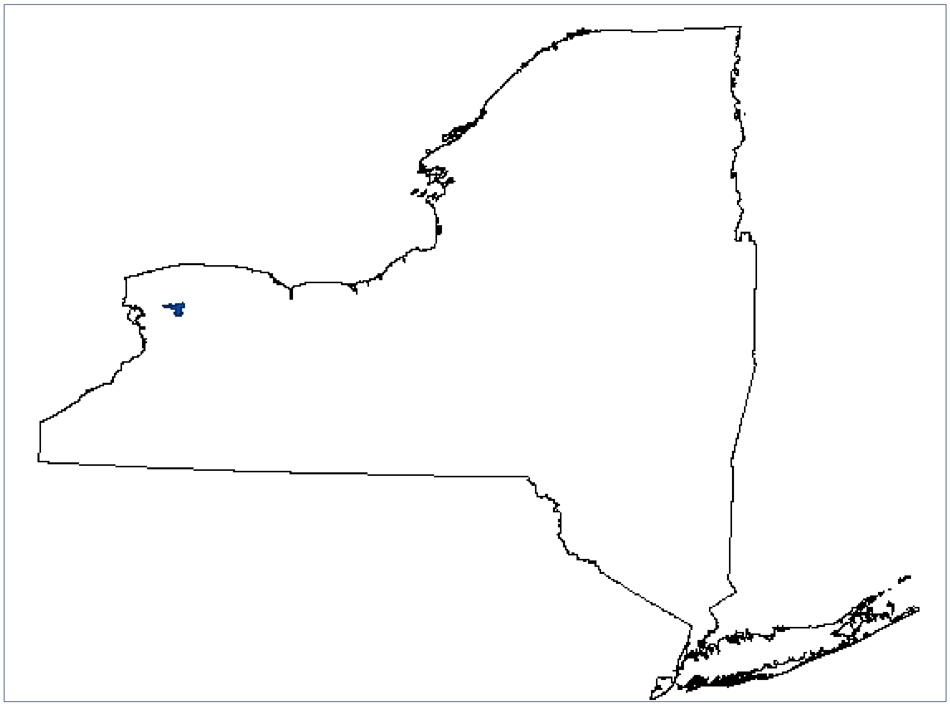

Figure 3. Records of salamander mussel in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
Pre-1970			
1971-2008			
2008-2023		1	0.1%

Table 1. Records of salamander mussel in New York.

Details of historic and current occurrence:

In the 1800s S. ambigua was collected from Lake Erie at Buffalo, Buffalo Creek (or Buffalo River), and Cayuga Creek at Lancaster (Strayer and Jirka 1997).

In 2018, a single, good condition, empty salamander mussel shell was found in a tributary to Lake Erie. This drainage has been badly damaged by urban development (Strayer and Jirka 1997). In addition, this species has not been found in other recent surveys of central and western New York streams (Mahar and Landry 2013, NY Natural Heritage Program 2013, The Nature Conservancy 2009, Harman and Lord 2010, White et al. 2011, NatureServe 2013). Its host, however, is still widespread around Buffalo (Strayer & Jirka 1997).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	600 km

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. **Size/Waterbody Type:** Medium River

b. **Geology:** Moderately Buffered

c. **Temperature:** Warm

d. **Gradient:** Low Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
Yes	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

S. ambigua has been collected from creeks and rivers of all sizes as well as from Lake Erie (Strayer and Jirka 1997) in areas of swift current (NatureServe 2013). It is typically found buried in fine mud, silt or sand (McMurray et al. 2012, Parmalee and Borgan1998) beneath large, flat rocks, which are probably used as shelters by its host, the mudpuppy (Strayer and Jirka 1997). It may also be found on mud or gravel bars (Cummings and Mayers 1992). S. ambigua is rarely found buried in the substrate with other mussels (Watters et al. 2009).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all

North American mussels, this species must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable substrate, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected hosts can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use hosts with limited home ranges (COSEWIC as cited in NatureServe 2013).

S. ambigua is the only North American freshwater mussel known to utilize a salamander, the mudpuppy (Parmalee and Bogan 1998). In addition, the mudpuppy is the only reported host for this species, with both transformation and natural infestation documented (Watters et al. 2009). There is some evidence that the glochidia are released in the fall (Clarke 1985), overwinter on their hosts, with metamorphosis occurring in May (Watters et al. 2009). Maximum age for this species is 10 years (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Human Intrusions & Disturbance	Work & Other Activities (bridge projects and other instream work)
2. Natural System Modifications	Other Ecosystem Modifications (dredging, impassable culverts)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (zebra and quagga mussels, Asian clams)
4. Pollution	Household Sewage & Urban Waste Water (road runoff of salts and metals, waste water treatment effluent, other regulated discharges, combined sewer overflows)
5. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers, sediment)
6. Climate Change & Severe Weather	Habitat Shifting & Alteration (warmer water temperatures)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (lampricide treatment)

At SGCN meetings that DEC conducted in December 2013 to evaluate the status of mussels, experts agreed there is too little information known about this species to evaluate threats. The general threats discussed below are relevant to this species.

General threats to mussels that are likely relevant range wide:

Agricultural Runoff
Populations of *S. ambigua* from river habitats are threatened primarily by declining water quality and the loss of habitat. The watersheds in southwestern Ontario, where the *S. ambigua* are still

found, are predominantly agricultural with high nutrient and sediment inputs to the watercourse from adjacent lands (Morris and Burridge 2006).
Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar and Landry 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Urban Development
The Buffalo River drainage, which includes New York's historic *S. ambigua* streams, has been badly damaged by urban development (Strayer and Jirka 1997). This would be a cause for concern if there were ever efforts to reintroduce *S. ambigua* to the area. The below text describes some threats to mussels associated with developed land.

Runoff from Developed Land
Developed lands are likely sources runoff containing metals and road salts. Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991; Liquori & Insler 1985; Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Treated and Untreated Wastewater
Recent studies show that mussel richness and abundance decreases with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal

exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals also originate from municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012).

Habitat Modifications
Ecosystem modifications, such as in-stream work associated with canal, navigational channel, or flood control dredging, bridge replacements, gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000). Seasonal draw downs of water bodies have been shown to impact unionid age distributions (Richardson et al. 2002).

Levees and flood walls confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999; Yeager 1993; Nedeau 2008).

Invasive Species
The main reason for the declines in *S. ambigua* lake populations, including the Lake St. Clair and Lake Erie populations, is the presence of the exotic zebra mussel (*Dreissena polymorpha*) (Morris & Burridge 2006). Invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugenis*) have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997; Watters et al. 2009). En masse, Dreissenids outcompete native mussels by removing food and oxygen from the water. They can also reduce reproductive success by filtering native mussel male gametes from the water column. They can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994).

Sea lamprey control treatments
The obligate parasitic nature of the reproductive cycle of this species necessitates a consideration of threats to the host species as well as the direct threats to the mussel (Morris and Burridge 2006). Significant limiting factors for the mudpuppy include habitat loss as a result of severe siltation and environmental contamination, particularly the use of the lampricide TFM. There is some evidence that siltation has extirpated the mudpuppy from some areas by reducing its access to nesting sites and hiding places (Gendron 1999).

Climate Change
The NatureServe Climate Change Vulnerability Index has been used in several states to help identify species that are particularly vulnerable to the effects of climate change. While *S. ambigua*

vulnerability was not evaluated for New York, the populations within Michigan are ranked as "extremely vulnerable" to climate change (Hoving et al., 2013).

Global climate change is expected (among other disruptions) to cause an increase in surface water temperatures. Although many species are tolerant of warm water, higher water temperatures may be an added stress for some. Increased water temperatures may also increase algal growth, which could result in reductions in dissolved oxygen levels at night (Morris and Burridge 2006). Galbraith et al. (2010) recently showed how regional climate patterns coupled with changing local water regimes and management strategies have shifted mussel populations from thermally sensitive species to thermally tolerant species.

In addition, warmer stream temperatures due to the combined effects of land use, such as removal of shaded buffers, and climate change may contribute to the loss of coldwater fisheries and *mussel* populations in some watersheds (Nedeau 2008). Temperature induced changes in fish communities could have a profound influence on the availability of hosts for freshwater mussels. Mussels that inhabit small streams and rivers and rely on fish adapted for cooler water might be most affected by climate change (Nedeau 2008).

Impoundments – Range wide
Range wide, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: ✓ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any "protected stream", its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussels habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York's mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Identify if any local populations of *S. ambigua* still exist in New York State. Strayer & Jirka (1997) suggest that examining habitat around Buffalo where its host species (mudpuppy) is still widespread. Lake Erie, the Niagara River, and its tributaries are most likely to yield viable populations.

- Assess the need and opportunity for relocation/reintroduction efforts. Conduct relocation or reintroduction where adequate sources can be identified and appropriate stream conditions exist (water quality, habitat, host species etc.).

- Evidence of historic occurrence of multiple New York State extirpated mussel species exists for the Niagara River. These species include: *Epioblasma triquetra, Lampsilis teres, Lampsilis abrupta, Obovaria olivaria, Potamilus capax*, *Quadrula pustulosa*, *Quadrula quadrula, Simpsonaias ambigua, and possibly Truncilla donaciformis*. To assess the potential for future reintroduction efforts, a pilot program relocating common species to suitable sections of the Niagara River should be initiated and its results assessed to gage the possible success of reintroduction efforts for extirpated species in this waterbody.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley & Tank 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Following any reintroduction efforts, develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Update wastewater treatment facilities in Buffalo to eliminate combined sewer outflows.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Within the Great Lakes watersheds, lamprey control efforts should consider specific, potentially adverse, impacts to native freshwater mussels when determining methods, including selection of lampricide formulations and concentrations. Lampricide treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard 2006).

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g., point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2. Recommended conservation actions for salamander mussel.

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	
Latest revision	January 16, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Sheepnose **Date Updated:** 1/17/2024

Scientific Name: *Plethobasus cyphyus* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Plethobasus cyphyus is not currently, and has not historically, been found in New York State. As this is not a New York State species, this P. cyphyus was removed from New York's Species of Greatest Conservation list in 2015.

I. Status

a. Current legal protected Status

i. **Federal:** Endangered **Candidate:** ______

ii. **New York:** None

b. Natural Heritage Program

i. **Global:** G3 - Vulnerable

ii. **New York:** N/A - Never found in NY **Tracked by NYNHP?:** No

Other Ranks:

-IUCN Red List: Endangered (2013)

-Northeast Regional SGCN: Yes (2023)

-Midwest Regional SGCN: Yes

- American Fisheries Society Status: Threatened (1993)

-Species of Regional Northeast Conservation Concern (Therres 1999)

Status Discussion:

P. cyphyus has been extirpated throughout much of its former range or reduced to several dozen isolated populations. This species has been eliminated from two-thirds of the total number of streams from which it was historically known although it still has a very wide distribution with dozens of occurrences in the Mississippi and Ohio basins (over two dozen streams in 14 states). The majority of the remaining populations are small and geographically isolated (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Declining	Declining			(blank)

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
Northeastern US	Yes	Declining	Declining			Yes
New York	No	N/A	N/A		Never found in NY	No
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Declining	Declining		Threatened, S1	Yes
Vermont	No	N/A	N/A			No
Ontario	No	N/A	N/A			(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

No monitoring activities for Sheepnose take place in New York, because this species is not known to have ever been found in New York.

Trends Discussion *(insert map of North American/regional distribution and status):*

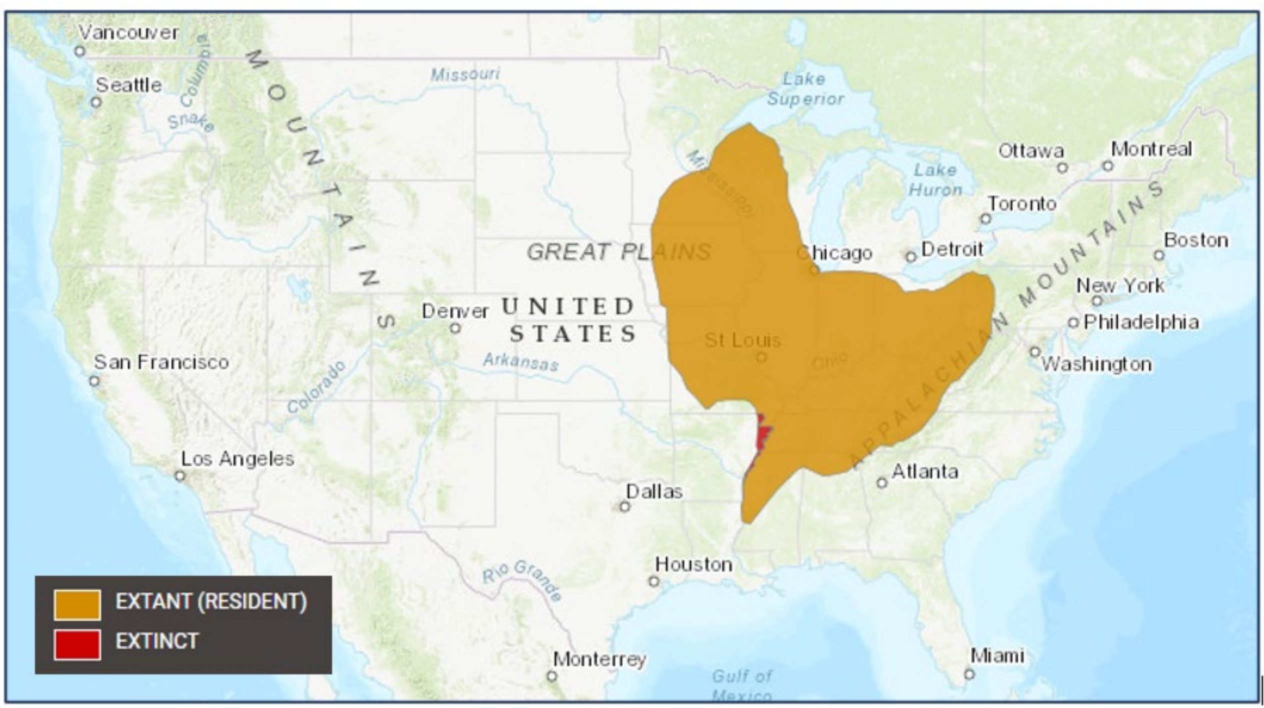

Figure 1. Sheepnose distribution (IUCN Redlist 2024)

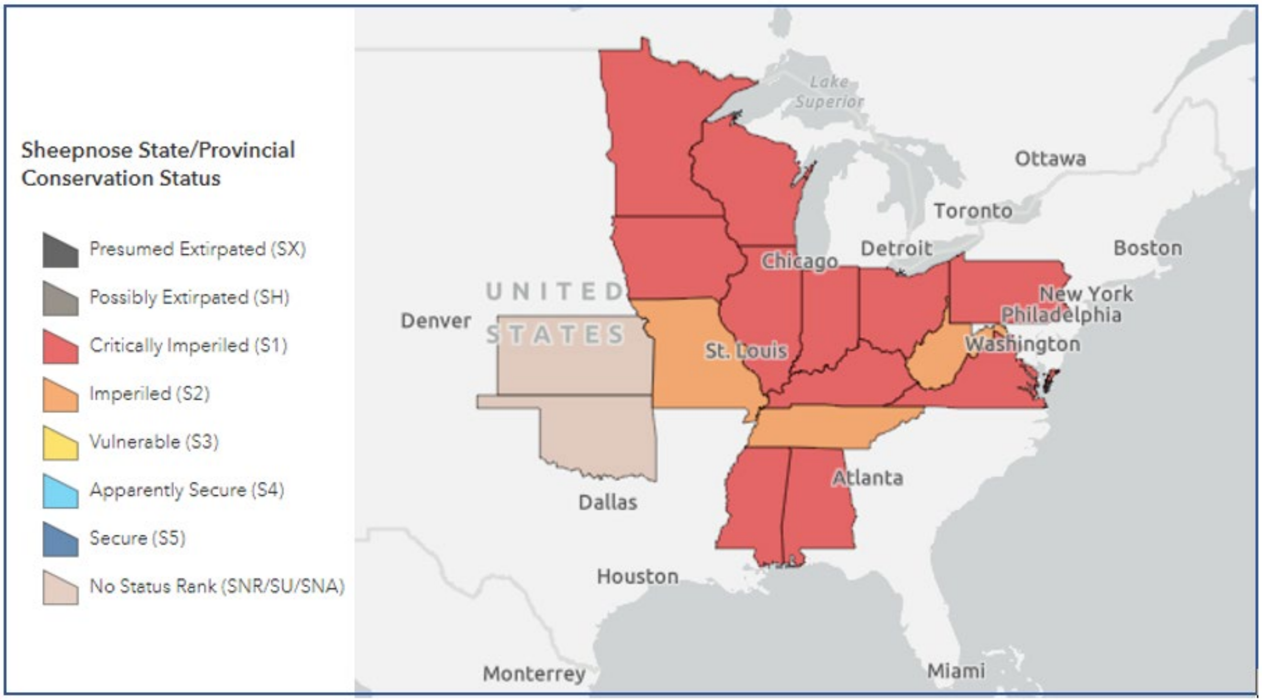

Figure 2. Sheepnose distribution and status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

Years	# of Records	# of Distinct Waterbodies	% of State
Pre-1995	0	0	0
1995-2004	0	0	0
2005-2014	0	0	0
2015- 2023	0	0	0

Table 1. Records of sheepnose in New York.

Details of historic and current occurrence:

There are no historic records for this species in New York State (Strayer and Jirka 1997) and there are no current records for this species in New York State (Strayer and Jirka 1997, White et al. 2011, Mahar and Landry 2013, Harman and Lord 2010, The Nature Conservancy 2009, NY Natural Heritage Program 2013).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
0%	(blank)	750 miles

Column options

Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type: N/A

b. Geology: N/A

c. Temperature: N/A

d. Gradient: N/A

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
Yes	Yes	(blank)	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

In other states, P. cyphyus is found in medium to large rivers in sandy mud, gravel, or gravel mixed with sand (Cummings and Mayer 1992, McMurray et al. 2012, Watters et al. 2009). It may be found in relatively fast current in less than two feet of water, as well as in depths of 12 to 15 feet in the Cumberland and Tennessee rivers (reservoirs) (Parmalee and Bogan 1998).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
No	(blank)	(blank)	No	No	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, P. cyphyus must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable substrate, they will burrow into the substrate, where they may remain for several years (Watters et al 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC 2003 in NatureServe 2013).

P. cyphyus is a short-term brooder (tachytictic) with eggs developing in June and glochidia appearing in July (Watters et al. 2009, Parmalee and Bogan 1998). Specimens of this species may reach 30 years (Watters et al. 2009). Glochidia have been found to transform on central stoneroller (Campostoma anomalum). Additional suspected hosts include sauger (Stizostedion canadens) (Watters et al. 2009), blackspotted topminnow, blacktail shiner, bluntnose minnow, brassy minnow, bullhead minnow, central stoneroller, common shiner, eastern blacknose dace, fathead minnow, longnose dace, mimic shiner, pearl dace, red shiner, river shiner, silver chub, southern redbelly dace, spotfin shiner, steelcolor shiner, striped shiner, suckermouth minnow, western mosquitofish, whitetail shiner (Guenther et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

No threats identified for New York populations because this species has never been found in New York.

General threats to mussels that are likely relevant range wide:

Impoundments – Range wide
Range wide, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Agricultural Runoff
Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central

New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Treated and Untreated Wastewater

Recent studies show that mussel richness and abundance decreases with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals also originate from municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012).

Runoff from Developed Land

Developed lands are likely sources runoff containing metals and road salts.
Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991; Liquori & Insler 1985; Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Invasive Species

Invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugenis*) have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997; Watters et al. 2009). En masse, Dreissenids outcompete native mussels by removing food and oxygen from the water. They can also reduce reproductive success by filtering native mussel male gametes from the water column. They can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994). In addition, ammonia from Asian clam die offs has been shown to be capable of exceeding acute effect levels of some mussel species (Cherry et al. 2005). Didymo (*Didymosphenia geminata*), a filamentous diatom, can form extensive mats that can smother stream bottom and occlude habitat for mussels (Spaulding & Elwell 2007)

Climate Change
The NatureServe Climate Change Vulnerability Index has been used in several states to help identify species that are particularly vulnerable to the effects of climate change. While sheepnose vulnerability was not evaluated for New York, the populations within the southern Appalachians are ranked as “extremely vulnerable” to climate change (2013).

Global climate change is expected (among other disruptions) to cause an increase in surface water temperatures. Although many species are tolerant of warm water, higher water temperatures may be an added stress for some. Increased water temperatures may also increase algal growth, which could result in reductions in dissolved oxygen levels at night (Morris & Burridge 2006). Galbraith et al. (2010) recently showed how regional climate patterns coupled with changing local water regimes and management strategies have shifted mussel populations from thermally sensitive species to thermally tolerant species.

In addition, warmer stream temperatures due to the combined effects of land use, such as removal of shaded buffers, and climate change may contribute to the loss of coldwater fisheries and mussel populations in some watersheds (Nedeau 2008). Temperature induced changes in fish communities could have a profound influence on the availability of hosts for freshwater mussels. Mussels that inhabit small streams and rivers and rely on fish adapted for cooler water might be most affected by climate change (Nedeau 2008).

Habitat Modifications
Ecosystem modifications, such as in-stream work associated with canal, navigational channel, or flood control dredging, bridge replacements, gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting “dredge” had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000). Seasonal draw downs of water bodies have been shown to impact unionid age distributions (Richardson et al. 2002).

Levees and flood walls confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999; Yeager 1993; Nedeau 2008).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: ✓ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

As a federally endangered species, this species is protected under the Endangered Species Act (ESA). The ESA provides protection against practices that kill or harm the species and requires planning for recovery and conservation actions.

Section 7(a) of the Federal Endangered Species Act, as amended, requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as Federally endangered or threatened. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR Part 402. Section 7(a)(4) requires Federal agencies to confer informally with the Service on any action that is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat. If a species is listed subsequently, Section 7(a)(2) requires Federal agencies to ensure that any activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of such a species or to destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Service.

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York’s mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c)of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

Since this species was never known to occur in New York, it is not advisable that conservation actions directed at this species are needed in New York State.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2. Recommended conservation actions for sheepnose.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	
Latest revision	January 17, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Slippershell mussel **Date Updated:** 1/15/2024

Scientific Name: *Alasmidonta viridis* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Alasmidonta viridis belongs to the subfamily Unioninae and the tribe Anodontini, which includes 16 extant and 1 likely extirpated New York species of the genera Alasmidonta, Anodonta, Anodontoides, Lasmigona, Pyganodon, Simpsonaias, Strophitus, and Utterbackia (Haag 2012, Graf and Cummings 2011). A. viridis is a member of the genus Alasmidonta, named for its lack of lateral teeth. The species name viridis refers to the green color of the periostracum (Watters et al. 2009).

In New York, A. viridis is found in three Erie basin waterbodies (Mahar and Landry 2012, NY Natural Heritage Program 2013). Although rare in New York, this edge of range species is considered "Apparently Secure" throughout its range. It occupies a wide range of habitats, from small streams to large rivers (Strayer and Jirka 1997), and it is typically found living in a substrate of sand and fine gravel.

In North America, approximately ⅔ to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al.2000). While A. viridis population trends in New York are unknown, it is assumed that they too are declining, due to a myriad of environmental stressors.

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** None, Proposed Threatened listing (2019)

b. Natural Heritage Program

i. **Global:** G4G5 – Apparently Secure / Secure

ii. **New York:** S1 – Critically imperiled **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Least Concern (2011)

-Northeast Regional SGCN: No (2023)

-Midwest Regional SGCN: Watchlist (Assessment priority)

- American Fisheries Society Status: Special Concern (1993)

Status Discussion:

This species is widespread in the eastern U.S. and is distributed from Lake Huron, St. Clair and Erie, and upper Mississippi River system, south to Ohio, Cumberland, and Tennessee River systems. Although intolerant of impoundment, it is considered stable throughout most of its range (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Declining	Declining			Choose an item.
Northeastern US	Yes	Choose an item.	Choose an item.			No
New York	Yes	Unknown	Unknown		S1	Yes
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	No	N/A	N/A			No
Vermont	No	N/A	N/A			No
Ontario	Yes	Unknown	Unknown	2003-2013	S3	Choose an item.
Quebec	No	N/A	N/A			Choose an item.

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

Trends for New York populations are difficult to determine as most historic data comes from opportunistic naturalist collections, as opposed to more comprehensive baseline surveys. For example, mussels were documented for the first time in 50 of the 106 streams surveyed to date by the Southern Lake Ontario mussel inventory project (Mahar and Landry 2013). This is because many of these streams had never before been surveyed for mussels, not because mussel distribution has dramatically increased. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993, Stein et al.2000). Based on New York's Natural Heritage S-rank, sparse historical data, and the plight of North America's freshwater mussels, it is assumed that trends are declining due to a myriad of environmental stressors.

Figure 1. Slippershell distribution (IUCN Redlist 2024)

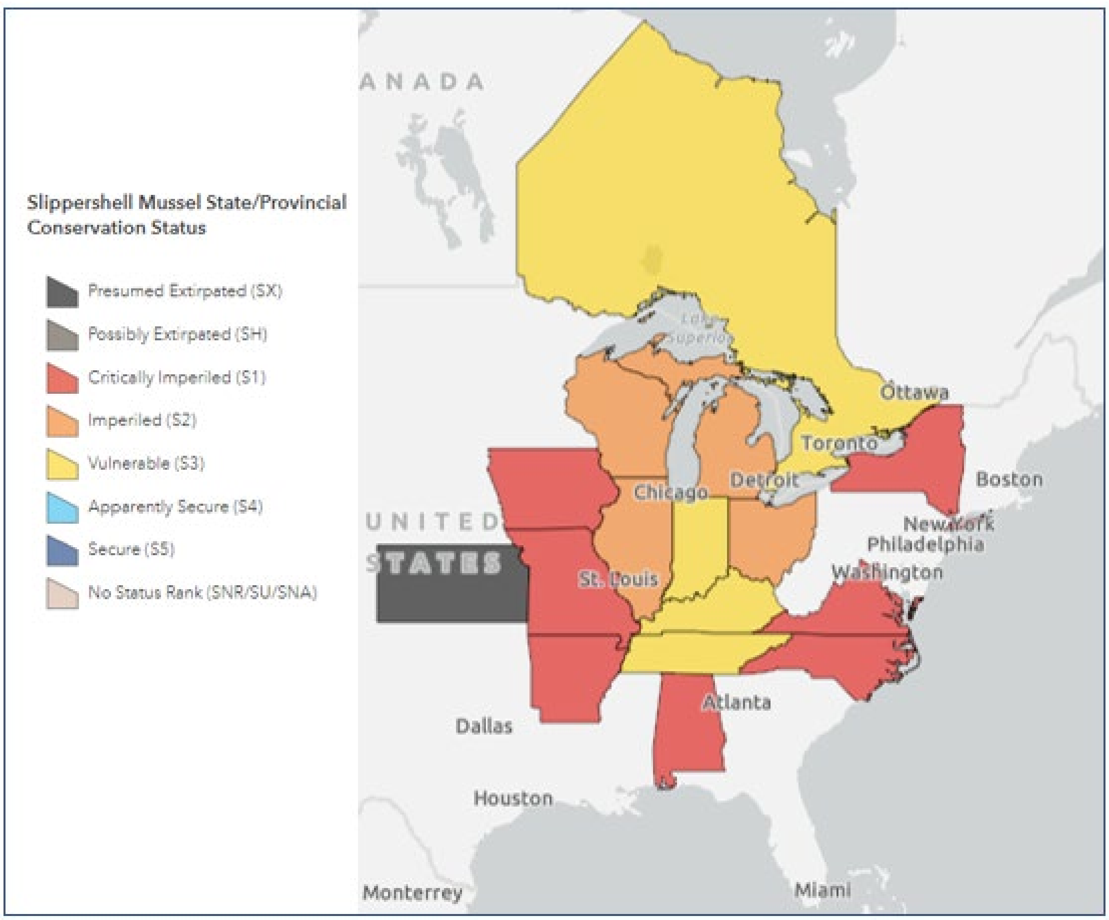

Figure 2. Slippershell status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

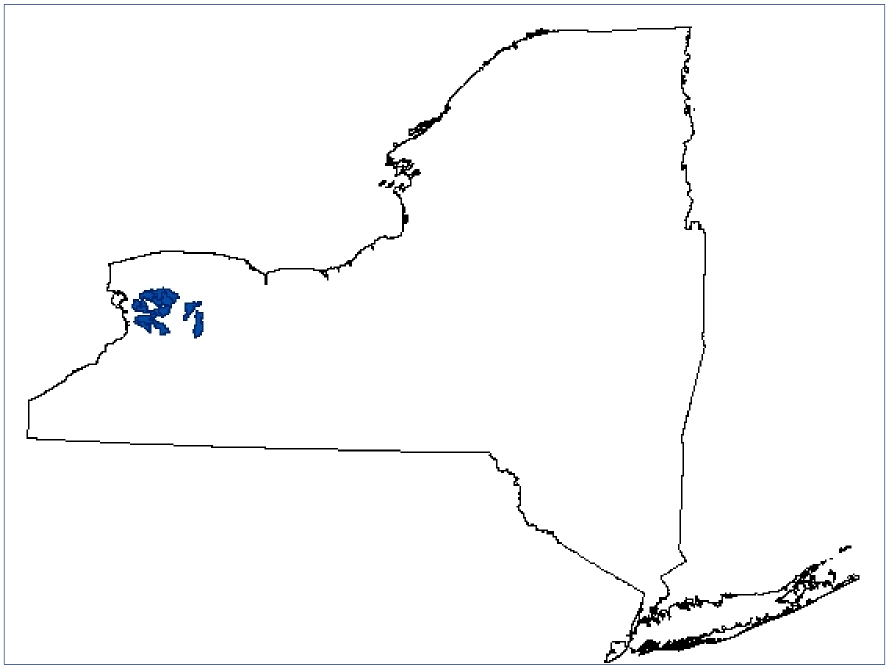

Figure 3. Records of slippershell in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
Total		10	0.7%

Table 1. Records of slippershell in New York.

Details of historic and current occurrence:

2024: A. viridis has been found in 10 waterbodies and 13 of New York's 1802 HUC 12 watersheds (0.7%)

A. viridis has historically been known from the Buffalo River basin, Niagara River, Tonawanda Creek, and the lower Genesee basin (Strayer and Jirka 1997). Mud Creek in Monroe County was the presumed location of the Genesee basin occurrence (Strayer and Jirka 1997), however, I was unable to locate a Mud Creek in Monroe County. There is, however, a known mussel stream named Mud Creek which is a tributary of Tonawanda Creek. It may be worth surveying for A. viridis in this tributary.

Post 1970, A. virdis has been found in 3 waterbodies in New York State (Figure 2). In the Erie basin, it has been found in Tonawanda Creek (Strayer and Jirka 1997), and as fresh shells in Beeman Creek, a Tonawanda Creek tributary (Mahar and Landry 2013), and Buffalo Creek (NY Natural Heritage Program 2013). In Beeman Creek, 88 shells were found (Mahar and Landry 2013), indicating that a large population still exists in this waterbody. No recent occurrences from the Niagara River or Monroe County have been reported.

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	350 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. **Size/Waterbody Type:** Headwater/Creek to Medium River

b. **Geology:** Moderately Buffered, Neutral

c. **Temperature:** Transitional Cool to Warm

d. **Gradient:** Low Gradient to Moderate-High Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
Yes	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

Throughout its range, this species is typically found in headwater streams but also may occur downstream (NatureServe 2013). In New York, it occupies a wide range of habitats, from small streams to large rivers. In fact, the largest historical collections of this species in New York have come from the Niagara River (Strayer and Jirka 1997). It is found in high to moderate gradient streams, and while it may be found in riffles, it is typically found living in a substrate of sand and fine gravel. In stretches where there is a continuous current it will thrive in a mud and sand bottom among roots of aquatic vegetation (Cummings and Mayer 1992, McMurray et al. 2012, Metcalf-Smith et al. 2005, NatureServe 2013). It is a small sized species that may burrow out of sight in sand or sandy mud, so may be easily overlooked.

It is thought to be a moderate habitat specialist (NatureServe 2013) and is not found in impounded waters (Watters 1995).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, A. viridis must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive nutrition and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable habitat, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as cited in NatureServe 2013).

This species has a periodic life history strategy, characterized by moderate to high growth rate, low to intermediate life span, age at maturity, and fecundity, but generally smaller body size than opportunistic species. Most species are long-term brooders. This life history strategy is considered an adaptation to allow species to persist in unproductive habitats or habitats that are subject to large-scale, cylindrical environmental variation or stress (Haag 2012).

A. viridis is probably bradytictic, with glochidia overwintering on in the female. Gravid females are present in September. Glochidia have been shown to transform on banded sculpin (Cottus carolinae) (Zale and Neves 1982). Other reported potential hosts include Johnny darter (Etheostoma nigrum) and mottled sculpin (Cottus bairdi) (Strayer and Jirka 1997, NatureServe 2013). Individuals typically live for less than 10 years (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Human Intrusions & Disturbance	Work & Other Activities (bridge projects and other instream work)
2. Natural System Modifications	Other Ecosystem Modifications (culverts)
3. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers, sediment)
4. Pollution	Household Sewage & Urban Waste Water (road runoff of salts and metals, other regulated discharges)
6. Pollution	Household Sewage & Urban Waste Water (septic overflows)

7. Climate Change & Severe Weather	Droughts
8. Climate Change & Severe Weather	Storms & Flooding (extreme storms)
9. Invasive & Problematic Species & Genes	Invasive Non-Native/Alien Species (die offs from unknown disease)
10. Invasive & Problematic Native Species & Genes	Problematic Native Species (beavers)

Agricultural Runoff

New York's populations of *A. viridis* are found in the Tonawanda Creek and Buffalo River watersheds. These are highly agricultural areas, with fields bordering the streams (New York State Landcover 2010). Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in western and central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar and Landry 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory mussel efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting in higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Runoff from Developed Land

In addition to agricultural fields, roads and residential structures are located adjacent to Tonawanda, Beeman, and Buffalo Creeks (New York State Landcover 2010). These developed areas are likely sources of non-point-source runoff containing metals and road salts. Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller and Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner and Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller and Zam 1991, Liqouri and Insler 1985, Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Habitat Modification

Ecosystem modifications, such as in-stream work associated with bridge replacements or gravel mining kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000). Although limited in geographic scope, their impact on a species with limited distribution would be devastating.

Water Temperature Changes

The NatureServe Climate Change Vulnerability Index has been used in several states to help identify species that are particularly vulnerable to the effects of climate change. While *A. viridis* vulnerability was not evaluated for New York, the populations within Michigan are ranked as "extremely vulnerable" to climate change (Hoving et al. 2013). Gailbreth et al. (2010) showed how regional climate patterns coupled with changing local water regimes and management strategies have shifted mussel populations from thermally sensitive species, such as *A. viridis*, to thermally tolerant species.

Impoundments

It has been noted that *A. viridis* is intolerant of impoundments (NatureServe 2013). While it is highly unlikely that new impoundments will be constructed in this area, culverts and bridge crossings should be properly maintained so that water does not collect upstream of the structures, due to debris build up or an inadequate sized instillation. In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Across its range, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery and King 1983, ESI 1993c).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: ✓ **No:**____ **Unknown:**____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any "protected stream", its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York's mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Priority conservation efforts for this species should focus on, but not be limited to, Beeman Creek (Mahar and Landry 2013).

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature.

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Establish a protocol whereas DEC staff work closely with state and local highway departments to reduce impacts to native mussels during maintenance and construction projects.

- Replace culverts that disrupt aquatic habitat connectivity to allow for passage of small fish species.

- Within the Great Lakes and Champlain watersheds, lamprey control efforts should consider specific, potentially adverse, impacts to native freshwater mussels when determining methods, including selection of lampricide formulations and concentrations. Lampricide treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard 2006).

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g. point and nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) -
https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2. Recommended conservation actions for slippershell.

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.

- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	February 26, 2014 (Samantha Hoff)
Latest revision	January 16, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Snuffbox **Date Updated:** 1/15/2024

Scientific Name: *Epioblasma triquetra* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

The status of Epioblasma triquetra in New York is unknown. It had been thought to be extirpated from the state and was last found prior to the 1950s in Lake Erie at Bay View, Buffalo Creek, and the Niagara River. One recently-dead shell was found in 1999 and two weathered shells were found in 2017-2018 in a tributary to the Niagara River. It is possible that further surveys will find small populations in larger tributaries of Lake Ontario and the Niagara River, as well as in the Allegheny basin (Strayer & Jirka 1997). This species was removed from the New York Species of Greatest Conservation list in 2015 but reinstatement should be considered based on these recent findings.

E. triquetra is the most widespread species of the Epioblasma family (Williams et al 2008). This species is listed as state and federally endangered and is ranked by The Natural Heritage Program as historic in New York and as imperiled throughout its range.

I. Status

a. Current legal protected Status

i. **Federal:** Endangered **Candidate:** ______

ii. **New York:** Endangered

b. Natural Heritage Program

i. **Global:** G2G3 – Imperiled / Vulnerable

ii. **New York:** SH - Historic **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Endangered (2015)

-Northeast Regional SGCN: Yes (2023)

-Midwest Regional SGCN: Yes

-Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Endangered (2011)

-American Fisheries Society Status: Threatened (1993)

-Species of Regional Northeast Conservation Concern (Therres 1999)

Status Discussion:

This species is declining throughout its widespread range and has become increasingly rare, although several dozen occurrences remain, many of them with good viability. Distribution is greatly fragmented but remains relatively wide. Long-term viability of most populations is questionable, especially those in large rivers where zebra mussel populations are now established. The degree of decline has not been established (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Declining	Declining			(blank)
Northeastern US	Yes	Choose an item.	Choose an item.			Yes
New York	Unknown	Unknown	Unknown		Endangered, SH	No
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Unknown	Unknown		Endangered, S2	Yes
Vermont	No	N/A	N/A			No
Ontario	Yes	Stable	Stable	2003-2013	Endangered, S1	(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

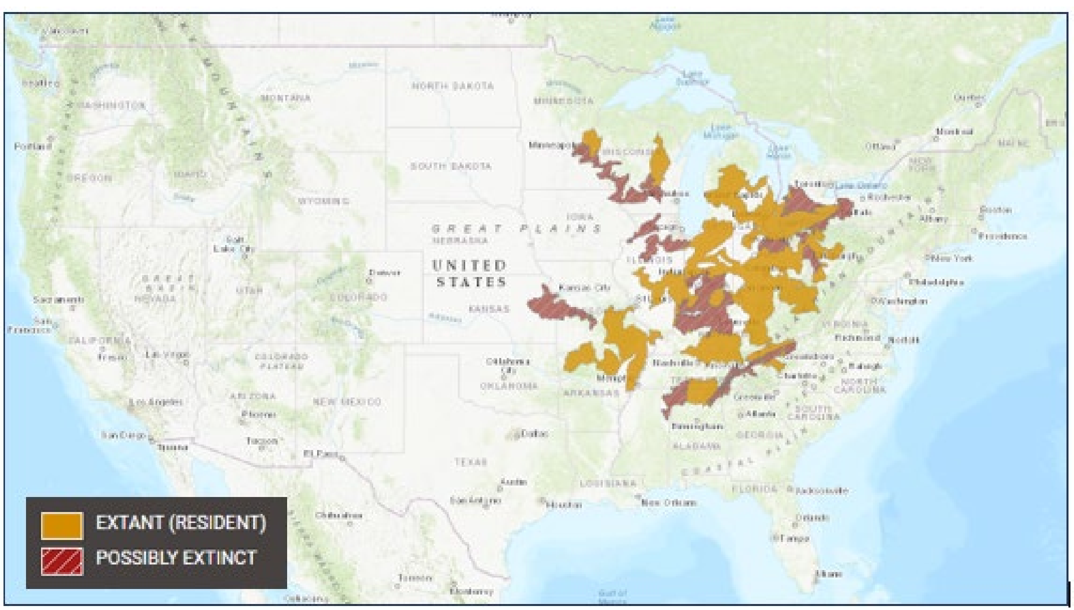

Figure 1. Snuffbox distribution (IUCN Redlist 2024)

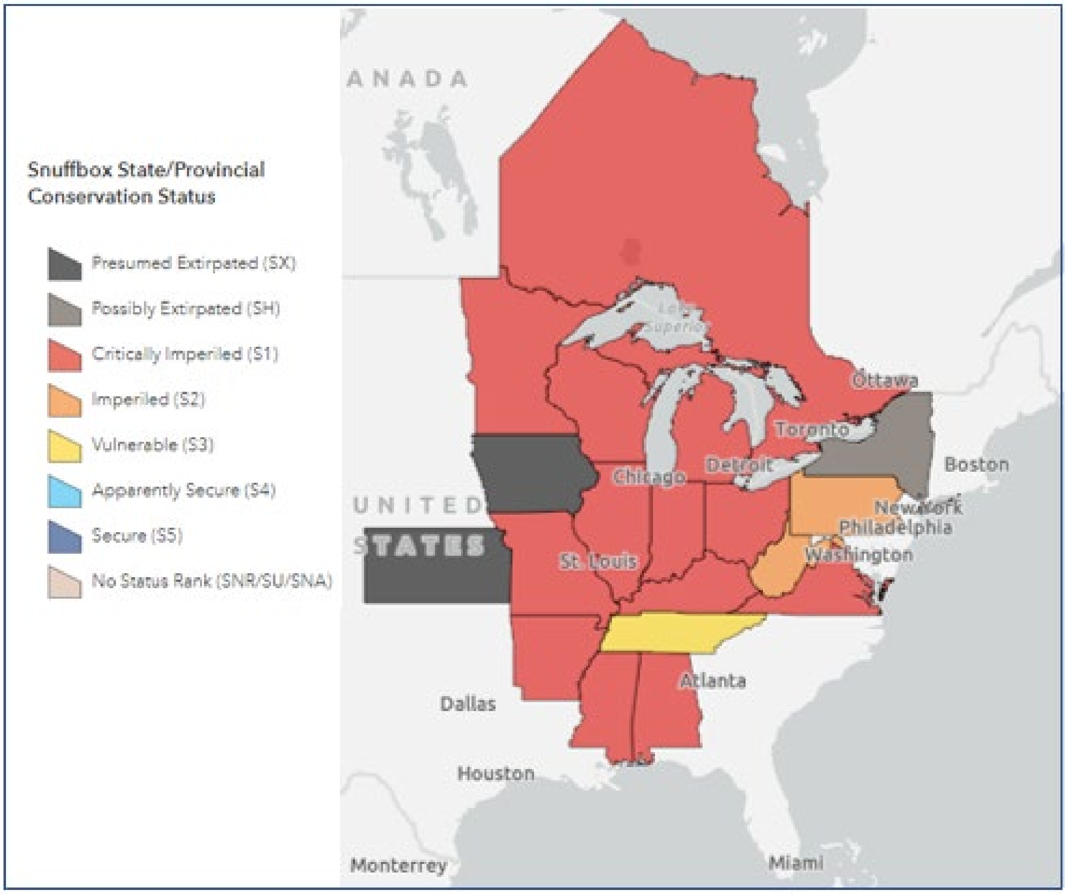

Figure 2. Snuffbox status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

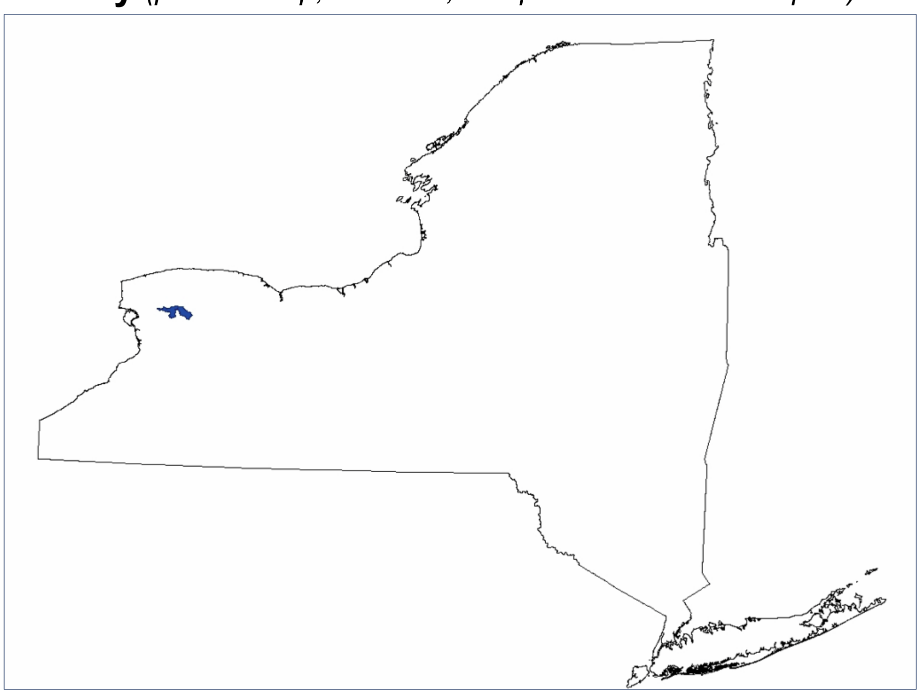

Figure 3. Records of snuffbox in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
	_______	_______	_______
	_______	_______	_______
	_______	_______	_______
Total	_______	1	0.1%

Table 1. Records of snuffbox in New York.

Details of historic and current occurrence:

New York E. triquetra has been collected from Lake Erie at Bay View, Buffalo Creek, and the Niagara River. All of these collections were made prior to 1950, (Strayer & Jirka 1997).

Shells of this species were found in 1999 and 2017-2018 in tributary to the Niagara River, indicating that an extant population may still exist in New York. The shells were found in 2 of New York's 1802 HUC 12 watersheds (0.1%). There are no recent live occurrences of this species live in New York (Strayer & Jirka 1997, The Nature Conservancy 2009, Harman and Lord 2010, White et al. 2011, Mahar and Landry 2013, NY Natural Heritage Program 2013, NatureServe 2013). Strayer and Jirka (1997) recommend searching for this species in the Niagara River and the larger tributaries of Lake Ontario and the Niagara River. It should also be sought in the Allegheny basin, as it has been found in Pennsylvania only a few kilometers from the New York border.

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	350 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type: Medium River

b. Geology: Moderately Buffered

c. Temperature: Warm

d. Gradient: Low Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
Yes	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item

Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

E. triquetra is typically a medium to high water quality species (Watters et al. 2009). It is chiefly found in medium-sized to large rivers in shallow riffles (depths of 2 inches to 2 feet) with clear, swift-flowing water and firm coarse sand and gravel substrates (Metcalfe-Smith et al. 2005, Cummings and Mayers 1992, McMurray et al. 2012, Parmalee and Borgan 1998, Watters et al. 2009, Spoo 2008). However, there is some evidence that it occurs most frequently in clear, hydrologically stable, low-gradient streams (Strayer & Jirka 1997). It has also been found in some lakes (ie. Lake Erie) (Strayer & Jirka 1997) and impoundments, but this is probably not a preferred habitat (Watters et al. 2009). This species is typically buries itself deeply in the substrate (Strayer and Jirka 1997, McMurray et al. 2012, Watters et al. 2009, Metcalfe-Smith et al. 2005, Williams et al. 2008).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Unknown	No	No	Unknown	Unknown	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, this species must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable substrate, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009). E. triquetra, in particular, has a rather drastic approach to parasitizing its host fish. The female specimens entrap the snout of the host fish in the shell. It then releases the glochidia directly through the gills of the host fish (Barnhart et al. 1998). This type of behavior limits this species' host fish selection to only those that can survive the encounter long enough for the glochidia to develop (Zanatta 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as cited in NaturesServe 2013).

This species is bradytictic, with eggs present in early September, glochidia forming in mid-September, and glochidia overwintering on the female until the following April or May. Individuals older than 15 years are rare (Watters et al. 2009). E. triquetra glochidia have been reported to transform on black sculpin (Cottus baileyi), mottled sculpin (Cottus bairdi), banded sculpin, (Cottus carolinae), Ozark sculpin (Cottus hypselarus), blackspotted topminnow (Fundulus olivaceous), logperch (Percina caprodes), blackside darter (Percina maculata), and Roanoke darter (Percina roanoka) (Watters et al. 2008).

VI. Threats *(from NY 2015 SWAP or newly described):*

Dams

Dams affect both upstream and downstream mussel populations by disrupting natural river flow patterns, scouring river bottoms, changing water temperatures, and eliminating habitat. Adapted to living in flowing water, the snuffbox cannot survive in the lakes or slow water created by dams. Snuffbox mussels depend on host fish to move upstream. Because dams block fish passage, they also prevent mussels from moving upstream, isolating downstream mussels from upstream populations. This fragmentation leads to small, unstable populations that easily die out.

Pollution

Adult mussels, because they are sedentary (meaning that they tend to stay in one place), are easily harmed by toxins and poor water quality caused by pollution. Pollution may come from specific, identifiable sources such as accidental spills, factory discharges, sewage treatment plants and solid waste disposal sites or from diffuse sources like runoff from cultivated fields, pastures, cattle feedlots, poultry farms, mines, construction sites, private wastewater discharges, and roads. Contaminants may directly kill mussels, but they may also reduce water quality, affect the ability of surviving mussels to have young, or result in lower numbers or disappearance of host fish.

Sedimentation

Although sedimentation is a natural process, poor land use practices, dredging, impoundments, intensive timber harvesting, heavy recreational use, and other activities accelerate erosion and increase sedimentation. Sediment that blankets a river bottom can suffocate mussels. Accelerated sedimentation may also reduce feeding and respiratory ability for snuffbox mussels, leading to decreased growth, reproduction, and survival.

Nonnative Species

The invasion of the nonnative zebra mussel into the U.S. poses a serious threat. Zebra mussels proliferate in such high numbers that they use up food resources and attach to native mussel shells in such large numbers that the native mussel cannot eat or breath. In free-flowing, relatively shallow rivers, zebra mussels do not appear to be as devastating to native mussels as they are in impounded rivers or lake environments. Some species have even been shown to be recovering beyond pre-zebra mussel invasion levels, while others have been effectively eliminated from the western basin of Lake Erie by these exotics (Strayer 2009). Another invasive species, the round goby, is a nonnative fish species that may displace native host fish species, thus reducing the ability of the snuffbox to reproduce (USFWS Snuffbox Factsheet, January 2012). In a recent study performed by Schwalb et al. in 2011, a log perch (*Percina caprodes)*, a known obligate host fish for *E. triquetra* population was studied by its dispersal potential. This study found that *P. caprodes* remain in a small area, which could restrict the dispersal and/or (re)colonization of *E. triquetra*, which may explain why the species populations are unable to rebound quickly from a sharp decline.

General threats to mussels that are likely relevant range wide:

Impoundments – Range wide

Range wide, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Agricultural Runoff

Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Treated and Untreated Wastewater

Recent studies show that mussel richness and abundance decreases with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals also originate from municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012).

Runoff from Developed Land

Developed lands are likely sources runoff containing metals and road salts.
Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991; Liquori & Insler 1985; Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Invasive Species

Invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugenis*) have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997; Watters et al. 2009). En masse, Dreissenids outcompete native mussels by removing food and oxygen from the water. They can also reduce reproductive success by filtering native mussel male gametes from the water column. They can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994). In addition, ammonia from Asian clam die offs has been shown to be capable of exceeding acute effect levels of some mussel species (Cherry et al. 2005). Didymo (*Didymosphenia geminata*), a filamentous diatom, can form extensive mats that can smother stream bottom and occlude habitat for mussels (Spaulding & Elwell, 2007).

Climate Change

Global climate change is expected (among other disruptions) to cause an increase in surface water temperatures. Although many species are tolerant of warm water, higher water temperatures may be an added stress for some. Increased water temperatures may also increase algal growth, which could result in reductions in dissolved oxygen levels at night (Morris & Burridge 2006). Galbraith et al. (2010) recently showed how regional climate patterns coupled with changing local water regimes and management strategies have shifted mussel populations from thermally sensitive species to thermally tolerant species.

In addition, warmer stream temperatures due to the combined effects of land use, such as removal of shaded buffers, and climate change may contribute to the loss of coldwater fisheries and *mussel* populations in some watersheds (Nedeau 2008). Temperature induced changes in fish communities could have a profound influence on the availability of hosts for freshwater mussels. Mussels that inhabit small streams and rivers and rely on fish adapted for cooler water might be most affected by climate change (Nedeau 2008).

Habitat Modifications

Ecosystem modifications, such as in-stream work associated with canal, navigational channel, or flood control dredging, bridge replacements, gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting “dredge” had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000). Seasonal draw downs of water bodies have been shown to impact unionid age distributions (Richardson et al. 2002).

Levees and flood walls confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999; Yeager 1993; Nedeau 2008).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓_ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

In February 2012, the U.S. Fish and Wildlife added the snuffbox to the list of endangered species giving the species full protection under the Endangered Species Act. The ESA provides protection against practices that kill or harm the species and requires planning for recovery and conservation actions.

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussels habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations.

A significant portion of the New York's mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Assess the need and opportunity for relocation/reintroduction efforts. Conduct relocation or reintroduction where adequate sources can be identified and appropriate stream conditions exist (water quality, habitat, host species etc).

- Evidence of historic occurrence of multiple New York State extirpated mussel species exists for the Niagara River. These species include: *Epioblasma triquetra, Lampsilis teres, Lampsilis abrupta, Obovaria olivaria, Potamilus capax*, *Quadrula pustulosa*, *Quadrula quadrula, Simpsonaias ambigua, and possibly Truncilla donaciformis*. To assess the potential for future reintroduction efforts, a pilot program relocating common species to suitable sections of the Niagara River should be initiated and its results assessed to gage the possible success of reintroduction efforts for extirpated species in this waterbody.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley & Tank 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Following any reintroduction efforts, develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Update wastewater treatment facilities in Buffalo to eliminate combined sewer outflows.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Within the Great Lakes watersheds, lamprey control efforts should consider specific, potentially adverse, impacts to native freshwater mussels when determining methods, including selection of lampricide formulations and concentrations. Lampricide treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard 2006).

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g. point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2. Recommended conservation actions for snuffbox.

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

VII. References

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	
Latest revision	January 16, 20224 (Amy Mahar)

Species Status Assessment

Common Name: Spindle lymnaea **Date Updated:**

Scientific Name: *Acella haldemani* **Updated By:**

Class: Gastropoda

Family: Lymnaeidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

This slender-shelled mollusk occurs in the Great Lakes-St. Lawrence River drainage from southeastern Ontario, southern Quebec and northern Vermont westward to Minnesota and southward to Illinois (Jokinen 1992). It is rare in occurrence rangewide (Kart et al. 2005). The spindle lymnaea occurs in lakes, where it attaches to submerged vegetation, spire down and about 20cm from the bottom substrate (Goodrich 1932). It occurred historically in five counties in New York and was last documented in Oswego County in 1971 (Harman and Berg 1971). This snail is easily overlooked in surveys because individuals do not move far from where they were hatched, and thus populations may be clumped at just one location within a lake (Morrison 1932, Jokinen 1992).

I. Status

a. Current legal protected Status

i. **Federal:** Not listed **Candidate:** No

ii. **New York:** Not listed

b. Natural Heritage Program

i. **Global:** G3

ii. **New York:** SNE **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List:

-Northeast Regional SGCN:

American Fisheries Society (AFS): Vulnerable

Status Discussion:

Jokinen (1992) called this mollusk rare in New York and did not detect it during surveys, nor did Strayer (1987). The most recent record is from Oswego County in 1971 (Harman and Berg 1971). It is believed to have been extirpated from the Lake Champlain basin, the Lake Erie basin, the SE Lake Ontario basin, and the Susquehanna basin (NYSDEC 2005).

Kart et al. (2005) note that species in the freshwater snails group in the Vermont State Wildlife Action Plan range from extirpated to declining to rare, and that spindle lymnaea in particular appears to be greatly reduced from its historic range. Spindle lymnaea is ranked as Critically Imperiled in Ontario and Vulnerable in Michigan, but is not ranked (SNR) in the other states and provinces where it occurs.

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Unknown	Unknown			Choose an item.
Northeastern US	Yes	Unknown	Unknown			Choose an item.
New York	Yes	Unknown	Unknown		Not listed	Choose an item.
Connecticut	No	Choose an item.	Choose an item.			Choose an item.
Massachusetts	No	Choose an item.	Choose an item.			Choose an item.
New Jersey	No	Choose an item.	Choose an item.			Choose an item.
Pennsylvania	No	Choose an item.	Choose an item.			Choose an item.
Vermont	Yes	Declining	Declining		Not listed	Yes
Ontario	Yes	Declining	Declining		Not listed	Choose an item.
Quebec	Yes	Unknown	Unknown			Choose an item.

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

None.

Trends Discussion *(insert map of North American/regional distribution and status):*

Spindle lymneae has been extirpated from four basins in New York: Lake Champlain, Lake Erie, SE Lake Ontario, and Susquehanna (NYSDEC 2005).

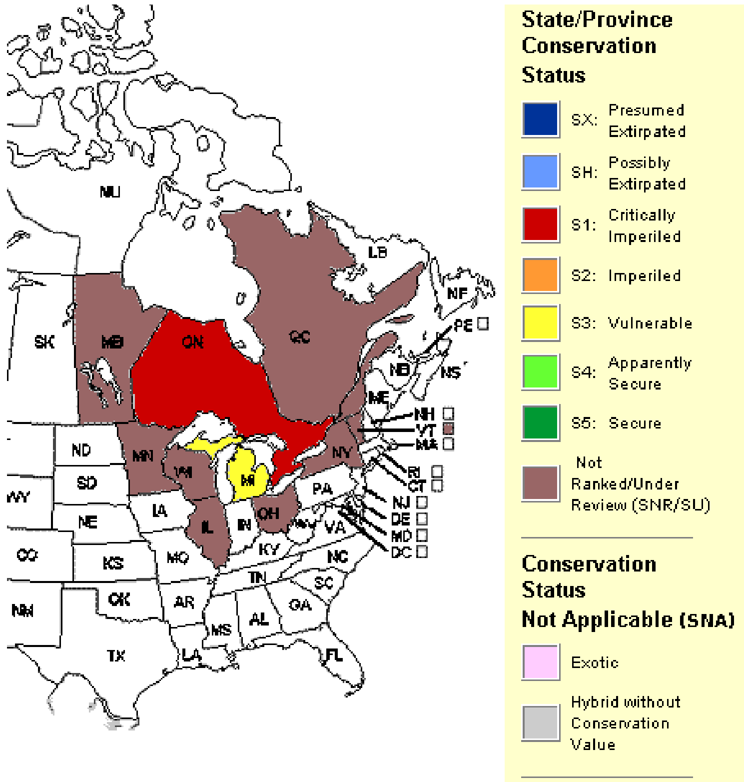

Figure 1. Conservation status of spindle lymnaea in North America (NatureServe 2013)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

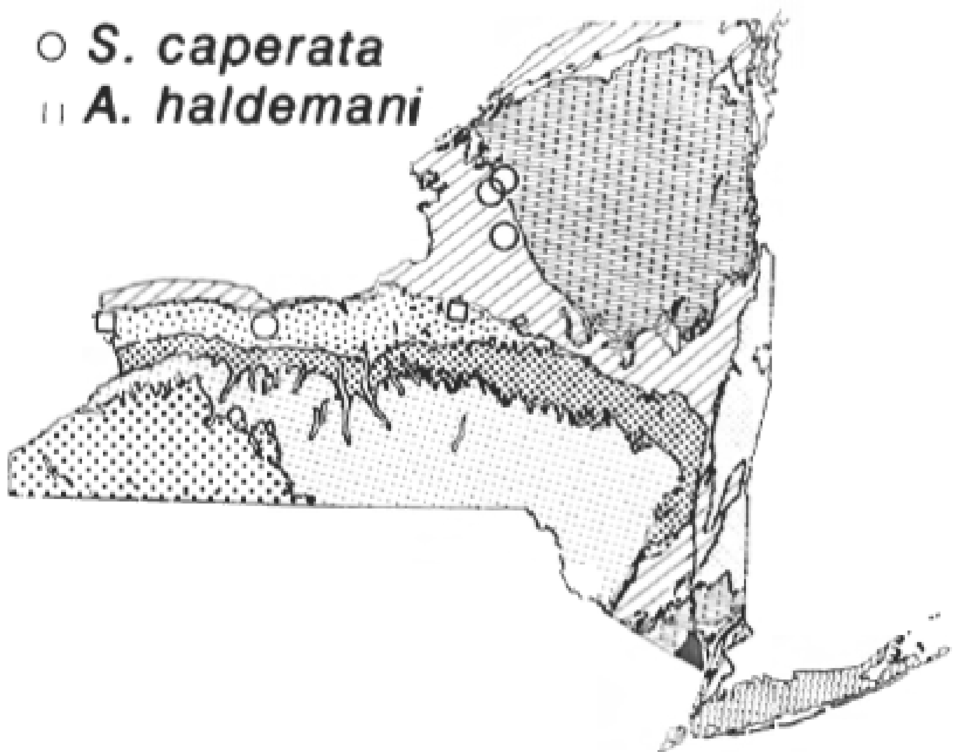

Figure 2. Records of *A. haldemani* (spindle lymnaea) in New York. Closed circles indicate records from current surveys, while open circles indicate records from museum specimens (Jokinen 1992).

Years	# of Records	# of Distinct Waterbodies	% of State
Pre-1995	_______	_______	_______
1995-2004	_______	_______	_______
2005-2014	_______	_______	_______
2015- 2023	_______	_______	_______

Table 1. Records of spindle lymnaea in New York.

Details of historic and current occurrence:

Jokinen (1992) reported that spindle lymnaea occurred historically in five counties: Clinton, Niagara, Onondaga, and Oswego. It was not detected in statewide surveys during four survey periods ranging from 1978 to 1991 by Jokinen (1992) or by Strayer (1987). It was documented at Oneida Lake, Oswego County (Harman and Berg 1971).

Spindle lymnaea has not been documented in New York since 1971. One dead shell was found near Lake Ontario during summer 2012 (Expert meeting).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Core	

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Lacustrine

b. Winter-stratified Monomictic Lake

c. Summer-stratified Monomictic Lake

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Stable	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

This snail is found in lakes with substrata that includes submerged logs, silt, sand, and mud in 0.3 to 2.0 meters of water (Jokinen 1992). Individuals attach to reeds and rushes about 20cm above the bottom (Goodrich 1932). Little is known about the chemical tolerance (Jokinen 1992) but Harman and Berg (1971) reported a pH of 8.1 in Oneida Lake where spindle lymnaea were found.

Aquatic gastropods are frequently used as bioindicators because they are sensitive to water quality and habitat alteration (Callil and Junk 2001, Salanki et al. 2003).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	Choose an item.	Choose an item.	Yes	Yes	Choose an item.

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Most gastropods belong to the clade Caenogastropoda, in which individuals mature slowly (requiring at least a year), are long-lived dioecious species with internal fertilization, and females generally attach eggs to firm substrates in late spring and early summer. Many species are narrow endemics associated with lotic habitats, often isolated in a single spring, river reach, or geographically restricted river basin (Johnson et al. 2013). In contrast, members of the clade Heterobranchia are hermaphroditic, mature quickly, and generally have shorter generation times (Johnson et al. 2013).

Spindle lymnaea has an annual cycle. About one month after ice has melted from the lake, eggs are laid in masses of 3 to 12 on submerged vegetation and sticks and logs on the bottom. Young hatch in ten days and grow rapidly. They overwinter and lay eggs during the following spring, then die by mid-summer. This snail does not travel far from where it was hatched and thus populations may be clumped in one area of a lake but not elsewhere (Morrison 1932).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Residential & Commercial Development	Housing & Urban Areas (habitat loss/degradation)
2. Natural System Modifications	Dams & Water Management/Use (dams, channelization)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (New Zealand mud snail)
4. Pollution	Industrial & Military Effluents (metals)

5. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers)
6. Pollution	Household Sewage & Urban Wastewater (untreated sewage)
7. Climate Change & Severe Weather	Habitat Shifting & Alteration

Insufficient information to assess threats.

High imperilment rates among freshwater gastropods have been linked to alteration, fragmentation and destruction of habitat and introduction of non-indigenous species. Causes of habitat degradation and gastropod species loss include dams, impounded reaches, development of riparian areas, channelization, erosion, excess sedimentation, groundwater withdrawal and associated impacts on surface streams (flows, temperature, dissolved oxygen), multiple forms of pollution (salt, metals such as Cu, Hg, Zn, untreated sewage, agricultural runoff, pesticides/fertilizers), changes in aquatic vegetation, and invasion of exotic species (Johnson et al. 2013). Most species live in the shallows (depths less than 3 m), where food abundance is greatest. As a result, drastic water fluctuations, such as draw-downs, may cause declines in snail populations (Hunt and Jones 1972).

The New Zealand mud snail (*Potamopyrgus antipodarum*) is a highly invasive species that was introduced in Idaho in the 1980s. It can have devastating consequences to aquatic ecosystems, reducing or eliminating native snail species (Benson et al. 2013). This snail was found established in Lake Ontario in 1991 (Zaranko et al. 1997) and in Lake Erie in 2005 (Levri et al. 2007).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓_ **No:** ____ **Unknown:** ____

If yes, describe mechanism and whether adequate to protect species/habitat:

The Protection of Waters Program provides protection for rivers, streams, lakes, and ponds under Article 15 of the NYS Environmental Conservation Law.

The Freshwater Wetlands Act provides protection for regulated wetlands greater than 12.4 acres in size under Article 24 of the NYS Conservation Law. The Adirondack Park Agency has the authority to regulate smaller wetlands within the Adirondack Park. The Army Corps of Engineers has the authority to regulate smaller wetlands in New York State, and the DEC has the authority to regulate smaller wetlands that are of unusual local importance. The Protection of Waters Program provides protection for rivers, streams, lakes, and ponds under Article 15 of the NYS Environmental Conservation Law.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

Basic biological information is lacking for most taxa of freshwater gastropods and there is a strong need for surveys and biological studies given the strong evidence of decline and extinction (Brown et al. 2008).

The following goals and recommended actions are provided in the NY Comprehensive Wildlife Conservation Strategy (NYSDEC 2005):

- Conduct surveys to determine distribution and population trends
- Identify habitat requirements for all life stages
- Develop specific plans for each listed species (or appropriate suite of species) that details status, threats, and actions necessary to reverse declines or maintain stable populations
- Develop fact sheets for each listed species for paper and online distribution

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2. Recommended conservation actions for spindle lymnaea.

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Originally prepared by	Kimberley Corwin
Date first prepared	June 18, 2013
First revision	February 20, 2014 (S. Hoff)
Latest revision	Transcribed March 2024

Species Status Assessment

Common Name: Threeridge **Date Updated:** 1/15/2024

Scientific Name: *Amblema plicata* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Amblema plicata belongs to the subfamily Ambleminae and the tribe Amblemini, which includes a single New York species of the genus Amblema (Haag, 2012). Until the advent of molecular phylogenetic analyses using mitochondrial DNA, the Amblemini and Quadrulini were united into a single taxon. Members of both tribes brood their larvae in all four demibranchs, and they tend to have shells sculptured with ridges, pustules or both (Graf and Cummings, 2011). A. plicata belongs to the genus Amblema, which is characterized by blunt margins on all four sides of its shell. A. plicata is characterized by folds on the lateral surface of the shell (Watters et al., 2009).

This species lives in lakes, creeks, and rivers, where it is often the most dominant species in the unionoid community. It is common in muddy, low-gradient streams and rivers (Strayer & Jirka, 1997). Since 1970, this species has been found in four New York waterbodies. It is prevalent in Cassadaga and Conewango Creeks in the Allegheny basin and shell specimens have been recently located in the Erie Canal at Macedon (Mahar & Landry, 2013). It has been extirpated from the Buffalo River drainage, yet remains abundant in Tonawanda Creek (Erie Basin). Watters et al. (2009) stated that this once widespread and abundant species has been locally extirpated in many parts of its former range, for unknown reasons.

In New York, A. plicata is ranked as “imperiled,” although it is secure throughout its range (NatureServe 2013). In North America, approximately ⅔ to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993, Stein et al.2000). While population trends in New York are unknown, it is assumed that they too are declining, due to a myriad of environmental stressors.

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** None, Proposed Special Concern listing (2019)

b. Natural Heritage Program

i. **Global:** G5 - Secure

ii. **New York:** S1S2 – Critically imperiled / Imperiled **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Least Concern (2012)

-Northeast Regional SGCN: No (2023)

Status Discussion:

A. plicata is considered common and widespread throughout much of the U.S. and Canada and is considered stable, or in some cases expanding, throughout its range (NatureServe, 2013). This species ranges from the coastal plain portion of Gulf drainages from the Escambia River in Florida west to Texas and northward into the Mississippi River drainage (Mulvey et al., 1997). Butler (1989) lists the distribution as throughout the Interior Basin and from the San Antonio River, Texas, east to the Choctawhatchee River, but not from the Yellow River. In Canada, it is restricted to southern Ontario, southern Manitoba, and southeastern Saskatchewan, but is widely distributed and often abundant. In Canada, this species is restricted to the Lake Erie drainage in Ontario (Metcalfe-Smith and Cadmore-Vokey, 2004). It extends into the Niagara River drainage in western New York (Strayer & Jirka, 1997 in NatureServe, 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Stable	Stable			(blank)
Northeastern US	Yes	Choose an item.	Choose an item.			No
New York	Yes	Unknown	Unknown		S1S2	Yes
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Unknown	Unknown		S2S3	Yes
Vermont	No	N/A	N/A			No
Ontario	Yes	Stable	Stable	2003-2013	S4	(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

Trends for New York populations are difficult to determine as most historic data comes from opportunistic naturalist collections, as opposed to more comprehensive baseline surveys. For example, mussels were documented for the first time in 50 of the 106 streams surveyed to date by the Southern Lake Ontario mussel inventory project (Mahar & Landry, 2013). This is because many of these streams had never before been surveyed for mussels, not because mussel distribution has dramatically increased. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al.2000). Based on New York's Natural Heritage S-rank, sparse historical data, and the plight of North America's freshwater mussels, it is assumed that trends are declining due to a myriad of environmental stressors.

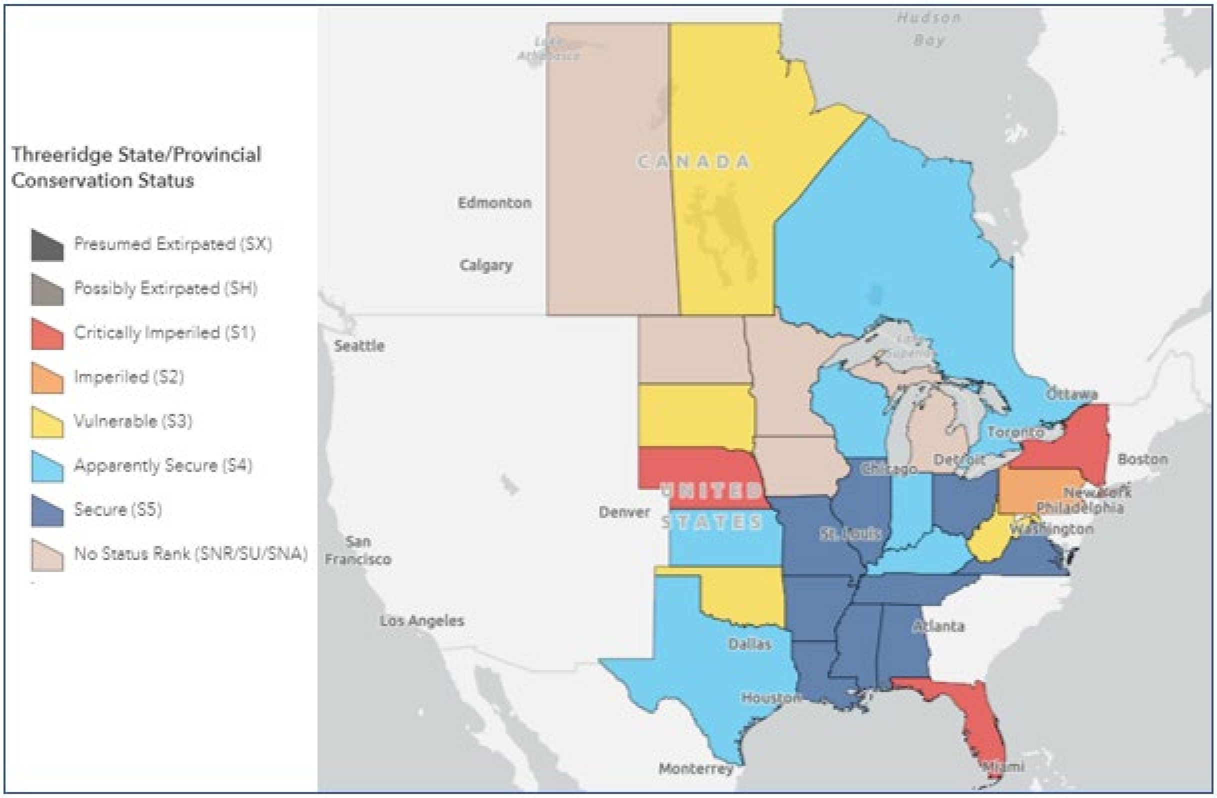

Figure 1. Threeridge distribution and status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

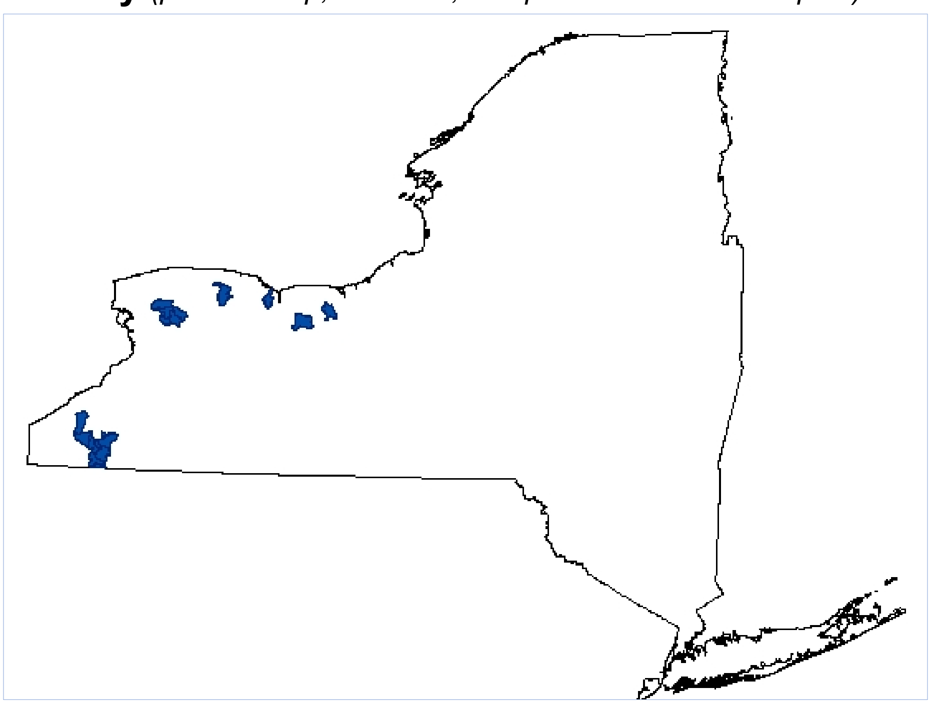

Figure 2. Records of threeridge in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
	_______	_______	_______
	_______	_______	_______
	_______	_______	_______
Total	_______	11	0.9%

Table 1. Records of threeridge in New York.

Details of historic and current occurrence:

2024: A. plicata has been found in 11 waterbodies and 16 of New York's 1802 HUC 12 waterbodies (0.9%).

This species has historically been recorded from low-gradient streams of the Allegheny basin, the Erie-Niagara basin, and several sites along the Erie Canal near Rochester. In addition, there are a few old, poorly documented, records of this species from central New York including: Oneida River, Skaneatales Lake, and old Erie Canal in Onondaga County, suggesting that it followed the Erie Canal well into central New York (Strayer & Jirka, 1997).

Since 1970, A. plicata has been found in four New York State waterbodies.

A. plicata has apparently been eliminated from the Buffalo River basin, but it remains abundant in Tonawanda Creek (Strayer & Jirka, 1997). In Tonawanda Creek at Rapids a moderate to relatively large population exists in stable habitat (NY Natural Heritage Program, 2013; Mahar & Landry, 2013). And at Royalton 4-5 animals per square meter of various sizes and age classes were found in 1998 (NY Natural Heritage Program, 2013). During The Nature Conservancy's 2005-2007 survey of the Allegheny drainage, 1584 live A. plicata was found at 30 of 105 sites. The greatest catches (up to 148 per hour) were in the mid and upper reaches of Cassadaga Creek, with some found in the mid and lower reaches of Conewango Creek. A. plicata was considered viable at 77% of the sites where found. None were found in the Upper Allegheny subbasin (The Nature Conservancy, 2009).

In Central NY, fresh shells, including juveniles and adults, were found in the Erie Canal at Macedon (Wayne County) (Mahar & Landry, 2013).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	80 km

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type: Small to Medium River

b. Geology: Moderately Buffered, Neutral

c. Temperature: Transitional Cool to Warm

d. Gradient: Low Gradient to Low-Moderate Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

A. plicata can be found in a variety of habitats, ranging from small streams to big rivers, and from locations such as lakes, reservoirs, rivers, and streams with little or no current to areas of very swift current. Individuals are found in a variety of substrates that are stable enough to support them, including mud, sand, and gravel (Metcalfe-Smith et al, 2005; Cummings & Mayer 1992; Watters et al., 2009). In New York, it is especially common in muddy, low-gradient creeks and rivers (Strayer & Jirka, 1997). It is most common in one to three feet of water, but has been found at depths of 30 feet (Parmalee & Bogan, 1998).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, A. plicata must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable habitat, they will burrow into the substrate, where they may remain for several years (Watters et al., 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as cited in NatureServe 2013).

This species has an equilibrium life history strategy, characterized primarily by long life span, mostly short term brooding, low to moderate growth rate, and late maturity, with low reproductive effort and fecundity that increases slowly after maturation. This life history strategy is considered to be favored in stable, productive habitats (Haag, 2012).

A.plicata is thought to be tachytictic, with eggs developing in May and glochidia forming from June through August. In Ohio, glochidia were released in July when water temperatures reached a sustained 20°F (Watters et al. 2009). Individuals of this species can live 50 years (Watters et al., 2009).

Hosts for A. plicata include a wide variety of fishes, including many centrarchids. Glochidia transformation was confirmed on rock bass (Ambloptites rupestris), shortnose gar (Lepisosteus platostomus), green sunfish (Lepomis cyanellus), pumpkinseed (Lepomis gibbosus), bluegill (Lepomis macrochirus), largemouth bass (Micropterus salmoides), yellow perch (Perca flavescens), white crappie (Pomoxis annularis), black crappie (Pomoxis nigromaculatus), and flathead catfish (Pylodictis olivaris). Infestation by glochidia, but not transformation was confirmed on mooneye (Hiodon tergisus), emerald shiner (Notropis antherinoides),spotfin shiner (Cyprinella spilopter), steelcolor shiner (Cyprinella whipplei), streamline chub (Erimystax dissimilis), black redhorse (Moxostoma duquesnei), golden redhorse (Moxostoma erythrurum), northern hogsucker (Hyperntelium nigricans), channel catfish (Ictalurus punctatus), logperch (Percina caprodes), freshwater drum (Aplodinotus grunniens) (Watters et al., 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Human Intrusions & Disturbance	Work & Other Activities (bridge projects and other instream work)
2. Natural System Modifications	Other Ecosystem Modifications (levees and flood walls, channelization, dredging, culverts)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (zebra mussels)
4. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers, sediment)
5. Pollution	Household Sewage & Urban Waste Water (road runoff of salts and metals, other regulated discharges)
6. Pollution	Household Sewage & Urban Waste Water (waste water treatment effluent, sewer and septic overflows)
7. Climate Change & Severe Weather	Droughts
8. Natural System Modifications	Dams & Water Management/Use (lowering of water table from agriculture, etc…, causing drying of habitat)

9. Climate Change & Severe Weather	Storms & Flooding (extreme storms)
10. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (die offs from unknown disease)

Watters et al. (2009) reports that this once widespread and abundant species is becoming rare and even extirpated in much of its range due to unknown factors.

Agricultural Runoff
Tonawanda Creek watershed is highly agricultural. And although the mid reaches of Cassadaga Creek are quite forested, both the upstream portions of Cassadaga Creek and the lower portions of Conewango Creek, in which *A. plicata* have been found, are influenced by limited agriculture. In addition, wood harvest or agricultural practices may be sources of siltation and pollution (New York State Landcover, 2010). Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis, 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry, 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag, 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag, 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al., 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag, 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag, 2012). In addition, ammonia adsorbs to sediment particles, resulting in higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom, 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al., 2012).

Runoff from Developed Land
All four New York water bodies that host *A. plicata* populations are intermittently bordered by interstate highways, state routes, and/or local roads and lawns. In addition, Cassadaga Creek also receives Jamestown's urban runoff via the Chadokoin River (New York State Landcover, 2012). These developed areas are likely sources of runoff (Gillis, 2012) containing metals and road salts. Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam, 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen, 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al., 2011).

In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991, Liquori & Insler 1985; Pandolfo et al., 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al., 2012).

Treated and Untreated Wastewater

Cassadaga Creek receives treated effluent from the city of Jamestown sewage treatment plant (SPDES, 2007). Furthermore, raw sewage from illegal dumping by recreational boats may be a concern for *A. plicata* populations in the Macedon section of the Erie Canal. Recent studies show that mussel richness and abundance decrease with increased proximity to sewage effluent (Wildenberg, 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al*.,* 1993 as cited in Watters et al., 2009) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al*.,* 1978). Endocrine disrupters from pharmaceuticals are also present in municipal sewage effluents and are increasingly common in rivers and lakes (Haag, 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag, 2012). It should be noted that in the Susquehanna Basin, Harman and Lord (2010) found no evidence that wastewater treatment plants were responsible for reductions in mussel species of greatest conservation need.

Habitat Modifications

Ecosystem modifications, such as isolated occurrences of canal dredging, instream work associated with bridge replacement or gravel mining, and vegetation removal kill mussels and destroy their habitat. This is of particular concern for the Erie Canal *A. plicata* population, as maintenance dredging by the NY Canal Corporation is an accepted practice. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge, 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy, 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge, 2000).
Threats present in the Erie Canal include maintenance dredging by the NY Canal Corporation and seasonal water draw downs. Seasonal draw downs of water bodies have been shown to impact unionid age distributions (Richardson et al. 2002) and it is likely that the Erie Canal water draw downs have negative impacts on the *A. plictata* population. During spring mussel surveys of the Erie Canal, it is not uncommon to find hundreds of fresh shells of multiple species, including *A. plicata,* and multiple age classes, many containing desiccating flesh along the exposed canal banks and bed (Mahar & Landry, 2013). This antidotal evidence suggests seasonal draw downs have a large impact on these populations.

Invasive Species

Invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugenis*) remain a threat to *A. plicata* populations in the Erie Canal, while zebra mussels pose a potential threat to populations in Cassadaga and Conewango Creeks, where they are present in the lower reaches. Chautauqua Lake's connection to Cassadaga Creek, Chadakoin Creek, is the main source of this exotic invasive. These invasive species have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka ,1997; Watters et al., 2009). En masse, Dreissenids outcompete native mussels by efficiently filtering food and oxygen from the water. They reduce reproductive success by filtering native mussel male gametes from the water column and they can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are

not able to rebury. Although zebra mussels will continue to cause problems for Chautauqua Lake, they currently appear to have minimal impact downstream. However, precautions should be taken to avoid invasions by zebra mussels to upstream locations, especially the headwater lakes in the Cassadaga system. Monitoring for zebra mussels in these lakes may provide early detection of this invader (The Nature Conservancy, 2009).
Sea lamprey control treatments – not certain if this is a threat as most occurrences are well upstream in the Tonawanda, however unsure if these areas are treated and the sensitivity of this species to lampricides.

Climate change
In a recent assessment of the vulnerability of at-risk species to climate change in New York, Schesinger et al. (2011) ranked this species as "highly vulnerable." This indicates that abundance and/or range extent within New York is likely to decrease significantly by 2050.

Impoundments – Range wide
Across its range, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓__ **No:**_____ **Unknown:**_____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any "protected stream", its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussels habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York's mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c)of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Priority conservation efforts for this species should focus on, but not be limited to, Cassadaga Creek and Tonawanda Creek (Mahar & Landry, 2013).

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley & Tank, 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Enforce No Discharge Zone, and promote the proper discharge of sewage by recreational boaters on the Erie Canal.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis, 2012).

- Establish a protocol whereas DEC staff work closely with state and local highway departments to reduce impacts to native mussels during maintenance and construction projects.

- Replace culverts that disrupt aquatic habitat connectivity to allow for passage of small fish species.

- Within the Great Lakes and Champlain watersheds, lamprey control efforts should consider specific, potentially adverse, impacts to native freshwater mussels when determining methods, including selection of lampricide formulations and concentrations.
  Lampricide treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard, 2006).

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account

for all contributing sources (e.g. point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2. Recommended conservation actions for threeridge.

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.

- Research potential interbreeding between Alasmidonta varicosa and Alasmidonta marginata and, if occurring, evaluate the potential threat to A. varicosa population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	February 26, 2014 (Samantha Hoff)
Latest revision	January 16, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Tidewater mucket **Date Updated:** 1/15/2024

Scientific Name: *Atlanticoncha ochracea* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Tidewater mucket, previously Leptodea ochracea, was recently added to a new genus, Atlanticoncha (Smith et al. 2020). Atlanticoncha ochracea belongs to the subfamily Ambleminae and the tribe Lampsilini, which includes 17 extant and 6 likely extirpated New York species of the genera Actinonaias, Epioblasma, Lampsilis, Leptodea, Ligumia, Obovaria, Potamilus, Ptychobranchus, Toxolasma, Truncilla, and Villosa (Haag 2012, Graf and Cummings 2011).

A. ochracea is a species that is usually found in depositional areas of waterbodies close to the ocean. Since 1970, A. ochracea has been found in only three New York waterbodies, but was common only in the freshwater tidal Hudson River (Strayer and Jirka 1997). Since the arrival of the zebra mussel (Dreissena polymorpha), its population has declined considerably (Strayer and Smith 1996) and it is expected to stabilize at 8 percent of its pre-invasion densities (Strayer and Malcom 2007). This species has also been reported from a couple of small Hudson River tributaries and from the Grass River in the St. Lawrence basin (Strayer and Jirka 1997). In New York, this species is ranked as "Critically imperiled," and is considered "Vulnerable" throughout its range.

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** None, Proposed Threatened listing (2019)

b. Natural Heritage Program

i. **Global:** G3G4 – Vulnerable / Apparently Secure

ii. **New York:** S1 – Critically imperiled **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Near Threatened (2012)

-Northeast Regional SGCN: Yes (2023)

- American Fisheries Society Status: Special Concern (1993)

-Species of Regional Northeast Conservation Concern (Therres 1999)

Status Discussion:

This is a widespread, though uncommon species along the coastal areas of the Atlantic Slope with noted declines in almost its entire range and some state level extirpations. Dispersal is limited to coastal plains ponds and rivers with direct connectivity to the Atlantic Ocean (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Declining	Declining			(blank)
Northeastern US	Yes	Declining	Declining			Yes
New York	Yes	Declining	Declining	1990 - 2013	S1	Yes
Connecticut	Yes	Declining	Declining		Special Concern, S2	Yes
Massachusetts	Yes	Declining	Declining		Special Concern, S2	Yes
New Jersey	Yes	Unknown	Unknown	1970 - 2013	Threatened, S2	Yes
Pennsylvania	Yes	Declining	Declining		S1	Yes
Vermont	No	N/A	N/A			No
Ontario	No	N/A	N/A			(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

Surveys are conducted during project reviews.

Trends Discussion *(insert map of North American/regional distribution and status):*

Figure 1. Tidewater mucket distribution (IUCN Redlist 2024)

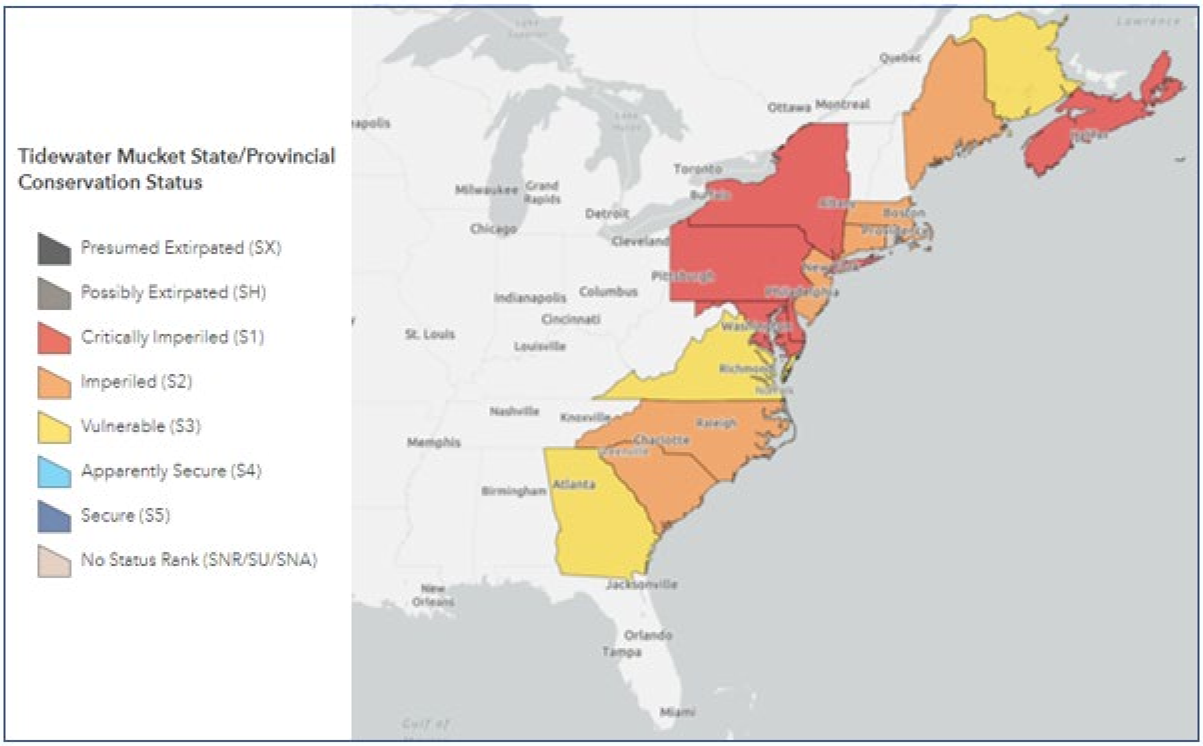

Figure 2. Tidewater mucket status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

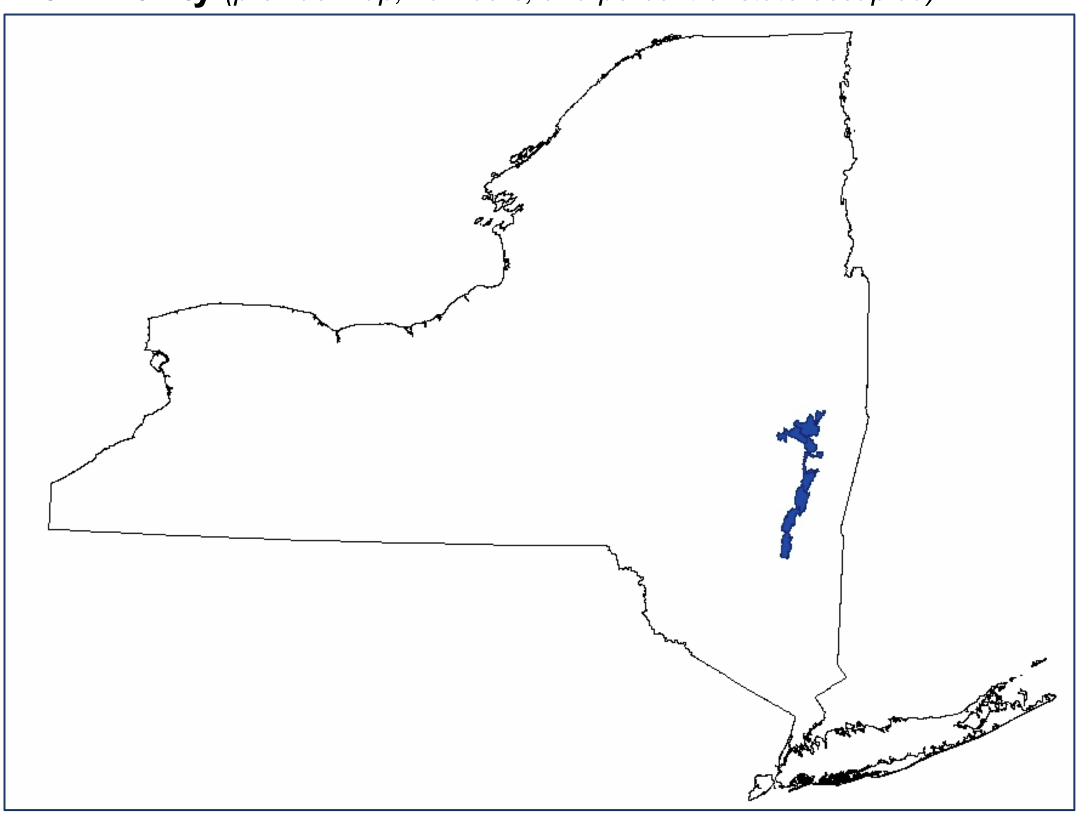

Figure 3. Records of tidewater mucket in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
	_______	_______	_______
	_______	_______	_______
	_______	_______	_______
Total	_______	3	0.5%

Table 1. Records of tidewater mucket in New York.

Details of historic and current occurrence:

2024: A. ochracea is has been found in the Hudson River and two tributaries to the Hudson River. It is found in 9 of New York's 1802 HUC 12 watersheds (0.5%).

Historically, in New York, A. ochracea was common only in the freshwater tidal Hudson River (Strayer and Jirka 1997). NY Natural Heritage (2013) reports this species from the Hudson River in Troy, Normans Kill (pre-1890), and at Bristol Beach, however no live specimens were reported from these sites upon recent revisit. A single, old, spent shell of A. ochracea was collected in 1965 in the St. Lawrence basin from the Grass River at Louisberg (Strayer and Jirka 1997).

Since 1970, A. ochracea has been found in 3 waterbodies in New York State (Figure 2).

In New York, A. ochracea was common only in the freshwater tidal Hudson River, where its range extended almost continuously from Troy to Kingston (Strayer and Jirka 1997, White et al. 2011). In 1991-1992, it constituted about 5% of the freshwater tidal Hudson River unionoid community of over one billion animals. Since the arrival of the zebra mussel (Dreissena polymorpha), the population of A. ochracea in the Hudson River declined considerably at a rate of 43 percent per year until 1998 when it was no longer detected in surveys. Populations recovered slightly in 2000–2005 and models suggest that populations will stabilize at 8% of their pre-invasion densities rather than disappearing from the Hudson River (Strayer and Malcom 2007). Also, in 2011, live specimens were found in the South Bay Creek and Marsh area near the City of Hudson.

Erickson and Fetterman (1996) reported a questionable occurrence of this species from the Grass River (Strayer and Jirka 1997). Far from previously known populations of the species, the origins and status of this population are obscure. It may represent a remnant population that survived glaciation in an offshore refugium, or these specimens may have been strays, brought up the St. Lawrence by anadromous fish (Strayer and Jirka 1997).

Since 1970, A. ochracea has been found in only three New York waterbodies, but was common only in the freshwater tidal Hudson River (Strayer and Jirka 1997). Since the arrival of the zebra mussel (Dreissena polymorpha), its population has declined considerably (Strayer and Smith 1996) and it is expected to stabilize at 8 percent of its pre-invasion densities (Strayer and Malcom 2007). In New York, this species is ranked as "Critically imperiled," and is considered "Vulnerable" throughout its range.

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Core	

Column options

Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type: Small River to Large/Great River

b. Geology: Moderately Buffered

c. Temperature: Transitional Cool to Warm

d. Gradient: Low Gradient to Moderate-High Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

A. ochracea is a freshwater species that is usually found in waterbodies close to, but not necessarily connected, to the ocean. It occurs in small to large tidal rivers, canals, coastal ponds; including artificial impoundments; and lakes that have connections with coastal waters. It inhibits muddy, sandy, and gravely substrates. A. ochracea has been found in water depths of one to more than 25 feet, in a variety of conditions, but seem to prefer depositional areas with slow currents (Nedeau 2008, Strayer and Jirka 1997).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, A. ochracea must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive nutrition and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable habitat, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as cited in NatureServe 2013).

This species has an opportunistic life history strategy. This strategy is often characterized by short life span, early maturity, high fecundity achieved soon after maturation, and, to a lesser extent, moderate to large body size. Species in this group have the fastest growth rates and highest reproductive effort. Nearly all opportunistic species are long-term brooders. This life history strategy is considered an adaptation for rapid colonization and persistence in disturbed and unstable but productive habitats (Haag 2012).

A. ochracea is a long-term brooder as eggs are fertilized in late summer and glochidia are released the following spring (Nedeau 2008). The only confirmed fish host for this species is white perch (Morone americana) (Nedeau 2008). A. ochracea is also known to heavily infest banded killifish (Fundulus diaphanus), which is thought to be a potential host (Kneeland and Rhymer 2008). The potential role of alewife (Alosa pseudoharengus) and striped bass (Morone saxatilis) as host fish needs further investigation. Longevity is probably less than 15 years (Nedeau 2008).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Human Intrusions & Disturbance	Work & Other Activities (bridge projects and other instream work)
2. Natural System Modifications	Other Ecosystem Modifications (levees and flood walls, channelization, dredging, impassable culverts)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (zebra mussels)
4. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers, sediment)
5. Pollution	Household Sewage & Urban Waste Water (road runoff of salts and metals, other regulated discharges)
6. Pollution	Household Sewage & Urban Waste Water (waste water treatment effluent, sewer and septic overflows)

7. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (die offs from unknown disease)

Anecdotal observations suggest that this species is sensitive to channel modification, pollution, sedimentation and low oxygen conditions. Threats include dams and other impoundments, channelization and dredging (NatureServe 2013).

Invasive Species
Invasive zebra mussels (*Dreissena polymorpha*) have been repeatedly cited as a threat to native mussel populations (Strayer and Jirka 1997; Watters et al. 2009). En masse, Dreissenids outcompete native mussels by efficiently filtering food and oxygen from the water. They reduce reproductive success by filtering native mussel male gametes from the water column and they can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994).

A. ochracea was known from the Hudson River at the time of the zebra mussel invasion and was abundant enough to appear regularly in samples. This species declined steeply after the zebra mussel invasion, with an annual decline rate of 43 percent per year in 1993– 1999. By 1999, population densities had fallen by 100% from their pre-invasion values, with *A. ochracea* not collected at all in 1998 or 1999. Populations recovered slightly from 2000–2005, deviating strongly from the trajectories predicted by the 1990–1999 data. Recruitment and growth of young unionids recovered to preinvasion levels. Nevertheless, the body condition of unionids in 2000– 2005 was no better than in 1993–1999. Simple exponential decay models based on the entire 1990–2005 data set suggest that *L. ochracea* populations will stabilize at 8% of their pre-invasion densities rather than disappearing from the Hudson River (Strayer and Malcom 2007).

Treated and Untreated Wastewater
Dozens of combined sewer overflow outflows discharge to the Hudson River into known *A. ochracea* habitat between Troy and Saugerties. Municipalities with CSO's include Troy, Albany, Coxsackie, Hudson, and Catskill ("Combined Sewer Overflow" 2012). In addition, *A. ochracea* habitat receives stormwater runoff and treated wastewater from adjacent municipalities (SPDES 2007). Recent studies show that mussel richness and abundance decrease with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals are also present in municipal sewage effluents and are increasingly common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012). It should be noted that in the Susquehanna Basin, Harman and Lord (2010) found no evidence that wastewater treatment plants were responsible for reductions in mussel species of greatest conservation need.

The banks of the Hudson are bordered by a mix of developed/urban land, roads, forested land, wetlands, and agriculture, including pasture and row crops (New York State Landcover 2010). Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in western and central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar and Landry 2013), indicating that runoff is a major threat to resident mussel populations.

Runoff from Developed Land

Developed lands and roads adjacent to the Hudson River are likely sources of storm water runoff containing metals and road salts. Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller and Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner and Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller and Zam 1991, Liqouri and Insler 1985, Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Agricultural Runoff

Agricultural practices and wood harvest may be sources of siltation and pollution. The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting in higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcolm 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Habitat Modifications

In the Hudson River, the US Army Corps of Engineers is authorized to perform maintenance navigation dredging under the Rivers and Harbors Act of 1899 and the Federal Clean Water Act. The total length of the existing navigation project (NYC to Waterford) is about 155 miles and includes channel maintenance with shoal removal, maintaining channel widths and depths, and widening at bends and in front of the cities of Troy and Albany to form harbors ("Introduction To The Hudson River" 2012).

Navigational dredging, and other ecosystem modifications such as in-stream work associated with bridge replacement and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy

2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000).

Impoundments – Range wide

Across its range, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery and King 1983, ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓_ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York’s mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Conservation efforts for this species should focus on the freshwater tidal Hudson River.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley and Tank 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis, 2012).

- Update wastewater treatment facilities in Troy, Albany, Coxsackie, Hudson, and Catskill to eliminate combined sewer outflows.

- Establish a protocol whereas DEC staff work closely with state and local highway departments to reduce impacts to native mussels during maintenance and construction projects.

- Work with Army Corps of Engineers to reduce the impacts of Hudson River dredging activities on native mussels.

- Replace culverts that disrupt aquatic habitat connectivity to allow for passage of small fish species.

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g. point and nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions

Action Category	Action
1.	
2.	

Table 2. Recommended conservation actions for tidewater mucket.

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	February 26, 2014 (Samantha Hoff)
Latest revision	January 16, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Tubercled blossom **Date Updated:** 1/17/2024

Scientific Name: *Epioblasma torulosa* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Epioblasma torulosa torulosa is currently believed to be extinct (NatureServe 2013). This species is not currently, and has not historically, been found in New York State (Strayer & Jirka 1997). This species was removed from the NYS Species of Greatest Conservation list in 2015.

E. torulosa belongs to the subfamily Ambleminae and the tribe Lampsilini, which includes 17 extant and 6 likely extirpated New York species of the genera Actinonaias, Epioblasma, Lampsilis, Leptodea, Ligumia, Obovaria, Potamilus, Ptychobranchus, Toxolasma, Truncilla, and Villosa (Haag 2012; Graf and Cummings 2011).

I. Status

a. Current legal protected Status

i. **Federal:** Delisted, declared extinct (USFWS 2023) **Candidate:** ____________

ii. **New York:** N/A – has never been found in NY

b. Natural Heritage Program

i. **Global:** GX – Presumed Extinct

ii. **New York:** N/A - Never found in NY **Tracked by NYNHP?:** No

Other Ranks:

-IUCN Red List: Critically endangered (2012)

-Northeast Regional SGCN: No (2023)

Status Discussion:

As a whole, the species has experienced a greater than 100% range reduction. All subspecies are thought to be extirpated except for Epioblasma torulosa rangiana which is extant in short stretches of eight to ten rivers that are largely disjunct, small, and peripheral (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	No	Extirpated	Extirpated			(blank)
Northeastern US	No	N/A	N/A		Never known from NE states	No
New York	No	N/A	N/A		Never known from NY	No
Connecticut	No	N/A	N/A			No

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	No	N/A	N/A			No
Vermont	No	N/A	N/A			No
Ontario	No	N/A	N/A			(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

There has been no monitoring for a species that has never been found in New York State.

Trends Discussion *(insert map of North American/regional distribution and status):*

The three subspecies of Epioblasma torulosa have been severely reduced in population. Epioblasma torulosa torulosa is currently believed to be extinct. Epioblasma torulosa rangiana is the only subspecies thought to still exist, occupying only 5% of its former range. Epioblasma torulosa torulosa never occurred in New York and is now extinct (Strayer & Jirka 1997, NatureServe 2013).

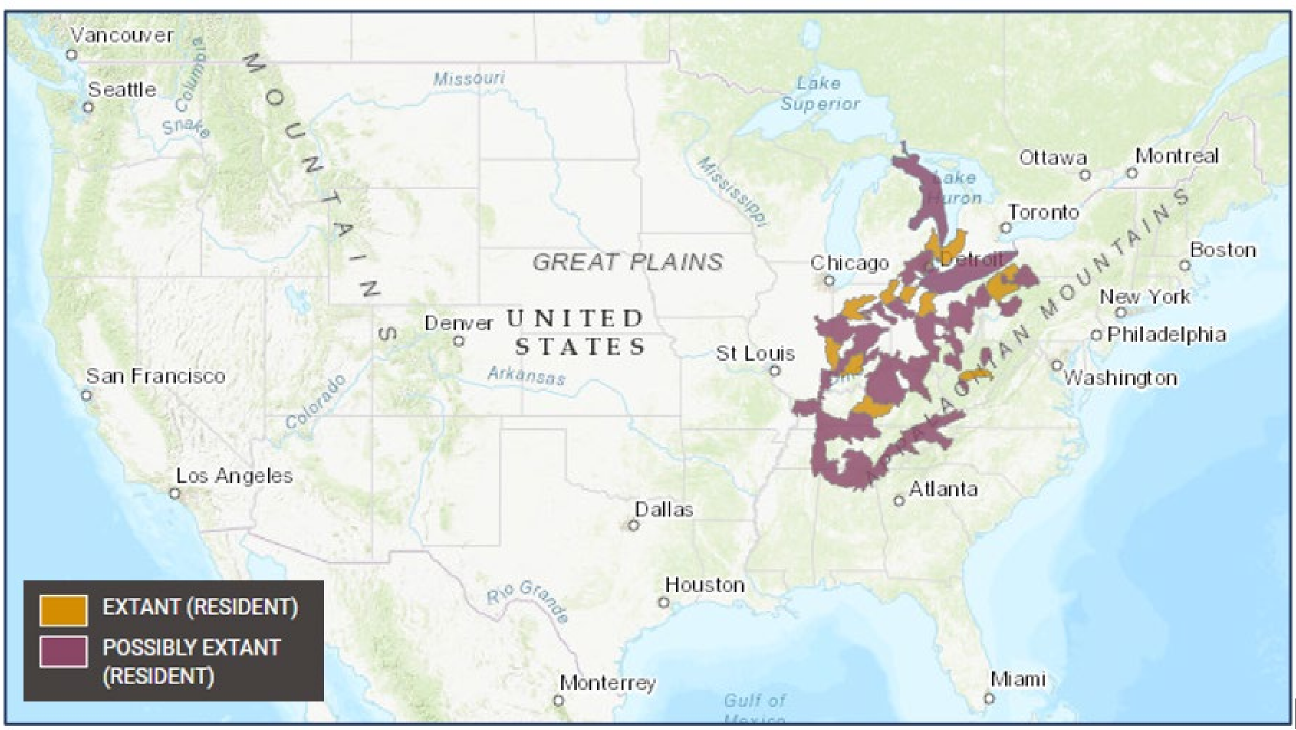

Figure 1. Tubercled blossom distribution (IUCN Redlist 2024)

Figure 2. Tubercled blossom distribution and status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

Years	# of Records	# of Distinct Waterbodies	% of State
Pre-1995	0	0	0
1995-2004	0	0	0
2005-2014	0	0	0
2015- 2023	0	0	0

Table 1. Records of tubercled blossom in New York.

Details of historic and current occurrence:

There are no historic records for this species in New York State (Strayer and Jirka 1997). There are no current records for this species in New York State, and this species is now thought to be extinct (Mahar and Landry 2013, NY Natural Heritage Program 2013, The Nature Conservancy 2009, Harman and Lord 2010, White et al. 2011, Strayer and Jirka 1997, NatureServe 2013).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
0%	Peripheral	600 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type: N/A

b. Geology: N/A

c. Temperature: N/A

d. Gradient: N/A

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
Yes	Yes	(blank)	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

Prior to extinction, in other states, E. torulosa torulosa was thought to live in medium to large rivers in riffle areas with swift current, typically in shallow water. Suitable substrates included coarse sand and gravel, stable sand and cobble, and firmly packed fine gravel (Cummings and Mayer 1992, Parmalee and Bogan 1998, Watters et al. 2009).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
No	Choose an item.	Choose an item.	No	No	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, E. torulosa torulosa must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable habitat, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC 2003 in NatureServe 2013).

This species is thought to be bradytictic and may live to 15 years old (Watters et al. 2009). Host fish are unknown, although other species of Epioblasma typically use darters and sculpins as hosts (Strayer and Jirka 1997).

VI. Threats *(from NY 2015 SWAP or newly described):*

This species has never been known from New York. It is considered extinct throughout its former range.

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: ✓ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

New York State Environmental Conservation Law, § 11-0535. 6 NYCRR Part 182: Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern; Incidental Take Permits

As a federally endangered species, this species is protected under the Endangered Species Act (ESA). The ESA provides protection against practices that kill or harm the species and requires planning for recovery and conservation actions.

Section 7(a) of the Federal Endangered Species Act, as amended, requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as Federally endangered or threatened. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR Part 402. Section 7(a)(4) requires Federal agencies to confer informally with the Service on any action that is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat. If a species is listed subsequently, Section 7(a)(2) requires Federal agencies to ensure that any activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of such a species or to destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Service.

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York's mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c)of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

N/A

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	
3.	
4.	

Table 2. (no recommended conservation actions for tubercled blossom.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	
Latest revision	January 17, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Wabash pigtoe **Date Updated:** 1/16/2024

Scientific Name: *Fusconaia flava* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Fusconaia flava belongs to the subfamily Ambleminae and the tribe Pleurobemini, which includes four extant and one likely extirpated New York species in the genera Elliptio, Fusconaia, and Pleurobema (Haag 2012). In general, the shells are of this tribe are unsculptured and larvae are brooded only in the outer demibranchs (with exceptions) (Graf and Cummings 2011). F. flava belongs to the genus Fusconaia, from the Latin word fuscus, meaning dark or dusky, and the species name flava referring to yellow-brown color of the periostracum (Watters et al. 2009).

In New York, F. flava is found in 16 waterbodies from the Erie-Niagara basin eastward to the Oswego basin (Mahar and Landry 2013). The species lives in running waters of all sizes and occasionally occurs in lakes. They can be found in muddy, hydrologically unstable, low gradient streams as well as course sand or gravel substrate (Strayer and Jirka 1997, Parmalee and Bogan 1998).

Although ranked as “imperiled” in New York, this edge of range species is considered secure throughout its range. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993, Stein et al.2000). While population trends in New York are unknown, it is assumed that they too are declining, due to a myriad of environmental stressors.

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** None, Proposed Special Concern listing (2019)

b. Natural Heritage Program

i. **Global:** G5 - Secure

ii. **New York:** S2 - Imperiled **Tracked by NYNHP?:** ________

Other Ranks:

-IUCN Red List: Least Concern (2011)

-Northeast Regional SGCN: No (2023)

Status Discussion:

F. flava is widely distributed along the entire Mississippi drainage from western New York to eastern Kansas, Nebraska, and South Dakota, south to Texas and Louisiana and Tombigbee River in Alabama. In Canada, it occurs in the Lake Huron, Lake St. Clair, and Lake Erie drainage basins of Ontario, and in the Red River- Nelson River system of Manitoba. It is generally considered stable throughout most of its range (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Stable	Stable			(blank)
Northeastern US	Yes	Choose an item.	Choose an item.			No
New York	Yes	Choose an item.	Choose an item.		S2	Yes
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Declining	Declining	2003-2013	S2S3	Yes
Vermont	No	N/A	N/A			No
Ontario	Yes	Unknown	Unknown	2003-2013	S2S3	(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

Trends for New York populations are difficult to determine as most historic data comes from opportunistic naturalist collections, as opposed to more comprehensive baseline surveys. For example, mussels were documented for the first time in 50 of the 106 streams surveyed to date by the Southern Lake Ontario mussel inventory project (Mahar and Landry 2013). This is because many of these streams had never before been surveyed for mussels, not because mussel distribution has dramatically increased. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993, Stein et al. 2000). Based on New York's Natural Heritage S-rank, sparse historical data, and the plight of North America's freshwater mussels, it is assumed that trends are declining due to a myriad of environmental stressors.

Figure 1. Wabash pigtoe distribution (IUCN Redlist 2024)

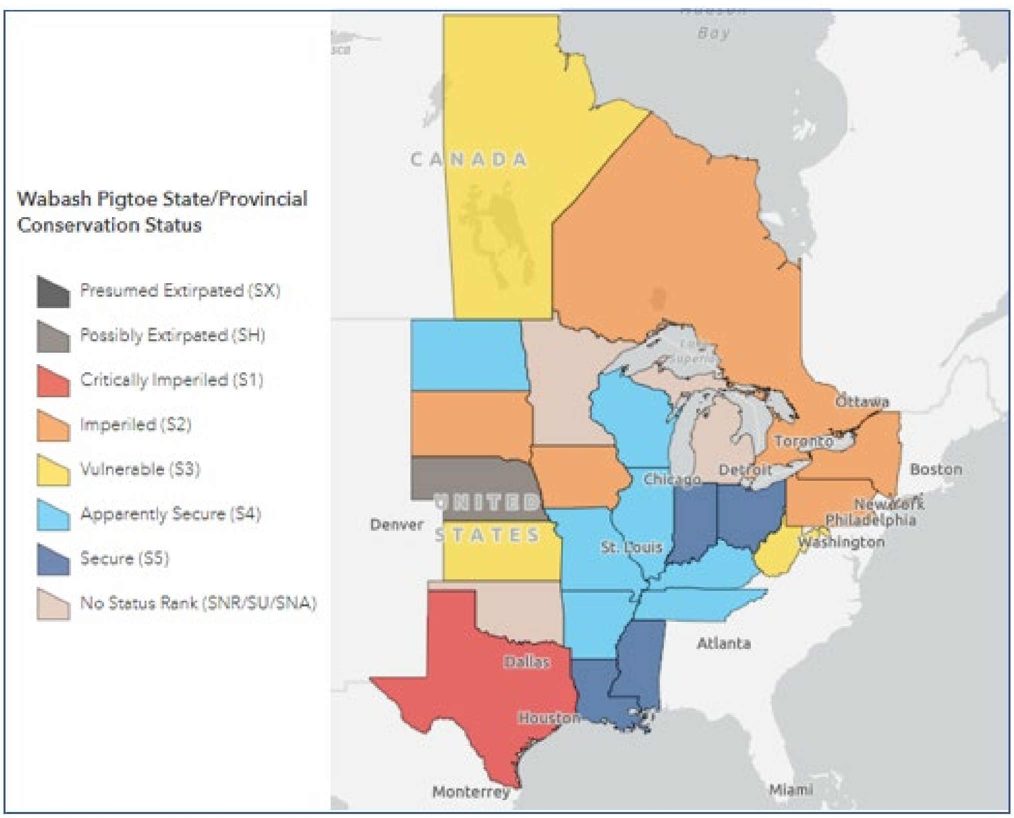

Figure 2. Wabash pigtoe status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

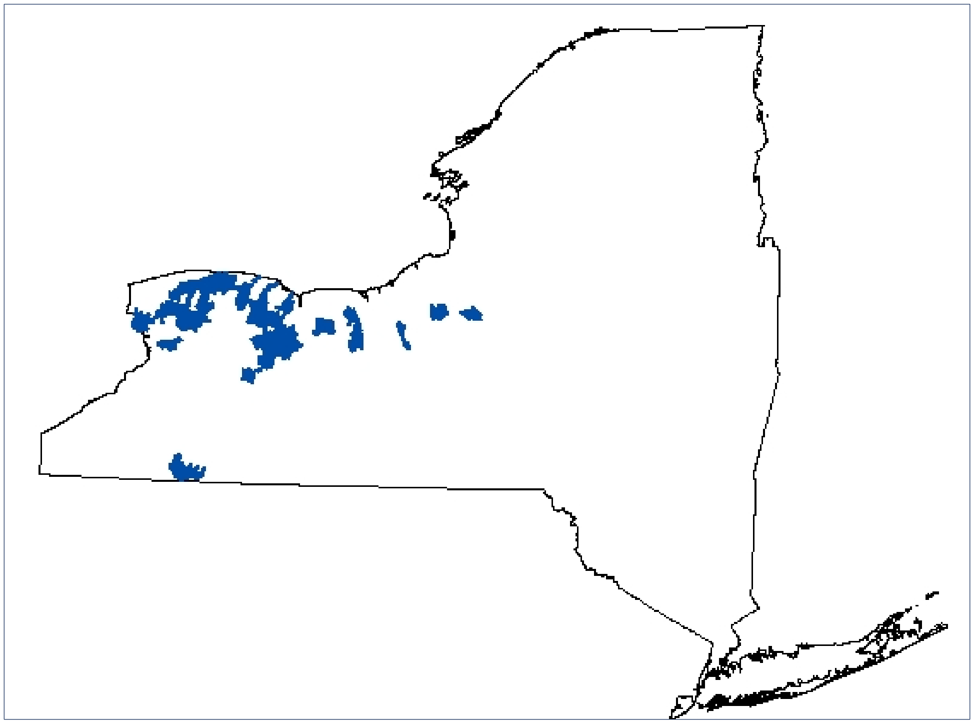

Figure 3. Records of Wabash pigtoe in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
Total		25	2.3%

Table 1. Records of Wabash pigtoe in New York.

Details of historic and current occurrence:

2024: F. flava has been found in 25 waterbodies and 41 of New York's 1802 HUC 12 watersheds (2.3%).

In New York, the northeastern edge of its range, F. flava occurs from the Erie-Niagara basin eastward into the Mohawk River. The easternmost records (Mohawk River from Utica to Mohawk: Old Erie Canal, Onondaga County) almost certainly represent a range extension through the Erie Canal. It is unclear whether populations in the lower Genesee basin and Canandaigua Outlet arose via natural, pre-Columbian dispersal or via the Erie Canal. There are no recent records from the Mohawk River. Curiously, F. flava has never been seen in the Allegheny basin in northern Pennsylvania or New York, although it is common further south and west in the Ohio basin (Strayer and Jirka 1997).

Since 1970, F. flava has been found in 16 New York State waterbodies (Figure 2).

F. flava is encountered regularly in western New York (Strayer and Jirka 1997). In the West Lake Ontario basin it has been found live in East Branch Eighteenmile Creek, Johnson Creek, Sandy Creek, East Branch Sandy Creek, and Salmon Creek, with shells found in Oak Orchard Creek. In the Lower Genesee basin, this species has been found live in Black Creek, Conesus Creek, Genesee River, and Honeoye Creek. In the Oswego basin, we have found shells in Ganaragua Creek and Canandaigua Outlet. No evidence of this species has been found in East Lake Ontario basin (Mahar and Landry 2013; Burlakova et al. in preparation). In the Erie basin, live animals have been found in Tonawanda Creek and the Niagara River (Burlakova et al., unpublished data) and shells were found in Cayuga Creek (New York Natural Heritage Program 2013). Shells have also been found in the Erie Canal (Mahar and Landry 2013).

Waterbodies with greatest F. flava abundance include Honeoye Creek with 867 live and the Genesee River with 205 live individuals found during recent surveys (Mahar and Landry 2013).

A New York Natural Heritage Program (2013) record from 1986 lists this species from Oswayo Creek in the Allegheny basin, however, this account is considered suspect for several reasons. There have never been records of the species from this watershed, and Pleurobema sintoxia is found in Oswayo Creek and may look very similar to F. flava, allowing for the possibility of misidentification. Moreover, recent intensive surveys of the Allegany basin by The Nature Conservancy (2009), which included this waterbody, did not detect this species.

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	400 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. **Size/Waterbody Type:** Small to Medium River

b. **Geology:** Moderately Buffered, Neutral to Highly Buffered, Calcareous

c. **Temperature:** Transitional Cool to Warm

d. **Gradient:** Low Gradient to Moderate-High Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

Although typically found in medium sized to large rivers (Metcalfe-Smith et al. 2005), this species can be found in running waters of all sizes, from small, headwater creeks to big rivers (ie. Niagara River), (Strayer and Jirka 1997) and lakes, including the Great Lakes (Metcalfe-Smith et al. 2005). Strayer and Jirka (1997) note that it seems to do well in muddy, hydrologically unstable, low gradient streams, while Parmalee and Bogan (1998) state that a stable substrate composed of coarse sand and gravel appears most suitable. F. flava may be found at depths up to 15 feet (NatureServe 2013).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable habitat, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as cited in NatureServe 2013).

This species has an equilibrium life history strategy, characterized primarily by long life span, mostly short term brooding, low to moderate growth rate, and late maturity, with low reproductive effort and fecundity that increases slowly after maturation. This life history strategy is considered to be favored in stable, productive habitats (Haag 2012).

F. flava is thought to be tachytictic, with eggs developing in May and glochidia developing from June to August. Glochidia do not overwinter on the female. Females abort conglutinates (mature or not) with little provocation. Watters et al. (2009) reported that glochidia will transform on silver shiner (Notropis photogenis), white crappie (Pomoxis annularis), and creek chub (Semotilus atromaculatus). Additional potential hosts for this species include black crappie (Pomoxis nigromaculatus), and bluegill (Lepomis macrochirus). Individuals of this species may reach over 25 years old (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Human Intrusions & Disturbance	Work & Other Activities (bridge projects and other instream work)
2. Natural System Modifications	Other Ecosystem Modifications (levees and flood walls, channelization, dredging, culverts)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (zebra mussels, rusty crayfish)
4. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers, sediment)
5. Pollution	Household Sewage & Urban Waste Water (road runoff of salts and metals, other regulated discharges)
6. Pollution	Household Sewage & Urban Waste Water (waste water treatment effluent, sewer and septic overflows)
7. Climate Change & Severe Weather	Droughts
8. Natural System Modifications	Dams & Water Management/Use (lowering of water table from agriculture, etc…, causing drying of habitat)
9. Climate Change & Severe Weather	Storms & Flooding (extreme storms)
10. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (die offs from unknown disease)

Agricultural Runoff

New York's southern Lake Ontario basin hosts the majority of the state's *F. flava* populations. Within this region, the primary land use adjacent to *F. flava* streams is agriculture, including cultivated cropland or pasture/hay cultivation (New York State Landcover 2010). Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in western and central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar and Landry 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Runoff from fertilizers is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting in higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Treated and Untreated Wastewater

At least eleven streams with populations of *F. flava* also receive effluent from wastewater/sewage treatment plants either directly or through nearby tributaries. These include Oak Orchard (at Medina), Johnson Creek (at Lyndonville), East Branch of Sandy Creek (at Holly), Black Creek (at South Byron, Bergen, and North Byron), Honeoye Creek (at Honeoye Falls, Honeoye, and Lima), Genesee River (at Geneseo, Avon, and Gates/Chili/Ogden), Conesus Creek (at Lakeville), Ganargua Creek (at Farmington and Victor), Canandaigua Outlet (at Shortsville, Phelps, and Clifton Springs) and the Erie Canal (SPDES 2007). The Niagara River receives effluent from numerous combined sewer overflows, in addition to wastewater treatment plant effluent ("Combined Sewer Overflow" 2012). Recent studies show that mussel richness and abundance decrease with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals are also present in municipal sewage effluents and are increasingly common in rivers and lakes (Haag, 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012). It should be noted that in the Susquehanna basin, Harman and Lord (2010) found no evidence that wastewater treatment plants were responsible for reductions in mussel species of greatest conservation need.

Runoff from Developed Land

All New York populations of *F. flava* are found in streams that are intermittently bordered by interstate highways, state routes, and/or local roads, in addition to multiple municipal areas such as Buffalo and its suburbs, Medina, Lyndonville, Holly, South Byron, Bergen, North Byron, Honeoye Falls, Honeoye, Lima, Geneseo, Avon, and Gates, Chili, Ogden, Lakeville, Farmington, Victor, Shortsville, Phelps, and Clifton Springs (New York State Landcover 2010). These developed lands are likely sources of by storm water runoff containing metals and road salts. Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller and Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner and Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller and Zam 1991, Liquori and Insler 1985, Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Habitat Modifications
Ecosystem modifications, such canal dredging, in-stream work associated with bridge replacement, gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Since this species has been found in 16 water bodies, such work, while devastating to individual populations, would not be expected to impact the species throughout its New York range. Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000).

Lamprey Control
F. flava populations are found in several stream that are regularly scheduled for sea lamprey control treatment. These streams include Sandy Creek and Johnson Creek in the Lake Ontario drainage.
In New York, tributaries harboring larval sea lamprey (*Petromyzon marinus*), are treated periodically with lampricides (TFM, or TFM/Niclosamide mixtures) by Fisheries and Oceans Canada and the U.S. Fish and Wildlife Service to reduce larval populations (Sullivan and Adair 2014). Niclosamide was originally developed as a molluscicide. While unionid mortality is thought to be minimal at TFM concentrations typically applied to streams to control sea lamprey larvae (1.0 –1.5 × sea lamprey MLC), increases in unionid mortality were observed when exposed to the niclosamide mixture, indicating that mussels may be at risk when the mixture is used in control operations. Treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard 2006).

Impoundments – Range wide
Across its range, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery and King 1983, ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: ✓ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any "protected stream", its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York's mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Priority conservation efforts for this species should focus on, but not be limited to, Honeoye Creek and the Genesee River (Mahar and Landry 2013).

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley and Tank 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Establish a protocol whereas DEC staff work closely with state and local highway departments to reduce impacts to native mussels during maintenance and construction projects.

- Replace culverts that disrupt aquatic habitat connectivity to allow for passage of small fish species.

- Within the Great Lakes and Champlain watersheds, lamprey control efforts should consider specific, potentially adverse, impacts to native freshwater mussels when determining methods, including selection of lampricide formulations and concentrations.
  Lampricide treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard USGS 2006).

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g., point and nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) -
https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	

Table 2. Recommended conservation actions for Wabash pigtoe.

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Latest revision	January 16, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Watercress snail **Date Updated:**

Scientific Name: *Fontigens nickliniana* **Updated By:**

Class: Gastropoda

Family: Hydrobiidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

The watercress snail was formerly considered member of the genus *Hydrobia* (Jokinen 1992). It is found in spring-fed streams above and below ground, most frequently in association with watercress (*Nasturtium officianale* or *Rorippa naturtium-aquaticum*). This tiny snail occurs in a patchy distribution from western New York through Wisconsin and southward through Virginia, with an extralimital population in Alabama (Jokinen 1992). If present in New York, watercress snail is likely limited to the westernmost portions of the state, though it was not documented during surveys by Jokinen (1992) or by Harman and Berg (1971).

I. Status

a. Current legal protected Status

i. **Federal:** Not listed **Candidate:** No

ii. **New York:** Not listed

b. Natural Heritage Program

i. **Global:** G5

ii. **New York:** S1S3 **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List:

-Northeast Regional SGCN:

American Fisheries Society (AFS): Currently stable

Status Discussion:

Dillon et al. (2006) described watercress snail as the most widespread and common of the nine *Fontigens* species monographed by Hershler et al. (1990). It is ranked as Critically Imperiled in Pennsylvania. In New York, this species occurred historically in the Allegany basin, and it is believed to have been extirpated from the Lake Erie basin and the Upper Hudson River basin (NYSDEC 2005).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Stable	Stable			Choose an item.
Northeastern US	Yes	Unknown	Unknown			Choose an item.
New York	Yes	Unknown	Unknown		Not listed	Choose an item.
Connecticut	No	Choose an item.	Choose an item.			Choose an item.
Massachusetts	No	Choose an item.	Choose an item.			Choose an item.
New Jersey	No	Choose an item.	Choose an item.			Choose an item.
Pennsylvania	Yes	Unknown	Unknown		Not listed (S1)	No
Vermont	No	Choose an item.	Choose an item.			Choose an item.
Ontario	No	Choose an item.	Choose an item.			Choose an item.
Quebec	No	Choose an item.	Choose an item.			Choose an item.

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

None.

Trends Discussion *(insert map of North American/regional distribution and status):*

Watercress snail has been extirpated from two watersheds in New York and has not been documented during surveys by Jokinen (1992) or Harman and Berg (1971).

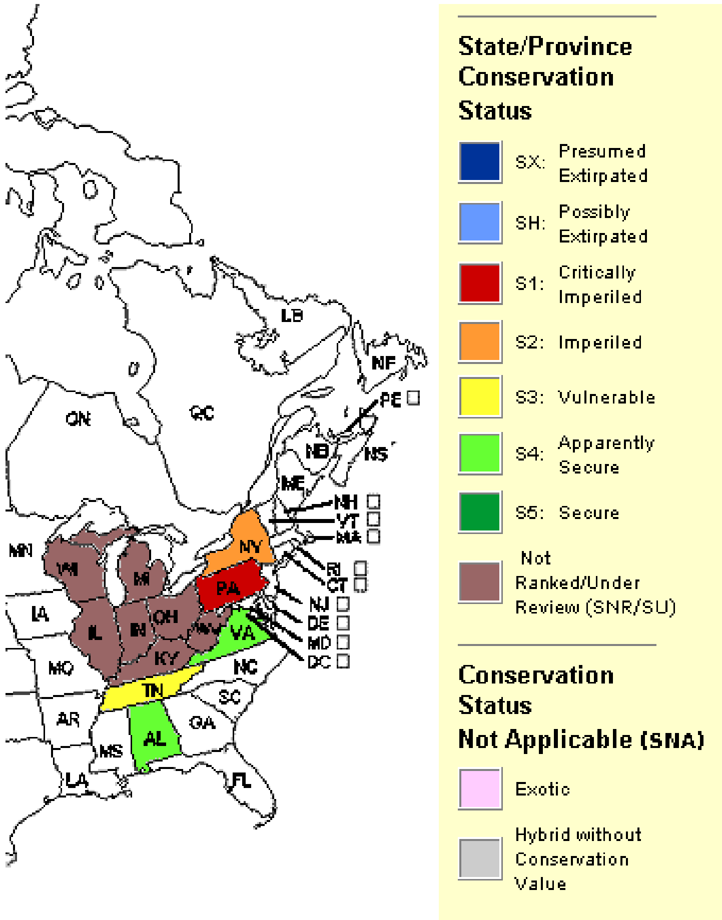

Figure 1: Conservation status of watercress snail in the United States (NatureServe 2013)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

Years	# of Records	# of Distinct Waterbodies	% of State
Pre-1995	_______	_______	_______
1995-2004	_______	_______	_______
2005-2014	_______	_______	_______
2015- 2023	_______	_______	_______

Table 1. Records of watercress snail in New York.

Details of historic and current occurrence:

The watercress snail is thought to have been extirpated from the Upper Hudson River basin and the Lake Erie basin. It occurred historically in the Allegany basin, but there are no recent records (NYSDEC 2005). Jokinen (1992) summarized historical occurrence in the late 1800s in Herkimer and Chautauqua counties, and notes a museum specimen from Niagara County.

Watercress snail was not documented during surveys by Jokinen (1992) or by Harman and Berg (1971). Jokinen (1992) suggests that if watercress snail is present in New York, it is likely restricted to western portions.

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Choose an item.	

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Sprig-fed Creek

b. Headwater/Creek

c. Intermittent Stream

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
Yes	Yes	Choose an item.	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

Snails in this family are associated with springs and spring runs where watercress (*Nasturtium officianale* or *Rorippa naturtium-aquaticum*) grows in thick mats (Jokinen 1992), as well as streams and pools inside caves (Dillon et al. 2006). Watercress snails require relatively cool, alkaline streams (Biggs et al. 2011). Evans (2004) found watercress snails in calcareous springs in Pennsylvania and stated that it would likely be found in the rich limestone valleys of the Central Appalachian Forest Ecoregion.

Dillon et al. (2006) noted that population densities become rapidly attenuated downstream, suggesting that this snail is dependent on constant temperatures, or another unique aspect of the spring environment.

Aquatic gastropods are frequently used as bioindicators because they are sensitive to water quality and habitat alteration (Callil and Junk 2001, Salanki et al. 2003).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	Choose an item.	Choose an item.	Yes	Yes	Choose an item.

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Sexes are separate in almost all Hydrobiidae. Eggs are laid singly and attached to solid substrates (Dillon et al. 2006).

Populations of watercress snail appear to maintain high densities year-round, suggesting that reproduction might be continuous (Dillon et al. 2006).

Most Gastropods belong to the clade Caenogastropoda, in which individuals mature slowly (requiring at least a year), are long-lived dioecious species with internal fertilization, and females generally attach eggs to firm substrates in late spring and early summer. Many species are narrow endemics associated with lotic habitats, often isolated in a single spring, river reach, or geographically restricted river basin (Johnson et al. 2013). In contrast, members of the clade Heterobranchia are hermaphroditic, mature quickly, and generally have shorter generation times (Johnson et al. 2013).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Residential & Commercial Development	Housing & Urban Areas (habitat loss/degradation)
2. Natural System Modifications	Dams & Water Management/Use (dams, channelization)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (New Zealand mud snail, Phragmites)
4. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers)
5. Natural System Modifications	Dams & Water Management/Use (groundwater withdrawal)
6. Energy Production & Mining	Mining & Quarrying (changes in hydrology due to gravel and limestone mining)

High imperilment rates among freshwater gastropods have been linked to alteration, fragmentation and destruction of habitat and introduction of non-indigenous species. Causes of habitat degradation and gastropod species loss include dams, impounded reaches, development of riparian areas, channelization, erosion, excess sedimentation, groundwater withdrawal and associated impacts on surface streams (flows, temperature, dissolved oxygen), multiple forms of pollution (salt, metals such as Cu, Hg, Zn, untreated sewage, agricultural runoff, pesticides/fertilizers), changes in aquatic vegetation, and invasion of exotic species (Johnson et al. 2013).

The New Zealand mud snail (*Potamopyrgus antipodarum*) is a highly invasive species that was introduced in Idaho in the 1980s. It can have devastating consequences to aquatic ecosystems, reducing or eliminating native snail species (Benson et al. 2013). This snail was found established in Lake Ontario in 1991 (Zaranko et al. 1997) and in Lake Erie in 2005 (Levri et al. 2007).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓_ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

The Protection of Waters Program provides protection for rivers, streams, lakes, and ponds under Article 15 of the NYS Environmental Conservation Law.

The Freshwater Wetlands Act provides protection for regulated wetlands greater than 12.4 acres in size under Article 24 of the NYS Conservation Law. The Adirondack Park Agency has the authority to regulate smaller wetlands within the Adirondack Park. The Army Corps of Engineers has the authority to regulate smaller wetlands in New York State, and the DEC has the authority to regulate smaller wetlands that are of unusual local importance. The Protection of Waters Program provides protection for rivers, streams, lakes, and ponds under Article 15 of the NYS Environmental Conservation Law.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

Basic biological information is lacking for most taxa of freshwater gastropods and there is a strong need for surveys and biological studies given the strong evidence of decline and extinction.

The following goals and recommended actions are provided in the NY Comprehensive Wildlife Conservation Strategy (NYSDEC 2005):

- Conduct surveys to determine distribution and population trends
- Identify habitat requirements for all life stages
- Develop specific plans for each listed species (or appropriate suite of species) that details status, threats, and actions necessary to reverse declines or maintain stable populations
- Develop fact sheets for each listed species for paper and online distribution

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	
2.	

Table 2. Recommended conservation actions for watercress snail.

VII. References

Benson, A.J., R.M. Kipp, J. Larson, and A. Fusaro. 2013. *Potamopyrgus antipodarum*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=1008 Revision Date: 6/11/2012.

Biggs, J., M. Walton, and T. Sternback. 2011. Survivability of watercress snails in springs of central Pennsylvania. Journal of Ecological Research 13:44-47.

Callil, T. C. and W. J. Junk. 2001. Aquatic gastropods as mercury indicators in the Pantanal of Pocone region (Mato Grosso, Brasil). Water, Air and Soil Pollution. 319:319-330.

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Zaranko, D.T., D.G. Farara, and F.G. Thompson. 1997. Another exotic mollusk in the Laurentian Great Lakes: the New Zealand native *Potamopyrgus antipodarum* (Gray 1843) (Gastropoda, Hydrobiidae).

Originally prepared by	Kimberley Corwin
Date first prepared	June 19, 2013
First revision	February 20, 2014 (S. Hoff)
Latest revision	Transcribed March 2024

Species Status Assessment

Common Name: Wavy-rayed lampmussel **Date Updated:** 1/16/2024

Scientific Name: *Lampsillis fasciola* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Lampsilis fasciola belongs to the subfamily Ambleminae and the tribe Lampsilini, which includes 17 extant and 6 likely extirpated New York species of the genera Actinonaias, Epioblasma, Lampsilis, Leptodea, Ligumia, Obovaria, Potamilus, Ptychobranchus, Toxolasma, Truncilla, and Villosa (Haag, 2012; Graf and Cummings, 2011).

L. fasciola is mainly found in and around riffle areas of clear, hydrologically stable, fast moving water (Watters et al., 2009). Since 1970, L. fasciola has been found in six New York waterbodies. Historically, it has been collected in the Erie, Western Lake Ontario, and Lower Genesee basins (Strayer & Jirka, 1997). L. fasciola no longer considered abundant in any New York location, however they are most commonly found in the Allegheny River and its tributaries (The Nature Conservancy, 2009).

With a state rank of "critically imperiled," L. fasciola is listed as threatened in New York State, although it is secure throughout its range (NatureServe, 2013). In North America, approximately ⅔ to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al.2000). While population trends in New York are unknown, it is assumed that they too are declining, due to a myriad of environmental stressors.

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** Threatened

b. Natural Heritage Program

i. **Global:** G5 - Secure

ii. **New York:** S1S2 – Critically imperiled / Imperiled **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Least Concern (2012)

-Northeast Regional SGCN: No (2023)

-Midwest Regional SGCN: Watchlist (Assessment priority)

-Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Special Concern (2010)

American Fisheries Society Status: Currently Stable (1993)

Status Discussion:

The range of this species includes the Great Lakes drainage; including the tributaries of Lake Michigan, Lake Huron, Lake St. Clair, Lake Erie, Lake Huron; and the Ohio-Mississippi drainage south to the Tennessee River system, with edge of range populations (especially in Canada) experiencing slight decline (NatureServe, 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Stable	Stable			(blank)
Northeastern US	Yes	Unknown	Unknown			No
New York	Yes	Choose an item.	Choose an item.		Threatened, S1S2	Yes
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Unknown	Unknown		S3S4	No
Vermont	No	N/A	N/A			No
Ontario	Yes	Increasing	Increasing	2003-2013	Threatened, S2	(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

Trends for New York populations are difficult to determine as most historic data comes from opportunistic naturalist collections, as opposed to more comprehensive baseline surveys. For example, mussels were documented for the first time in 50 of the 106 streams surveyed to date by the Southern Lake Ontario mussel inventory project (Mahar & Landry, 2013). This is because many of these streams had never before been surveyed for mussels, not because mussel distribution has dramatically increased. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al.2000). Based on New York's Natural Heritage S-rank, sparse historical data, and the plight of North America's freshwater mussels, it is assumed that trends are declining due to a myriad of environmental stressors.

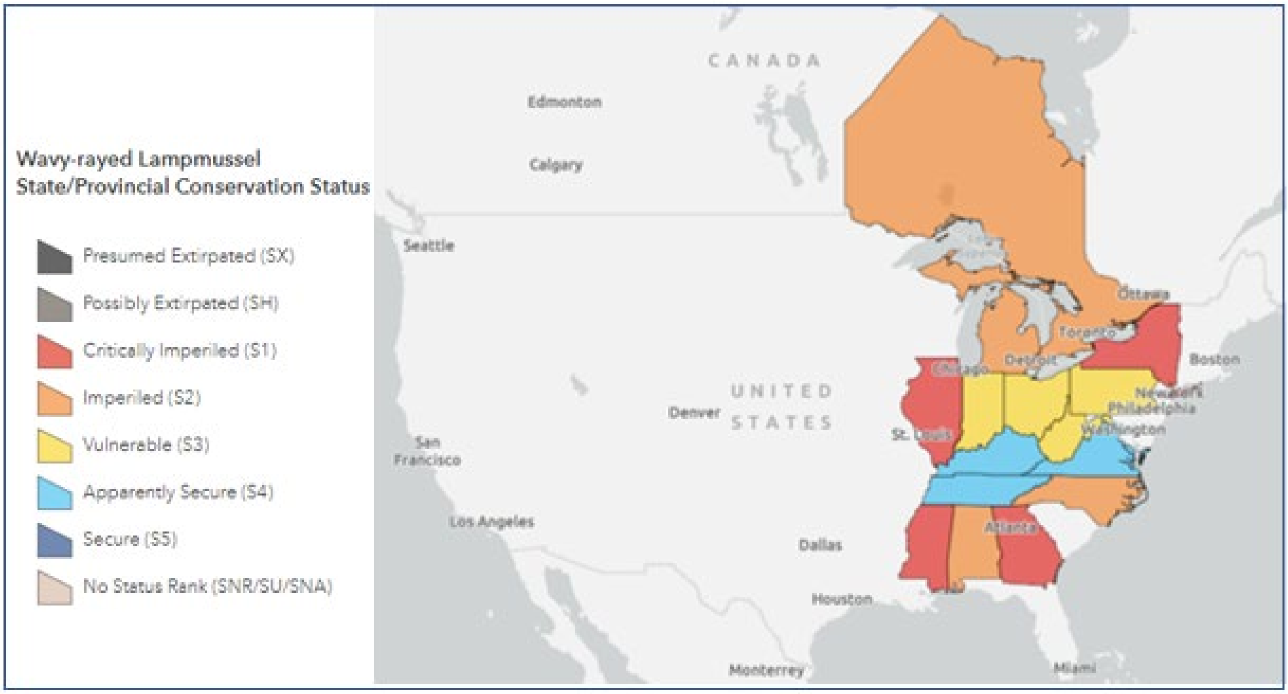

Figure 1. Wavy-rayed lampmussel status and distribution (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

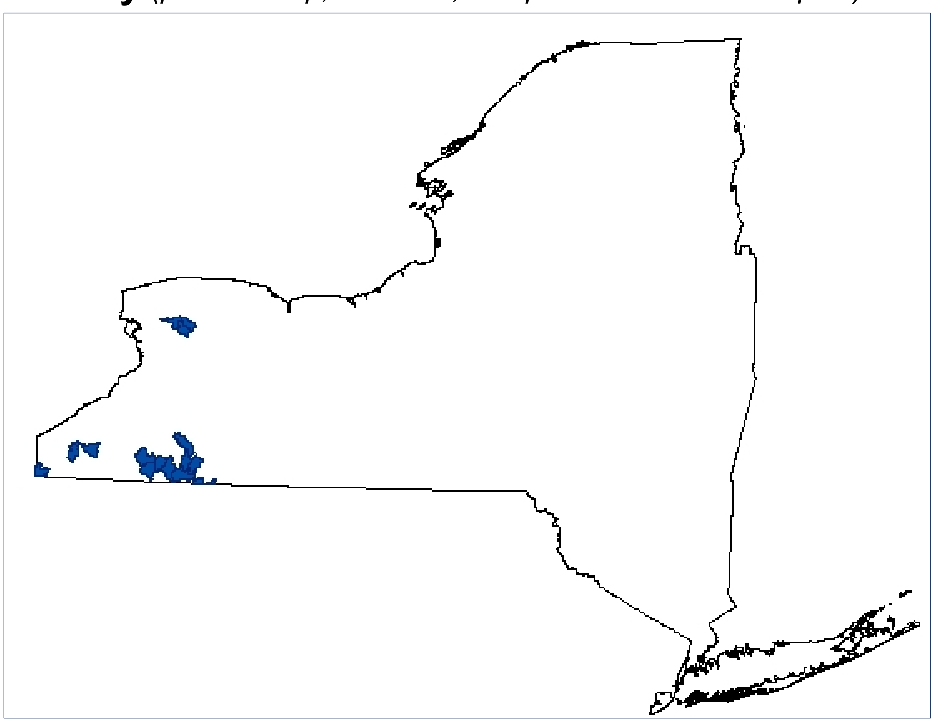

Figure 2. Records of wavy-rayed lampmussel in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
	______	______	______

	_______	_______	_______
	_______	_______	_______
Total	_______	12	0.8%

Table 1. Records of wavy-rayed lampmussel in New York.

Details of historic and current occurrence:

2024: L. fasciola has been found in 12 waterbodies and 15 of New York's 1802 HUC 12 watersheds (0.8%).

Prior to the 2005 Nature Conservancy survey of the Allegheny basin, fewer than 20 specimens had ever been seen in the New York. Historically, L. fasciola has been collected in the Great Lakes basin from the Niagara River, Medina (presumably Oak Orchard Creek), and the Genesee River (Strayer and Jirka 1997).

Since 1970, L. fasciola has been found in six New York State waterbodies (Figure 2).

Between 2005 and 2007, 79 live L. fasciola were found in the Allegheny River between Olean and Salamanca and in Oswayo Creek, a tributary to the Allegheny River. It was also found as shells in Olean Creek. They were never considered abundant at any sites but greatest catches were in the Allegheny River around Olean and in Oswayo Creek. This species was considered viable at 8 of 22 sites where it was found (The Nature Conservancy, 2009). One more live L. fasciola was found in Allegheny River at Olean in 2013 (Burlakova, Karatayev, unpublished data). In 2009, five live individuals and one spent shell found in Red House Brook, a tributary to the Allegheny River (New York Natural Heritage Program, 2013). There is also an occurrence recorded for French Creek (NY Natural Heritage Program, 2013; 2 live found in 2013; Burlakova and Karatayev, unpublished data).

In the Erie Basin's Tonawanda Creek, four spent shells, two of which were recently dead, were found in 1998 (New York Natural Heritage Program, 2013), and one live mussel in 2011 (Burlakova, unpublished data).

Although rare in New York State, L.fasciola is relatively stable within its core biogeographic region (Haag, 2012).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Peripheral	375 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type: Medium River to Headwater/Creek

b. Geology: Moderately Buffered

c. Temperature: Cold to Warm

d. Gradient: Low Gradient to Moderate-High Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
Yes	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

Watters et al. (2009) describes L. fasciola as a high-water-quality species of fast moving water. It is mainly found in and around riffle areas of clear, hydrologically stable, small- to medium-sized streams and rivers of various sizes, at depths of up to 1 m with clean substrates of gravel and sand, stabilized with cobble and boulders (Watters et al., 2009; Strayer & Jirka, 1997; Metcalfe-Smith et al., 2005; Cummings & Mayer, 1992). Although, according to Spoo (2008) this species buries itself in mud, fine sand, or a sand-gravel mix. Its habitat specificity is considered by NatureServe (2013) to be narrow to moderate.

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, L.fasciola must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable habitat, they will burrow into the substrate, where they may remain for several years (Watters et al., 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as cited in NatureServe, 2013).

It has a periodic life history strategy, characterized by moderate to high growth rate, low to intermediate life span, age at maturity, and fecundity, but generally smaller body size than opportunistic species. Most species are long-term brooders. This life history strategy is considered an adaptation to allow species to persist in unproductive habitats or habitats that are subject to large-scale, cylindrical environmental variation or stress (Haag, 2012).

L. fasciola is bradytictic, with glochidia overwintering on the female. This species spawns in August, and is gravid the following May to August, although it is suspected that this species may have two broods per year with gravid females found from August to October and again from April to August (Zale & Neves, Ortmann, and Watters & O'Dee as cited in Watters et al., 2009). Glochidia have been found to transform on largemouth bass (Micropterus salmoides) and longear sunfish (Lepomis megalotis). An additional possible host for this species is smallmouth bass (Micropterus dolomieu) (Strayer & Jirka, 1997; Watters et al., 2009, Spoo 2008, Zale & Neves, 1982a; 1982b). Specimens greater than 20 years old are rare (Watters et al., 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Human Intrusions & Disturbance	Work & Other Activities (bridge projects and other instream work)
2. Natural System Modifications	Other Ecosystem Modifications (levees and flood walls, channelization, dredging, culverts)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (zebra mussels, rusty crayfish)
4. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers, sediment)
5. Pollution	Household Sewage & Urban Waste Water (road runoff of salts and metals, other regulated discharges)
6. Pollution	Household Sewage & Urban Waste Water (waste water treatment effluent, sewer and septic overflows)
7. Climate Change & Severe Weather	Droughts
8. Natural System Modifications	Dams & Water Management/Use (lowering of water table from agriculture, etc…, causing drying of habitat)
9. Climate Change & Severe Weather	Storms & Flooding (extreme storms)
10. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (die offs from unknown disease)

Agricultural Runoff
The largest populations of *L. fasciola* are found in the Allegheny basin, between Olean and Salamanca. Roughly half of this length of stream is bordered by agriculture, primarily in the Olean/Allegany area (New York State Landcover, 2010). Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis, 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry, 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag, 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag, 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al., 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag, 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag, 2012). In addition, ammonia adsorbs to sediment particles, resulting in higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom, 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Runoff from Developed Land
Between Olean and Salamanca, the Allegheny River is intermittently bordered by interstate highways, state routes, and several local roads. In addition, the habitat of *L.fasciola* receives stormwater runoff from the cities of Olean, Salamanca, and the village of Portville, either directly to the Allegheny River or through tributaries (New York State Landcover, 2010). These developed lands are likely sources of stormwater runoff containing metals and road salts. Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam, 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen, 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al., 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991; Liquori & Insler 1985; Pandolfo et al., 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al., 2012).

Treated Wastewater
The habitat of *L.fasciola* receives treated waste water from the cities of Olean, Salamanca, and the village of Portville, either directly to the Allegheny River or through tributaries (SPDES, 2007). Recent studies show that mussel richness and abundance decrease with increased proximity to sewage effluent (Wildenberg, 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater

treatment plants has been found to be toxic to glochidia (Goudraeu et al., 1993) and at sub-lethal exposure adult mussels exhibit decreased respiratory efficiency (Anderson et al., 1978). Endocrine disrupters from pharmaceuticals are also present in municipal sewage effluents and are increasing common in rivers and lakes (Haag, 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012). It should be noted that in the Susquehanna basin, Harman and Lord (2010) found no evidence that wastewater treatment plants were responsible for reductions in mussel species of greatest conservation need.

Flood Control Projects
Within the habitat of *L.fasciola*, large stretches of the Allegheny River are in leveed, water control projects, requiring periodic maintenance ("New York State Flood Protection," 2013). Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. These structures confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al., 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke, 1999; Yeager, 1993; Nedeau, 2008).

Other Ecosystem Modifications
Ecosystem modifications, such as isolated occurrences of canal dredging, instream work associated with bridge replacement, gravel removal, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge, 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy, 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge, 2000).

Climate Change
In a recent assessment of the vulnerability of at-risk species to climate change in New York, Schesinger et al. (2011) ranked this species as "moderately vulnerable." This indicates that abundance and/or range extent within New York is likely to decrease by 2050.

Other
Studies show that *L. fasciola* abundance and distribution is highly dependent on the presence of specific host fish (McNichols et al., 2010). Degradation of host fish species from the ecosystem can result in lowered reproduction rates, thus reducing the *L. fasciola* population.

Impoundments - Range wide
Across its range, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range.

Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓_ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

New York State Environmental Conservation Law, § 11-0535. 6 NYCRR Part 182: Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern; Incidental Take Permits

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any "protected stream", its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York's mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c)of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Priority conservation efforts for this species should focus on, but not be limited to, Oswayo Creek and the Allegheny River near Olean.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al., 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis, 2012).

- Establish a protocol whereas DEC staff work closely with state and local highway departments to reduce impacts to native mussels during maintenance and construction projects.

- Establish a protocol whereas DEC staff work closely with flood control management to reduce or impacts to native mussels during maintenance flood control projects.

- In areas subject to tree harvest, promote best forestry practices to reduce/eliminate sedimentation and to ensure that substantial woody vegetation in areas directly adjacent to streams continue to provide temperature-moderating shade to the stream.

- Replace culverts that disrupt aquatic habitat connectivity to allow for passage of small fish species.

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g. point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - ***https://www.iucnredlist.org/resources/conservation-actions-classification-scheme***

Conservation Actions	
Action Category	**Action**
1.	

Table 2. Recommended conservation actions for wavy-rayed lampmussel.

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between Alasmidonta varicosa and Alasmidonta marginata and, if occurring, evaluate the potential threat to A. varicosa population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.

- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	February 26, 2014 (Samantha Hoff)
Latest revision	January 16, 2024 (Amy Mahar)

Species Status Assessment

Common Name: White heelsplitter **Date Updated:** 1/17/2024

Scientific Name: *Lasmigona complanata* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Lasmigona complanata is thought to be extirpated in New York State. It has not been observed in New York in over 80 years. This species was removed from the New York Species of Greatest Conservation List in 2015.

L. complanata belongs to the subfamily Unioninae, diagnosed by the presence of subtriangular glochidia with large, medial hooks, and the tribe Anodontini, which includes 16 extant and 1 likely extirpated New York species of the genera Alasmidonta, Anodonta, Anodontoides, Lasmigona, Pyganodon, Simpsonaias, Strophitus, and Utterbackia (Haag, 2012, Graf and Cummings, 2011). Lasmigona complanata was recognized as being comprised of two subspecies, L. c. complanata, and L. c. alabamensis, but L. c. alabamensis was elevated to species status based on shell morphology and preliminary genetic analysis (Williams et al. 2008).

This species may be found in a variety of habitats, from medium-sized rivers to permanent sloughs, backwater bays, lakes, and reservoirs. In North America it is widespread from Canada to the Gulf and Pennsylvania to Montana. Modern surveys have shown that this species is on an upward trend in terms of range and abundance (NatureServe 2013).

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** None

b. Natural Heritage Program

i. **Global:** G5 - Secure

ii. **New York:** SNA – Not Applicable **Tracked by NYNHP?:** No

Other Ranks:
-IUCN Red List: Least Concern (2015)

-Northeast Regional SGCN: No (2023)

Status Discussion:

This species is distributed throughout the entire Mississippi River drainage from Lake Winnipeg-Nelson River system to western Ontario, the middle Great Lakes-St. Lawrence River system and tributaries of Lake Michigan, Lake St. Clair, and Lake Erie; Pennsylvania west to Minnesota and Iowa south to Oklahoma and Louisiana, and in the western Gulf Coast drainage. It is considered stable throughout its range and expanding in some places (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Stable	Stable			(blank)
Northeastern US	Yes	Unknown	Unknown			No
New York	No	Extirpated	Extirpated			No
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	Yes	Declining	Unknown	2010 assessment	S1S2	Choose an item.
Vermont	No	N/A	N/A			No
Ontario	Yes	Stable	Stable	2003-2013	S4	(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

Trends Discussion *(insert map of North American/regional distribution and status):*

In the short term, the species has shown to be increasing in distribution, at about 10-25%. Long term, L. complanata has seen an increase somewhere between 10-25% and a decrease of 30%. Many studies have shown no examples at sites that historically held L. complanata, indicating the species has become extirpated (NatureServe 2013).

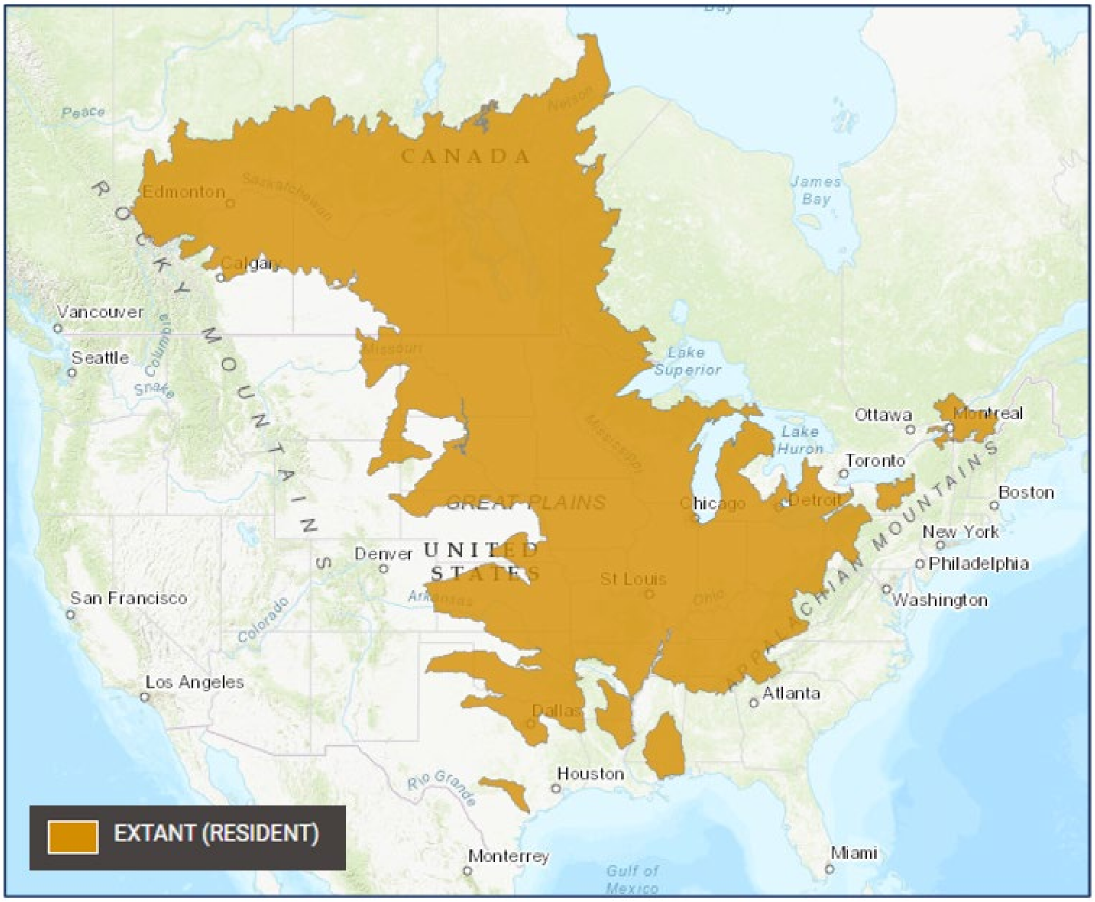

Figure 1. White heelsplitter distribution (IUCN Redlist 2024)

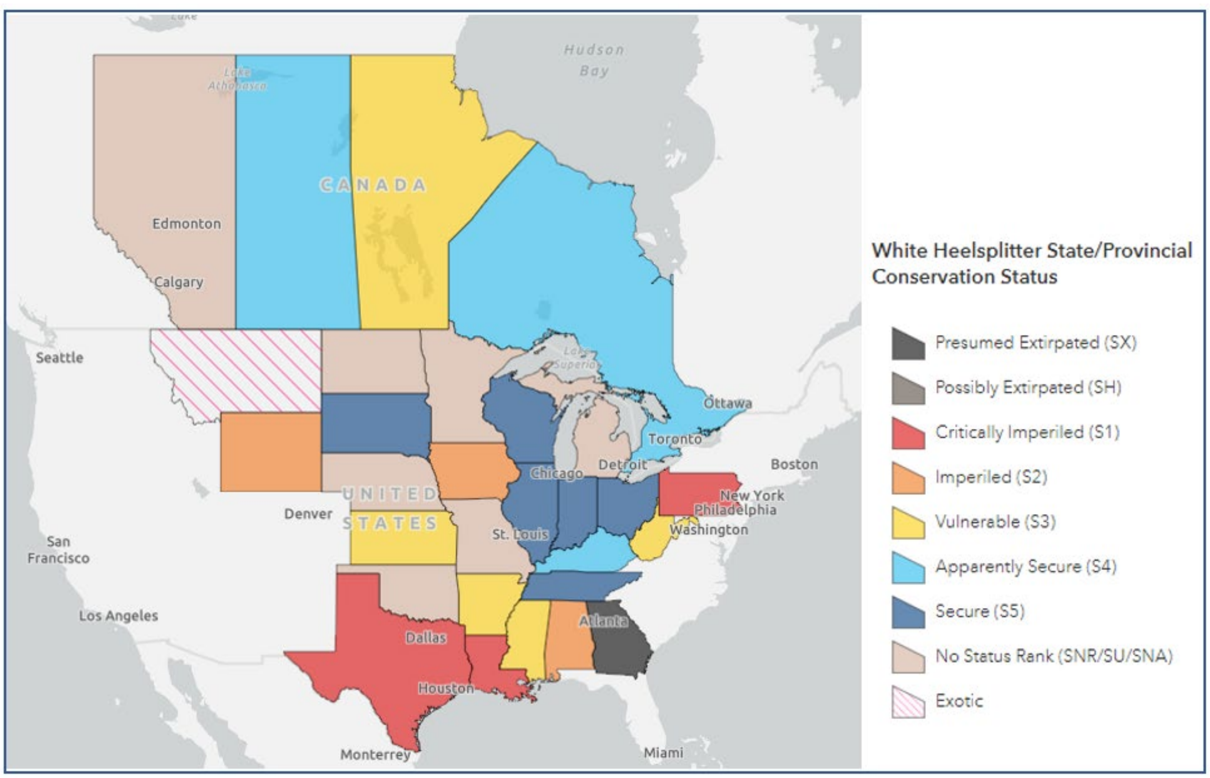

Figure 2. White heelsplitter status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

Years	# of Records	# of Distinct Waterbodies	% of State
Pre-1995	____	1	1 of 56 HUC 8 watersheds
1995-2004	0	0	0
2005-2014	0	0	0
2015- 2023	0	0	0

Table 1. Records of white heelsplitter in New York.

Details of historic and current occurrence:

Several specimens were taken from the Erie Canal at Pittsford in the 1920's. There are also several old, indefinite records from "western New York" or "Buffalo" (Strayer & Jirka 1997).

Despite recent surveys of many low gradient streams and the Erie Canal between Buffalo and Rochester, there are no recent records for this species from New York (Mahar and Landry 2014).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
0%	Peripheral	300 miles

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type:

b. Geology:

c. Temperature:

d. Gradient:

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item

Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

In other states, L. complanata may be found in a variety of habitats, from small streams to medium-sized rivers (often in pools or sluggish waters), permanent sloughs, backwater bays, lakes, and reservoirs. It is most commonly found in low-gradient, quiet waters, usually less than three feet in depth although it has been found at depths of 15 to 20 feet. Substrates include mud, silt, sand, or fine gravel (Cummings and Mayers 1992, Metcalfe-Smith et al. 2005, Parmalee & Bogan 1998, Strayer & Jirka 1997, Watters et al. 2009).

Because of its ability to parasitize common carp, it is common below sewage outfalls and impoundments (Watters et al. 2009). It is one of few unionids that seem to do well in disturbed habitats (Metcalfe-Smith et al. 2005, Strayer & Jirka 1997).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
No	Choose an item.	Choose an item.	No	No	Choose an item.

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, L. complanata must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable substrate, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as cited in NatureServe 2013).

Most reported hosts are centrarchids. Glochidia are known to transform on common carp (Cyprinus carpio), banded killifish (Fundulus diaphanous), green sunfish (Lepomis cyanellus), orangespotted sunfish (Lepomis humilis), longear sunfish (Lepomis megalotis), largemouth bass (Micropterus salmoides), yellow perch (Perca flavescens), white crappie (Pomoxis annularis), and black crappie (Pomoxis nigromaculatus), Additional potential hosts include gizzard shad

(Dorosoma cepedianum), longnose gar (Lepisosteus osseus), river redhorse (Moxostoma carinatum), and sauger (Sander canadensis) (Watters et al. 2009). L. complanata is bradytictic, with gravid females from September to the following May. Individuals rarely live more than 12 years (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

None; species is extirpated in New York. At SGCN meetings that DEC conducted in December 2013 to evaluate the status of mussels, experts agreed that this species is extirpated. The general threats discussed below are likely relevant to this species if it were present in New York.

Impoundments – Range wide
Range wide, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Agricultural Runoff
Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry 2013), indicating that runoff is a major threat to resident mussel populations.

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Treated and Untreated Wastewater

Recent studies show that mussel richness and abundance decreases with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals also originate from municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012).

Runoff from Developed Land

Developed lands are likely sources runoff containing metals and road salts.
Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991; Liquori & Insler 1985; Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Invasive Species

Invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugenis*) have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997; Watters et al. 2009). En masse, Dreissenids outcompete native mussels by removing food and oxygen from the water. They can also reduce reproductive success by filtering native mussel male gametes from the water column. They can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994). In addition, ammonia from Asian clam die offs has been shown to be capable of exceeding acute effect levels of some mussel species (Cherry et al. 2005). Didymo (*Didymosphenia geminata*), a filamentous diatom, can form extensive mats that can smother stream bottom and occlude habitat for mussels (Spaulding & Elwell 2007)

Climate Change

Global climate change is expected (among other disruptions) to cause an increase in surface water temperatures. Although many species are tolerant of warm water, higher water temperatures may be an added stress for some. Increased water temperatures may also increase algal growth, which could result in reductions in dissolved oxygen levels at night (Morris & Burridge 2006). Galbraith et al. (2010) recently showed how regional climate patterns coupled with changing local water regimes and management strategies have shifted mussel populations from thermally sensitive species to thermally tolerant species.

In addition, warmer stream temperatures due to the combined effects of land use, such as removal of shaded buffers, and climate change may contribute to the loss of coldwater fisheries and *mussel* populations in some watersheds (Nedeau 2008). Temperature induced changes in fish communities could have a profound influence on the availability of hosts for freshwater mussels. Mussels that inhabit small streams and rivers and rely on fish adapted for cooler water might be most affected by climate change (Nedeau 2008).

Habitat Modifications
Ecosystem modifications, such as in-stream work associated with canal, navigational channel, or flood control dredging, bridge replacements, gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000). Seasonal draw downs of water bodies have been shown to impact unionid age distributions (Richardson et al. 2002).

Levees and flood walls confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999; Yeager 1993; Nedeau 2008).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓_ **No:** ____ **Unknown:** ____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any "protected stream", its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussels habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York's mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Conduct surveys of low-gradient streams and canals from Buffalo to Rochester (Strayer & Jirka 1997). Conducting initial searches for this species would be the first step in the conservation of this species in New York.

- Assess the need and opportunity for relocation/reintroduction efforts. Conduct relocation or reintroduction where adequate sources can be identified and appropriate stream conditions exist (water quality, habitat, host species etc.).

- Following any reintroduction efforts, develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley & Tank 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Establish a protocol whereas DEC staff work closely with state and local highway departments to reduce impacts to native mussels during maintenance and construction projects.
- Replace culverts that disrupt aquatic habitat connectivity to allow for passage of small fish species.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g., point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	

Table 2. Recommended conservation actions for white heelsplitter.

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between Alasmidonta varicosa and Alasmidonta marginata and, if occurring, evaluate the potential threat to A. varicosa population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.

- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Originally prepared by	Amy Mahar and Jenny Landry
Date first prepared	June 2013
First revision	
Latest revision	January 17, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Yellow lampmussel

Date Updated: 1/15/2024

Scientific Name: *Lampsillis cariosa*

Updated By: Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Lampsilis cariosa belongs to the subfamily Ambleminae and the tribe Lampsilini, which includes 17 extant and 6 likely extirpated New York species of the genera Actinonaias, Epioblasma, Lampsilis, Leptodea, Ligumia, Obovaria, Potamilus, Ptychobranchus, Toxolasma, Truncilla, and Villosa (Haag 2012; Graf and Cummings 2011). L. cariosa is one of seven species of the genus Lampsilis that have been found in New York (Strayer and Jirka 1997).

Since 1970, L. cariosa has been found in 25 New York waterbodies. L. cariosa occurs in small to large rivers, especially in riffles (Ortmann 1919, Strayer 1993), and is often fairly abundant where it occurs (Strayer & Jirka 1997). This species has declined between 30% and 50% in both the short and long term (NatureServe 2013). It is declining everywhere along its range, which includes most of the Atlantic coast, from Georgia to Nova Scotia.

In New York, L. cariosa is ranked as vulnerable, and as vulnerable/apparently secure throughout its range (NatureServe 2013). In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al., 2000). While population trends in New York are unknown, it is assumed that they too are declining, due to a myriad of environmental stressors.

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** None, Proposed Special Concern listing (2019)

b. Natural Heritage Program

i. **Global:** G3G4 – Vulnerable / Apparently Secure

ii. **New York:** S2S3 **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Vulnerable (2015)

-Northeast Regional SGCN: Yes (2023)

- Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Special Concern (11/1/2013)

- American Fisheries Society Status: Threatened (1993)

Species of Regional Northeast Conservation Concern (Therres 1999)

Status Discussion:

Range, though widespread geographically, has contracted significantly with local extirpations and abundance in decline nearly everywhere except a few exceptional sites in New York and Maine. Area of occupancy has declined even more than range extent, as most occurrences are represented by small populations having poor viability with few individuals (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Declining	Declining	Short and long term		(blank)
Northeastern US	Yes	Declining	Declining			Yes
New York	Yes	Unknown	Unknown			Yes
Connecticut	Yes	Unknown	Unknown		Endangered, S1S2	Yes
Massachusetts	Yes	Declining	Declining		Endangered, S1S2	Yes
New Jersey	Yes	Unknown	Unknown	1970 - 2013	Threatened, S2	Yes
Pennsylvania	Yes	Stable	Stable		S4	Yes
Vermont	No	N/A	N/A			No
Ontario	No	N/A	N/A			(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

As part of a State Wildlife Grant, NYSDEC Region 8 Fish and Wildlife staff conducted a native freshwater mussel baseline inventory of tributaries in central and western New York, 2009 to 2020.

Trends Discussion *(insert map of North American/regional distribution and status):*

Trends for New York populations are difficult to determine as most historic data comes from opportunistic naturalist collections, as opposed to more comprehensive baseline surveys. For example, mussels were documented for the first time in 50 of the 106 streams surveyed to date by the Southern Lake Ontario mussel inventory project (Mahar & Landry, 2013). This is because many of these streams had never before been surveyed for mussels, not because mussel distribution has dramatically increased. In North America, approximately 2/3 to ¾ of native mussel species are extinct, listed as endangered or threatened, or are in need of conservation status (Williams et al. 1993; Stein et al.2000). Based on New York's Natural Heritage S-rank, sparse historical data, and the plight of North America's freshwater mussels, it is assumed that trends are declining due to a myriad of environmental stressors.

Figure 1. Yellow lampmussel distribution (IUCN Redlist 2024)

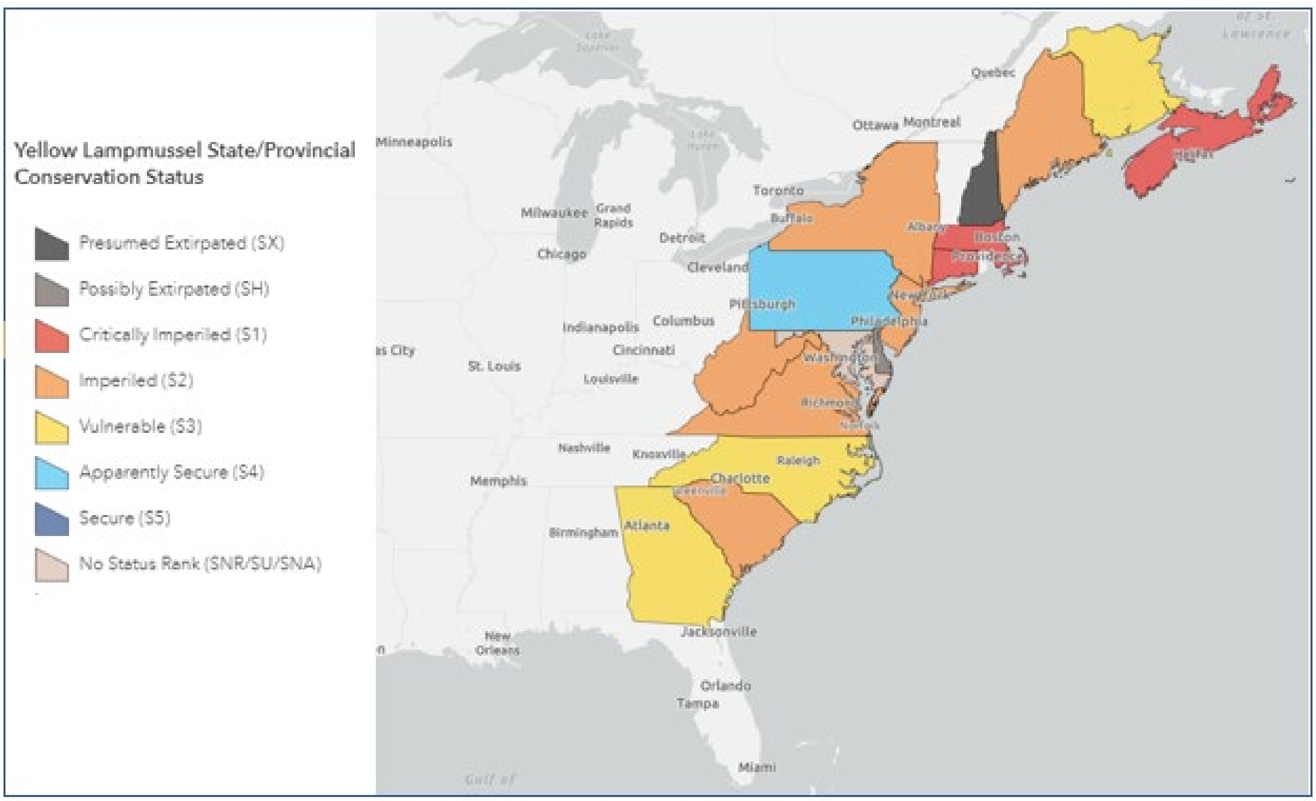

Figure 2. Yellow lampmussel status (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

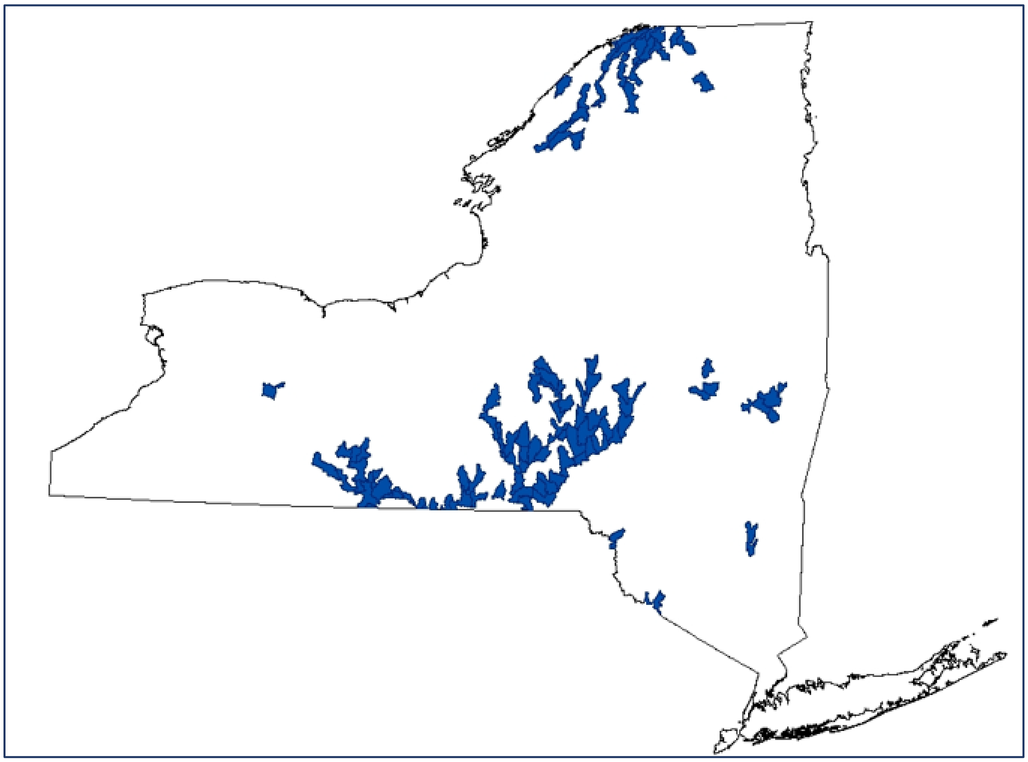

Figure 3. Records of yellow lampmussel in New York (NYSDEC 2022)

Years	# of Records	# of Distinct Waterbodies	% of State
	_______	_______	_______
	_______	_______	_______
	_______	_______	_______
Total	_______	36	5.2%

Table 1. Records of yellow lampmussel in New York.

Details of historic and current occurrence:

2024: L. cariosa has been found in 36 waterbodies in 94 of New York's 1802 HUC 12 watersheds (5.2%).

In New York, there are many L. cariosa records from the Susquehanna and Hudson basins. For several records from the Hudson basin, including the Hudson River at Troy and Albany, and The Normans Kill, only historic occurrences have been recorded (NY Natural Heritage Program 2013). Although L. cariosa is not known from the Champlain basin, it is widespread in the St. Lawrence basin in northern New York. Records from elsewhere in the state are scattered. In 1895 it was reported from the "Delaware River system," and it is known from the Delaware basin in Pennsylvania (Ortmann 1919). L. cariosa may have occurred in the Passaic system in New York because it has been found just over the state line in the Ramapo River, New Jersey. Records of L. cariosa from central New York are questionable because of potential confusion with L. cardium however, records from "Oswego;" Oswego River (1887); Seneca River (1895); Cross Lake; and

[Erie?] Canal, Rochester seem to be authentic. It is unclear whether L. cariosa reached the Oswego basin via the Erie Canal or was present in the basin in pre-Columbian times (Strayer and Jirka 1997).

L. cariosa is currently found in 25 waterbodies in New York State. It seems to be rare in the Hudson River, although it is still reproducing and common in the Susquehanna basin and lower Schoharie Creek. It also still occurs in several tributaries of the St. Lawrence in northern New York (Strayer and Jirka 1997).

In the Susquehanna basin, they were recently found in the main stem of the Susquehanna River, Butternut Creek, Canisteo River, Catatonk Creek, Chemung River, Chenango River, Genegantslet Creek, Otego Creek, Otselic River, Payne Brook, Sangerfield River, Schenevus Creek, Susquehanna River, Tigoa River, Tioughnioga River, East Branch Tioughnioga River, and the Unadilla River (Harman and Lord 2010, NY Natural Heritage Program 2013).

In the Hudson basin, it has been found post-1970 in Schoharie Creek and Indian Kill at Norrie Point. In the St. Lawrence River basin, it has been found in the Grass River, Little Salmon River, Oswegatchie River, Raquette River, St. Regis River, and West Branch Deer Creek. It has also been found in the Delaware River in the Delaware basin (NY Natural Heritage Program 2013).

Streams with high densities of L. cariosa include the Chenango River, Norwich and north; the Raquette River at Sugar Island and between Raymondville and Rooseveltown; and the Susquehanna River, especially at sites near Damascus, north of Windsor and east of Binghamton, and at Otego (NY Natural Heritage Program 2013, Harman and Lord 2010).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
1-25%	Core	

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type: Small River to Large/Great River

b. Geology: Moderately Buffered

c. Temperature: Warm to Transitional Cool

d. Gradient: Low Gradient to Low-Moderate Gradient

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	Yes	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

In New York, L. cariosa lives in small to large rivers, especially in riffles (Ortmann 1919, Strayer 1993 in Staryer and Jirka 1997). It is often fairly abundant where it occurs. L. cariosa also lives in lakes in Maine, but no records are known from New York lakes (Strayer and Jirka 1997). Throughout its range, it has been found in medium to large rivers and lakes, including free-flowing rivers with rocky substrates. In the Connecticut River, it has been found in shallow water and areas more than 30 feet deep, usually in slow to moderate flow conditions. Within its core range in Massachusetts, it exhibited a distinct preference for sand and fine gravel substrates, and was proportionately more abundant in shallow sandbars than it was in nearby areas that were deeper and had a rocky or muddy substrate (Nedeau 2008).

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Yes	No	No	Yes	Yes	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, L. cariosa must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable substrate, they will burrow into the substrate, where they may remain for several years (Watters et al 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC 2003 in NatureServe 2013).

L. cariosa is bradytictic with eggs fertilized in the late summer and glochidia released the following spring. White perch (Morone americana) and yellow perch (Perca flavescens) may be the primary hosts. Other potential hosts include striped bass (Morone saxatilis), banded killifish (Fundulus diaphanus), chain pickerel (Esox niger), white sucker (Catostomus commersonii), smallmouth bass (Micropterus dolomieu), and largemouth bass (Micropterus salmoides). Longevity could exceed 20 years, with life spans exceeding 30 years not unlikely (Nedeau 2008).

VI. Threats *(from NY 2015 SWAP or newly described):*

Threats to NY Populations	
Threat Category	**Threat**
1. Human Intrusions & Disturbance	Work & Other Activities (bridge projects and other instream work)
2. Natural System Modifications	Other Ecosystem Modifications (levees and flood walls, channelization, dredging, culverts)
3. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (zebra mussels, rusty crayfish)
4. Pollution	Agricultural & Forestry Effluents (pesticides, fertilizers, sediment)
5. Pollution	Household Sewage & Urban Waste Water (road runoff of salts and metals, other regulated discharges)
6. Pollution	Household Sewage & Urban Waste Water (waste water treatment effluent, sewer and septic overflows)
7. Climate Change & Severe Weather	Droughts
8. Natural System Modifications	Dams & Water Management/Use (lowering of water table from agriculture, etc…, causing drying of habitat)
9. Climate Change & Severe Weather	Storms & Flooding (extreme storms)
10. Invasive & Other Problematic Species & Genes	Invasive Non-Native/Alien Species (die offs from unknown disease)
11. Energy Production & Mining	Oil & Gas (hydraulic fracturing)

This species is in decline almost everywhere it occurs (e.g., almost extirpated in CT, nearly extirpated in MA). In recent times, it is never found in high numbers. No direct harvest has occurred for this species. The species appears to be mildly tolerant of eutrophication and siltation but susceptible to toxins. Given extent or range, overall threats of declining water quality are limited. The introduced zebra mussel, *Dreissena polymorpha*, will have negative impacts on this species, especially in slow flowing waters of larger streams and in lakes (NatureServe 2013).

Agricultural Runoff

Roughly 25% of the total watersheds where L. cariosa is located is in agriculture (New York State Landcover 2010). Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry 2013), indicating that runoff is a major threat to resident mussel populations.

Species such as *L. cariosa* that have a mantle modified to attract host fish are thought to rely on the visual acuity of their fish hosts to facilitate transfer of glochidia from the female to the host. This indicates the potential importance of turbidity in interfering with reproduction (Nedeau 2008).

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag, 2012). In addition, ammonia adsorbs to sediment particles, resulting in higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Runoff from Developed Land

Nearly all of the *L. cariosa* habitat is intermittently bordered by interstate highways, state routes, and several local roads. In addition, the habitat of *L. cariosa* receives stormwater runoff from the cities of Hornell, Elmira, Corning, Binghamton, Oneonta, Norwich, Potsdam, Massena and Morrisville, either directly or through tributaries (New York State Landcover 2010). These developed lands are likely sources of stormwater runoff containing metals and road salts. Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al., 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991; Liquori & Insler 1985; Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Treated Wastewater

The habitat of *L. cariosa* receives treated wastewater from the cities of Hornell, Elmira, Corning, Binghamton, Oneonta, Norwich, Potsdam, Massena and Morrisville either directly or through tributaries (SPDES 2007). Recent studies show that mussel richness and abundance decrease with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals are also present in municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012). It should be noted that in the Susquehanna basin, Harman and Lord (2010) found no evidence that wastewater treatment plants were responsible for reductions in mussel species of greatest conservation need.

Flood Control Projects
Within the habitat of *L. cariosa,* large stretches of Rivers are in leveed, water control projects, requiring periodic maintenance, For example the Canisteo and Chemung rivers in the Southern Tier of New York State("New York State Flood Protection" 2013). Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. These structures confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999; Yeager 1993; Nedeau 2008).

Other Ecosystem Modifications
Ecosystem modifications, such as isolated occurrences of canal dredging, instream work associated with bridge replacement, gravel removal, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000).

Climate Change
The NatureServe Climate Change Vulnerability Index has been used in several states to help identify species that are particularly vulnerable to the effects of climate change. While *L. cariosa* vulnerability was not evaluated for New York, populations within Pennsylvania are ranked as "highly vulnerable" to climate change (2013).

Impoundments - Range wide
Across its range, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Hybridization
Specimens thought to be *Lampsilis cariosa* from the Potomac River Basin in Maryland may be hybridizing with *Lampsilis cardium* or *Lampsilis ovata* (introduced to the Potomac Basin) (Art Bogan pers. comm. 1998). Anatomical or genetic work needs to be done to understand this situation. A portion of collections may have shell material mis-identified as another *Lampsilis* (Author pers. obs. 1998). In North Carolina, Stiven and Alderman (1992) noted conchological and genetic differences of specimens from different habitats as well as significant differences from *Leptodea ochracea* and *Lampsilis radiata* (NatureServe 2013).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: _✓_ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any “protected stream”, its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York’s mussel resources occur within Class C and D waters. Approximately 40% of waterbodies containing L. cariosa are considered “unprotected” streams (Standards C and D). An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c)of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, salts from entering these aquatic systems , as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al., 2012). Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis, 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis, 2012).

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g., point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) -
https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	

Table 2. Recommended conservation actions for yellow lampmussel.

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between *Alasmidonta varicosa* and *Alasmidonta marginata* and, if occurring, evaluate the potential threat to *A. varicosa* population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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Originally prepared by	Amy Mahar and Jenny Landry

Date first prepared	November 15, 2013
First revision	February 26, 2014 (Samantha Hoff)
Latest revision	January 16, 2024 (Amy Mahar)

Species Status Assessment

Common Name: Yellow sandshell **Date Updated:** 1/17/2024

Scientific Name: *Lampsillis teres* **Updated By:** Amy Mahar

Class: Bivalvia

Family: Unionidae

Species Synopsis *(a short paragraph which describes species taxonomy, distribution, recent trends, and habitat in New York):*

Lampsilis teres is thought to be extirpated in New York State. Prior to 1925, two specimens were collected from the Niagara River (Strayer & Jirka 1997). There are no more recent occurrences in New York State. This species was removed from the New York Species of Greatest Conservation list in 2015.

L. teres belongs to the subfamily Ambleminae and the tribe Lampsilini, which includes 17 extant and 6 likely extirpated New York species of the genera Actinonaias, Epioblasma, Lampsilis, Leptodea, Ligumia, Obovaria, Potamilus, Ptychobranchus, Toxolasma, Truncilla, and Villosa (Haag, 2012; Graf and Cummings, 2011). The distribution of L. teres is widespread throughout most of the Mississippi River system and Gulf drainages (Watters et al. 2009). This species is ranked by The Natural Heritage Program as historic in New York and secure throughout its range.

I. Status

a. Current legal protected Status

i. **Federal:** None **Candidate:** No

ii. **New York:** None

b. Natural Heritage Program

i. **Global:** G5 - Secure

ii. **New York:** SH – Possibly Extirpated **Tracked by NYNHP?:** Yes

Other Ranks:

-IUCN Red List: Least Concern (2012)

-Northeast Regional SGCN: No (2023)

-Midwest Regional SGCN: Yes

-American Fisheries Society Status: Currently Stable (1993)

Status Discussion:

This species is widespread and secure throughout most of its range across the Mississippi drainage (NatureServe 2013).

II. Abundance and Distribution Trends

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
North America	Yes	Stable	Stable			(blank)

Region	Present?	Abundance	Distribution	Time Frame	Listing status	SGCN?
Northeastern US	No	Extirpated	Extirpated			No
New York	No	Extirpated	Extirpated			No
Connecticut	No	N/A	N/A			No
Massachusetts	No	N/A	N/A			No
New Jersey	No	N/A	N/A			No
Pennsylvania	No	N/A	N/A			No
Vermont	No	N/A	N/A			No
Ontario	No	N/A	N/A			(blank)
Quebec	No	N/A	N/A			(blank)

Column options
Present?: Yes; No; Unknown; No data; (blank) or Choose an Item
Abundance and Distribution: Declining; Increasing; Stable; Unknown; Extirpated; N/A; (blank) or Choose an item
SGCN?: Yes; No; Unknown; (blank) or Choose an item

Monitoring in New York *(specify any monitoring activities or regular surveys that are conducted in New York):*

Trends Discussion *(insert map of North American/regional distribution and status):*

The short term trend for this species is relatively stable with less than 10% change. The long term trend has been between a slight growth of 10-25% to a decline of 30%. It has had some local extinctions, yet still remains stable and widespread throughout a large range (NatureServe 2013).

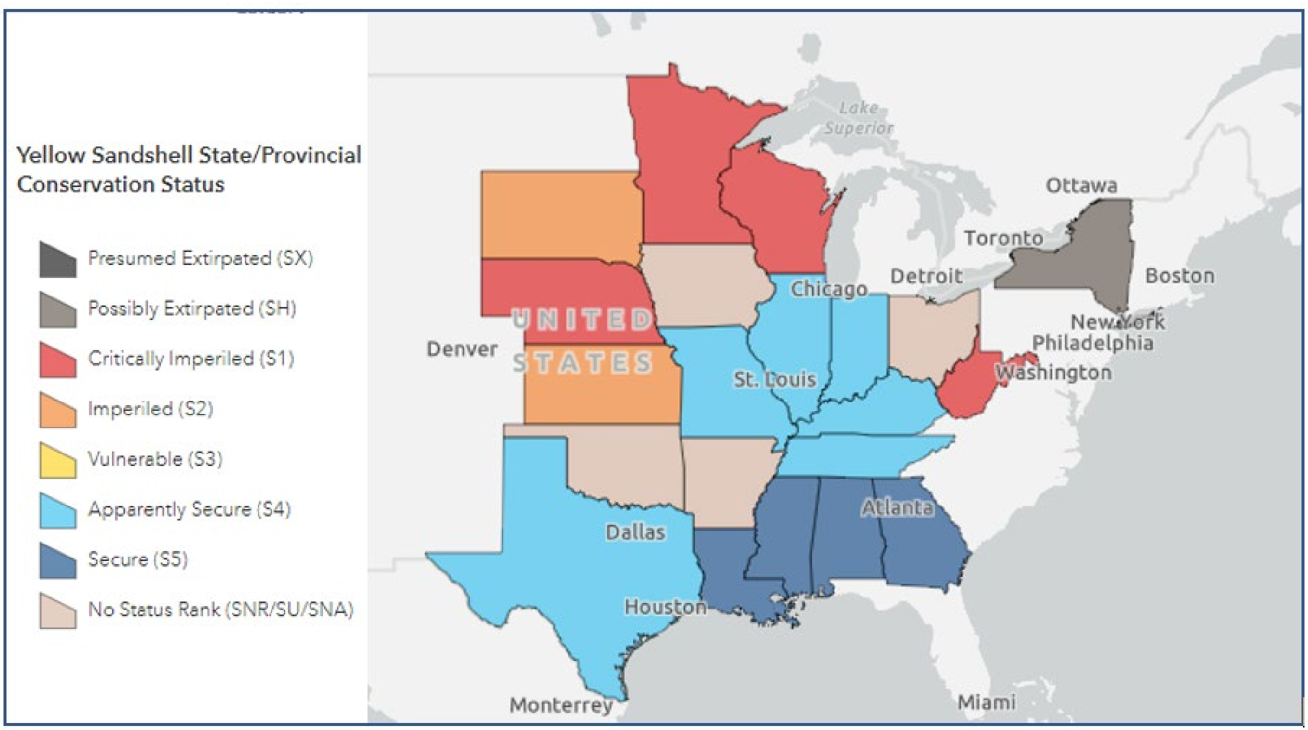

Figure 1. Yellow sandshell distribution (NatureServe 2024)

III. New York Rarity *(provide map, numbers, and percent of state occupied)*

Years	# of Records	# of Distinct Waterbodies	% of State
Pre-1995	2	1	1 of 56 HUC 8 watersheds
1995-2004	0	0	0
2005-2014	0	0	0
2015- 2023	0	0	0

Table 1. Records of yellow sandshell in New York.

Details of historic and current occurrence:

There are a few historic L. teres records from the "Niagara River," "western New York," and "near Buffalo." Two authentic specimens from Niagara River exist, both of which were collected before 1925 (Strayer & Jirka 1997). Williams et al. (2008) notes that this species is known from the Niagara River, New York, in the Great Lakes and St. Lawrence basin, although Watters et al. (2009) states that L. teres is absent from the Great Lakes basin.

There are no recent L. teres occurrences in New York (Strayer & Jirka 1997, Mahar and Landry 2014, NY Natural Heritage Program 2013, The Nature Conservancy 2009, Harman and Lord 2010, White et al. 2011, NatureServe 2013).

New York's Contribution to Species North American Range:

Percent of North American Range in NY	Classification of NY Range	Distance to core population, if not in NY
0%	Disjunct	550 km

Column options
Percent of North American Range in NY: 100% (endemic); 76-99%; 51-75%; 26-50%; 1-25%; 0%; Choose an item
Classification of NY Range: Core; Peripheral; Disjunct; (blank) or Choose an item

IV. Primary Habitat or Community Type *(from NY crosswalk of NE Aquatic, Marine, or Terrestrial Habitat Classification Systems):*

a. Size/Waterbody Type:

b. Geology:

c. Temperature:

d. Gradient:

Habitat or Community Type Trend in New York

Habitat Specialist?	Indicator Species?	Habitat/ Community Trend	Time frame of Decline/Increase
No	No	Unknown	

Column options
Habitat Specialist and Indicator Species: Yes; No; Unknown; (blank) or Choose an item
Habitat/Community Trend: Declining; Stable; Increasing; Unknown; (blank) or Choose an item

Habitat Discussion:

In other states, L. teres is primarily found in medium to large rivers (Strayer and Jirka 1997, Cummings and Mayer 1992), but is more common in large water bodies (Williams et a.l 2008), rarely straying into smaller streams (Watters et al. 2009). This species is found in mud, sandy mud, sand and gravel substrates (Watters et al. 2009, McMurray et al. 2012, Cummings and Mayer 1992, Williams et al. 2008, Strayer and Jirka 1997), often in slow to moderate current, such as in oxbows and stream borders, but also may be found in swift current (Williams et al 2008). It is most frequently encountered along shore and channel slopes and overbanks of some reservoirs (Williams et al 2008). In the Apalachicola-Chattahoochee-Flint River basin, located in the southeastern United States, over 50% of individuals collected were listed as having sand as primary substrate, followed by mud (29%), rock (13%), and silt (4%) (Box & Williams 2000). It is tolerant of reservoirs, and of silt, more so than most other unionids (NatureServe 2013). Strayer and Jirka (1997) suggest that the Niagara River probably provides the only suitable habitat in New York for this species.

V. Species Demographic, and Life History:

Breeder in NY?	Non-breeder in NY?	Migratory Only?	Summer Resident?	Winter Resident?	Anadromous/ Catadromous?
Unknown	Choose an item.	Choose an item.	Unknown	Unknown	(blank)

Column options
First 5 fields: Yes; No; Unknown; (blank) or Choose an item
Anadromous/Catadromous: Anadromous; Catadromous; (blank) or Choose an item

Species Demographics and Life History Discussion *(include information about species life span, reproductive longevity, reproductive capacity, age to maturity, and ability to disperse and colonize):*

Upstream males release sperm into the water. Females downstream take up the sperm with incoming water. Fertilization success may be related to population density, with a threshold density required for any reproductive success to occur. Eggs are fertilized within the female. Like nearly all North American mussels, this species must parasitize an often specific vertebrate host to complete its life cycle. It is suspected that some mussel populations are not recruiting because their hosts no longer occur with them. Once released by the female, glochidia must acquire a suitable host or die, usually within 24-48 hours. L. teres employs a pulsating mantle flap lure display after dark, with no daytime display (Rypel 2008). After attaching to a suitable host, glochidia encyst, usually at the fish's gills or fins and receive food and dispersal. Once the glochidia metamorphose into juveniles, they drop from the host. If they land in suitable substrate, they will burrow into the substrate, where they may remain for several years (Watters et al. 2009).

In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom. The only time that significant dispersal can take place is during the parasitic phase. Infected host fishes can transport the larval unionids into new habitats, and can replenish depleted populations with new individuals. Dispersal is particularly important for genetic exchange between populations. Dispersal is likely to be a slow process for mussels which use resident fishes with limited home ranges as their hosts (COSEWIC as cited in NatureServe 2013).

L. teres is bradytictic with glochidia overwintering in the gills of the female. Individuals older than 10 years are rare (Watters et al. 2009). Glochidia of this species have been shown to transform on longnose gar (Lepisosteus osseus), shortnose gar (Lepisosteus platostomus), greenthroat darter (Etheostoma jordani), redbreast sunfish (Lepomis auritus), and bluegill (Lepomis macrochirus)

(Watters et al. 2009). Daniel and Brown (2012) confirmed additional hosts for L. teres: largemouth bass (Micropterus salmoides), white crappie (Pomoxis annularis), and orangespotted sunfish (Lepomis humilis), and red ear sunfish (Lepomis microlophus) and blacktail shiner? (Notropis venustus). Other suspected hosts include rock bass (Ambloplites rupestris), common carp (Cyprinus carpio), green sunfish (Lepomis cyanellus), warmouth (Lepomis gulosus), yellow perch (Perca flavescens), black crappie (Pomoxis nigromaculatus), and shovelnose sturgeon (Scaphirhynchus platorynchus) (Watters et al. 2009).

VI. Threats *(from NY 2015 SWAP or newly described):*

Insufficient information to assess threats.

General threats to mussels that are likely relevant range wide:

Impoundments – Range wide
Range wide, impoundments likely contributed to the reduced distribution of mussels that we see today. Vaughn and Taylor (1999) observed a mussel extinction gradient with a gradual, linear increase in mussel species richness and abundance with increasing distance downstream from impoundments. Species and their hosts that require shallow, oxygenated, fast-flowing water quickly are eliminated. Continuously cold water from both increased water depth upstream of the dam and dam discharges downstream of the dam may prevent reproduction. Impoundment increases silt load and eutrophication, resulting in changes in the fish fauna, and therefore the availability of hosts. Dams represent distributional barriers to fish hosts, and therefore to the mussels themselves. The zoogeographic patterns of several species suggest a dam-limited range. Dams also act as sediment traps, often having many feet of silt and debris caught on their upstream side. These areas generally are without mussels. Below the dam, the tailwaters often have dense mussel beds, as these reaches are the only areas left that still have oxygenated, fast moving water. This is exemplified by the distribution of beds in the lower Muskingum River, Ohio (Stansbery & King 1983; ESI 1993c).

In addition, improperly sized and poorly installed or poorly maintained culverts have impacts similar to dams in that they fragment habitat, preventing the movement by host fish, and effectively isolating mussel populations. And because culverts are located at nearly every road-stream intersection, there is the potential for landscape level fragmentation of mussel habitat.

Agricultural Runoff
Aquatic habitats lacking vegetated buffers of adequate width are threatened by runoff from urban areas, roads, lawns, and agricultural land (Gillis 2012). If best management practices are not closely adhered to, mussel habitat adjacent to wood harvest or agricultural land is subjected to pesticide, fertilizer, and silt/sediment runoff. During recent mussel surveys in Western and Central New York, it has been documented that sufficient vegetated riparian buffers are often lacking along known mussel streams (Mahar & Landry 2013), indicating that runoff is a major threat to resident mussel populations.

Species that have a mantle modified to attract host fish are thought to rely on the visual acuity of their fish hosts to facilitate transfer of glochidia from the female to the host. For such species, this indicates that increases in turbidity associated with runoff may in interfere with reproduction and be especially detrimental to the species (Nedeau 2008).

The presence of pesticides and fertilizers in our rural watersheds is nearly ubiquitous (Haag 2012). And because pesticides and their associated surfactants adsorb onto sediment particles, sedimentation may act as a vector for their transport into the aquatic system (Haag 2012). Mussels are more sensitive to pesticides than many other animals (Watters et al. 2009). Although effects of pesticides are species-specific, sub-lethal levels of PCBs, DDT, malathion, and other compounds inhibit respiratory efficiency and accumulate in the tissues. Atrazine and permethrin at sublethal concentrations reduced juvenile growth (Bringolf et al. 2007a, 2007b) and environmental levels of atrazine altered mussel movement and aggregation behavior (Flynn and Spellman 2009). Pesticides can affect mussels in many ways, but the full range of long-term effects remains unknown (Haag 2012).

Fertilizer runoff is also a concern. High inputs of nitrogen from fertilizers can cause increases in ammonia in the water and the substrate, leading to direct toxicity for a wide range of mussel species. Mussels, especially in their early life stages, are more sensitive to un-ionized ammonia than other organisms, and high sensitivity is seen across a range of species and life histories (Haag 2012). In addition, ammonia adsorbs to sediment particles, resulting higher nitrogen concentrations in the substrate than in the overlying water. The nitrogen present in the interstitial spaces in the substrate is thought to result in juvenile mortality and to prevent recruitment by some mussel species (Strayer and Malcom 2012). Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley et al. 2012).

Treated and Untreated Wastewater

Recent studies show that mussel richness and abundance decreases with increased proximity to sewage effluent (Wildenberg 2012). The input of biomaterial from wastewater treatment plants depletes dissolved oxygen levels, negatively impacting mussels. Ammonia from wastewater treatment plants has been found to be toxic to glochidia (Goudraeu et al. 1993) and at sub-lethal exposure, adult mussels exhibit decreased respiratory efficiency (Anderson et al. 1978). Endocrine disrupters from pharmaceuticals also originate from municipal sewage effluents and are increasing common in rivers and lakes (Haag 2012). In mussels, chronic exposure to estrogenic compounds in effluents caused feminization of male mussels, but these individuals did not produce eggs, suggesting major disruption of reproductive function (Gagne et al. 2011). The long-term effects of these compounds on mussels are unknown (Haag 2012).

Runoff from Developed Land

Developed lands are likely sources runoff containing metals and road salts.
Mussels are particularly sensitive to heavy metals, more so than many other animals used in toxicological tests (Keller & Zam 1991). Low levels of metals may interfere with the ability of glochidia to attach to the host (Huebner & Pynnonen 1992), suggesting that U.S. EPA ambient water quality criteria may not adequately protect mussels from toxic metals (Wang et al. 2011). In addition, increases in salinity from the runoff of salt used for clearing roads in winter may be lethal to glochidia and juvenile mussels (Keller & Zam 1991; Liquori & Insler 1985; Pandolfo et al. 2012). Based on these studies, the U.S. EPA's ambient water quality criterion for acute chloride exposures may not be protective of all freshwater mussels (Pandolfo et al. 2012).

Invasive Species

Invasive zebra and quagga mussels (*Dreissena polymorpha* and *Dreissena bugenis*) have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997; Watters et al. 2009). En masse, Dreissenids outcompete native mussels by removing food and oxygen from the water. They can also reduce reproductive success by filtering native mussel male gametes from the water column. They can foul the shells of the native mussels to the point that their valves can no longer open. In heavily invested areas, they may transform a habitat by hardening the substrate, such that dislodged mussels are not able to rebury (USFWS 1994). In addition, ammonia from Asian clam die offs has been shown to be capable of exceeding acute effect levels of some mussel species (Cherry et al. 2005). Didymo (*Didymosphenia geminata*), a filamentous diatom, can form extensive mats that can smother stream bottom and occlude habitat for mussels (Spaulding & Elwell 2007).

Climate Change
Global climate change is expected (among other disruptions) to cause an increase in surface water temperatures. Although many species are tolerant of warm water, higher water temperatures may be an added stress for some. Increased water temperatures may also increase algal growth, which could result in reductions in dissolved oxygen levels at night (Morris & Burridge 2006). Galbraith et al. (2010) recently showed how regional climate patterns coupled with changing local water regimes and management strategies have shifted mussel populations from thermally sensitive species to thermally tolerant species.

In addition, warmer stream temperatures due to the combined effects of land use, such as removal of shaded buffers, and climate change may contribute to the loss of coldwater fisheries and *mussel* populations in some watersheds (Nedeau 2008). Temperature induced changes in fish communities could have a profound influence on the availability of hosts for freshwater mussels. Mussels that inhabit small streams and rivers and rely on fish adapted for cooler water might be most affected by climate change (Nedeau 2008).

Habitat Modifications
Ecosystem modifications, such as in-stream work associated with canal, navigational channel, or flood control dredging, bridge replacements, gravel mining, and vegetation removal kill mussels and destroy their habitat. For example, dredging for vegetation removal has been shown to remove up to 23% of mussels in spoils (Aldridge 2000). Further evidence for disruption was provided by mussel surveys adjacent to approximately 20 river miles of Conewango Creek that had been channelized and straightened in the first half of the 20th century. The resulting "dredge" had no riffle or run habitat and sites just below and above this channelized section contained few or no mussels (The Nature Conservancy 2009). Although limited in geographic scope these habitat modification activities have long term impacts on mussels and their distribution (Aldridge 2000). Seasonal draw downs of water bodies have been shown to impact unionid age distributions (Richardson et al. 2002).

Levees and flood walls confine larger rivers, preventing the river from inundating its natural floodplains and wetlands to minimize flood damage. Additionally, many smaller streams have been channelized and bermed by landowners and highway departments to protect farm fields and other structures. Channelization and dredging associated with flood control projects are catastrophic to mussels and have been implicated in the decline of some populations (Watters et al. 2009). The result of these projects is altered seasonality of flow and temperature regimes, increased stream velocities, unstable substrates, changed patterns of sediment scour and deposition, including streambank erosion, altered transport of particulate organic matter (the food base for mussels), and a general degradation of stream habitat (Benke 1999; Yeager 1993; Nedeau 2008).

Are there regulatory mechanisms that protect the species or its habitat in New York?

Yes: ✓ **No:** _____ **Unknown:** _____

If yes, describe mechanism and whether adequate to protect species/habitat:

Mussel habitats receive some generic protection under several New York State regulations (NYCRR) promulgated under the authority of the New York Environmental Conservation Law (ECL), specifically Part 608 of the NYCRR: Use and Protection of Waters, and Part 617 of the NYCRR: State Environmental Quality Review (SEQR). Part 608 provides protection of some mussel habitats by regulating and requiring environmental review of the modification or disturbance of any "protected stream", its bed or bank, and removal of sand, gravel or other material from its bed or banks (608.2 Disturbance of Protected Streams). This does not provide adequate protection of mussels and their habitats as it only protects streams or particular portions of a streams for which there has been adopted by NYSDEC or any of its predecessors any of the following classifications or standards: AA, AA(t), A, A(t), B, B(t) C(t), or Streams designated (t)(trout) also include those more specifically designated (ts)(trout spawning). Mussel habitats may also receive some additional protections as the construction, repair, breach or removals of dams, and the excavation and placement of fill in navigable waters are subject to regulation and environmental review under Part 608, 608.3 and 608.5 respectively. Under Part 608, projects requiring a permit can be conditioned by NYSDEC to include best management practices, such as sediment and erosion protections. Through the review process, these projects can also be modified to reduce impacts in order to meet permit issuance standards.

Under Part 608, protection of unlisted species of mussels is general and relatively limited. More importantly, Class C and D waters with mussels do not receive protection under these regulations. A significant portion of the New York's mussel resources occur within Class C and D waters. An additional but not insignificant gap in protection occurs because agricultural activities consisting of the crossing and re-crossing of a protected stream by livestock or wheeled farming equipment normally used for traditional agricultural purposes or of withdrawing irrigation water in a manner which does not otherwise alter the stream, are exempt from these regulations and environmental review.

Water quality certifications required by Section 401 of the Federal Water Pollution Control Act, Title 33 United States Code 1341(see subdivision (c) of this Section) may provide protection for freshwater mussels and their habitats from some activities that would potentially have adverse impacts by regulating construction or operation of facilities that may result in any discharge into navigable waters. Water quality certifications set water quality-related effluent limitations, water quality standards, thermal discharge criteria, effluent prohibitions and pretreatment standards for projects on navigable waters.

The State Environmental Quality Review (SEQR, Part 617 NYCRR) may also protect mussels and their habitats by requiring the consideration of environmental factors into the existing planning, review and decision-making processes of state, regional and local government agencies for activities that require discretionary approval. SEQR requires the preparation of an Environmental Impact Statement, including an alternatives analysis, for those activities that may result in a substantial adverse change in ground or surface water quality; a substantial increase in potential for erosion, flooding, leaching or drainage problems; the removal or destruction of large quantities of vegetation or fauna; substantial interference with the movement of any resident or migratory fish or wildlife species; impacts on a significant habitat area; substantial adverse impacts on a threatened or endangered species of animal or plant, or the habitat of such a species; other significant adverse impacts to natural resources; or, a substantial change in the use, or intensity of use, of land including agricultural, open space or recreational resources, or in its capacity to support existing uses.

New York State has numerous laws and regulations that both directly or indirectly protect waters of the state (mussel habitats) including regulations governing direct discharges to surface and groundwater, storm water, agricultural activities, pesticides, flood control, and dams. Without these regulations, mussels would certainly be in worse shape; however, most of these generic protections are not adequate in scope or specific enough to mussel threats to protect the mussel resources of New York State.

Describe knowledge of management/conservation actions that are needed for recovery/conservation, or to eliminate, minimize, or compensate for the identified threats:

- Survey the Niagara River to confirm presence of this species in New York (Strayer & Jirka 1997). New York is currently not considered part of this species range.

- Assess the need and opportunity for relocation/reintroduction efforts. Conduct relocation or reintroduction where adequate sources can be identified and appropriate stream conditions exist (water quality, habitat, host species etc.).

- Evidence of historic occurrence of multiple New York State extirpated mussel species exists for the Niagara River. These species include: *Epioblasma triquetra, Lampsilis teres, Lampsilis abrupta, Obovaria olivaria, Potamilus capax*, *Pustulosa pustulosa*, *Quadrula quadrula, Simpsonaias ambigua, and possibly Truncilla donaciformis*. To assess the potential for future reintroduction efforts, a pilot program relocating common species to suitable sections of the Niagara River should be initiated and its results assessed to gage the possible success of reintroduction efforts for extirpated species in this waterbody.

- Modify marine mussel regulations or the definition of protected wildlife in NYCRR to clarify that freshwater mussels are protected under ECL. Current regulations could be interpreted that freshwater mussels may only be protected as shellfish without a season within the Marine District.

- Through landowner incentive programs or regulation, riparian buffers, particularly those that also provide shade, should be added/maintained/widened, along agricultural fields, subdivisions, and along major roads to decrease the levels of nitrogen, pesticides, sediment, heavy metals, and salts from entering these aquatic systems, as well as to moderate water temperature. Studies have suggested decreasing sediment loads entering aquatic systems as the best way to decrease the impact of numerous stressors for mussels in general (Roley & Tank 2012).

- Require all state agencies to maintain appropriate vegetative buffers along streams, rivers and lakes on state-owned or state managed properties.

- Following any reintroduction efforts, develop and implement a comprehensive monitoring strategy that identifies protocols, including locations and specific intervals, for regular monitoring of known mussel populations to detect assess trends and detect dangerous declines.
- Update wastewater treatment facilities in Buffalo to eliminate combined sewer outflows.

- Coordinate with local wastewater treatment facilities to improve ammonia removal of treated discharge. This has been documented as a threat to Unionids at multiple life stages, and therefore needs to be addressed (Gillis 2012).

- Mussel sensitivity to particular pollutants should be considered or addressed in the regulation of wastewater and stormwater discharges to groundwater and surface waters, State Pollutant Discharge Elimination Systems (SPDES). This should be reflected in effluent limitations for discharges, including discharges from P/C/I facilities (Private/Commercial/Industrial), CAFO facilities (Concentrated Animal Feeding Operations), High Volume Hydraulic Fracturing Discharges, and Wastewater treatment plants, etc. Discharges whose receiving waters have mussels, particularly those with known populations of mussels listed as Endangered, Threatened, Special concern or SGCN, should be carefully reviewed for potential impacts to mussels. For example, deleterious levels of ammonia (a component of many types of discharges) and molluscicides (a commonly used water treatment chemical in discharged water) should not be permitted.

- Within the Great Lakes watersheds, lamprey control efforts should consider specific, potentially adverse, impacts to native freshwater mussels when determining methods, including selection of lampricide formulations and concentrations. Lampricide treatment managers should use caution when using the combination of TFM and niclosamide in streams with known mussel populations and every effort should be made to maintain lampricide concentrations at or near the MLC for sea lamprey to minimize the risk to this important faunal group (Boogaard 2006).

- NYSDEC should consider sensitivity of freshwater mussels to specific pollutants in the establishment and setting of water quality standards and TMDLs for waters containing freshwater mussels. A Total Maximum Daily Load (TMDL) specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDLs account for all contributing sources (e.g., point & nonpoint sources, and natural background levels), seasonal variations in the pollutant load, and incorporate a margin of safety that accounts for unknown or unexpected sources of the pollutant. In essence, a TMDL defines the capacity of the waterbody to absorb a pollutant and still meet water quality standards. The Clean Water Act requires states to identify waterbodies that do not meet water quality standards after application of technology-based effluent limitations. For these "impaired waters," states must consider the development of alternative strategies, including TMDLs, for reducing the pollutants responsible for the failure to meet water quality standards.

Complete Conservation Actions table using IUCN conservation actions taxonomy at link below. Use headings 1-6 for Action Category (e.g., Land/Water Protection) and associated subcategories for Action (e.g., Site/Area Protection) - https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

Conservation Actions	
Action Category	**Action**
1.	

Table 2. Recommended conservation actions for yellow sandshell.

The Comprehensive Wildlife Conservation Strategy (NYSDEC 2006) includes recommendations for the following actions for freshwater mussels:

Habitat management:

- Manage areas of important mussel populations by controlling degradation factors (e.g.. Controlling livestock access, point source or non-point source pollution, flow alteration, etc.)
- Develop methods to improve and restore freshwater bivalve habitat.

Habitat research:

- Conduct research to determine habitat parameters necessary for good populations of each species of species-at-risk listed mussels.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.

Habitat restoration:

- Restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Invasive species control:

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in all New York watersheds and actions that will be taken to control them before they become threats.
- Conduct research on control of exotic bivalve species that compete with native mussels and exotic crustaceans or fish which may prey on them.

Life history research:

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research potential interbreeding between Alasmidonta varicosa and Alasmidonta marginata and, if occurring, evaluate the potential threat to A. varicosa population integrity.
- Determine fish hosts for species where this is not known for populations living in New York.
- Research population dynamics of listed mussel species including connectivity of populations or subpopulations and genetic distinctness of populations or subpopulations.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Modify regulation:

- Modify marine mussel regulations to be clearer that freshwater mussels are protected under ECL.

New regulation:

- Ban the importation of fish that feed on freshwater mollusks (e.g.. black carp).
- Require inclusion of all stages of freshwater mussels in testing for approval of new pesticides in New York.

Other action:

- Develop an outreach program to private landowners through the Landowner Incentive Program to educate the public about freshwater mussel protection and initiate projects to prevent or repair impacts from land use on mussels.
- Increase regional permit control of development and highway projects that may impact native mussels.
- Develop standard monitoring/survey protocols for development projects in all watersheds in New York.
- Evaluate threats to mussels in each New York watershed and prioritize areas for actions to address the threats.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Begin evaluation of members of the family Sphaeridae (fingernail clams) for inclusion into the species at risk list.

Population monitoring:

- Conduct population estimates of species-at-risk listed mussel species in NY
- Conduct surveys to determine distribution of species-at-risk listed mussel species in NY.

Regional management plan:

- Incorporate freshwater mussel goals and objectives into regional water quality and fish management plans and policies.

Relocation/reintroduction:

- Where appropriate, reintroduce listed mussels into appropriate habitat within their historic range.

Statewide management plan:

- Incorporate freshwater mussel goals and objectives into statewide water quality and fish management plans and policies.

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