NEW YORK
NON-NATIVE PLANT INVASIVENESS RANKING FORM

Scientific name:	Berberis thunbergii (includes all hybrids with other Berberis species) USDA Plants Code: BETH
Common names:	Japanese barberry
Native distribution:	Asia
Date assessed:	March 4, 2008; September 5, 2008
Assessors:	Jinshuang Ma; Gerry Moore
Reviewers:	LIISMA SRC
Date Approved:	9-24-2008 Form version date: 22 October 2008

New York Invasiveness Rank: Very High (Relative Maximum Score >80.00)

Distribution and Invasiveness Rank (*Obtain from PRISM invasiveness ranking form***)**

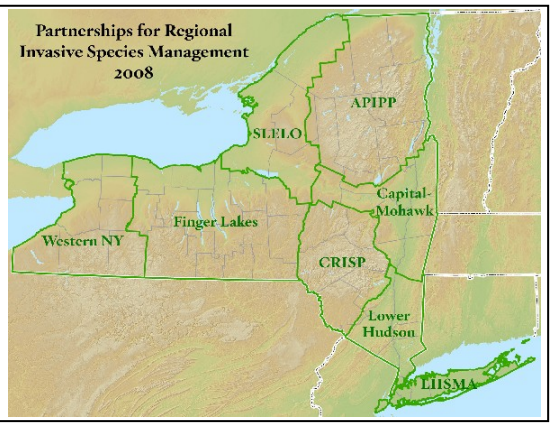
	Status of this species in each PRISM:	Current Distribution	PRISM Invasiveness Rank
1	Adirondack Park Invasive Program	Not Assessed	Not Assessed
2	Capital/Mohawk	Not Assessed	Not Assessed
3	Catskill Regional Invasive Species Partnership	Not Assessed	Not Assessed
4	Finger Lakes	Not Assessed	Not Assessed
5	Long Island Invasive Species Management Area	Widespread	Very High
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	40 (40)	37
2	Biological characteristic and dispersal ability	25 (25)	22
3	Ecological amplitude and distribution	25 (25)	25
4	Difficulty of control	10 (10)	7
	Outcome score	100 (100)[b]	91[a]
	Relative maximum score †		91.00
	New York Invasiveness Rank §	Very High (Relative Maximum Score >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 to persist without cultivation in NY? (reliable source; voucher not required)	
☒	Yes – continue to A1.2
☐	No – continue to A2.1
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:
Weldy & Werier,, 2005; Brooklyn Botanic Garden, 2008.

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

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

Documentation:
Sources of information (e.g.: distribution models, literature, expert opinions):
Weldy & Werier, 2005; Brooklyn Botanic Garden, 2008.

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	Widespread
Lower Hudson	Not Assessed
Saint Lawrence/Eastern Lake Ontario	Not Assessed
Western New York	Not Assessed

Documentation:
Sources of information:
Weldy & Werier, 2005; Brooklyn Botanic Garden, 2008.

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

Other potential or known suitable habitats within New York:

Documentation:
Sources of information:
Ehrenfeld, 1997, 1999; Harrington et al., 2004; Silander & Klepeis, 1999; Maybury, 2003; Brooklyn Botanic Garden, 2008.

B. INVASIVENESS RANKING

1. ECOLOGICAL IMPACT

1.1. Impact on Natural Ecosystem Processes and System-Wide Parameters (e.g. fire regime, geomorphological changes (erosion, sedimentation rates), hydrologic regime, nutrient and mineral dynamics, light availability, salinity, pH)

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 (e.g., has a perceivable but mild influence on soil nutrient availability)	3
C.	Significant alteration of ecosystem processes (e.g., increases sedimentation rates along streams or coastlines, reduces open water that are important to waterfowl)	7
D.	Major, possibly irreversible, alteration or disruption of ecosystem processes (e.g., the species alters geomorphology and/or hydrology, affects fire frequency, alters soil pH, or fixes substantial levels of nitrogen in the soil making soil unlikely to support certain native plants or more likely to favor non-native species)	10
U.	Unknown	

Score 10

Documentation:
Identify ecosystem processes impacted (or if applicable, justify choosing answer A in the absence of impact information)
Soil under B. thunbergii had higher pH, higher nitrification rates (conversion of ammonium to nitrate), and often higher N mineralization rates than soil under Vaccinium pallidum (blueberry) in NJ; these findings were replicated in the greenhouse (Ehrenfeld et al. 2001). Barberry litter was higher in N, and decomposed more rapidly (with little N immobilization), than did native plant litter. These changes may lead to a positive feedback loop in which barberry increases the rate of nitrate production, which it preferentially takes up to support rapid growth and high biomass production (Ehrenfeld et al. 2001). B. thunbergii may facilitate non-native earthworm increases, which also alter soil chemistry and function (Kourtev et al. 1999)
Sources of information:
Ehrenfeld et al. 2001. Kourtev et al. 1999

1.2. Impact on Natural Community Structure

A.	No perceived impact; establishes in an existing layer without influencing its structure	0
B.	Influences structure in one layer (e.g., changes the density of one layer)	3
C.	Significant impact in at least one layer (e.g., creation of a new layer or elimination of an existing layer)	7
D.	Major alteration of structure (e.g., covers canopy, eradicating most or all layers below)	10
U.	Unknown	

Score 7

Documentation:
Identify type of impact or alteration:
Berberis thunbergii has been shown to significantly increase the shrub layer density and can, in some cases, come into areas where there is not currently a shrub layer, thus creating a new layer; might also be eliminating layers below it but more information needed.
Sources of information:
Ehrenfeld, 1997, 1999; Ehrenfeld et al. 2001; Baskin, 2002; Maybury 2003.

1.3. Impact on Natural 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 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: 10

Documentation:
Identify type of impact or alteration:
Altered soil pH, N concentrations and N cycling increases the likelihood of additional exotic invasions, which tend to prefer soils with higher pH and nutrient availability. Maybury (2003) reports that it replaces the understory Vaccinium layers but hard data or citations not presented. Since barberry is not a preferred deer food, deer browse pressure is increased on native plants which may prevent their recruitment (Eschtruth & Battles 2008; Rawinski unpub.).
Sources of information:
Ehrenfeld, 1997, 1999; Ehrenfeld et al 2001; Maybury, 2003; Eschtruth and Battles, 2008; Rawinksi 2008 unpublished.

1.4. 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. Examples include reduction in nesting/foraging sites; reduction in habitat connectivity; injurious components such as spines, thorns, burrs, toxins; suppresses soil/sediment microflora; interferes with native pollinators and/or pollination of a native species; hybridizes with a native species; hosts a non-native disease which impacts a native species)

A.	Negligible perceived impact	0
B.	Minor impact	3
C.	Moderate impact	7
D.	Severe impact on other species or species groups	10
U.	Unknown	

Score: 10

Documentation:
Identify type of impact or alteration:
Causes "profound effects on the microbial community of the soil" which include altered microbial community structure and function (Kourtev et al. 2002). Also alters earthworm fauna. Possesses spines which decrease palatability to deer (Rawinski unpub).
Sources of information:
Kourtev et al, 1998; Kourtev et al, 1999; Kourtev et al., 2002; Rawinski 2008 unpub.

Total Possible: 40
Section One Total: 37

2. BIOLOGICAL CHARACTERISTICS AND DISPERSAL ABILITY

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

A.	No reproduction by seeds or vegetative propagules (i.e. plant sterile with no sexual or asexual reproduction).	0
B.	Limited reproduction (fewer than 10 viable seeds per plant AND no vegetative reproduction; if viability is not known, then maximum seed production is less than 100 seeds per plant and no vegetative reproduction)	1
C.	Moderate reproduction (fewer than 100 viable seeds per plant - if viability is not known,	2

then maximum seed production is less than 1000 seeds per plant - OR limited successful vegetative spread documented)

D. Abundant reproduction with vegetative asexual spread documented as one of the plants prime reproductive means OR more than 100 viable seeds per plant (if viability is not known, then maximum seed production reported to be greater than 1000 seeds per plant.) 4

U. Unknown

Score 4

Documentation:
Describe key reproductive characteristics (including seeds per plant):
Two thousand or more fruits (each fruit is one to few-seeded) can occur on a single plant, although some cultivars (e.g., 'Aurea', 'Bogozom', 'Crimson Pygmy', 'Kobold', 'Monlers') produce much less fruit and seed (Lovinger & Anisko, 2004; Lehrer et al., 2006a, 2006b). Viability reported to be high (Davis, 1927; Lovinger & Anisko, 2004; Lehrer et al., 2006a, 2006b) for the species but lower for some of the aforementioned ('Aurea', 'Crimson Pygmy') cultivars (Lehrer, 2006a, 2006b). One year old seedling of some cultivars (e.g., 'Aurea', 'Crimson Pygmy') also reported to have reduced growth vigor (Lehrer et al, 2006b). Branches reported to root freely when in contact with soil (WDNR, 2004).
Sources of information:
Davis, 1927;Wisconsin Department of Natural Resources, 2004; Lehrer, 2006a, 2006b; authors' personal observations.

2.2. Innate potential for long-distance dispersal (e.g. bird dispersal, sticks to animal hair, buoyant fruits, pappus for wind-dispersal)

A. Does not occur (no long-distance dispersal mechanisms) 0

B. Infrequent or inefficient long-distance dispersal (occurs occasionally despite lack of adaptations) 1

C. Moderate opportunities for long-distance dispersal (adaptations exist for long-distance dispersal, but studies report that 95% of seeds land within 100 meters of the parent plant) 2

D. Numerous opportunities for long-distance dispersal (adaptations exist for long-distance dispersal and evidence that many seeds disperse greater than 100 meters from the parent plant) 4

U. Unknown

Score 4

Documentation:
Identify dispersal mechanisms:
Fruits are eaten by birds, small mammals and wild turkeys and transported long distances by this means. Silander and Klepeis (1999) report that most seedlings are generally found beneath exisiting plants, with some found tens of meters away from nearest adult, but this is not direct evidence that there is not long-distance dispersal.
Sources of information:
Silander & Klepeis, 1999; Mehrhoff et al, 2003; Lehrer pers. comm.

2.3. Potential to be spread by human activities (both directly and indirectly – possible mechanisms include: commercial sales, use as forage/revegetation, spread along highways, transport on boats, contaminated compost, land and vegetation management equipment such as mowers and excavators, 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 dispersal mechanisms:
Commercially sold; can be transported indirectly through brush removal. [Note not related to scoring: Lehrer et al. (2006c) reported that some of the commonly grown purple- and yellow-leaf types readily produce green-leaf offspring resembling the wild type barberry, although the percentage of green-leaf offspring varied widely by genotype. The authors noted that their findings do not "provide any definitive link between cultivated and naturalized Japanese barberry."]
Sources of information:
Maybury, 2003; Lovinger & Anisko, 2004; Lehrer, 2006a, 2006b, 2006c; author's (Moore's) personal observations.

2.4. Characteristics that increase competitive advantage, such as shade tolerance, ability to grow on infertile soils, perennial habit, fast growth, nitrogen fixation, allelopathy, etc.

A. Possesses no characteristics that increase competitive advantage 0
B. Possesses one characteristic that increases competitive advantage 3
C. Possesses two or more characteristics that increase competitive advantage 6
U. Unknown

Score 6

Documentation:
Evidence of competitive ability:
Shade tolerant, perennial habit, grows on infertile soils, unpalatable to white-tailed deer.
Sources of information:
Ehrenfeld, 1997, 1999; Eschtruth and Battles, 2008; authors', Lehrer's and Jordan's personal observations.

2.5. Growth vigor

A. Does not form thickets or have a climbing or smothering growth habit 0
B. Has climbing or smothering growth habit, forms a dense layer above shorter vegetation, forms dense thickets, or forms a dense floating mat in aquatic systems where it smothers other vegetation or organisms 2
U. Unknown

Score 2

Documentation:
Describe growth form:
Can form thickets.
Sources of information:
Mehrhoff et al., 2003; Ehrenfeld 1997.

2.6. Germination/Regeneration

A. Requires open soil or water and disturbance for seed germination, or regeneration from vegetative propagules. 0
B. Can germinate/regenerate in vegetated areas but in a narrow range or in special conditions 2
C. Can germinate/regenerate in existing vegetation in a wide range of conditions 3
U. Unknown (No studies have been completed)

Score 3

Documentation:
Describe germination requirements:
Seeds readily germinate in varied habitat types, soil types and disturbance regimes.
Observed germinating in exisiting vegetation.
Sources of information:
Silander & Klepeis, 1999; Lehrer unpublished; author's (Moore's) personal observations.

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

A. No 0
B. Yes 3
U. Unknown

Score 0

Documentation:
Species:
Berberis vulgaris present in NY but assessed only as a moderate invasive; B. julianae also reported from state but not known if it is spreading from existing planted localities.

Total Possible 25
Section Two Total 22

3. ECOLOGICAL AMPLITUDE AND DISTRIBUTION

3.1. Density of stands in natural areas in the northeastern USA and eastern Canada (use same definition as Gleason & Cronquist which is: "The part of the United States covered extends from the Atlantic Ocean west to the western boundaries of Minnesota, Iowa, northern Missouri, and southern Illinois, south to the southern boundaries of Virginia, Kentucky, and Illinois, and south to the Missouri River in Missouri. In Canada the area covered includes Nova Scotia, Prince Edward Island, New Brunswick, and parts of Quebec and Ontario lying south of the 47th parallel of latitude")

A. No large stands (no areas greater than 1/4 acre or 1000 square meters) 0
B. Large dense stands present in areas with numerous invasive species already present or disturbed landscapes 2
C. Large dense stands present in areas with few other invasive species present (i.e. ability to invade relatively pristine natural areas) 4
U. Unknown

Score 4

Documentation:
Identify reason for selection, or evidence of weedy history:
Has been reported and observed to become established in areas where few other invasive species are present.
Sources of information:
Ehrenfeld, 1997, 1999; Maybury, 2003; Mehrhoff et al., 2003; author's (Moore's) personal observations.

3.2. 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 two or more of the habitats given at A2.3, with at least one a natural habitat. 1
C. Known to occur in three or more of the habitats given at A2.3, with at least two a natural habitat. 2
D. Known to occur in four or more of the habitats given at A2.3, with at least three a natural habitat. 4
E. Known to occur in more than four of the habitats given at A2.3, with at least four a natural habitat. 6
U. Unknown

Score 6

Documentation:
Identify type of habitats where it occurs and degree/type of impacts:
See A2.3.

Sources of information:
Ehrenfeld, 1997, 1999; Harrington et al., 2004; Silander & Klepeis 1999; Maybury, 2003; Brooklyn Botanic Garden, 2008.

3.3. Role of disturbance in establishment

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. 4
U. Unknown

Score 4

Documentation:
Identify type of disturbance:
Reported and observed to establish in areas without any recent natural or anthropogenic disturbances.
Sources of information:
Ehrenfeld, 1997, 1999; Maybury, 2003; Mehrhoff, 2003; author's (Moore's) personal observations.

3.4. Climate in native range

A. Native range does not include climates similar to New York 0
B. Native range possibly includes climates similar to at least part of New York. 1
C. Native range includes climates similar to those in New York 3
U. Unknown

Score 3

Documentation:
Describe what part of the native range is similar in climate to New York:
Temperate Asia.
Sources of information:
Maybury, 2003; Brooklyn Botanic Garden, 2008.

3.5. Current introduced distribution in the northeastern USA and eastern Canada (see question 3.1 for definition of geographic scope)

A. Not known from the northeastern US and adjacent Canada 0
B. Present as a non-native in one northeastern USA state and/or eastern Canadian province. 1
C. Present as a non-native in 2 or 3 northeastern USA states and/or eastern Canadian provinces. 2
D. Present as a non-native in 4–8 northeastern USA states and/or eastern Canadian provinces, and/or categorized as a problem weed (e.g., “Noxious” or “Invasive”) in 1 northeastern state or eastern Canadian province. 3
E. Present as a non-native in >8 northeastern USA states and/or eastern Canadian provinces. and/or categorized as a problem weed (e.g., “Noxious” or “Invasive”) in 2 northeastern states or eastern Canadian provinces. 4
U. Unknown

Score 4

Documentation:
Identify states and provinces invaded:
CT, DC, DE, IA, IL, IN, KY, MA, MD, ME, MI, MN, NH, NJ, NY, OH, PA, RI, VA, VT, WI, WV; NB, NS, ON, PE, QC.
Sources of information:
- See known introduced range in plants.usda.gov, and update with information from states and Canadian provinces.

U.S.D.A., 2008.

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

A.	Present in none of the PRISMs	0
B.	Present in 1 PRISM	1
C.	Present in 2 PRISMs	2
D.	Present in 3 PRISMs	3
E.	Present in more than 3 PRISMs or on the Federal noxious weed lists	4
U.	Unknown	

Score: 4

Documentation:
Describe distribution:
See A1.1
Sources of information:
Weldy & Werier, 2005; Brooklyn Botanic Garden, 2008.

Total Possible: 25
Section Three Total: 25

4. DIFFICULTY OF CONTROL

4.1. Seed banks

A.	Seeds (or vegetative propagules) remain viable in soil for less than 1 year, or does not make viable seeds or persistent propagules.	0
B.	Seeds (or vegetative propagules) remain viable in soil for at least 1 to 10 years	2
C.	Seeds (or vegetative propagules) remain viable in soil for more than 10 years	3
U.	Unknown	

Score: 2

Documentation:
Identify longevity of seed bank:
Seeds remain viable for at least a year. Seeds have physiological dormany requiring cold stratification. No evidence for viability of more than 10 years.
Sources of information:
Davis, 1927; Baskin et al., 1993.

4.2. Vegetative regeneration

A.	No regrowth following removal of aboveground growth	0
B.	Regrowth from ground-level meristems	1
C.	Regrowth from extensive underground system	2
D.	Any plant part is a viable propagule	3
U.	Unknown	

Score: 1

Documentation:
Describe vegetative response:
Resprouts readily from ground-level and slightly subterranean buds. Cutting it off at base will not kill the plant.
Sources of information:
Maybury, 2003; authors' and Lehrer's personal observations.

4.3. Level of effort required

A.	Management is not required: e.g., species does not persist without repeated anthropogenic disturbance.	0

B.	Management is relatively easy and inexpensive: e.g. 10 or fewer person-hours of manual effort (pulling, cutting and/or digging) can eradicate a 1 acre infestation in 1 year (infestation averages 50% cover or 1 plant/100 ft^2).	2
C.	Management requires a major short-term investment: e.g. 100 or fewer person-hours/year of manual effort, or up to 10 person-hours/year using mechanical equipment (chain saws, mowers, etc.) for 2-5 years to suppress a 1 acre infestation. Eradication is difficult, but possible (infestation as above).	3
D.	Management requires a major investment: e.g. more than 100 person-hours/year of manual effort, or more than 10 person hours/year using mechanical equipment, or the use of herbicide, grazing animals, fire, etc. for more than 5 years to suppress a 1 acre infestation. Eradication may be impossible (infestation as above).	4
U.	Unknown	

Score	4

Documentation:
Identify types of control methods and time-term required:
Hand pulling using thick gloves and weed wrench on smaller plants; repeated cuttings, treatment with glyphosphate, and control burning are all effective. Nonetheless, large stands will require major time investments.
Sources of information:
Swearingen et al, 2002; Maybury, 2003.

Total Possible	10
Section Four Total	7
Total for 4 sections Possible	100
Total for 4 sections	91

C. STATUS OF CULTIVARS AND HYBRIDS:

At the present time (May 2008) there is no protocol or criteria for assessing the invasiveness of cultivars 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.

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 cultivars of the species known to be available: 'Anderson', 'Antares', 'Aurea', 'Aurea Nana', 'Bagatelle', 'Bailgreen', 'Bailone', 'Bailsel', 'Bailtwo', 'Bogozam', 'Concorde', 'Crimson Dwarf', 'Crimson Pygmy', 'Crimson Velvet', 'Criruzam', 'Erecta', 'Gentry', 'Golden Devine', 'Golden Ring', 'Green Pygmy', 'Helmond Pillar', 'Inermis', 'Kelleriis', 'Kobold', 'Lime Glow', 'Marshall Upright', 'Minor', 'Monlers', 'Monomb', 'Monry', 'Rose Glow', 'Royal Cloak', 'Sparkle', 'Tara'.

Hybrid: Berberis thunbergii and B. vulgaris can hybridize, resulting in B. ottawensis. We don't have enough information to evaluate the hybrid separately. In this case we are considering the hybrid to have the same invasive nature as B. thunbergii**.**

References for species assessment:

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Lehrer, J.M., M.H.Brand, and J.D. Lubell. 2006c. Seedling populations produced by colored-leaf genotypes of Japanese barberry (Berberis thunbergii DC.) contain seedlings with green leaf phenotype. Journal of Environmental Horticulture 24(3): 133-136.

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