

# NEW YORK TERRESTRIAL INVERTEBRATES INVASIVENESS RANKING FORM

Scientific name: Adelges tsugae  
 Common names: Hemlock Woolly Adelgid  
 Native distribution: Japan  
 Date assessed: 12/20/2012  
 Assessors: E. Schwartzberg  
 Reviewers: \_\_\_\_\_  
 Date Approved: \_\_\_\_\_ Form version date: 10 June 2009

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

<b>Distribution and Invasiveness Rank</b> ( <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 Assessed
2	Capital/Mohawk	Not Assessed
3	Catskill Regional Invasive Species Partnership	Not Assessed
4	Finger Lakes	Not Assessed
5	Long Island Invasive Species Management Area	Not Assessed
6	Lower Hudson	Not Assessed
7	Saint Lawrence/Eastern Lake Ontario	Not Assessed
8	Western New York	Not Assessed

<b>Invasiveness Ranking Summary</b> (see details under appropriate sub-section)		Total (Total Answered*) Possible	Total
1	Ecological impact	30 (30)	27
2	Biological characteristic and dispersal ability	30 (30)	17
3	Ecological amplitude and distribution	30 (30)	23
4	Difficulty of control	10 (10)	9
	Outcome score	100 (100) <sup>b</sup>	76 <sup>a</sup>
	Relative maximum score <sup>†</sup>		76.00
	New York Invasiveness Rank <sup>§</sup>	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."

<sup>†</sup>Calculated as 100(a/b) to two decimal places.

<sup>§</sup>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 to persist without cultivation in NY? (reliable source; voucher not required)		
<input checked="" type="checkbox"/>	Yes – continue to A1.2	
<input type="checkbox"/>	No – continue to A2.1; Yes <input type="checkbox"/> NA; Yes <input type="checkbox"/> USA	
A1.2. In which PRISMs is it known (see inset map)?		
<input type="checkbox"/>	Adirondack Park Invasive Program	
<input checked="" type="checkbox"/>	Capital/Mohawk	
<input checked="" type="checkbox"/>	Catskill Regional Invasive Species Partnership	
<input checked="" type="checkbox"/>	Finger Lakes	
<input checked="" type="checkbox"/>	Long Island Invasive Species Management Area	
<input checked="" type="checkbox"/>	Lower Hudson	
<input type="checkbox"/>	Saint Lawrence/Eastern Lake Ontario	
<input checked="" type="checkbox"/>	Western New York	

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**Documentation:**

Sources of information:

iMapInvasives, 2012; National Agricultural Pest Information System, 2012.

A2.0. Is this species listed on the Federal Injurious Fish and Wildlife, Noxious Weed or PPQ Action Required 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)

- 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):

ADAFF, 2012.

***If the species does not occur and is not likely to occur with 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                                       |
|---|--|---|
| <input type="checkbox"/> Salt/brackish waters     | <input type="checkbox"/> Salt/brackish marshes                 | <input type="checkbox"/> Cultivated*                  |
| <input type="checkbox"/> Freshwater tidal         | <input type="checkbox"/> Freshwater marshes                    | <input type="checkbox"/> Grasslands/old fields        |
| <input type="checkbox"/> Rivers/streams           | <input type="checkbox"/> Peatlands                             | <input checked="" type="checkbox"/> Shrublands        |
| <input type="checkbox"/> Natural lakes and ponds  | <input type="checkbox"/> Shrub swamps                          | <input checked="" type="checkbox"/> Forests/woodlands |
| <input type="checkbox"/> Vernal pools             | <input checked="" type="checkbox"/> Forested wetlands/riparian | <input type="checkbox"/> Alpine                       |
| <input type="checkbox"/> Reservoirs/impoundments* | <input type="checkbox"/> Ditches*                              | <input checked="" type="checkbox"/> Roadsides*        |
|   | <input type="checkbox"/> Beaches and/or coastal dunes          |   |

Other potential or known suitable habitats within New York:

**Documentation:**

Sources of information:

McWilliams and Schmidt, 1999.

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**B. INVASIVENESS RANKING**

*1. ECOLOGICAL IMPACT*

**1.1. Impact on Natural Ecosystem Processes and System-Wide Parameters**

- A. No perceivable impact on ecosystem processes based on research studies or the absence of impact if a species is widespread and/or has been present in the northeast for > 50 years. 0
- B. Influences ecosystem processes to a minor degree 3
- C. Significant alteration of ecosystem processes 7
- D. Major, possibly irreversible, alteration or disruption of ecosystem processes 10
- U. Unknown

Score

**Documentation:**

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

Affects system-wide parameters including nutrient dynamics, light, temperature, and water.

**Sources of information:**

Daley et al., 2007; Jenkins et al., 1999; Siderhurst et al., 2010; Stadler et al., 2006.

**1.2. Impact on Terrestrial Community Composition (species specific)**

- A. No perceived impact; causes no apparent change in native populations 0
- B. Influences community composition (e.g., reduces the number of individuals in 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

**Documentation:**

Identify type of impact or alteration:

Affects Hemlock forest stands to a major extent. Shown to indirectly affect brook trout as a result of increased stream temperature resulting from increased light after defoliation.

Sources of information:

Orwig and Foster, 1998; Siderhurst et al., 2010.

**1.3. Impact on other species or species groups (cumulative impact of this species on the animals, fungi, microbes, and other organisms in the community it invades.**

- A. Negligible perceived impact – no host damage 0
- B. Minor impact – limited host damage (aesthetics or restricts commercial trade) 3
- C. Moderate impact - extensive damage – kills host in 2-5 years (prohibits commercial trade) 7
- D. Severe impact on other species or species groups – kills or predisposed host within 2 years (prohibits commercial trade) 10
- U. Unknown

Score

**Documentation:**

Identify type of impact or alteration: (control methods and time-term required)

Kills host tree (Eastern hemlock) within four years.

Sources of information:

Orwig and Foster, 1998.

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<b>Total Possible</b>	30
<b>Section One Total</b>	27

**2. BIOLOGICAL CHARACTERISTICS AND DISPERSAL ABILITY**

**2.1. Mode and rate of reproduction (population dynamic - fecundity)**

- A. No reproduction (does not complete life cycle) 0
- B. Limited reproduction (minimal population expansion - able to complete only 1 life cycle) 3
- C. Moderate reproduction (mod. population expansion - able to complete 2 or 3 life cycles) 5
- D. Abundant and/or asexual reproduction (high population expansion – able to complete more than 3 lifecycles) 8
- U. Unknown (life cycle information is not available)

Score 5

**Documentation:**

Describe key reproductive characteristics:  
 Polymorphic reproduction with two generations per year.  
 Sources of information:  
 McClure, 1987; 1989.

**2.2. Innate potential for long-distance dispersal (e.g. under it's own power)**

- A. Does not occur (no long-distance dispersal mechanisms) 0
- B. Infrequent or inefficient long-distance dispersal (little or no flight capacity) 2
- C. Moderate capabilities for long-distance dispersal (up to 5 miles) 4
- D. High capabilities for long-distance dispersal (5 miles or greater) 6
- U. Unknown

Score 2

**Documentation:**

Identify dispersal mechanisms:  
 Transported by wind up to 1000 m.  
 Sources of information:  
 McClure, 1990.

**2.3. Potential to be spread by human activities (both directly and indirectly – possible mechanisms include: commercial sales, spread along highways, transport on cargo, contaminated firewood, compost, land and vegetation management equipment such as mowers and excavators, soil, 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) 3
- U. Unknown

Score 3

**Documentation:**

Identify spread mechanisms:  
 Can be spread on nursery stock. Also can be spread by humans or deer.  
 Sources of information:  
 Cornell Plantations, 2012; McClure, 1990; State of Maine, 2012.

**2.4. Potential to be spread by acts of nature (hurricanes, flooding, storms, etc.), and by other animals (mammals/birds/reptiles/insects).**

- A. Does not occur 0
- B. Low (rarely occurs – 5 or more years between occurrences, requires a severe event) 1

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- C. Moderate (sometimes occurs – less than every 3-5 years, requires a moderate event) 2
- D. High (commonly transported by nature and/or animals – may occur every 1-2 years) 3
- U. Unknown

Score 

3
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**Documentation:**

Identify spread mechanisms:

Can be carried by birds, humans, deer, or wind.

Sources of information:

McClure, 1990.

2.5. Characteristics that increase competitive advantage such as not being palatable, no primary predator, eats many hosts, has natural or chemical defenses, fills a vacant niche, has tolerance to various extremes such as pH, temperatures, etc., is a generalist, has highly evolved defense mechanisms, has behavioral adaptations, etc.

- A. Possesses no characteristics that increase competitive advantage 0
- B. Possesses one (1) or two (2) characteristic that increases competitive advantage 2
- C. Possesses three (3) or four (4) characteristics that increase competitive advantage 4
- D. Possesses five (5) or more characteristics that increase competitive advantage 8
- U. Unknown

Score 

2
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**Documentation:**

Describe competitive advantages:

Minimal native predators. Possess chemical defenses that may aid against predation.

Sources of information:

Jones at al., 2012; McClure, 1987; Wallace and Hain, 2000.

2.6. Other species in the genus invasive in New York or elsewhere

- A. No 0
- B. Yes 2
- U. Unknown

Score 

2
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**Documentation:**

Species:

Balsam Woolly Adelgid, (*Adelges piceae*)

Balch, 1952.

**Total Possible**

30
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**Section Two Total**

17
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**3. ECOLOGICAL AMPLITUDE AND DISTRIBUTION**

3.1. Current introduced distribution in the North America (which includes: Antigua, Barbuda, Bahamas, Barbados, Belize, Canada, Costa Rica, Cuba, Dominica, Dominican Rep., El Salvador, Granada, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, St. Kitts & Nevis, St. Lucia, St. Vincent, Grenadines, Trinidad and Tobago and the United States)

- A. Not known to be established in North America 0
- B. Established as a non-native in one country in North America. 1
- C. Established as a non-native in 2 or 3 countries in North America. 2
- D. Established as a non-native in 4 or more countries in North America. 3

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U. Unknown

Score

**Documentation:**

Identify states and provinces invaded:

Northeastern United States.

Sources of information:

TNYISC, 2012.

3.2. Current introduced distribution in the northeastern USA (CT, DE, ME, MD, MA, NH, NJ, PA, RI, VT, VI, WV) and eastern Canada (In Canada, includes Nova Scotia, Prince Edward Island, New Brunswick, and parts of Quebec and Ontario lying south of the 47th parallel of latitude.)

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

Score

**Documentation:**

Identify states and provinces invaded:

CT, DE, MW, MD, MA, NH, NJ, PA, RI, VT, VI, WV. Also in GA, SC, TN.

Sources of information:

TNYISC, 2012.

3.3. 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

**Documentation:**

Describe distribution:

LIISMA, Lower Hudson, CRISP, Western NY, Finger Lakes, Capital Region.

Sources of information:

iMapInvasives, 2012; TNYISC, 2012.

3.4. Distance to known occurrences in the northeastern USA and eastern Canada.

- A. No population known to be established 0
- B. Established population in nonadjacent states/provinces 3
- C. Established population in adjacent states/provinces 5
- U. Unknown

Score

**Documentation:**

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Identify reason for selection, or evidence Present in all adjoining U.S. states.

Sources of information:  
TNYISC, 2012.

### 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 1/2 a natural habitat.  | 2 |
| C. | Known to occur in 4 or more of the habitats given at A2.3, with at least 3 a natural habitat. | 4 |
| U. | Unknown   |   |

Score 2

#### Documentation:

Identify type of habitats where it occurs and degree/type of impacts:  
Shrublands, Forests/Woodlands, Forested Wetlands/Riparian, Roadsides.  
Sources of information:  
McWilliams and Schmidt, 1999.

### 3.6. Role of human and natural disturbance in establishment

- |    |  |   |
|----|--|---|
| A. | Requires human disturbances to establish.  | 0 |
| B. | May occasionally establish in undisturbed areas but can readily establish in areas with natural or human disturbances. | 1 |
| C. | Can establish independent of any known human or natural disturbances.  | 3 |
| U. | Unknown  |   |

Score 3

#### Documentation:

Describe distribution:  
Can spread by with alone.  
Sources of information:  
McClure, 1990.

### 3.7. Climate in native range (e.g., similar latitudinal range)

- |    |  |   |
|----|--|---|
| A. | Native range does not include climates similar to New York               | 0 |
| B. | Native range possibly includes climates similar to portions of New York. | 3 |
| C. | Native range includes climates similar to those in New York              | 6 |
| U. | Unknown  |   |

Score 3

#### Documentation:

Describe what part of the native range is similar in climate to New York:  
Climate score high of 7 in New York when compared to Japan.  
Sources of information:  
ADAFF, 2012.

<b>Total Possible</b>	<b>23</b>
<b>Section Three Total</b>	<b>30</b>

## 4. DIFFICULTY OF CONTROL & DETECTION

### 4.1. Re-establishment potential

- |    |  |   |
|----|--|---|
| A. | No known vector for re-establishment following removal | 0 |
| B. | Re-establishment from 1 vector following removal       | 1 |
| C. | Re-establishment from 2-3 vectors following removal    | 2 |
| D. | Re-establishment from > 3 vectors following removal    | 3 |
| U. | Unknown  |   |

Score 2

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**Documentation:**

Describe vegetative response:

Wind and birds serve as vectors. Deer browsing positively correlated with Hemlock Woolly Adelgid density.

Sources of information:

McClure, 1990.

**4.2. Status of monitoring protocols for species**

- A. No known monitoring protocols exist 0
- B. Monitoring protocols are available from other countries or states 1
- C. Monitoring protocols appropriate to New York State are available 2
- U. Unknown

Score 2

**Documentation:**

Describe vegetative response:

Available protocols appropriate to New York State.

Sources of information:

Costa and Onken, 2006; Whitmore, 2009.

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

- A. No known monitoring resources are available 0
- B. Monitoring resources may be available 1
- C. Established resources are available including commercial and/ or research tools 2
- U. Unknown

Score 2

**Documentation:**

Identify types of control methods and time-term required:

Monitoring resources are available.

Sources of information:

Costa and Onken, 2006.

**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-term required:

Biological control is a major tactic for control. Other tactics available such as soil injection of systemic insecticides for selected trees, usually of high value.

Sources of information:

Cheah et al., 2004; Costa et al., 2005; Webb et al., 2003.

Total Possible 10  
Section Four Total 9



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<b>Total for 4 sections Possible</b>	100
<b>Total for 4 sections</b>	76

**C. STATUS OF HYBRIDS:**

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.

Some hybrids of the species known to be available: None known

**References for species assessment:**

- Balch, R.E. 1952. Studies on the balsam woolly aphid (*Adelges piceae* Ratz.) and its effects on Balsam Fir, *Abies balsamea* (L.) Mill. Department of Agriculture of Canada, No. 867: 1-76.
- Cheah, C.A., M.E. Montgomery, S. Salom, B.L. Parker, S. Costa, and M. Skinner. 2004. Biological control of hemlock woolly adelgid. USDA Forest Service, Forest Health Technology Enterprise Team. <<http://www.invasive.org/hwa/hwa.pdf>>; [Accessed on December 20, 2012].
- Australian Department of Agriculture, Fisheries, and Forestry (ADAFF). 2012. Climatch Mapping Tool. <<http://adl.brs.gov.au:8080/Climatch/climatch.jsp>>; [Accessed on December 20, 2012].
- Cornell Plantations, Cornell University. 2012. Hemlock Woolly Adelgid: FAQ's. <<http://www.cornellplantations.org/our-gardens/natural-areas/invasive/hemlock-woolly-adelgid/FAQ>>; [Accessed on December 20, 2012].
- Costa, S.D. and B. Onken, 2006. Standardizing sampling for detection and monitoring of hemlock woolly adelgid in eastern hemlock forests. USDA Forest Service, Forest Health Technology Enterprise Team, Technology Transfer. <<http://www.fs.fed.us/foresthealth/technology/pdfs/HWASampling.pdf>>; [Accessed on December 20, 2012].
- Costa, S.D., B.L. Parker, V. Gouli, M. Brownbridge, M. Skinner, and S. Gouli, 2005. Insect-killing fungi as a component of hemlock woolly adelgid integrated pest management. Third Symposium on Hemlock Woolly Adelgid in the Eastern United States, Asheville, NC. February 1-3, 2005, USDA Forest Service, Forest Health Technology Enterprise Team: p. 155-160.
- Daley, M.J., N.G. Phillips, C. Pettijohn, and J.L. Hadley. 2007. Water use by eastern hemlock (*Tsuga canadensis*) and black birch (*Betula lenta*): Implications of effects of the hemlock woolly adelgid. *Canadian Journal of Forest Research* 37(10): 2031-2040.
- iMapInvasives: An Online Mapping Tool for Invasive Species Locations. 2012. <[iMapInvasives.org](http://iMapInvasives.org)>; [Accessed on December 20, 2012].
- Jenkins, J.C, J.D Aber, and C.D Canham. 1999. Hemlock woolly adelgid impacts on community structure and N cycling rates in eastern hemlock forests. *Canadian Journal of Forest Research* 29(5): 630-645.
- Jones, A.C., D.E. Mullins, T.H. Jones, and S.M. Salom. 2012. Potential feeding deterrents found in hemlock woolly adelgid, *Adelges tsugae*. *Naturwissenschaften* 99(7): 583-586.
- McClure, M. 1989. Evidence of a polymorphic life cycle in the hemlock woolly adelgid, *Adelges tsugae* (Homoptera: Adelgidae). *Annals of the Entomological Society of America* 82(1): 50-54.

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- McClure, M.S. 1987. Biology and control of hemlock woolly adelgid. Bulletin of the Connecticut Agricultural Experiment Station 851(9).  
<[http://www.na.fs.fed.us/fhp/hwa/pdfs/mcclure\\_hwa.pdf](http://www.na.fs.fed.us/fhp/hwa/pdfs/mcclure_hwa.pdf)>; [Accessed on December 20, 2012].
- McClure, M.S. 1990. Role of wind, birds, deer, and humans in the dispersal of hemlock woolly adelgid (Homoptera: Adelgidae). Environmental Entomology, 19(1): 36-43.
- McWilliams, W.H., and T.L. Schmidt. 1999. Composition, structure, and sustainability of hemlock ecosystems in eastern North America. Proceedings of Sustainable Management of Hemlock Ecosystems in Eastern North America. USDA Forest Service, Northeastern Research Station . pp. 5-10.
- Orwig, D.A., and D.R. Foster. 1998. Forest response to the introduced hemlock woolly adelgid in southern New England, USA. Journal of the Torrey Botanical Society. pp. 60-73.
- National Agricultural Pest Information System. Pest Tracker. 2012.  
<<http://pest.ceris.purdue.edu/map.php?code=IRAZAHA#>>; [Accessed on December 20, 2012].
- Siderhurst, L.A., H.P. Griscom, M. Hudy, and Z.J. Bortolot. 2010. Changes in light levels and stream temperatures with loss of eastern hemlock (*Tsuga canadensis*) at a southern appalachian stream: Implications for brook trout. Forest Ecology and Management 260(10): 1677-1688.
- Stadler, B., T. Müller, and D. Orwig. 2006. The ecology of energy and nutrient fluxes in hemlock forests invaded by hemlock woolly adelgid. Ecology 87(7): 1792-1804.
- State of Maine, Department of Conservation, Maine Forest Service.  
<<http://www.maine.gov/doc/mfs/HWAOverview.htm>>; [Accessed on December 20, 2012].
- The New York Invasive Species Clearinghouse (TNYISC). Cornell Cooperative Extension Invasive Species Program. 2012. Hemlock Woolly Adelgid.  
<[http://www.nyis.info/index.php?action=invasive\\_detail&id=24](http://www.nyis.info/index.php?action=invasive_detail&id=24)>; [Accessed on December 20, 2012].
- Wallace, M.S., and F.P. Hain. 2000. Field surveys and evaluation of native and established predators of the hemlock woolly adelgid (Homoptera: Adelgidae) in the southeastern United States. Environmental Entomology 29(3): 638-644.
- Webb, R.E., J.R. Frank, and M.J. Raupp. 2003. Eastern hemlock recovery from hemlock woolly adelgid damage following Imidaclopid therapy. Journal of Arboriculture 29(5): 298-302.
- Whitmore, M.C. 2009. Early detection of the hemlock woolly adelgid (*Adelges tsugae*) in small northeastern hemlock (*Tsuga canadensis*) woodlots. Cornell University Cooperative Extension. ForestConnect Fact Sheet.  
<<http://www2.dnr.cornell.edu/ext/info/pubs/FC%20factsheets/HWA%20Fact%20Sheet.pdf>>; [Accessed on December 20, 2012].

**Citation:** The New York Terrestrial 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 Terrestrial 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

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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 Albany and Plattsburgh; and Cary Institute of Ecosystem Studies. Those organizations listed with an asterisk comprised the Terrestrial Invertebrate Working Group.

### **References for ranking form:**

The Analytic Hierarchy Process Prioritization Pest List for 2009. 2009. New York State Department of Agriculture, Division of Plant Industry.

Guidelines for the Import of Live Terrestrial Invertebrates. 2004. Commonwealth of Australia, Department of the Environment, Water, Heritage and the Arts.

Guidelines for Pathway-Initiated Pest Risk Assessment. 2000. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Permits and Risk Assessment, Commodity Risk Analysis Branch, 4700 River Road, Unit 133, Riverdale, MD 20737-1236.

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, New York.

Natural Resources Board Order No. IS-34-06, Invasive Species Identification, Classification and Control. 2008. Wisconsin Department of Natural Resources, Madison, Wisconsin.

List of Specimens taken to be Suitable for Live Import. 1999. Environment Protection and Biodiversity Conservation Act 1999.