

NEW YORK FISH & AQUATIC INVERTEBRATE INVASIVENESS RANKING FORM

Scientific name: Hypophthalmichthys nobilis
 Common names: Bighead Carp
 Native distribution: Southern and Central China
 Date assessed: 06/12/2013
 Assessors: D. Adams
 Reviewers: _____
 Date Approved: _____ Form version date: 3 January 2013

New York Invasiveness Rank: Moderate (Relative Maximum Score 50.00-69.99)

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

Invasiveness Ranking Summary (see details under appropriate sub-section)		Total (Total Answered*) Possible	Total
1	Ecological impact	30 (<u>30</u>)	21
2	Biological characteristic and dispersal ability	30 (<u>30</u>)	17
3	Ecological amplitude and distribution	30 (<u>30</u>)	17
4	Difficulty of control	10 (<u>10</u>)	7
	Outcome score	100 (<u>100</u>) ^b	62 ^a
	Relative maximum score †		62
	New York Invasiveness Rank §	Moderate (Relative Maximum Score 50.00-69.99)	

* 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)		
<input type="checkbox"/>	Yes – continue to A1.2	
<input checked="" type="checkbox"/>	No – continue to A2.1; Yes <input checked="" type="checkbox"/> NA; Yes <input checked="" type="checkbox"/> USA	
A1.2. In which PRISMs is it known (see inset map)?		
<input type="checkbox"/>	Adirondack Park Invasive Program	
<input type="checkbox"/>	Capital/Mohawk	
<input type="checkbox"/>	Catskill Regional Invasive Species Partnership	
<input type="checkbox"/>	Finger Lakes	
<input type="checkbox"/>	Long Island Invasive Species Management Area	
<input type="checkbox"/>	Lower Hudson	
<input type="checkbox"/>	Saint Lawrence/Eastern Lake Ontario	

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<input type="checkbox"/>	Western New York
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Documentation:

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

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)

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

Documentation:

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

www.nas.er.usgs.gov; www.fishbase.org

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

Documentation:

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

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.

- | | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Aquatic Habitats</p> <p><input type="checkbox"/> Marine</p> <p><input checked="" type="checkbox"/> Salt/ brackish waters</p> <p><input type="checkbox"/> Freshwater tidal</p> <p><input checked="" type="checkbox"/> Rivers/streams</p> <p><input checked="" type="checkbox"/> Natural lakes and ponds</p> <p><input type="checkbox"/> Vernal pools</p> <p><input checked="" type="checkbox"/> Reservoirs/ impoundments*</p> | <p>Wetland Habitats</p> <p><input checked="" type="checkbox"/> Salt/brackish marshes</p> <p><input checked="" type="checkbox"/> Freshwater marshes</p> <p><input type="checkbox"/> Peatlands</p> <p><input type="checkbox"/> Shrub swamps</p> <p><input type="checkbox"/> Forested wetlands/riparian</p> <p><input checked="" type="checkbox"/> Ditches*</p> <p><input type="checkbox"/> Beaches/or coastal dunes</p> | <p>Upland Habitats</p> <p><input type="checkbox"/> Cultivated*</p> <p><input type="checkbox"/> Grasslands/old fields</p> <p><input type="checkbox"/> Shrublands</p> <p><input type="checkbox"/> Forests/woodlands</p> <p><input type="checkbox"/> Alpine</p> <p><input type="checkbox"/> Roadsides*</p> <p><input type="checkbox"/> Cultural*</p> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Other potential or known suitable habitats within New York:

Documentation:

Sources of information:

nas.er.usgs.gov; www.fishbase.org

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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 10

Documentation:

Identify ecosystem processes impacted (or if applicable, justify choosing answer A in the absence of impact information)

Bighead carp are large and are planktivorous suggesting they could potentially deplete zooplankton populations.

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

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:

Asian carps have been shown to affect zooplankton communities. Resource use and trophic levels of the fish community change when Asian carp are present.

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

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

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U. Unknown

Score

7

Documentation:

Identify type of impact or alteration:

A decline in the availability of plankton can lead to reductions in populations of native species that rely on plankton for food. Adult fish most at risk from such competition include gizzard shad.

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

Total Possible

30

Section One Total

21

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

1

Documentation:

Describe key reproductive characteristics:

Its breeding requirements are very specialized and stocks are maintained by artificial reproduction or continuous importation.

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

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:

Undertakes long distance upriver migration for spawning at start of a rapid flood and water level increase.

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

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

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Score 2

Documentation:

Identify dispersal mechanisms:

Undertakes long distance upriver migration for spawning at start of a rapid flood and water level increase. After spawning adults migrate for foraging habitats and larvae drift downstream and settle in shallows and backwaters. Juvenile and adults form separate large schools and migrate downstream to deeper places in main course of river to overwinter.

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

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:

Introduced to numerous countries and has achieved a near global distribution. Marketed fresh and frozen.

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

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:

Can survive brackish waters up to 7 ppt when introduced into estuaries and coastal lakes.

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

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 4

Documentation:

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Evidence of competitive ability:
 Juveniles and adults form large schools.
 Sources of information:
www.nas.er.usgs.gov; www.fishbase.org

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 2

Documentation:
 Identify species:
 Closely related to Silver Carp.

Total Possible	30
Section Two Total	17

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:
 This species has been recorded from within or along the borders of at least 18 states, including CO IL VI WV OH.
 Sources of information:

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

www.nas.er.usgs.gov; www.fishbase.org

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 0

Documentation:
 Describe distribution:
 Not documented in any PRISMs.
 Sources of information:
www.nas.er.usgs.gov; www.fishbase.org

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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

Documentation:

Describe known or potential releases:

Bighead carp were first imported into the US in 1972 by a private fish farmer in Arkansas who wanted to use them in combination with other phytophagous fishes to improve water quality and increase fish production in culture ponds.

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

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

Documentation:

Describe population density:

In 1994 several thousand bighead carp escaped from flooded hatchery ponds at an aquaculture facility and have dispersed gradually downstream.

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

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

Documentation:

Identify type of habitats where it occurs and degree/type of impacts:

Occurs in rivers with marked water level fluctuations. Forages in shallow and warm backwaters lakes and flooded areas. Breeds in very deep turbid waters above 18 degrees C with high current and high oxygen concentrations.

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

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).

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- 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 2

Documentation:
 Identify type of disturbance:
 Established post flooding of aquaculture facilities.
 Sources of information:
 USFWS 2007

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., $\geq 30\%$). 8
- U. Unknown.

Score 4

Documentation:
 Describe known climate similarities:
 Temperate 4-26 degrees C.
 Sources of information:
 nas.er.usgs.gov; www.fishbase.org

Total Possible 30
 Section Three Total 17

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:
 Introduced around the world for aquaculture management. Marketed fresh and frozen.
 Sources of information:
 www.nas.er.usgs.gov; www.fishbase.org

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

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Score

1

Documentation:

Describe protocols:

Currently established in the Mississippi River basin and monitored regularly.

Sources of information:

www.nas.er.usgs.gov; www.fishbase.org

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

1

Documentation:

Describe resources:

Great Lakes fisheries monitoring program.

Sources of information:

NYS DEC Great Lakes Fisheries Program

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:

If introduced to the Great Lakes this species is expected to establish populations.

Sources of information:

nas.er.usgs.gov; www.fishbase.org

Total Possible	<table border="1" style="width: 50px; text-align: center;"><tr><td>10</td></tr></table>	10
10		
Section Four Total	<table border="1" style="width: 50px; text-align: center;"><tr><td>7</td></tr></table>	7
7		

Total for 4 sections Possible	<table border="1" style="width: 50px; text-align: center;"><tr><td>100</td></tr></table>	100
100		
Total for 4 sections	<table border="1" style="width: 50px; text-align: center;"><tr><td>62</td></tr></table>	62
62		

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.

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Genetic variants of the species known to exist: Yes

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:

New York State Department of Environmental Conservation, Great Lakes Fisheries Unit.

www.nas.er.usgs.gov

www.fishbase.org

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:

Bomford, M. 2008. Risk Assessment Models for Establishment of Exotic Vertebrates in Australia and New Zealand. Invasive Animals Cooperative Research Centre, Canberra.

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Long Island Sound Interstate Aquatic Invasive Species Management Plan. 2007. Balcom, N. editor, New England Interstate Water Pollution Control Commission.

Molnar, J., R. Gamboa, C. Revenga, and M. Spalding. 2008 Assessing the Global Threat of Invasive Species to Marine Biodiversity. *Front. Ecol. Environ.*

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Standard Methodology to Assess the Risks From Non-native Species Considered Possible Problems to the Environment. 2005. DEFRA.

Trinational Risk Assessment Guidelines for Aquatic Alien Invasive Species. 2009. Commission for Environmental Cooperation. Montreal, Canada.

Witmer, G., W. Pitt and K. Fagerstone. 2007. Managing Vertebrate Invasive Species. USDA National Wildlife Research Center Symposia, Fort Collins, Colorado.