INDIANA

NON-NATIVE PLANT INVASIVENESS RANKING FORM

ASSESSMENT FOR INVASIVE PLANTS NOT IN TRADE
Form originally created for use in New York
Indiana Form version date: November 1, 2010

Scientific name:	Dioscorea polystachya (D. oppositifolia, misapplied) USDA Plants Code: DIOP
Common names:	Chinese Yam, cinnamon vine
Native distribution:	East Asia
Date assessed:	04/06/2011
Assessors:	Pia Marie Paulone and Ellen Jacquart
Reviewers:	Mike Everidge and Jason Larson
Date Approved:	September 21, 2012

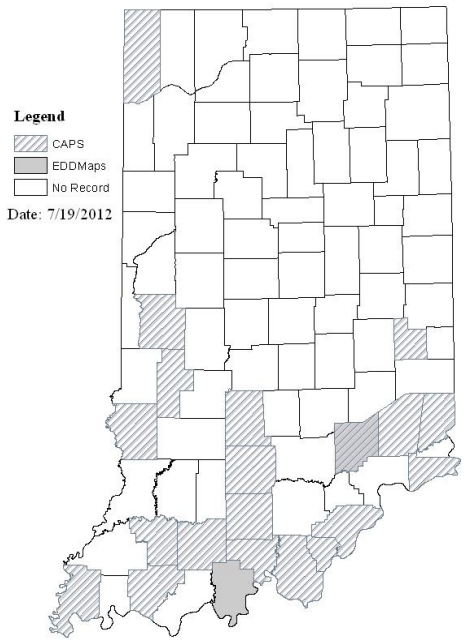
Indiana Invasiveness Rank: High (Relative Maximum Score 70.00-80.00)

Invasiveness Ranking Summary (see details under appropriate sub-section)		Total (Total Answered*) Possible	Total
1	Ecological impact	40 (20)	14
2	Biological characteristic and dispersal ability	25 (25)	20
3	Ecological amplitude and distribution	25 (25)	22
4	Difficulty of control	10 (10)	7
	Outcome score	100 (80)[b]	63[a]
	Relative maximum score †		78.75
	Indiana Invasiveness Rank §	High (Relative Maximum Score 70.00-80.00)	

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

A. DISTRIBUTION (KNOWN/POTENTIAL):

A1 Has this species been documented to persist without cultivation in IN? (reliable source; voucher not required)	
☒	**Yes – continue to A2.2**
☐	No – continue to A2.1
A2What is the likelihood that this species will occur and persist outside of cultivation given the climate in Indiana? (obtain from occurrence data in other states with similar climates)	
x	Likely – continue to A3
☐	Not likely – stop here. There is no need to assess the species



Documentation:
Sources of information:
A1 Sources of information: Range maps compiled from PLANTS database, http://plants.usda.gov/java/; Indiana CAPS database, http://extension.entm.purdue.edu/CAPS/index.html; Indiana IPSAWG reports (unpublished); and EDDMapS reports, http://eddmaps.org/

A3 Describe the potential or known suitable habitats within Indiana (underlined). Natural habitats include all habitats not under active human management. Managed habitats are indicated with an asterisk.

Aquatic Habitats	**Wetland Habitats**	**Upland Habitats**
Rivers/streams	Marshes	**Forest**
Natural lakes and ponds	Fens	**Savannas**
Reservoirs/impoundments*	Bogs	Barrens
	Shrub swamps	Prairies
	Forested wetlands/riparian	Cultivated*
	Beaches/dunes	**Old Fields***
	Ditches*	**Roadsides***

Other potential or known suitable habitats within Indiana:
Urban waste areas.

Documentation:
Sources of information:
Zhengyi & Raven, 2000; Thomas et al., 2005; Thomas et al., 2006; Brooklyn Botanic Garden, 2009.

B. INVASIVENESS RANKING
Questions apply to areas similar in climate and habitats to Indiana unless specified otherwise.

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 U

Documentation:
Identify ecosystem processes impacted (or if applicable, justify choosing answer A in the absence of impact information)
No studies on the impact on natural ecosystem processes known.

Sources of information:
Heffernan, 2004.

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:
Able to climb on and over adjacent vegetation, forming a thick blanket (and new vegetation layer) of leaves that shades out other plant species. When it climbs onto large trees, it may eventually become heavy enough to bend and break the stems of small trees. No evidence of major alteration of structure.
Sources of information:
Tu, 2002

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 7

Documentation:
Identify type of impact or alteration:
Large stands can significantly reduce population sizes of native species.
Sources of information:
Tu, 2002; Thomas et al., 2006

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 U

Documentation:

Identify type of impact or alteration:
No studies on the impact on other species or species groups known.
Sources of information:
Heffernan, 2004.

Total Possible	20
Section One Total	14

2. BIOLOGICAL CHARACTERISTICS AND DISPERSAL ABILITY

2.1. Mode and rate of reproduction

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, then maximum seed production is less than 1000 seeds per plant - OR limited successful vegetative spread documented)	2
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):
While Dioscorea polystachya has not been documented to reproduce sexually in North America (only one pistillate specimens reported), it is able to rapidly expand its range by the proliferation of axillary bulbils. One study (Thomas et al., 2006) found 18 of 50 plants studied produced bulbils at a mean of 14.8+/-SE 1.7 bulbils per meter of stem. Another report (Tu, 2002) found each vine is capable of producing an average 20 bulbils per year, and fragmented, broken, or even partially eaten bulbils are still capable of producing healthy plants.
Sources of information:
Flora of North America Editorial Committee, 2002; Tu, 2002; Thomas et al., 2006.

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:
Hydrochory: documented bulbil dispersal of over 200 meters by water (Thomas et al., 2005).
Epizoochory: rodents documented carring away bulbils to be consumed; partially eaten bulbils are still capable of producing healthy plants.

Possible wind dispersal of winged seeds winged but seeds not known. (Zhengyi & Raven, 2000)
Sources of information:
Zhengyi & Raven, 2000; Tu, 2002; Thomas et al., 2005.

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 2

Documentation:
Identify dispersal mechanisms:
Rarely planted as a garden ornamental and for edible tubers; discarding of yard waste with viable tubers could result in indirect spread.
Sources of information:
Flora of North America Editorial Committee, 2002; Tu, 2002.

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:
Perennial, shade tolerant, able to grow on infertile soils. Fast-growing perennial with a deep, persistent, root-like tuber, which provides rapid early-season growth and substantial food reserves to form new plants in subsequent years. Can tolerate light levels ranging from full sun to full shade and is well adapted to exploit any increase in soil nutrient levels, making it an excellent competitor for soil resources.
Sources of information:
Tu, 2002; Mueller et al., 2003; author's pers. obs.

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:
Able to climb on and over adjacent vegetation, forming a thick blanket of leaves that shades out other plant species.
Sources of information:
Tu, 2002.

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 2

Documentation:
Describe germination requirements:
Dioscorea polystachya has not been documented to reproduce by seed in North America, but does produce bulbils. One study (Thomas et al., 2006) suggests that bulbil regeneration is restricted to sites with well drained soils, while poorly drained soils hasten rot in bulbils. One greenhouse study found bulbils had 100% germination (Tu, 2002).
Sources of information:
Flora of North America Editorial Committee, 2002; Tu, 2002; Thomas et al., 2006.

2.7. Other species in the genus invasive in Indiana or elsewhere

A. No 0
B. Yes 3
U. Unknown

Score 0

Documentation:
Species: *Dioscorea bulbifera* in southeast U.S.
Weldy & Werier, 2005; Brooklyn Botanic Garden, 2008

Total Possible 25
Section Two Total 20

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:
Numerous infestations in Indiana have been reported over an acre in size; Perry County infestation reported by author is approximately 3 acres of dense infestation. There are similar reports elsewhere in the northeast U.S.
Sources of information:
Tu, 2002; author's observation

3.2. Number of habitats the species may invade

A.	Not known to invade any natural habitats given at A2.2	0
B.	Known to occur in two or more of the habitats given at A2.2, with at least one a natural habitat.	1
C.	Known to occur in three or more of the habitats given at A2.2, with at least two a natural habitat.	2
D.	Known to occur in four or more of the habitats given at A2.2, with at least three a natural habitat.	4
E.	Known to occur in more than four of the habitats given at A2.2, with at least four a natural habitat.	6
U.	Unknown	

Score 4

Documentation:
Identify type of habitats where it occurs and degree/type of impacts:
See A2.2.
Sources of information:
Cavers et al., 1979; Byers & Quinn, 1987; Nuzzo, 1992a, 1993a; 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:
While initial infestations of D. polystachya are generally associated with human-caused disturbances, it has also been documented to establish in pristine habitats, especially riparian corridors. Infestations along Mosquito Creek in Harrison County, IN are an example.
Sources of information:
Tu, 2002; Thomas et al., 2006; Jacquart pers. obs.

3.4. Climate in native range

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

Score 3

Documentation:
Describe what part of the native range is similar in climate to Indiana:
Northern China, Korea, Japan.
Sources of information:
Zhengyi & Raven, 2000.

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, IL, IN, KY, MA, MD, NJ, NY, OH, PA, VA, VT, WV
Sources of information:
See known introduced range in plants.usda.gov, and update with information from states and Canadian provinces.
U.S.D.A., 2009.

3.6. Current introduced distribution of the species in natural areas in Indiana

A.	Present in no Indiana counties	0
B.	Present in 1-10 Indiana counties	1
C.	Present in 11-20 Indiana counties	2
D.	Present in 21-50 Indiana counties	3
E.	Present in more than 50 Indiana counties or on Federal noxious weed list	4
U.	Unknown	

Score 3

Documentation:
Describe distribution:
Documented in 20 counties; see A1.1.
Sources of information:
CAPS map, 2007

Total Possible 25
Section Three Total 22

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	0

viable seeds or persistent propagules.

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:
Dioscorea polystachya has not been documented to reproduce by seed in North America, but does produce bulbils. One study (Thomas et al., 2006) found after 1 year, the highest percentages of bulbils were viable under leaves, and much lower percentages were viable over leaves, in soil, and in a creek (76.0 +/- 6.8, 21.2 +/- 9.6, 21.6 +/- 3.6, and 5.2 +/- 5.2%), respectively. One greenhouse study found bulbils had 100% germination (Tu, 2002). No evidence of bulbils surviving for more than 10 years.
Sources of information:
Flora of North America Editorial Committee, 2002; Tu, 2002; Thomas et al., 2006.

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:
Fast-growing perennial with a deep, persistent, root-like tuber which provides rapid early-season growth and substantial food reserves to form new plants in subsequent years. The tuber is not an extensive system.
Sources of information:
Tu, 2002; Mueller et al., 2003.

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:
Chemical- Herbicide application appears to be the most effective means to control D. polystachya in large infestations. One application of some herbicides can effectively kill all new germinating bulbils, but repeat treatments are probably necessary to completely kill

large underground tubers that originally supported large mature vines. The herbicides glyphosate or triclopyr have been the most successful at killing D. polystachya. Several other herbicides having diverse modes of action provided minimal control.

Mechanical- In small isolated patches, good control may be achieved by the manual removal of the entire tuber. Hand-pulling the newly sprouted bulbils, making sure to remove the entire bulbil, can also provide good control, but these manual methods are extremely time and labor intensive. Repeated cutting may provide good control, but will require several years of follow-up treatment.

Fire- there is ambiguity regarding the efficacy of fire. Sites burned have reduced amounts of bulbils the following year; but it is unclear whether this is the result of fire destroying the bulbils or the leaf litter protecting the bulbils.

BioControl- While there are currently no available biocontrol agents for D. polystachya; this species has been targeted for future collaborative research into biological control.

Sources of information:
Tu, 2002; Mueller et al., 2003; Ding et al., 2006; Main et al., 2006; Thomas et al., 2006.

Total Possible	10
Section Four Total	7

Total for 4 sections Possible	80
Total for 4 sections	62

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Acknowledgments: The IN ranking form is an adaptation for Indiana use of the form created for New York by Jordan et al. (2009), cited below. Documentation for species assessed for New York are used for Indiana where they are applicable. The Invasive Plant Advisory Committee was created by the Indiana Invasive Species Council in October 2010, and is made up of the original members of the Indiana Invasive Plant Assessment Working Group (IPSAWG). Original members of IPSAWG included representatives of the The Nature Conservancy; Indiana Native Plant and Wildflower Society; Indiana Nursery and Landscape Association; Indiana Chapter of the American Society of Landscape Architects; Indiana Forage Council; Indiana Wildlife Federation; Indiana State Beekeepers Association; Indiana Beekeeper's Association; Department of Natural Resources; Hoosier National Forest; Indiana Academy of Science; Natural Resources Conservation Service; Indiana Department of Environmental Management; Indiana Department of Transportation; Purdue Cooperative Extension Service; Seed Administrator, Office of the Indiana State Chemist.

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