

plant community with which it had not previously been associated) must be provided. If not available in a published, quantitative form, this evidence must include written observations from at least three appropriate biologists.

1. Is species invasive ONLY when natural disturbance regime and scale have been altered? (e.g. where frequency, extent, or severity of fires have been reduced by human activity).

If **YES** then go to questions 1-b 2.

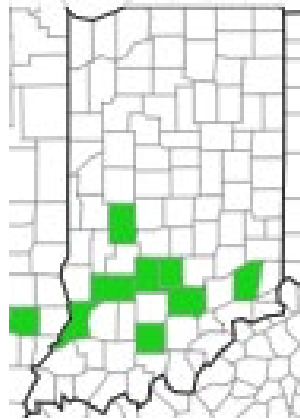
If **NO** – the species is invasive, go to Section II (below).

2. Has this species ever been known to persist, following colonization, when the natural regime is resumed and the natural flora/communities recover? (e.g., is not an early successional species that only temporarily invades disturbed sites.)

If **YES** (or unknown) - the species is invasive, go to Section II (below).

If **NO** (known not to persist) the species is currently not invasive in Indiana. Go to Section III-c (page 4) to assess the species' potential for future invasion.

EDDMaps.org reports the species growing out of cultivation on ten sites in eight counties as of August 2, 2019: Brown, Clay, Greene, Jackson, Knox, Monroe, Orange and Ripley.



Section II Ecological Impacts of Invasion Impact Index

II-a Known Impacts at WORST SITE(S) (without, or before, any control effort)

Add up points for ALL impact statements (i through vi) that are true at the worst affected site(s) then go to question II-b. Evidence of impacts must be provided. If not available in published, quantitative form, this evidence must include written observations from at least *three* appropriate biologists, including specific locations of observations. Scientific names of impacted species (e.g., State-listed or native species with which hybridization occurs) must be included on the response form. If there is no evidence of an impact, then assign 0 points unless the impact is considered very likely (e.g., fixes N₂ in low nutrient soil that can change the flora) or the impact (except vi) has been demonstrated in similar habitats in states. In these cases assign 0.5 points.

Points

- i) Causes long-term, broad alterations in ecosystem processes changing the community as a whole (e.g. invasion of cattails changes hydrology, drying the site and allowing open aquatic

systems to become forested).

Roots form symbiotic relationship with the nitrogen-fixing bacterium Rhizobium. Large infestations may increase nitrogen fixation of soil. Can decrease light availability when growing on and over trees, but increase light availability when it kills trees. (Valder, 1995). However, there is no direct evidence of these impacts.

- ii) Has negatively impacted Indiana State-listed or Federal-listed plants or animals (choose one of the following):

Displacement, death or hybridization has been documented AND occurs in at least 20% of known locations of the listed species, OR these effects occur in less than 20% of known locations of the listed species, but at least 4 different listed species are affected.

12

Displacement, death or hybridization occurs in less than 20% of locations of the listed species OR impacts are considered likely because the listed and invasive species closely co-habit (e.g., compete for light).

4

Not aware of rare plant or animal impacts by this species in Indiana.

- iii) Displaces or precludes native vegetation (affecting mortality and/or recruitment) by achieving infestations in the state that have at least 50% coverage of this species (as defined in the glossary) in the affected stratum that meet any of the following criteria:

a) collectively add up to at least 10 acres

b) are 5 infestations of at least 0.25 acres

c) are 5 infestations that cover an entire localized community

(e.g. sinkhole, seeps, fens, bogs, barrens, cliffs)

d) are 5 infestations some of which are at least 0.25 acres and others of which cover entire localized communities.

12

Only two of the nine reports provided an acreage estimate of the wisteria invasion; one was 1 acre and the other was 0.92 acres. Based on observations of other infestations in the state (including a large unreported infestation at Crane Naval Reserve), at least five of the reports are over 0.25 acres (Jacquart, personal observation).

- iv) Changes community structure in ways other than vegetation displacement (e.g., alters wildlife abundance, adds a new stratum, or increases stem density within a stratum by more than 5-fold).

4

W. sinensis can form very dense thickets (Ramely & Swearingen, 1998). However, Glenn and Moore noted that there is no recorded creation or elimination of a new layer by W. sinensis (Glenn & Moore, 2009). Pods and seeds are toxic if ingested- possible poisoning of native fauna? Roots

symbiotic with N-fixing bacterium, Rhizobium, so likely has some impact on soil microorganisms (Valder, 1995). Wisteria impacts natural areas changing soil nitrogen levels. (Wang, 2011). However, there is no direct evidence of these impacts.

- v) Hybridizes with native Indiana plants or commercially available species.
Many naturalized populations are hybrids of the two species (W. sinensis and W. floribunda) (Trusty et al., 2007a).

4

- vi) Covers over 15% of invaded stratum (but if 12 points were assigned for statement iii, do not assign points here) on > 10 acres in the state.

3

Total points (place in worksheet page 7): **16**

II-b Range of Habitats in Which Species is Invasive

Forest: 1)Dry upland, **2)Dry-mesic upland**, **3)Mesic upland**, 4)Mesic floodplain, 5)Wet-mesic floodplain, 6)Wet floodplain, 7)Bluegrass till plain flatwoods*, 8)Boreal flatwoods*, 9)Central till plain flatwoods, 10)Dry flatwoods*, 11)Sand flatwoods*, 12)Southwestern lowland mesic flatwoods*

Savanna: **13)Mesic savanna***, 14)Dry sand savanna*, 15)Dry-mesic sand savanna*

Barrens: 16)Limestone bedrock*, 17)Sandstone bedrock*, 18)Siltstone bedrock*, 19)Chert*, 20)Gravel*, 21)Sand*, 22) Clay*

Prairie: 23)Dry-mesic prairie*, 24)Mesic prairie*, 25)Wet prairie*, 26)Dry sand prairie*, 27)Dry-mesic sand prairie*, 28)Wet-mesic sand prairie*, 29)Wet sand prairie*

Wetland: **30)Marl beach***, **31)Acid bog***, **32)Circumneutral bog***, **33)Fen***, **34)Forested fen***, **35)Muck and Sand flats***, **36)Marsh**, **37)Sedge meadow***, **38)Panne***, **39)Acid seep***, **40)Calcareous seep***, **41)Circumneutral seep***, **42)Forest swamp**, **43)Shrub swamp**

Lake: **44)Lake**, **45)Pond**

Stream: **46)Low-gradient creek**, **47)Medium-gradient creek**, **48)High-gradient creek**, **49)Low-gradient river**, **50)Medium-gradient river**, **51)Major river**

Primary: **52)Aquatic cave***, 53)Terrestrial cave*, 54)Eroding cliff*, 55)Limestone cliff*, 56)Overhang cliff*, 57)Sandstone cliff*, 58)Lake dune*, **59)Gravel wash***

Is this species known to be invasive in at least four habitat-types (note – rare habitat-types are marked with a * and count as 2 when adding) OR does it occur in at least one habitat-type of each of the terrestrial and palustrine/aquatic lists (palustrine/aquatic habitats are shown in **bold**) Two forest and one savanna habitats noted.

If YES then multiply total score from II-a by 1.5

then go to Section II-c (Below)
If NO then multiply total score from II-a by 1
then go to Section II-c (Below)

Place point total in worksheet, page 10.

II-c Proportion of Invaded Sites with Significant Impacts

Of the invaded sites, might any of the worst impacts [items i-v in section II-a] only occur under a few, identifiable, environmental conditions (i.e., edaphic or other biological conditions occurring in 1-10% of the sites)? Documentation of evidence must be provided for a **YES** answer.

If NO or NO SCORE on items i to v in section II-a
then go to Section III

If **YES** then go to Section A (page 7)

Section III

Potential for Expansion.

Potential Index

This section evaluates a species' actual and/or potential for expansion in Indiana.

III-a Potential for Becoming Invasive in Indiana

1. Is information available on the occurrence of new populations of this species in Indiana over the last 5 years?
If **YES** then go to section III-b
If **NO** go to Section III-c to estimate potential for expansion based on the biology of the species.

III-b. Known Rate of Invasion.

1. Was this species reported in more than two new discrete sites (e.g., lakes, parks, fragments of habitats at least 5 miles apart) in any 12-month period within the last 5 years?
If **NO** then P = Low; then go to Section IV
If **YES** then P = High; then go to Section IV

III-c. Estimated Rate of Invasion. This section is used to predict the risk of invasion for species that are 1) not currently invasive in the state, and 2) invasive in the state but for which no data on current rate of spread exists. These questions are based on Hiebert et al. 1995.

1. Does this species hybridize with any State-listed plants or commercially important species? (E.g., exhibit pollen / genetic invasion.)
If **YES** then go to Section B (page 7)
If **NO** then go to question III-c 2.

2. Add up all points from statements that are true for this species. Points

- i. Ability to complete reproductive cycle in area of concern
 - a. not observed to complete reproductive cycle 0
 - b. observed to complete reproductive cycle **5**

Seeds are produced annually in Indiana populations (personal observation, Ellen

ii. Mode of reproduction

- a. reproduces almost entirely by vegetative means 1
- b. reproduces only by seeds 3
- c. reproduces vegetatively and by seed **5**

W. sinensis reproduces mainly by vegetative means from horizontal stolons: it may spread by seeds if conditions are favorable (Remaley & Swearingen 1998).

iii. Vegetative reproduction

- a. no vegetative reproduction 0
- b. vegetative reproduction rate maintains population 1
- c. vegetative reproduction rate results in moderate increase in population size 3
- d. vegetative reproduction rate results in rapid increase in population size **5**

While wisteria racemes may have up to 170 flowers and seeds can be produced in favorable conditions, it is unusual for more than one or two flowers to produce pods. Vegetative growth is rampant and the main method of wisteria spread (Valder 1995, Nature Conservancy 2008)

iv. Frequency of sexual reproduction for mature plant

- a. almost never reproduces sexually in area 0
- b. once every five or more years 1
- c. every other year 3
- d. one or more times a year **5**

Seeds are produced annually in Indiana populations (personal observation, Ellen Jacquart, 2019)

v. Number of seeds per plant

- a. few (0-10) **1**
- b. moderate (11-1,000) 3
- c. many-seeded (> 1,000) 5

While wisteria racemes may have up to 170 flowers and seeds can be produced in favorable conditions, it is unusual for more than one or two flowers to produce pods. Vegetative growth is rampant and the main method of wisteria spread (Valder 1995, Nature Conservancy 2008)

vi. Dispersal ability

- a. little potential for long-distance dispersal **0**
- b. great potential for long-distance dispersal 5

Hydrochory- seeds reportedly transported down rivers, but infestations often not near water (Lu 2005, Nature Conservancy 2008)

vii. Germination requirements

- a. requires open soil and disturbance to germinate 0
- b. can germinate in vegetated areas but in a narrow range or in special conditions 3
- c. can germinate in existing vegetation in a wide range of

conditions **5**
Seeds reported to lack dormancy and to germinate readily (Valder 1995)

viii. Competitive ability

- a. poor competitor for limiting factors 0
- b. moderately competitive for limiting factors 3
- c. highly competitive for limiting factors **5**

It is a perennial plant, is shade tolerant, has a symbiotic relationship with Rhizobium, and is highly adapted to water-stress (Valder 1995, Nature Conservancy 2008)

Total points for questions i – viii (place in worksheet page 10): 31

Section IV	Difficulty of Management	Management Index
------------	--------------------------	------------------

IV Factors That Increase the Difficulty of Management

Add up all points from statements that are true for this species then go to Section V (page 5). Assign 0.5 point for each statement for which a true/false response is not known.

	<u>Points</u>
i) Control techniques that would eliminate the worst-case effects (as listed in Section II) have been investigated but none has been found.	15
ii) This species is difficult to control without significant damage to native species because: it is widely dispersed throughout the sites (i.e., does not occur within discrete clumps nor monocultures); it is attached to native species (e.g., vine, epiphytes or parasite); or there is a native plant which is easily mistaken for this invader in: (choose one) <ul style="list-style-type: none"> ≥ 50% of discrete sites in which this species grows; 10 25% to 50% of discrete sites in which this species grows. 7 <i>It is a vine that grows up native trees, making it difficult to kill without impacting native plant species.</i>	7
iii) Total contractual costs of known control method per acre in first year, including access, personnel, equipment, and materials (any needed re-vegetation is not included) > \$2,000/acre (estimated control costs are for acres with a 50% infestation) 5 <i>Because the vines grow over native plants, control options are more complicated and slower to avoid non-target impacts.</i>	5
iv) Further site restoration is <i>usually</i> necessary following plant control to reverse ecosystem impacts and to restore the original habitat-type or to prevent immediate re-colonization of the invader.	5
v) The total area over which management would have to be conducted is: (choose one) <ul style="list-style-type: none"> ≥ 100 acres; 5 	5

< 100 but > 50 acres.	2
≤ 50 but > 10 acres.	1
≤ 10 acres	1/2
<i>We don't have documented populations totaling over 10 acres, though it is likely they exist.</i>	
vi) Following the first year of control of this species, it would be expected that individual sites would require re-survey or re-treatment, due to recruitment from persistent seeds, spores, or vegetative structures, or by dispersal from outside the site: (choose one)	
at least once a year for the next 5 years;	10
one to 4 times over the next 5 years;	6
regrowth not known	2
<i>Extensive underground rhizomes and roots have great ability to resprout.</i>	
vii) Occurs in more than 20 discrete sites (e.g., water-basins, parks, fragments of habitats at least 5 miles apart).	3
<i>Ten sites reported in EDDMaps; it is likely there are more.</i>	
viii) The number of viable, independent propagules per mature plant (e.g., seeds, spores, fragments, tubers, etc. detached from parent) is > 200 per year AND one or more of the following:	
A. the propagules can survive for more than 1 year;	
B. the propagules have structures (fleshy coverings, barbs, plumes, or bladders) that indicate they may spread widely by birds, mammals, wind or water;	
C. the infestations at 3 or more sites exhibit signs of long-distance dispersal. Some possible indicators of long-distance dispersal include: the infestation has outlier individuals distant [>50 yards] from the core population; the infestation apparently lacks sources of propagules within 1/4 mile.	3
<i>Seeds reported to lack dormancy and to sprout readily, but no seed banking/viability studies found (Moore 2009).</i>	
ix) Age at first reproduction is within first 10% of likely lifespan and/or less than 3 months.	2
Total points (place in worksheet page 8):	25.5

Section V	Commercial Value	Value Index
------------------	-------------------------	--------------------

V-a Commercial Value

Does this species have any commercial value?

If response is **NO** then V = 0 and Go to

Conversion of Index Scores to Index

V-b Factors that Indicate a Significant Commercial Value

Add up all points from statements that are true for this species. Assign 0.5 point for each statement for which a true/false response is not known.

	<u>Points</u>
i) This species is sold in national or regional retail stores (e.g., Walmart, Home Depot, Publix).	10
ii) State-wide there are more than 20 commercial growers of this species.	7
iii) More than five growers in Indiana rely on this species as more than 10% of their production.	3
iv) This species has provided a crop, turf, or feed source (e.g., forage, nectar) that has been, or resulted in, a significant source of income for at least five farmers for over 20 years.	3
v) This species is utilized statewide	3
vi) There are more than 100 retail seed outlets statewide	3
Total points (place in worksheet page 8):	13

Section A (from Section II-c)

A1 Can the habitats in which the worst-case ecological impacts occur (items i to v in Section II-a) be clearly defined as different from invaded sites where there are no such impacts (e.g., defined by edaphic or biological factors)? (If ecological impacts include negative effects on a State-listed species, then the specific habitats in which that State-listed species occurs must be clearly distinguishable from habitats in which it does not occur.)

If **NO** then return to Section III (page 4)

If **YES** then Go to question A2 and prepare such a site definition

A2 Can an estimate be made of the maximum distance that propagules (or pollen if hybridization is a concern) might reasonably be expected to disperse?

If **NO** then return to Section III (page 4)

If **YES** then prepare instructions for Specified and Limited Use based on maximum dispersal distance (e.g., may be acceptable for use in specific areas but not near habitats where impacts are high.) Reassess if the incidence of worst-case impacts increases above 10% or within 10 years, whichever is earlier. THEN resume the assessment at Section III to provide scores for the other indices.

Section B (from Section III-c or if Value = High and Impact = Medium)

B1 Are there specific circumstances in which this species could be used that would not be expected to result in escape and invasion? (E.g., foliage plants that are only used indoors and which can be reasonably prevented, by conspicuous labeling, from use or disposal in the landscape.)

If NO, then retain the previously derived Conclusion.

If YES, then Acceptable for Specified and Limited Use where regulations and educational programs for penalties and enforcement of misuse exist.

Reassess this species every 2 years.

Worksheet for Assessment

Section I:

Follow directions to different sections.

Section II :

Impacts Point Total: 16 X (1 or 1.5) = 16 **Impacts**

Section III:

Potential = High Medium or Low 31 **Potential for Expansion**

Section IV:

Difficulty of Management Point Total: 25.5 **Difficulty of Management**

Section V:

Commercial Value Point Total: 13 **Value**

Conversion of Total Score to Rank

Invasive Ranking Summary	Score
Ecological Impacts	16
Potential For Expansion	31
Difficulty of Management	25.5
Total Score:	72.5
	Medium
<i>Rankings: Low < 45, Medium 45 – 80, High > 80</i>	

Assessment History

Original assessment:

Reviewed and updated: 7/24/19 by Ross Miller and Ellen Jacquart.

Reviewed and approved: 10/30/2019 by IPAC (Dawn Slack, Will Drews, David Gorden, Stephanie Schuck, Brenda Howard)

Literature Cited

Glenn, S. and G. Moore. 2009. Invasiveness ranking system for non-native plants of New York: *Wisteria Sinesis*. Unpublished. The Nature Conservancy, Cold Spring Harbor, NY; Brooklyn Botanic Garden, Brooklyn, NY; The Nature Conservancy, Albany, NY.

Lu, S. and Maybury. rev. 2005. *Wisteria sinensis*. U.S. Invasive Species Impact Rank (I-Rank). NatureServe Explorer.

<http://explorer.natureserve.org/servlet/NatureServe?searchName=Wisteria%20sinensis>.

[Accessed on November 12, 2019].

Nature Conservancy. 2008. Weed Notes- *Wisteria sinensis* (Chinese Wisteria), *Wisteria floribunda* (Japanese Wisteria). <https://www.invasive.org/gist/moredocs/wisspp01.pdf> [Accessed on November 12, 2019].

Remaley, T. and J. Swearingen. 1998. Exotic wisterias - *Wisteria sinensis*. Plant Conservation Alliance Alien Plant Working Group (PCA APWG) Weeds Gone Wild Factsheets. <https://www.invasive.org/weedcd/pdfs/wgw/exoticwisterias.pdf> [Accessed December 12, 2019]

Trusty, J.L. et al. 2007. Identity of naturalized exotic *Wisteria* (Fabaceae) in the south-eastern United States. *Weed Research* (Oxford), 47(6):479-487. <http://www.blackwell-synergy.com/loi/wre> [Accessed November 2019]

Valder, P. 1995. *Wisterias: a comprehensive guide*. Timber Press, Portland, OR. 160 pp.

Wang Z; Zhang J; Zhang D, 2011. Screening of plants with N fixation efficiency and high N concentration in leaf litter in Shanghai. *Chinese Landscape Architecture*, 4:20.