Species Status Assessment

Class: **Bivalvia**
Family: **Unionidae**
Scientific Name: ***Lasmigona subviridis***
Common Name: **Green floater**

Species synopsis:

Lasmigona subviridis 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). *L. subviridis* is a member of the *Lasmigona* genus, from the Greek words *elasma*, referring to the "plate-like" lateral tooth. The species name *subviridis* refers to its light green color (Watters et al. 2009).

This species is found in the Atlantic Slope from North Carolina to New York, as well as the Kanawha River basin in North Carolina, Virginia, and West. Virginia. Since 1970, this species has been found live in thirteen New York waterbodies. Most records are from the Susquehanna River drainage, but records from the Mohawk, Hudson, Genesee, and Oswego River basins, and the Erie Canal also exist. The species has declined throughout most of its range, and relatively few populations remain in New York (Strayer & Jirka 1997).

L. subviridis is ranked as "critically imperiled" in New York and "vulnerable" 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 and Legal Protected Status

i. Federal ____ _____None__________________________**Candidate?** ___**No**__

ii. New York _____Threatened – Species of Greatest Conservation Need______

b. Natural Heritage Program Rank

i. Global _____G3 - Vulnerable____

ii. New York S1S2 – Critically imperiled/Imperiled **Tracked by NYNHP?** _Yes_

Other Rank:

IUCN Red List Category: Near threatened
American Fisheries Society Status: Threatened (1993)
Species of Regional Northeast Conservation Concern (Therres 1999)

Status Discussion:
L. subviridis has recently been found more infrequently and generally in lower numbers than in the past, with many documented extirpated occurrences. However, this species is easier to overlook than others and might be under-sampled. It still maintains a wide range, although there is considerable confusion as to the taxonomy of this species in the northern part of its range. Although occurrences are still widespread, decline is evident at many localities and historical extirpations have occurred in Georgia and Kentucky (NatureServe 2013).

II. 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** ___X___ **No data** _______

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

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

i. **Abundance**

_X__ **declining** ____**increasing** ____**stable** ____**unknown**

ii. **Distribution:**

__X__ **declining** ____**increasing** ____**stable** ____**unknown**

Time frame considered: _____1970-present___________________________________
Listing Status: ____S1 - Endangered____________________ SGCN? __Yes________

The green floater has not been recorded live in NJ since 1996 – this sighting is of one individual, recorded in the Stony Brook, Mercer County. Since then, several older shells have been taken from the Pequest River, Warren County (Davenport, 2012).

ONTARIO **Not Present** ___X___ **No data** _______

PENNSYLVANIA **Not Present** ________ **No data** _______

i. **Abundance**

__X__ **declining** ____**increasing** ____**stable** ____**unknown**

ii. **Distribution:**

__X__ **declining** ____**increasing** ____**stable** ____**unknown**

Time frame considered: ____
Listing Status: ___S2___________________________________ SGCN? __No________

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 New York 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 2015). 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.

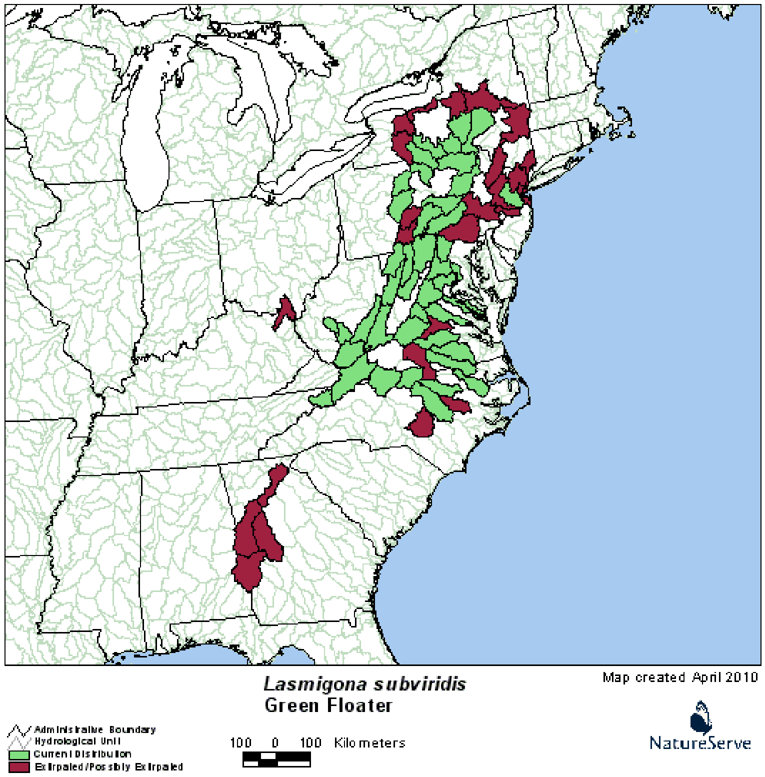

Figure 1. *L. subviridis* distribution in North America (NatureServe 2013).

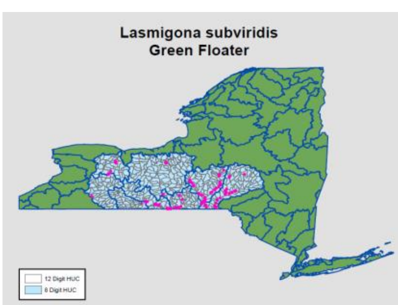

Figure 2. Post 1970 distribution *of L. subviridus* in New York (Mahar & Landry 2015, Harman and Lord 2010, The Nature Conservancy 2009, New York Natural Heritage Program 2013, White et al. 2011).

III. New York Rarity, if known:

Historic	# of Animals	# of Locations	% of State
prior to 1970	_unknown_	_~14 waterbodies_	11 of 56 HUC 8 watersheds_
prior to 1980	________	________	________
prior to 1990	________	________	________

Details of historic occurrence:
Most of the records from New York are from the Susquehanna River drainage (approximately nine waterbodies), where *L. subviridis* was widespread. NY Natural Heritage Program (2013) reported occurrences in the Susquehanna from both Willseyville Creek and Cayuta Creek in 1959. *L. subviridis* was not found at either of these sites upon revisit in the late 1990's. It has been reliably recorded from a few sites in the Mohawk and Hudson Rivers, although not in the last century. *L. subviridis* was also recorded prior to 1970 in the Oswego River basin near Syracuse; Chittenango Creek (1956); the Erie Canal near Baldwinsville; and the Genesee River drainage (Strayer & Jirka, 1997).

Current	# of Animals	# of Locations	% of State
	~514 live	_13 confirmed waterbodies	7 of 56 HUC 8 watersheds

Details of current occurrence:
Since 1970, *L.subviridis* has been found in thirteen New York State waterbodies (Figure 2).

A recent State Wildlife Grants funded survey of portions of the Susquehanna basin detected live *L. subviridis* at 7 sites in the Unadilla River (79 live), 7 sites in the Chenango River (20 live), 6 sites in the Susquehanna River (155 live), 5 sites in the Tioughnioga River (45 live), 5 sites in the Chemung River (51 live) (8 live – Mahar & Landry 2014), and 2 sites in the Sangerfield River (10 live) (Harman &, Lord 2010). There are also reports of live mussels from 3 sites in Catatonk Creek (3 live) (Harman &, Lord 2010; NY Natural Heritage Program, 2013). In the Cohocton subbasin, *L. subviridis* was found live in Fivemile Creek (40 live) and in the Cohocton River near Bath (102 live) (Mahar & Landry 2014).

In the Genesee River basin, three live specimens were found in the Genesee River at Mt. Morris and at least one live specimen was found at Geneseo (Livingston Co). Additional live individuals were found in Black Creek (Allegany Co), a tributary to the upper Genesee River. Fresh shells were also found in the Genesee River, including a juvenile specimen just downstream of Honeoye Creek confluence (Rush, Monroe Co.) and an adult specimen just upstream of Oatka Creek confluence (Henrietta, Monroe Co.) (Mahar & Landry 2015).

In the Seneca basin, *L. subviridis* was found live in Crane Brook (3 live) and Fall Creek (1 live) (Mahar & Landry 2015).

Two specimens of *L. subviridis* were reported from the Grass River drainage in northern New York's St. Lawrence basin (1996), but this record is well out of the known range of the species and must be verified (Strayer & Jirka 1997).

New York's Contribution to Species North American Range:

% of NA Range in New York	**Classification of New York Range**
____ 100 (endemic)	**__X__ Core**
____ 76-99	**_____ Peripheral**
____ 51-75	**____ Disjunct**
____ 26-50	**Distance to core population:**
__X__ 1-25	**__________**

IV. Primary Habitat or Community Type:

1. Medium River; Low Gradient; Assume Moderately Buffered (Size 3+ rivers); Transitional Cool

2. Medium River; Moderate-High Gradient; Assume Moderately Buffered (Size 3+ rivers); Warm

3. Medium River; Low-Moderate Gradient; Assume Moderately Buffered (Size 3+ rivers); Warm

Habitat or Community Type Trend in New York:

____ Declining ____Stable ____ Increasing __X__Unknown

Time frame of decline/increase: ____

Habitat Specialist? __X__ Yes ______No

Indicator Species? __X__ Yes _____ No

Habitat Discussion:

L. subviridis is considered to be a species of creeks and small rivers (Watters et al. 2009, Strayer & Jirka 1997, Ortman 1919). Watters et al. (2009) noted that it is not typically a large river species.

Despite this, in New York, this species has been most commonly found in large and medium sized rivers (Susquehanna River, Chemung River, Chenango River, Unadilla River, Tioghnioga River, Genesee River). *L. subviridis* is most commonly found in gravel or sandy substrate in water depths of one to four feet (NatureServe 2013, Ortmann 1919, Spoo 2008, Watters et al. 2009). It is thought to be intolerant of strong currents and occurs in pools and other calm water areas (Ortmann 1919, Watters et al. 2009, NatureServe 2013). It seems to occur more often in good condition (Watters et al., 2009), good water quality (NatureServe 2013), hydrologically stable streams than in those subject to severe floods and droughts (Strayer & Jirka 1997).

V. 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:

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).

L. subviridis is a short lived species, usually living 3 to 4 years, and rarely attaining 7 years of age (Watters et al. 2009). It is one of few hermaphroditic unionids (Strayer & Jirka 1997, Watters et al. 2009). Hermaphroditism affords benefits when population densities are low; under such conditions, females may switch to self-fertilization to ensure that recruitment continues. In addition, this is one of only two North American species confirmed to metamorphose without a host. Fully formed juveniles were found in the adult female's marsupial in April from Pennsylvania and North Carolina populations (Watters et al. 2009). In Virginia, this species was found to be gravid in August (NatureServe 2013). Ortmann (1919) reported that it is bradytictic, brooding eggs and glochidia from August to June. In the adult form, freshwater mussels are basically sessile; movement is limited to a few meters of the lake or river bottom (COSEWIC 2003 as cited in NatureServe 2013).

VI. Threats:

Agricultural Runoff

Agricultural practices and wood harvest in the basins with *L. subviridis* populations may be sources of siltation and pollution. Although only 27 percent of the land in the New York portion of the Susquehanna basin is agriculture (Homer 2007) the large majority of this agriculture is located adjacent to streams, many of which are identified as *L. subviridis* habitat. Seventy percent of the land cover in the basin is in forest. In the lower Genesee basin, *L. subviridis* has also been found in highly agricultural areas ("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 2015), 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).

Treated and Untreated Waste Water

In the Susquehanna basin, known *L. subviridis* habitat is located downstream of the numerous combined sewer outflow (CSO) outfalls in the City of Elmira (10 outfalls) and the City of Binghamton (9 outfalls) ("Combined Sewer Overflow" 2012). In addition, *L. subviridis* habitat receives treated waste water from the municipalities of Corning, Painted Post, Erwin, Elmira, Waverly, Owego, Binghamton and its suburbs, Whitney Point, Green, Sidney, and Bainbridge (SPDES 2007). 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 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 waste water treatment plants were responsible for reductions in mussel species of greatest conservation need.

Runoff from Developed Land

All New York waterbodies that host *L. subviridis* populations are intermittently bordered by interstate highways, state routes, and/or local roads. Municipalities bordering *L. subviridis* habitat include Corning, Painted Post, Erwin, Elmira, Waverly, Owego, Binghamton and its suburbs, Whitney Point, Green, Sidney, and Bainbridge (New York State Landcover 2010). These developed lands are likely sources of 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 & 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, Liqouri & 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).

Flood Control Projects

L. subviridis has been found within or adjacent to stream reaches shaped by levee and/or floodwall flood control projects in Elmira and Corning/Painted Post on the Chemung River, Nichols on the Susquehanna River, Binghamton on the Susquehanna River and Chenango River, and Whitney Point on the Tioughnioga River ("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 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 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, and has subsequently been recommended only as a monitored and highly managed effort (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 threat to *A. varicosa* populations in the Chenango River, particularly downstream of Eastonbrook Reservoir in Madison County, the West Branch of the Tioughnioga River near Cortland, and in the Susquehanna River at Binghamton and south of Copperstown (Harman & Lord 2010, iMapInvasives 2013). Harman and Lord (2010) note that zebra mussels are moving downstream from these headwater areas on the Susquehanna and are fouling and killing native pearly mussels. This invasive species has been repeatedly cited as a threat to native mussel populations (Strayer & Jirka 1997, Watters et al. 2009). 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.

Water Temperature Change

Stream temperature can increases due to many factors such as global climate change as well as industrial activities. 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 "extremely vulnerable." This indicates that abundance and/or range extent within New York is extremely likely to substantially decrease or disappear by 2050. Gailbreth 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. This threat could result in a decrease in the diversity of freshwater mussels in watersheds.

Impoundments – Range wide

Across its range, impoundments likely contributed to the reduced distribution 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

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:

- Priority conservation efforts for this species should focus on, but not be limited to, the Susquehanna River, especially in the area of high abundance between Windsor and the Pennsylvania border, the Unadilla River, and the Chemung 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 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).
- Update wastewater treatment facilities in Elmira and Binghamton to eliminate combined sewer outflows.
- 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 & 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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