# NEW YORK
# FISH & AQUATIC INVERTEBRATE INVASIVENESS RANKING FORM

| | |
|---|---|
| Scientific name: | Alosa pseudoharengus |
| Common names: | Alewife, Gaspereau, Sawbelly, Spreau, Kyak, Kiack, River Herring, Glut Herring |
| Native distribution: | Native to NY and eastern United States (non-native to western NY outside of Atlantic drainage (GISD 2005). |
| Date assessed: | 4/8/2013 |
| Assessors: | E. Schwartzberg |
| 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 (***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 (30) | 20 |
| 2 | Biological characteristic and dispersal ability | 30 (30) | 12 |
| 3 | Ecological amplitude and distribution | 30 (30) | 21 |
| 4 | Difficulty of control | 10 (7) | 2 |
| | Outcome score | 100 (97)[b] | 55[a] |
| | Relative maximum score † | | 56.70 |
| | 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) | |
|---|---|
| ☒ | 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:
Most records from 1985 (see Fuller et al 2012, NatureServe Explorer 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:
Erie canal.

Documentation:

Sources of information:
GISD 2005.

**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 3

Documentation:
Identify ecosystem processes impacted (or if applicable, justify choosing answer A in the absence of impact information)
Although top-down effects of alewife planktivory, or lack thereof after introducitons of higher trophic level fish decreased alewife populations, have been implicated in altered water clarity (Scavia et al 1986), ecosystem process effects of alewives appear to be minor.
Sources of information:
Scavia et al. 1988

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:
Alewives feed efficiently and selectively on large zooplankton, causing drastic alterations in size, abundance, and community structure (VTDEC 2011). This intern affects other planktoniverous fish, including yellow perch and rainbow smelt. However, while predation of plankton by alewives affects plankton communities more than nutirent loading (Scavia et al. 1988), others suggest that another planktiverous organism, Bythotrephes, rather than fish, have a greater influence on Great Lakes plankton communities (Lehman 1991).

Sources of information:
Scavia et al. 1988, Lehman 1991, VTDEC 2011.

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: 10

Documentation:
Identify type of impact or alteration:
Alewives are associated with declines in abundance of native fises in the Laurentian Great Lakes (GISD 2005, VTDEC 2013). They compete with other planktoniverous fish, including yellow perch and rainbow smelt and prey upon yellow perch and lake trout larvae (Eck et al. 1987, VTDEC 2013). Alewives indirrectly negatively affect Atlantic salmon and lake trout through Cayuga Syndrome and Early mortality Syndrome, thiamine deficiency-mediated syndromes attributed to feeding primarily on alewives (Fisher et al 1996, Fitzsimons et al 1999).
Sources of information:
Fisher et al 1996, Fitzsimons et al 1999, Eck et al. 1987, GISD 2005, VTDEC 2013.

Total Possible: 30
Section One Total: 20

*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:
Reproduce after two years of age and can deposit up to 10,000 to 12,000 eggs per year(AIS 2013), with lifetime eggloads between 48,000 - 360,000 eggs (oceanic) and 13,200 and 49,200 eggs (landlocked) (GISD 2005).
Sources of information:
AIS 2013, GISD 2005.

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:
Anadromous, but oterewise non-migratory.
Sources of information:
GISD 2005, NatureServe Explorer 2013.

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:

Sources of information:

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:
Thought to have reached Lake Ontario via the man-made Erie Canal (Fuller et al. 2012). Other populations thought to be a result of illegal stocking and historic co-introduction with American shad stocking (Fuller et al. 2012).
Sources of information:
Fuller 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 0

Documentation:
Evidence of competitive ability:
Alewives are prone to mass die-offs, for which the mechanism is unknown but speculated to be a combination of nutritional deficiancy and low cold tolerance (Snyder and Hennessey 2003). It is speculated that their successful introduction into the Great Lakes was the result of declines of predators such as lake trout and Atlantic salmon resulting from 19th century

over-fishing and predation by the exotic sea lamprey (Fuller et al. 2012).
Sources of information:
Snyder and Hennessey 2003, Fuller 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: 4

Documentation:
Evidence of competitive ability:
Alewives feed ton plankton, but also prey upon eggs and fry of other fish (omniverous).
Sources of information:
Fuller et al. 2012.

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:
Alosa aestivalis (may not be considered invasive).

Total Possible: 30
Section Two Total: 12

*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:
Entire eastern shoreboard, PA, OH, IN, IL, WI, MN.
Sources of information:
- See known introduced range at www.usda.gov, and update with information from states and Canadian provinces.

Fuller et al. 2012.

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 5

Documentation:
Describe distribution:
Hisotric records, mostly from 1985, occur throughout NY, but currently occur in southern NY and in Lake Ontario.
Sources of information:
Fuller et al. 2012, NaureServe Explorer 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 0

Documentation:
Describe known or potential releases:
Very little evidence for recent release events, and literature suggests most release events occured in the late 19th and early 20th century (Fuller et al. 2012).
Sources of information:
Fuller et al. 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:
Alewives account for 70–90% of the total fish by weight in Lake Michigan (Becker 1983).
Sources of information:
Becker 1983.

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:
Marine, rivers, lakes, and canals.
Sources of information:
Fuller 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 0

Documentation:
Identify type of disturbance:

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:
Native range includes NY.
Sources of information:
Fuller et al 2012.

Total Possible 30
Section Three Total 21

*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 U

Documentation:
Identify source/ vectors:
Because alewives are pervasive, especially in the great Lakes, and their status as non-native has been disputed, it is difficult to comment on re-establishment potential.
Sources of information:
GISD 2005.

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 2

Documentation:
Describe protocols:
Monitoring and management for alewives is low priority (Bean 2002, VTDEC 2013).
Sources of information:
Bean 2002, VTDEC 2011.

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:
Monitoring and management for alewives is low priority (Bean 2002, VTDEC 2013). VT DEC has decided against action at this time (VTDEC 2011).
Sources of information:
Bean 2002, VTDEC 2011.

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 0

Documentation:
Identify types of control methods and time required:
Stocking and management of alewife predators, including increaed efforts to re-introduce Atlantic salmon may be a useful control measure for alewives with little investment as compared to other control measures (Bean 2002).
Sources of information:
Bean 2002.

| | |
|---|---|
| Total Possible | 7 |
| Section Four Total | 2 |
| **Total for 4 sections Possible** | 97 |
| **Total for 4 sections** | 55 |

**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:**

Aquatic Invasive Species (AIS) 2013. Alewife. <http://www.in.gov/dnr/files/ALEWIFE.pdf>; [Accessed on March 7, 2013].

Bean, T. 2002. Introduced Species Summary Project Alewife (Alosa pseudoharengus). <http://www.columbia.edu/itc/cerc/danoff-burg/invasion_bio/inv_spp_summ/alewife.html#Distribution>; [Accessed on March 8, 2013].

Becker, G.C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison, WI. 1052 pp. <http://digital.library.wisc.edu/1711.dl/EcoNatRes.FishesWI>; [Accessed on march 8, 2013].

Eck, G. W., & Wells, L. (1987). Recent changes in Lake Michigan's fish community and their probable causes, with emphasis on the role of the alewife (Alosa pseudoharengus). Canadian Journal of Fisheries and Aquatic Sciences,44(S2), 53-60.

Fisher, J. P., Fitzsimons, J. D., Combs Jr, G. F., & Spitsbergen, J. M. (1996). Naturally occurring thiamine deficiency causing reproductive failure in Finger Lakes Atlantic salmon and Great Lakes lake trout. Transactions of the American Fisheries Society, 125(2), 167-178.

Fitzsimons, J. D., Brown, S. B., Honeyfield, D. C., & Hnath, J. G. (1999). A Review of Early Mortality Syndrome(EMS) in Great Lakes Salmonids: Relationship with Thiamine Deficiency. Ambio, 28(1), 9-15.

Fuller, P., E. Maynard, D. Raikow, J. Larson, A. Fusaro, and M. Neilson. 2012. Alosa pseudoharengus. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. <http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=490>; [Accessed on March 7, 2013].

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Scavia, D., Fahnenstiel, G. L., Evans, M. S., Jude, D. J., & Lehman, J. T. (1986). Influence of salmonine predation and weather on long-term water quality trends in Lake Michigan. Canadian Journal of Fisheries and Aquatic Sciences,43(2), 435-443.

Scavia, D., Lang, G. A., & Kitchell, J. F. (1988). Dynamics of Lake Michigan plankton: a model evaluation of nutrient loading, competition, and predation. Canadian Journal of Fisheries and Aquatic Sciences, 45(1), 165-177.

Snyder, R. J., & Hennessey, T. M. (2003). Cold tolerance and homeoviscous adaptation in freshwater alewives (Alosa pseudoharengus). Fish Physiology and Biochemistry, 29(2), 117-126.

Vermont Department of Environmental Conservation (VTDEC), 2011. Alewife Fact Sheet. <http://www.anr.state.vt.us/dec/waterq/lakes/htm/ans/lp_alewife.htm>; [Accessed on March 7, 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:**

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

Broken Screens: The Regulation of Live Animal Imports in the United States. 2007. Defenders of Wildlife, Washington, DC.

Copp, G. H., R. Garthwaite and R. E. Gozlan. 2005. Risk Identification and Assessment of Non-native Freshwater Fishes: Concepts and Perspectives on Protocols for the UK. Sci. Ser. Tech Rep., Cefas Lowestoft, 129: 32pp.

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