Species Status Assessment

Class: **Bivalvia**
Family: **Unionidae**
Scientific Name: ***Ligumia nasuta***
Common Name: **Eastern Pondmussel**

Species synopsis:

Ligumial nasuta is a freshwater mussel of the family Unionidae and subfamily Lampsilinae. 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. nasuta* is one of two species of the genus Ligumia that have been found in New York (Strayer and Jirka 1997).

In New York, *L. nasuta* is most often found in quiet waters in estuaries, lakes, in slackwater areas of rivers, canals, or slow streams, but it has also been found regularly in the Niagara River (Strayer & Jirka 1997, Nedeau 2008). *L. nasuta* inhabits in a wide range of substrates (Nedeau 2008), although it is thought to prefer fine sand and mud (Metcalfe-Smith et al. 2005, Watters et al. 2009).

Since 1970, *L. nasuta* has been found in 21 New York waterbodies. It is a widespread species that once was locally abundant from the Great Lakes to much of the Atlantic Slope, but has experienced decline in most areas (NatureServe 2013). Although not widespread in New York, *L. nasuta* can still be encountered regularly (Strayer & Jirka 1997). This species has been heavily impacted by zebra mussels in the St. Lawrence River basin, Hudson River estuary, lower Great Lakes, and elsewhere throughout the state (Strayer & Jirka 1997).

In New York, *L. nasuta* is ranked as imperiled/vulnerable, although it is apparently 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.

Status

a. Current and Legal Protected Status

i. **Federal** None________________________________**Candidate?** ____No____

ii. **New York** _None – Species of Greatest Conservation Need___

b. Natural Heritage Program Rank

i. **Global** _ G4 - Apparently secure____

ii. **New York** _S2S3 – Imperiled/Vulnerable **Tracked by NYNHP?** _Yes__

Other Rank:

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Endangered
IUCN Red List Category: Near threatened
American Fisheries Society Status: Threatened (1993)
Species of Regional Northeast Conservation Concern (Therres 1999)

Status Discussion:

This is a widespread species that was once locally abundant from the Great Lakes to the Atlantic Slope, but has experience decline in most areas (significantly so in the Canadian Great Lakes to New York and New England) although still maintains hundreds, if not thousands, of populations across its range (NatureServe 2013).

I. Abundance and Distribution Trends

a. North America

i. Abundance

__x___ declining ____increasing _____stable ____unknown

ii. Distribution:

___x__ declining ____increasing _____stable ____unknown

Time frame considered: ____

b. Regional

i. Abundance

__x___ declining ____increasing ____stable _____unknown

ii. Distribution:

___x__ declining ____increasing ____stable ______unknown

Regional Unit Considered:_______Northeast_____________________________
Time Frame Considered: ____

c. Adjacent States and Provinces

CONNECTICUT Not Present _______ No data _______

i. Abundance

____ declining ____increasing ____stable __x___unknown

ii. Distribution:

____ declining ____increasing ____stable __x___unknown

Time frame considered: ____
Listing Status: _________S1S2 – Special Concern_________________ SGCN? __________

MASSACHUSETTS **Not Present** _______ **No data** _______

i. Abundance

____ declining ____increasing ____stable __x__unknown

ii. Distribution:

____ declining ____increasing ____stable __x___unknown

Time frame considered: ____

Listing Status: _____S3 – Special Concern_____________________ SGCN? __Yes__

NEW JERSEY **Not Present** _______ **No data** _______

i. Abundance

____ declining ____increasing ____stable __X__unknown

ii. Distribution:

____ declining ____increasing ____stable __X__unknown

Time frame considered: ___1970-Present___________________________

Listing Status: __________S2- Threatened__________________ SGCN? ___Yes___

This species is probably more abundant than reported in the Delaware River and tributaries. Impacts to water quality, along with proposed in stream projects, threaten existing populations. Sea level rise, salt water intrusion, and extreme weather events all pose long term threats (Davenport 2012). Bowers-Altman (personal communication 2013) states “although I have chosen abundance and distribution as unknown, gut feeling is that for both, some areas are relatively stable, while others are declining.”

ONTARIO **Not Present** _________ **No data** _______

i. Abundance

__x__ declining ____increasing ______stable ____unknown

ii. Distribution:

__x__ declining ____increasing ______stable ____unknown

Time frame considered: _______2003-2013_______________________________

Listing Status: __________S1____

In Canada, this species is uncommon and declining and only occurs in Ontario where it is threatened severely by zebra mussels (Metcalfe-Smith & Cudmore-Vokey 2004). It has been lost from nearly all its former range in Canada, but still occurs in the delta area of Lake St. Clair and a recent population in Lyn Creek (tributary of upper St. Lawrence River) near the outlet of Lake Ontario (COSEWIC 2007). Resampling of the St Clair refuge site in 2011 indicated a 91% decline in abundance in this the largest remaining population in Canada (DFO unpublished data).

PENNSYLVANIA **Not Present** ________ **No data** ______

i. Abundance

____ declining ____increasing ____stable __x__unknown

ii. Distribution:

____ declining ____increasing ____stable __x__unknown

Time frame considered: ____
Listing Status: ____________S1______________________ SGCN? ________

QUEBEC **Not Present** __X__ **No data** ______

VERMONT **Not Present** __X__ **No data** _______

d. NEW YORK **No data** ______

i. Abundance

____ declining ____increasing __X__stable _____unknown

ii. Distribution:

____ declining ____increasing __X__stable ______unknown

Time frame considered: ____

Monitoring in New York.

As part of a State Wildlife Grant, NYSDEC Region 8 Fisheries and Wildlife staff is conducting a baseline survey of tributaries in central and western NY for native freshwater mussels 2009 – 2017.

Trends Discussion:

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.

New York Natural Heritage Program (2013) Online Conservation Guide for *L. nasuta* reports that this species was once a major component of the lower Great lakes drainage basin, but is now virtually absent owing to the zebra mussel invasion. *L. nasuta* comprised about 5% of the pre-1960 Unionid records in the lower Great Lakes in Ontario, but dropped to 2.5% of the records post-1960. Between 1930 to 1982, this species was the second most common Unionid in western Lake Erie (Nalepa et al. 1991), but by 1991 it had disappeared (Schloesser and Nalepa 1994).

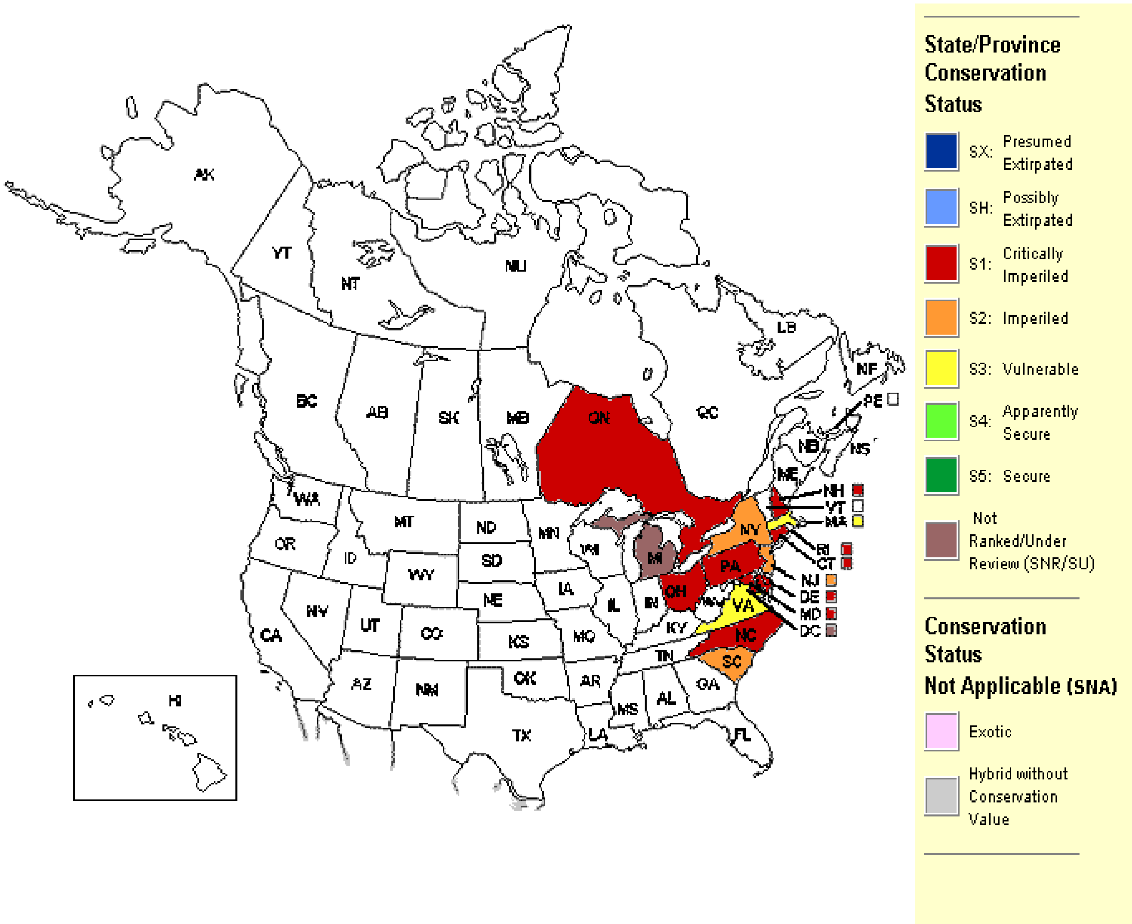

Figure 1. *L. nasuta* distribution in North America (NatureServe 2013)

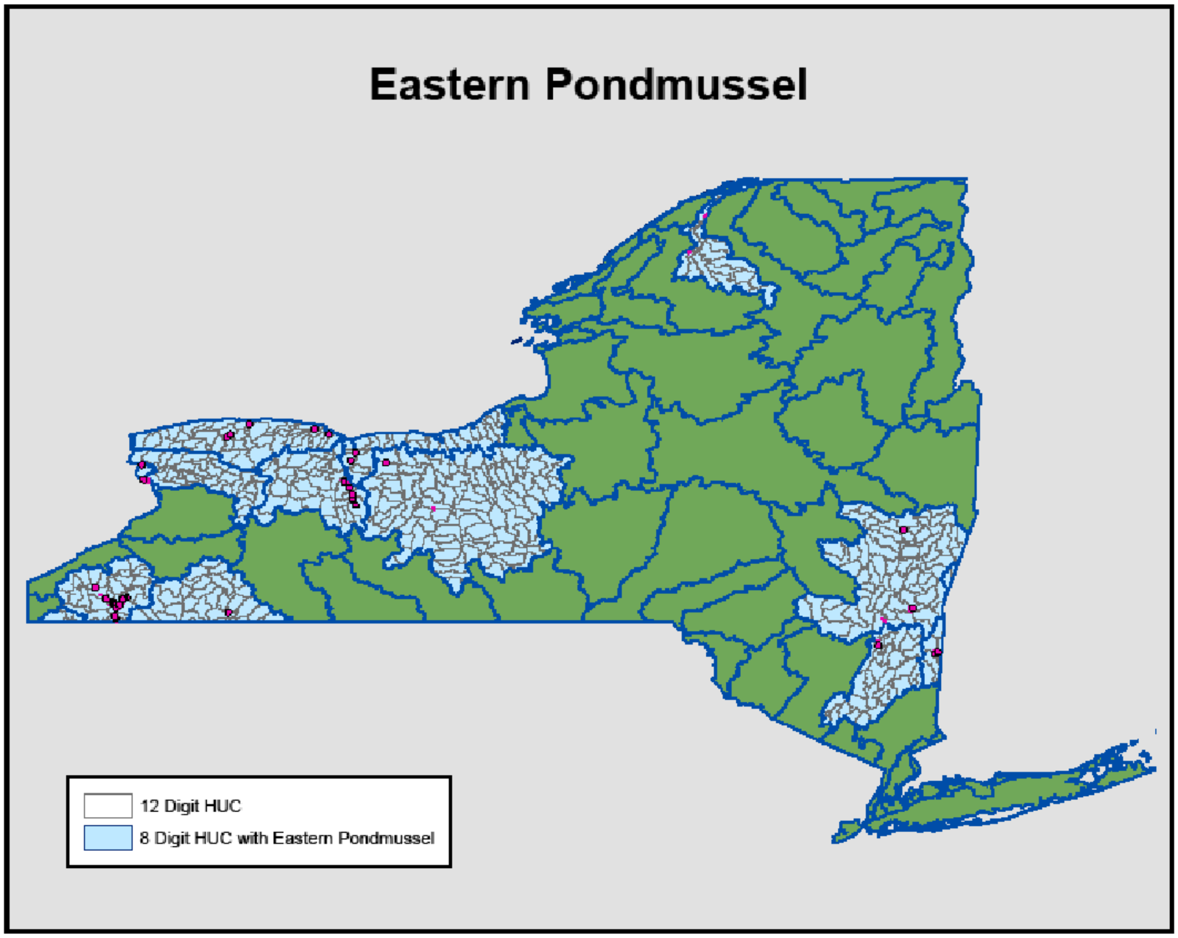

Figure 2. Post 1970 *L. nasuta* distribution in New York State (Mahar & Landry 2013; Harman & Lord 2010; The Nature Conservancy 2009; New York Natural Heritage Program 2013; White et al. 2011).

II. New York Rarity, if known:

Historic	# of Animals	# of Occurrences	% of State
prior to 1970	unknown	~12 waterbodies	9 of 56 HUC 8 watersheds
prior to 1980	________	________	________
prior to 1990	________	________	________

Details of historic occurrence:

Although *L. nasuta* originated on the Atlantic Slope, it has dispersed into much of New York and is most common in the western part of the state. It seems to be missing all together from the Susquehanna basin (Ortmann 1919). It is scattered in the Erie-Niagara drainage, central New York, and the St. Lawrence River and its tributaries, Oswegatchie River at Gouverneur and Indian River. There is an old record from a private fen in Genesee County (Strayer and Jirka 1997). It has been reported from one tributary to Lake Ontario in Niagara County (likely Twelvemile Creek or East

Branch of Twelvemile Creek) and two tributaries to Lake Ontario in eastern Wayne County in the vicinity of Sodus Bay and Port Bay. In the Upper Hudson it had been found in North Chuctanunda Creek, as well as various locations along the Hudson River (Strayer and Jirka 1997).

Current	# of Animals	# of Occurrences	% of State
	~118 live	21 waterbodies	12 of 56 HUC 8 watersheds

Details of current occurrence:

Since 1970, *L. nasuta* has been found in 21 New York State waterbodies.

In the Lower Genesee basin 20 live *L. nasuta* were found in Honeoye and Bebee Creeks. In the West Lake Ontario basin shells were found in Oak Orchard, West, and Larkin Creeks. Shells were also found in the Mid Lake Ontario basin in Irondequoit Creek and the Erie Canal (Mahar & Landry 2013). In recent surveys of the Allegheny basin, 42 live individuals were found in Conewago and Cassadaga Creeks of the Conewago sub-basin, and populations were considered viable at five sites. Catches peaked at 8.6 individuals per hour in lower Cassadaga Creek. It has also been recorded live from the Allegheny River basin near Weston Mills (NY Natural Heritage Program 2013), Chautauqua Lake, and the Chadokoin River (Strayer & Jirka 1997). It was probably introduced into the Chautauqua area, perhaps with stocked fish (Strayer & Jirka 1997). *L. nasuta* have been found live in the Niagara River at Beaver Island and as shells at Buckhorn Island (NY Natural Heritage Program 2013), in Spicer Creek (2) and at Strawberry Island (1) in 2011 (Burlakova, Karatayev, unpublished data). From 54 sites at 33 locations in Lake Ontario surveyed in 2012 (Burlakova, Karatayev et al. in preparation) we found 12 *L. nasuta* in Lake Ontario tributaries and nearby wetlands (3 in North Pond, 3 in Salmon River mouth (both in Oswego Co, near Pulaski), and 6 in Black River Bay (Jefferson Co, near Sackets Harbor)). In the Hudson basin there are records of live individuals in Lake Taghkanic and Webatuck Creek (28 live), and a single dead animal was found in Indian Kill at Norrie Point (NY Natural Heritage Program 2013; Strayer & Jirka 1997). One live mussel was found in Mohawk River (42.90464N, 73.68376W, Mechanicville, Saratoga Co.) in 2010 (Karatayev, Burlakova, unpublished data). In the Delaware basin, this species has been reported from Tennahnah Lake in Sullivan County (Strayer & Jirka 1997). In the St. Lawrence basin, it has been found in the Grass River and its tributary Harrison Creek (White et. al. 2011).

Waterbodies with greatest *L. nasuta* abundance include lower Cassadaga Creek, Webatuck Creek, and Honeoye Creek between Honeoye Falls and Honeoye Lake, and its tributary Bebee Creek, and Black River Bay of Lake Ontario.

New York's Contribution to Species North American Range:

% of NA Range in New York

____ 100 (endemic)

____ 76-99

____ 51-75

____ 26-50

__X__ 1-25

Classification of New York Range

____ Core

____ Peripheral

____ Disjunct

Distance to core population:

____

I. Primary Habitat or Community Type:

1. Headwater/Creek; Low-Moderate Gradient; Moderately Buffered, Neutral; Transitional Cool

2. Small River; Low Gradient; Moderately Buffered, Neutral; Transitional Cool

3. Small River; Low-Moderate Gradient; Moderately Buffered, Neutral; Transitional Cool

Habitat or Community Type Trend in New York:

__X__ Declining ____Stable ____ Increasing ____Unknown

Time frame of decline/increase: __________1990 – present__________

Habitat Specialist? __X__ Yes ______ No

Indicator Species? __X__ Yes ______ No

Habitat Discussion:

L. nasuta is most often found in quiet waters in estuaries, lakes, in slackwater areas of rivers, canals, or slow streams, but it has also been found regularly in the Niagara River (Strayer & Jirka 1997, Nedeau 2008). However, it is more commonly found in deeper areas of low-gradient and non-tidal rivers than in small shallow streams. It is also known to occur in ponds (Nedeau 2008). *L. nasuta* inhabits in a wide range of substrates, including gravel and cobble (Nedeau 2008), although it is thought to prefer fine sand and mud (Metcalfe-Smith et al. 2005, Watters et al. 2009).

II. New York Species Demographics and Life History

__X_ Breeder in New York

_X_ Summer Resident

_X_ Winter Resident

____ Anadromous

____ Non-breeder in New York

____ Summer Resident

____ Winter Resident

____ Catadromous

____ Migratory only

____Unknown

Species Demographics and Life History Discussion:

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. nasuta* 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).

L. nasuta is bradytictic with fertilization occurring in late summer and glochidia released the following spring (Watters et al. 2009). This species uses a visual display to attract host fish. The display behavior occurs primarily during daylight and pauses at night and when turbidity is increased. Fish hosts have not yet been determined. Closely related species have been reported to parasitize centrarchids as well as banded killifish (Nedeau 2008, Strayer & Jirka 1997). This species may live for ten years or more (Watters et al. 2009).

III. Threats:

Agricultural Runoff

Several waterbodies in which *L. nasuta* has been found, including Honeoye Creek, Oak Orchard Creek, Webatuck Creek, and the Erie Canal, flow through heavily agricultural areas (New York State Landcover 2010) and are likely impacted by associated siltation, pesticide and nutrient loading. 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.

Increases in turbidity associated with agricultural runoff may be especially detrimental to *L. nasuta*, as this species uses visual cues to attract host fish, as its display frequency stops under conditions of high turbidity (Corey et al. in NatureServe 2013).

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 14 of New York waterbodies that host *L. nasuta* 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 Niagara River receive urban runoff from Buffalo, Oak Orchard Creek receives runoff from Medina, Honeoye Creek receives runoff from Honeoye and Honeoye Falls, and populations in the lower reaches of the Cassadaga and Conewango receive runoff from Jamestown. In addition, Erie Canal populations between Pittsford and Macedon receive urban storm water runoff through various municipalities (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 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

Several habitats of *L. nasuta* populations receive treated effluent from sewage treatment plants (SPDES 2007). The Niagara River, Oak Orchard Creek from Medina, Honeoye Creek at Honeoye and Honeoye Falls, and Cassadaga Creek receives treated effluent from the city of Jamestown sewage treatment plant (SPDES 2007). Furthermore, raw sewage enters known *L. nasuta* habitat from Combined Sewer Overflows to the Niagara River from Buffalo and Oak Orchard Creek from Medina (Combined Sewer Overflow 2013). In addition, illegal dumping of sewage by recreational boats may be a concern for *L. nasuta* populations in 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 waste water 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 waste water 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).

Erie Canal Specific Habitat Modifications

Based on the number of fresh shells found, it is thought that the Erie Canal system hosts a significant *L. nasuta* population. 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 *L. nasuta* populations. During spring mussel surveys of the Erie Canal, it is not uncommon to find hundreds of fresh shells of multiple species, including *L. nasuta,* 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 mussels (*Dreissena polymorpha*) are present in *L. nasuta* habitat in the lower reaches of Cassadaga and Conewango Creeks (The Nature Conservancy 2009). They have also been detected in the Oak Orchard Creek, downsteam of the Medina dam, where L. nasuta shells have been found (NY Natural Heritage Program 2013, Mahar & Landry 2013). In the Erie Canal, zebra and quagga mussels (*Dreissena bugenis*) and Asian clams (*Corbicula*) have been found in large numbers.

Invasive zebra and quagga mussels have been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997, Watters et al. 2009). Rangewide, over 90% of historical records for *L. nasuta* are in waters that are now infested with zebra mussels and therefore uninhabitable. The species has declined dramatically and now occurs as two small, widely separated populations, one in the delta area of Lake St. Clair and one in a tributary of the upper St. Lawrence River. There is evidence that declines may be continuing (NatureServe 2013). En masse, Dreissenids out compete 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). 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).

Sea lamprey control treatments – in tributaries to Lake Ontario.

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 & 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?

__ __ No **_____ Unknown**

__x__ Yes

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, lower Cassadaga Creek, Webatuck Creek, and Honeoye Creek between Honeoye Falls and Honeoye Lake, and its tributary Bebee 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, 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.

- 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.

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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