NEW YORK
FISH & AQUATIC INVERTEBRATE INVASIVENESS RANKING FORM

Scientific name:	Hemimysis anomala
Common names:	Bloody Red Shrimp
Native distribution:	Hemimysis anomala is native to the Black Sea, the Azov Sea and the Ponto-Caspian Sea and is historically native to rivers in these watersheds including the Don, Danube, Dnieper and Dniester.
Date assessed:	6/27/13
Assessors:	Erin L. White
Reviewers:	
Date Approved:	Form version date: 3 January 2013

New York Invasiveness Rank: High (Relative Maximum Score 70.00-80.00)

Distribution and Invasiveness Rank (*Obtain from PRISM invasiveness ranking form***)**			
	Status of this species in each PRISM:	Current Distribution	PRISM Invasiveness Rank
1	Adirondack Park Invasive Program	Not Assessed	Not Assessed
2	Capital/Mohawk	Not Assessed	Not Assessed
3	Catskill Regional Invasive Species Partnership	Not Assessed	Not Assessed
4	Finger Lakes	Not Assessed	Not Assessed
5	Long Island Invasive Species Management Area	Not Assessed	Not Assessed
6	Lower Hudson	Not Assessed	Not Assessed
7	Saint Lawrence/Eastern Lake Ontario	Not Assessed	Not Assessed
8	Western New York	Not Assessed	Not Assessed

Invasiveness Ranking Summary (see details under appropriate sub-section)		Total (Total Answered*) Possible	Total
1	Ecological impact	30 (20)	14
2	Biological characteristic and dispersal ability	30 (30)	18
3	Ecological amplitude and distribution	30 (24)	22
4	Difficulty of control	10 (10)	5
	Outcome score	100 (71)[b]	59[a]
	Relative maximum score †		70.23
	New York Invasiveness Rank §	High (Relative Maximum Score 70.00-80.00)	

* For questions answered "unknown" do not include point value in "Total Answered Points Possible." If "Total Answered Points Possible" is less than 70.00 points, then the overall invasive rank should be listed as "Unknown."
†Calculated as 100(a/b) to two decimal places.
§Very High >80.00; High 70.00−80.00; Moderate 50.00−69.99; Low 40.00−49.99; Insignificant <40.00

A. DISTRIBUTION (KNOWN/POTENTIAL): Summarized from individual PRISM forms

A1.1. Has this species been documented in NY? (reliable source; voucher not required)	
☒	Yes – continue to A1.2
☐	No – continue to A2.1; Yes ☐ NA; Yes ☐ USA
A1.2. In which PRISMs is it known (see inset map)?	
☐	Adirondack Park Invasive Program
☐	Capital/Mohawk
☐	Catskill Regional Invasive Species Partnership
☒	Finger Lakes
☐	Long Island Invasive Species Management Area
☐	Lower Hudson

☒	Saint Lawrence/Eastern Lake Ontario
☐	Western New York

Documentation:
Sources of information:
(Brooking et al. 2010, The Nature Conservancy 2013, U.S. Geological Survey 2013)

A2.0. Is this species listed on the Federal Injurious Fish and Wildlife list?
☐ Yes – the species will automatically be listed as Prohibited, no further assessment required.
☒ No – continue to A2.1

A2.1. What is the likelihood that this species will occur and persist given the climate in the following PRISMs? (obtain from PRISM invasiveness ranking form and/ or Climatch score)

Very Likely	Adirondack Park Invasive Program
Very Likely	Capital/Mohawk
Very Likely	Catskill Regional Invasive Species Partnership
Very Likely	Finger Lakes
Very Likely	Long Island Invasive Species Management Area
Very Likely	Lower Hudson
Very Likely	Saint Lawrence/Eastern Lake Ontario
Very Likely	Western New York

Documentation:
Sources of information (e.g.: distribution models, literature, expert opinions):

If the species does not occur and is not likely to survive and reproduce within any of the PRISMs, then stop here as there is no need to assess the species.

A2.2. What is the current distribution of the species in each PRISM? (obtain rank *from PRISM invasiveness ranking forms*)

	Distribution
Adirondack Park Invasive Program	Not Assessed
Capital/Mohawk	Not Assessed
Catskill Regional Invasive Species Partnership	Not Assessed
Finger Lakes	Not Assessed
Long Island Invasive Species Management Area	Not Assessed
Lower Hudson	Not Assessed
Saint Lawrence/Eastern Lake Ontario	Not Assessed
Western New York	Not Assessed

Documentation:
Sources of information:

A2.3. Describe the potential or known suitable habitats within New York. Natural habitats include all habitats not under active human management. Managed habitats are indicated with an asterisk.

Aquatic Habitats	Wetland Habitats	Upland Habitats
☐ Marine	☐ Salt/brackish marshes	☐ Cultivated*
☒ Salt/ brackish waters	☐ Freshwater marshes	☐ Grasslands/old fields
☒ Freshwater tidal	☐ Peatlands	☐ Shrublands
☒ Rivers/streams	☐ Shrub swamps	☐ Forests/woodlands
☒ Natural lakes and ponds	☐ Forested wetlands/riparian	☐ Alpine
☐ Vernal pools	☐ Ditches*	☐ Roadsides*
☒ Reservoirs/ impoundments*	☐ Beaches/or coastal dunes	☐ Cultural*

Other potential or known suitable habitats within New York:

Documentation:
Sources of information:

(Kipp et al. 2012)

B. INVASIVENESS RANKING

1. ECOLOGICAL IMPACT

1.1. Impact on Ecosystem Processes and System-wide Parameters (e.g., water cycle, energy cycle, nutrient and mineral dynamics, light availability, or geomorphological changes (erosion and sedimentation rates).

A.	No perceivable impact on ecosystem processes based on research studies, or the absence of impact information if a species is widespread (>10 occurrences in minimally managed areas), has been well-studied (>10 reports/publications), and has been present in the northeast for >100 years.	0
B.	Influences ecosystem processes to a minor degree, has a perceivable but mild influence	3
C.	Significant alteration of ecosystem processes	7
D.	Major, possibly irreversible, alteration or disruption of ecosystem processes	10
U.	Unknown	

Score 7

Documentation:
Identify ecosystem processes impacted (or if applicable, justify choosing answer A in the absence of impact information)
Marty et al. (2010) indicate bloody red shrimp are heavy grazers on algae and zooplankton and can therefore alter the energy flow of an aquatic system, but they suggest more studies are necessary to determine the degree of these effects and whether they are positive or negative. In addition, Borcherding et al. (2006) highlight the high lipid content of these shrimp and their impact as a high energy food source for fish predators.
Sources of information:
(Borcherding et al. 2006, Marty et al. 2010)

1.2. Impact on Natural Habitat/ Community Composition

A.	No perceived impact; causes no apparent change in native populations	0
B.	Influences community composition (e.g., reduces the number of individuals of one or more native species in the community)	3
C.	Significantly alters community composition (e.g., produces a significant reduction in the population size of one or more native species in the community)	7
D.	Causes major alteration in community composition (e.g., results in the extirpation of one or several native species, reducing biodiversity or change the community composition towards species exotic to the natural community)	10
U.	Unknown	

Score 7

Documentation:
Identify type of impact or alteration:
Pothoven et al. (2007) stated that the abundance of some native zooplankton declined after bloody red shrimp became established in a new reservoir in the Netherlands and other studies show that similar species (other mysids) have altered zooplankton abundance and distributions. There are cases where this species has caused both increases and decreases in fish populations, but their presence has been shown to have an effect in community structure (Kipp et al. 2012).
Sources of information:
(Pothoven et al. 2007, Kipp et al. 2012)

1.3. Impact on other species or species groups, including cumulative impact of this species on other organisms in the community it invades. (e.g., interferes with native predator/ prey dynamics; injurious components/ spines; reduction in spawning; hybridizes with a native species; hosts a non-native disease which impacts a native

species)

A.	Negligible perceived impact	0
B.	Minor impact (e.g. impacts 1 species, <20% population decline, limited host damage)	3
C.	Moderate impact (e.g. impacts 2-3 species and/ or 20-29% population decline of any 1 species, kills host in 2-5 years, ,)	7
D.	Severe impact on other species or species groups (e.g. impacts >3 species and/ or ≥30% population decline of any 1 species, kills host within 2 years, extirpation)	10
U.	Unknown	

Score: U

Documentation:
Identify type of impact or alteration:
Pothoven et al. (2007) stated that the abundance of some native zooplankton declined after bloody red shrimp became established in a new reservoir in the Netherlands and other studies show that similar species (other mysids) have altered zooplankton abundance and distributions. There are cases where this species has caused both increases and decreases in fish populations, but their presence has been shown to have an effect in community structure (Kipp et al. 2012). Marty et al. (2010) indicate bloody red shrimp are heavy grazers on algae and zooplankton and can therefore alter the energy flow of an aquatic system, but they suggest more studies are necessary to determine the degree of these effects and whether it is positive or negative. In addition, Borcherding et al. (2006) highlight the high lipid content of these shrimp and their impact as a high energy food source for fish predators. However, there is evidence that mysid introductions can negatively impact communities by increasing parasitism and biomagnification of contaminants in fish (Kipp et al. 2012).
Sources of information:
(Borcherding et al. 2006, Pothoven et al. 2007, Marty et al. 2010, Kipp et al. 2012)

Total Possible: 20
Section One Total: 14

2. BIOLOGICAL CHARACTERISTICS AND DISPERSAL ABILITY

2.1. Mode and rate of reproduction (provisional thresholds, more investigation needed)

A.	No reproduction (e.g. sterile with no sexual or asexual reproduction).	0
B.	Limited reproduction (e.g., intrinsic rate of increase <10%, low fecundity, complete one life cycle)	1
C.	Moderate reproduction (e.g., intrinsic rate of increase between 10-30%, moderate fecundity, complete 2-3 life cycles)	2
D.	Abundant reproduction (e.g., intrinsic rate of increase >30%, parthenogenesis, large egg masses, complete > 3 life cycles)	4
U.	Unknown	

Score: 2

Documentation:
Describe key reproductive characteristics:
Bloody red shrimp reach sexual maturity in about 45 days and females can produce 2-4 broods per year with up to 70 eggs per clutch.
Sources of information:
(University of Wisconsin Sea Grant Institute 2012, U.S. Geological Survey 2013)

2.2. Migratory behavior

A.	Always migratory in its native range	0
B.	Non-migratory or facultative migrant in its native range	2
U.	Unknown	

Score: 2

Documentation:
Describe migratory behavior:

Sources of information:

2.3. Biological potential for colonization by long-distance dispersal/ movement (e.g., veligers, resting stage eggs, glochidia)

A.	No long-distance dispersal/ movement mechanisms	0
B.	Adaptations exist for long-distance dispersal, but studies report that most individuals (90%) establish territories within 5 miles of natal origin or within a distance twice the home range of the typical individual, and tend not to cross major barriers such as dams and watershed divides	1
C.	Adaptations exist for long-distance dispersal, movement and evidence that offspring often disperse greater than 5 miles of natal origin or greater than twice the home range of typical individual and will cross major barriers such as dams and watershed divides	2
U.	Unknown	

Score 0

Documentation:
Identify dispersal mechanisms:
Range extensions have occurred through natural dispersal downstream from or connected to sites where they were originally introduced. They possess the ability to survive in freshwater and brackish waters, which increases the likelihood of suitable habitats for colonization from introduced sites. However, Audzijonyte et al. (2008) note its limited natural dispersal capacity, as it has difficulty swimming upstream.
Sources of information:
(Audzijonyte et al. 2008, Kestrup and Ricciardi 2008)

2.4. Practical potential to be spread by human activities, both directly and indirectly – possible vectors include: commercial bait sales, deliberate illegal stocking, aquaria releases, boat trailers, canals, ballast water exchange, live food trade, rehabilitation, pest control industry, aquaculture escapes, etc.)

A.	Does not occur	0
B.	Low (human dispersal to new areas occurs almost exclusively by direct means and is infrequent or inefficient)	1
C.	Moderate (human dispersal to new areas occurs by direct and indirect means to a moderate extent)	2
D.	High (opportunities for human dispersal to new areas by direct and indirect means are numerous, frequent, and successful)	4
U.	Unknown	

Score 2

Documentation:
Identify dispersal mechanisms:
Human activities which have dispersed bloody red shrimp include ballast water exchange in North America. In Europe, reservoir stocking has introduced populations to new areas.
Sources of information:
(Audzijonyte et al. 2008, Kestrup and Ricciardi 2008, Kipp et al. 2012)

2.5. Non-living chemical and physical characteristics that increase competitive advantage (e.g., tolerance to various extremes, pH, DO, temperature, desiccation, fill vacant niche, charismatic species)

A.	Possesses no characteristics that increase competitive advantage	0
B.	Possesses one characteristic that increases competitive advantage	4
C.	Possesses two or more characteristics that increase competitive advantage	8

U. Unknown

Score 4

Documentation:
Evidence of competitive ability:
Bloody red shrimp are tolerant of a variety of salinities from 0-10ppm, allowing them to inhabit and travel through freshwater and brackish waters.
Sources of information:
(Kipp et al. 2012)

2.6. Biological characteristics that increase competitive advantage (e.g., high fecundity, generalist/ broad niche space, highly evolved defense mechanisms, behavioral adaptations, piscivorous, etc.)

A. Possesses no characteristics that increase competitive advantage 0
B. Possesses one characteristic that increases competitive advantage 4
C. Possesses two or more characteristics that increase competitive advantage 8
U. Unknown

Score 8

Documentation:
Evidence of competitive ability:
H. anomala have a high feeding rate, growth rate, and maturation rate and are omnivorous with the ability to switch feeding modes depending on food availability.
Sources of information:
(Pothoven et al. 2007)

2.7. Other species in the family and/ or genus invasive in New York or elsewhere?

A. No 0
B. Yes 2
U. Unknown

Score 0

Documentation:
Identify species:

Total Possible 30
Section Two Total 18

3. ECOLOGICAL AMPLITUDE AND DISTRIBUTION

3.1. Current introduced distribution in the northern latitudes of USA and southern latitude of Canada (e.g., between 35 and 55 degrees).

A. Not known from the northern US or southern Canada. 0
B. Established as a non-native in 1 northern USA state and/or southern Canadian province. 1
C. Established as a non-native in 2 or 3 northern USA states and/or southern Canadian provinces. 2
D. Established as a non-native in 4 or more northern USA states and/or southern Canadian provinces, and/or categorized as a problem species (e.g., "Invasive") in 1 northern state or southern Canadian province. 3
U. Unknown

Score 3

Documentation:
Identify states and provinces:
Ontario, Canada and IL, MI, OH, NY in the United States.
Sources of information:

- See known introduced range at www.usda.gov, and update with information from states and Canadian provinces.

(U.S. Geological Survey 2013)

3.2. Current introduced distribution of the species in natural areas in the eight New York State PRISMs (Partnerships for Regional Invasive Species Management)

A.	Established in none of the PRISMs	0
B.	Established in 1 PRISM	1
C.	Established in 2 or 3 PRISMs	3
D.	Established in 4 or more PRISMs	5
U.	Unknown	

Score: 3

Documentation:
Describe distribution:
Bloody red shrimp has been established in the Finger Lakes and SLELO PRISMS.
Sources of information:
(The Nature Conservancy 2013, U.S. Geological Survey 2013)

3.3. Number of known, or potential (each individual possessed by a vendor or consumer), individual releases and/ or release events

A.	None	0
B.	Few releases (e.g., <10 annually).	2
C.	Regular, small scale releases (e.g., 10-99 annually).	4
D.	Multiple, large scale (e.g., ≥100 annually).	6
U.	Unknown	

Score: U

Documentation:
Describe known or potential releases:
The literature focuses on the likely cause of the first sightings in North America, which is attributed to ballast water exchange. The species is difficult to detect and may persist for some time without detection due in part to nocturnal activity; therefore, populations and number of release events are unknown.
Sources of information:
(Kipp et al. 2012, University of Wisconsin Sea Grant Institute 2012)

3.4. Current introduced population density, or distance to known occurrence, in northern USA and/ or southern Canada.

A.	No known populations established.	0
B.	Low to moderate population density (e.g., ≤1/4 to < 1/2 native population density) with few other invasives present and/ or documented in 1 or more non-adjacent state/ province and/ or 1 unconnected waterbody.	1
C.	High or irruptive population density (e.g., ≥1/2 native population density) with numerous other invasives present and/ or documented in 1 or more adjacent state/ province and/ or 1 connected waterbody.	2
U.	Unknown	

Score: 2

Documentation:
Describe population density:
While population density is unknown, the species has been documented as established in at least 5 states and provinces bordering the Great Lakes.

Sources of information:
(U.S. Geological Survey 2013)

3.5. Number of habitats the species may invade

A. Not known to invade any natural habitats given at A2.3. 0
B. Known to occur in 2 or 3 of the habitats given at A2.3, with at least 1 or 2 natural habitat(s). 2
C. Known to occur in 4 or more of the habitats given at A2.3, with at least 3 natural habitats. 3
U. Unknown.

Score 3

Documentation:
Identify type of habitats where it occurs and degree/type of impacts:
The species could invade a wide variety of freshwater to brackish natural aquatic habitats.
Sources of information:
(Kipp et al. 2012)

3.6. Role of anthropogenic (human related) and natural disturbance in establishment (e.g. water level management, man-made structures, high vehicle traffic, major storm events, etc).

A. Requires anthropogenic disturbances to establish. 0
B. May occasionally establish in undisturbed areas but can readily establish in areas with natural or anthropogenic disturbances. 2
C. Can establish independent of any known natural or anthropogenic disturbances. 3
U. Unknown.

Score 3

Documentation:
Identify type of disturbance:
There is no mention in literature searched of an anthropogenic disturbance requirement for this species to establish in new locations.
Sources of information:

3.7. Climate in native range (e.g., med. to high, ≥5, Climatch score; within 35 to 55 degree latitude; etc.)

A. Native range does not include climates similar to New York (e.g., <10%). 0
B. Native range possibly includes climates similar to portions of New York (e.g., 10-29%). 4
C. Native range includes climates similar to those in New York (e.g., ≥30%). 8
U. Unknown.

Score 8

Documentation:
Describe known climate similarities:
88% of NY stations are >5 on Climatch.
Sources of information:
(Austrailian Department of Agriculture, Fisheries, and Forestry (ADAFF) 2013)

Total Possible 24
Section Three Total 22

4. DIFFICULTY OF CONTROL

4.1. Re-establishment potential, nearby propagule source, known vectors of re-introduction (e.g. biological supplies, pets, aquaria, aquaculture facilities, connecting waters/ corridors, mechanized transportation, live wells, etc.)

A. No known vectors/ propagule source for re-establishment following removal. 0

B. Possible re-establishment from 1 vector/ propagule source following removal and/ or viable <24 hours. 1
C. Likely to re-establish from 2-3 vectors/ propagule sources following removal and/ or viable 2-7 days. 2
D. Strong potential for re-establishment from 4 or more vectors/ propagule sources following removal and/or viable >7 days. 3
U. Unknown.

Score 2

Documentation:
Identify source/ vectors:
Known vectors include ship ballast water exchange as well as connectivity of aquatic corridors.
Sources of information:
(Kipp et al. 2012)

4.2. Status of monitoring and/ or management protocols for species

A. Standardized protocols appropriate to New York State are available. 0
B. Scientific protocols are available from other countries, regions or states. 1
C. No known protocols exist. 2
U. Unknown

Score 0

Documentation:
Describe protocols:
Sampling protocols exist in the literature and have been implemented in Germany, the Netherlands, as well as the North American Great Lakes. NOAA (2013) has implemented the Hemimysis Monitoring Network in the Great Lakes working with state Sea Grants. NY Sea Grant (2013) studied the ecosystem effects of H. anomala with partners in Lake Ontario from 2009-2011.
Sources of information:
(Ketelaars et al. 1999, Borcherding et al. 2006, Pothoven et al. 2007, New York Sea Grant 2013, NOAA 2013)

4.3. Status of monitoring and/ or management resources (e.g. tools, manpower, travel, traps, lures, ID keys, taxonomic specialists, etc.)

A. Established resources are available including commercial and/ or research tools 0
B. Monitoring resources may be available (e.g. partnerships, NGOs, etc) 1
C. No known monitoring resources are available 2
U. Unknown

Score 0

Documentation:
Describe resources:
Describe resources:
Sampling protocols and descriptions of capture methods and nets and traps for monitoring are available online through NOAA (2013) and have been used through their Hemimysis Monitoring Network in the Great Lakes. New York Sea Grant (2013) worked with Cornell University, USGS Great Lakes Science Center, (and also the Ontario Ministry of Natural Resources), so there would be taxonomic specialists available in New York.
Sources of information:
(Ketelaars et al. 1999, Borcherding et al. 2006, Pothoven et al. 2007, New York Sea Grant 2013, NOAA 2013)

4.4. Level of effort required

A. Management is not required. (e.g., species does not persist without repeated human mediated action.) 0

B.	Management is relatively easy and inexpensive; invasive species can be maintained at low abundance causing little or no ecological harm. (e.g., 10 or fewer person-hours of manual effort can eradicate a local infestation in 1 year.)	1
C.	Management requires a major short-term investment, and is logistically and politically challenging; eradication is difficult, but possible. (e.g., 100 or fewer person-hours/year of manual effort, or up to 10 person-hours/ year for 2-5 years to suppress a local infestation.)	2
D.	Management requires a major investment and is logistically and politically difficult; eradication may be impossible. (e.g., more than 100 person-hours/ year of manual effort, or more than 10 person hours/year for more than 5 years to suppress a local infestation.)	3
U.	Unknown	

Score	3

Documentation:
Identify types of control methods and time required:
While monitoring programs exist in the Great Lakes region, management or control of established populations does not appear to have been attempted.
Sources of information:
(Nunn and Cowx 2012, CABI 2013)

Total Possible	10
Section Four Total	5

Total for 4 sections Possible	71
Total for 4 sections	49

C. STATUS OF GENETIC VARIANTS AND HYBRIDS:

At the present time there is no protocol or criteria for assessing the invasiveness of genetic variants independent of the species to which they belong. Such a protocol is needed, and individuals with the appropriate expertise should address this issue in the future. Such a protocol will likely require data on cultivar fertility and identification in both experimental and natural settings.

Genetic variants of the species known to exist:

Hybrids (crosses between different parent species) should be assessed individually and separately from the parent species wherever taxonomically possible, since their invasiveness may differ from that of the parent species. An exception should be made if the taxonomy of the species and hybrids are uncertain, and species and hybrids can not be clearly distinguished in the field. In such cases it is not feasible to distinguish species and hybrids, and they can only be assessed as a single unit.

Hybrids of uncertain origin known to exist:

References for species assessment:

Audzijonyte, A., K. J. Wittmann, and R. Väinölä. 2008. Tracing recent invasions of the Ponto-Caspian mysid shrimp Hemimysis anomala across Europe and to North America with mitochondrial DNA. Diversity and Distributions 14:179–186.

Austrailian Department of Agriculture, Fisheries, and Forestry (ADAFF). 2013. Climatch Mapping Tool. <htpp://adl.brs.gov.au:8080/Climatch/climatch.jsp>; [Accessed on June 26, 2013].

Borcherding, J., S. Murawski, and H. Arndt. 2006. Population ecology, vertical migration and feeding of the Ponto-Caspian invader Hemimysis anomala in a gravel-pit lake connected to the River Rhine. Freshwater Biology 51:2376–2387.

Brooking, T. E., L. G. Rudstam, S. D. Krueger, J. R. Jackson, A. B. Welsh, and W. W. Fetzer. 2010. First occurrence of the mysid Hemimysis anomala in an inland lake in North America, Oneida Lake, NY. Journal of Great Lakes Research 36:577–581.

CABI. 2013. Hemimysis anomala In: Invasive Species Compendium. Wallingford, UK: CAB International. [Online]. Available: www.cabi.org/isc. [Accessed: 27-Jun-2013].

Invasive Species Specialist Group (ISSG). 2013. Global Invasive Species Database. [Online]. Available: http://www.issg.org/database/species/ecology.asp?si=217&fr=1&sts=sss&lang=EN. [Accessed: 11-Jan-2013].

Kestrup, A., and A. Ricciardi. 2008. Occurrence of the Ponto-Caspian mysid shrimp Hemimysis anomala (Crustacea, Mysida) in the St. Lawrence River. Aquatic Invasions 3:461–464.

Ketelaars, H. A., F. E. Lambregts-van de Clundert, C. J. Carpentier, A. J. Wagenvoort, and W. Hoogenboezem. 1999. Ecological effects of the mass occurrence of the Ponto–Caspian invader, Hemimysis anomala GO Sars, 1907 (Crustacea: Mysidacea), in a freshwater storage reservoir in the Netherlands, with notes on its autecology and new records. Hydrobiologia 394:233–248.

Kipp, R. M., A. Ricciardi, J. Larson, and A. Fusaro. 2012. Hemimysis anomala. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. [Online]. Available: http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=2627. [Accessed: 27-Jun-2013].

Marty, J., M. R. Twiss, J. J. Ridal, Y. De Lafontaine, and J. M. Farrell. 2010. From the Great Lakes flows a Great River: overview of the St. Lawrence River ecology supplement. Hydrobiologia 647:1–5.

New York Sea Grant. 2013. Forecasting Ecosystem Effects of a New Invader, hemimysis anomala, in Lake Ontario [Online]. Available: http://www.seagrant.sunysb.edu/projects/t/forecasting-ecosystem-effects-of-a-new-invader-hemimysis-anomala-in-lake-ontario?q=hemimysis. [Accessed: 27-Jun-2013].

NOAA. 2013. Great Lakes aquatic non-indigenous species information system. Hemimysis anomala. Recommended sampling protocols. [Online]. Available: http://www.glerl.noaa.gov/res/Programs/glansis/hemi_protocols.html. [Accessed: 26-Jun-2013].

Nunn, A. D., and I. G. Cowx. 2012. Diel and seasonal variations in the population dynamics of Hemimysis anomala, a non-indigenous mysid: implications for surveillance and management. Aquatic Invasions 7:357–365.

Pothoven, S. A., I. A. Grigorovich, G. L. Fahnenstiel, and M. D. Balcer. 2007. Introduction of the Ponto-Caspian bloody-red mysid Hemimysis anomala into the Lake Michigan basin. Journal of Great Lakes Research 33:285–292.

The Nature Conservancy. 2013. iMapInvasives: An Online Mapping Tool for Invasive Species Locations [Online]. Available: iMapInvasives.org. [Accessed: 03-Jan-2013].

U.S. Geological Survey. 2013. Nonindigenous Aquatic Species Database. Gainesville, Florida. [Online]. Available: http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=214. [Accessed: 03-Jan-2013].

University of Wisconsin Sea Grant Institute. 2012. Bloody-red shrimp (Hemimysis anomala) [Online]. Available: http://www.seagrant.wisc.edu/Home/Topics/InvasiveSpecies/Details.aspx?PostID=664. [Accessed: 26-Jun-2013].

Citation: The New York Fish & Aquatic Invertebrate Invasiveness Ranking Form is an adaptation of the New York Plant Invasiveness Ranking Form. The original plant form may be cited as: Jordan, M.J., G. Moore and T.W. Weldy. 2008. Invasiveness ranking system for non-native plants of New York. Unpublished. The Nature Conservancy, Cold Spring Harbor, NY; Brooklyn Botanic Garden, Brooklyn, NY; The Nature Conservancy, Albany, NY.

Acknowledgments: The New York Fish and Aquatic Invertebrate Invasiveness Ranking Form incorporates components and approaches used in several other systems, cited in the references below. Valuable contributions by members of the Invasive Species Council and Invasive Species Advisory Committee were incorporated in revisions

of this form. Members of the Office of Invasive Species Coordination's Four-tier Team, who coordinated the effort, included representatives of the New York State Department of Environmental Conservation* (Division of Fish, Wildlife and Marine Resources, Division of Lands and Forests, Division of Water); The Nature Conservancy; New York Natural Heritage Program; New York Sea Grant*; Lake Champlain Sea Grant*; New York State Department of Agriculture and Markets (Division of Plant Industry and Division of Animal Industry); Cornell University (Department of Natural Resources and Department of Entomology); New York State Nursery and Landscape Association; New York Farm Bureau; Brooklyn Botanic Garden; Pet Industry Joint Advisory Council*; Trout Unlimited*; United States Department of Agriculture Animal and Plant Health Inspection Service (Plant Protection and Quarantine and Wildlife Services); New York State Department of Transportation; State University of New York at Albany and Plattsburgh*; and Cary Institute of Ecosystem Studies. Those organizations listed with an asterisk comprised the Fish and Aquatic Invertebrate Working Group.

References for ranking form:

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