August 3, 2005 template version

Assessment of Invasive Species in Indiana's Natural Areas

OFFICIAL Miscanthus (*Miscanthus sinensis* and *Miscanthus x giganteus*) ASSESSMENT

Answers are underlined and in **bold,** comments are inserted in *italics*

Members of 3/23/07 assessment subcommittee: Ellen Jacquart, Phil O'Connor, Ken Collins, Dave Gorden, Jeff Kiefer, Kate Howe

Miscanthus sinensis	**Score**	
Ecological Impacts	33	
Potential for Expansion	22	
Difficulty of Management	17	
Total Score:	**72**	**Medium**
Rankings: Low < 45, Medium 45 – 80, High > 81		

Miscanthus x giganteus	**Score**	
Ecological Impacts	0	
Potential for Expansion	10	
Difficulty of Management	0	
Total Score:	**10**	**Low**
Rankings: Low < 45, Medium 45 – 80, High > 81		

Contents of the Assessment:

Section I – Invasion Status. Determines whether the species being evaluated is invasive in Indiana.
Section II – Ecological Impacts of Invasion. Evaluates the significance of impacts of the species.
Section III – Potential for Expansion. Evaluates the actual and/or potential expansion of the species.
Section IV – Difficulty of Management. Evaluates how hard it is to control the invasive species.
Section V – Commercial Value. Evaluates how valuable the species is economically in Indiana.

Questions in Sections I – V may direct you to one or more of the following sections for particular invasive species:
Section A. For species which have impacts limited to a few sites, assesses the potential for further spread.
Section B. For species which have medium impacts but high value, assesses whether species could be used in specific circumstances that would prevent escape and invasion.

A worksheet for use with the assessment is found on page 9.

Automatic Exemption From the Assessment

Is this species listed on any federal or on an Indiana state noxious, or prohibited plant lists?
If **YES** then do not proceed with assessment but indicate a conclusion of **Do not use this plant** on the front of the response form.

Edited by Alison Clements, Margaret David, Dong Lee, Jacob Krebs, 9/20/2012

If **NO** then go to Section I.

Section I Invasion Status

1-a Current Invasion in Indiana

1. Does this species occur in any natural areas in Indiana?

If NO then go to Section III-c (*Miscanthus x giganteus)*

If **YES** then go to 1-a 2. *(Miscanthus sinensis)*

M. sinensis has moved out of cultivation in golf courses (Indianapolis), power lines (Brown County), and old fields (Big Oaks NWR and an Orange Co. old home site). Overlease et al (2006) notes it moving out of cultivation in four counties – Warrick, Orange, Switzerland, and Pulaski (Overlease et al., 2006). Since these populations are in close proximity to natural areas, it will be assessed in Section II There are no reports of Miscanthus x giganteus moving outside of cultivation in IN; in fact, no one was aware of sites where it has been planted in the state. There simply isn't enough information at this point to complete an assessment for the species. Therefore, Section II will not be filled out. More information is needed for M. x giganteus to determine its invasive potential; it will be given a rank of 'caution'.

2. Does it ONLY occur in natural areas of Indiana because it has persisted from its previous cultivation (e.g., in abandoned farmland or homesteads)?

If **YES** then go to Section III-c.

If **NO** then go to Section 1-b (below). *(Miscanthus sinensis)*

1-b Invasion Status in Indiana

Evidence of invasion (forming self-sustaining and expanding populations within a 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.

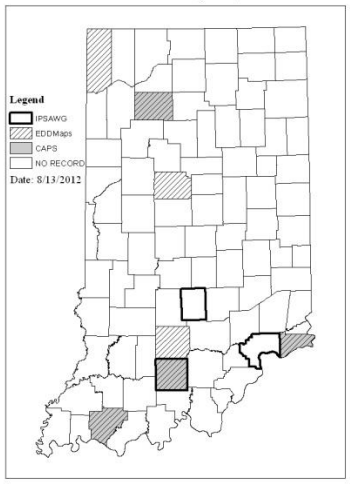
   If **NO** – the species is invasive, go to Section II (below).

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.)

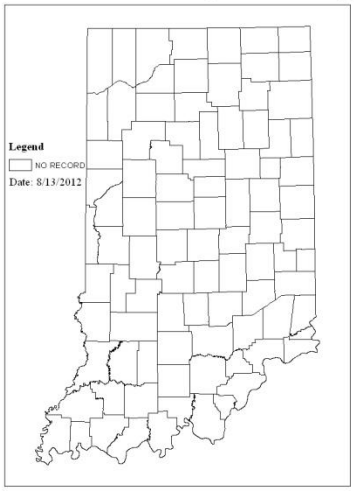
   If **YES** (or unknown) - the species is invasive, go to Section II (below).

   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.

Reported Status of Chinese Silvergrass, Miscanthus sinensis



Reported Status of Giant Miscanthus Hybrid, Miscanthus x gigantea



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 N_2 in low nutrient soil that can change the flora) or the impact (except vi) has been demonstrated in similar habitats in other states. In these cases assign 0.5 points. *Answers are for M. sinensis only.*

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). **15**
Soils under 4-16 years of cultivated Miscanthus on different sites in Europe had greater content of organic carbon and total nitrogen. Also, the cation exchange capacities (CEC) and contents of plant available potassium had increased. Among the physical soil properties, decreases in bulk density as well as increases in porosity and water retention were observed. Once established, can lead to low levels of nitrate leaching and improved groundwater quality. May increase fire frequency and intensity due to large amount of flammable fine fuels produced by dead leaves and stems; burns very hot and very quickly (Taylor in Fellows, 2007). Decreases light availability to those species that may grow below the species near the soil surface.
Sources of information:
Christian & Riche, 1998; Kahle et al., 1999; Hansen et al., 2004; Fellows, 2007

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

No reports of this

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

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**

Large clumping grass that changes the density and significantly increases the height of the herb layer.

Sources of information:

Jacquart's personal observations.

v) Hybridizes with native Indiana plants or commercially-available species. 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 9): **22**

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**) 6 *non-rare habitat-types.*

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 9.

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

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 *M. sin. M x gig.*

a. not observed to complete reproductive cycle	0	**0**
b. observed to complete reproductive cycle	**5**	5

There is great variability in seed production among cultivars of M. sinensis. Meyer (2003) suggests some cultivars (e.g. variegated leaf cultivars) produce less seed, at least when grown in isolation. She also notes that when different Miscanthus cultivars are grown together, they may produce significant amounts of seed (Meyer, 2003). This may be due to self-incompatibility of Miscanthus (USDA-NRCS, 2010). She suggests that ornamental plantings are the likely source of "wild type" Miscanthus due to crossings. Darke (1999) noted that "Ironically, the invasive potential of Miscanthus has been enhanced by horticultural development" as many of the antique cultivars (e.g. 'Gracillimus', 'Variegatus', and 'Zebrinus') require very long, hot seasons to flower and seed. New cultivars, such as 'Graziella' and 'Malepartus' were developed and selected for their ability to flower in short seasons, thus increasing potential for seed production" (Darke, 1999). NRCS - Rose Lake Plant Material Center is studying an unknown cultivar of M. sinensis for use as a vegetative barrier to slow water from farm fields. It will be grown in isolation and also close to fertile Miscanthus to see if it can then produce seed. Planting tests will happen in WV, MO, NY, KS and seed heads will be collected and tested for viability at Rose Lake (USDA-NRCS, 2010). In summary, since clearly the wild type and some cultivars of Miscanthus sinensis can produce seed, (b) is the correct choice.

On the other hand, many accounts of Miscanthus x giganteus note that it is a sterile hybrid, an allopolyploid (Meyer and Tchida 1999, Adati and Shiotani 1962; Greef, Deuter, Jung, and Schondelmaier 1997). Raghu et al. (2006) notes, however, that "allopolyploidy does not guarantee continued sterility" (Raghu et al., 2006). Given current knowledge of the species, (a) is chosen, but there is a recognition that more work is necessary to determine whether this hybrid is truly sterile.

ii. Mode of reproduction .

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

iii. Vegetative reproduction

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

M. sinensis has no vegetative reproduction. M. sacchariflorus, the other parent of Miscanthus x giganteus, has "aggressive spreading rhizomes that form colonies" according to Greenlee (1992). Given that Miscanthus x giganteus is readily propagated from rhizomes commercially, (c) seems reasonable.

iv. Frequency of sexual reproduction for mature plant

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

v. Number of seeds per plant

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

A very large M. sinensis plant could potentially have >1000 seeds, but an average plant would certainly produce 11-1,000 seeds. A study from Japan (cited in Waggy, 2011) found 64-1024 seeds per plant (Hayashi, 1979). Other studies found anywhere from a low of 535to 140,000 seeds per m^2 (Hayashi 1979). See discussion under 2i for more on seed production of both M. sinensis and Miscanthus x giganteus.

vi. Dispersal ability

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

Seed has no special structures (berry, wings, hooks) for long distance dispersal.

vii. Germination requirements

a. requires open soil and disturbance to germinate	0	**0**
b. can germinate in vegetated areas but in a narrow range or in special conditions	**3**	3
c. can germinate in existing vegetation in a wide range of conditions	5	5

Moist, sunny environments are necessary for establishment of M. sinensis (Darke, 1999). Since Miscanthus x giganteus is not known to produce seed, 0 points were assigned.

viii. Competitive ability

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

M. sinensis does fairly well in low nutrient soil and is able to move into sod areas and outcompete other graminoids. However, we have not yet seen it completely dominate areas – instead, scattered three foot tall clumps covering <50% of the field is the norm. This led us to choose (b). Miscanthus x giganteus, due to its height (up to 13 feet) and ability to dominate areas where it grows (one of the reasons it is being promoted as a biofuel is its dense growth form leading to high biomass/acre). This led us to choose (c).

Total points for questions i – viii (place in worksheet page 9): **22** **10**

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. Assign 0.5 point for each statement for which a true/false response is not known. *Answers are for M. sinensis only.*

	Points
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)	
≥ 50% of discrete sites in which this species grows;	10
25% to 50% of discrete sites in which this species grows.	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
iv) Further site restoration is *usually* necessary following plant control to reverse ecosystem impacts and to restore the original habitat-type or to prevent immediate re-colonization of the invader. *Not in our experience.*	5
v) The total area over which management would have to be conducted is: (choose	

one).

≥ 100 acres; 5
< 100 but > 50 acres. 2
< 50 but > 10 acres. **1**
≤10 acres ½

Based on known reports, it is likely there are 10-50 acres infested in Indiana.

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

vii) Occurs in more than 20 discrete sites (e.g., water-basins, parks, fragments of habitats at least 5 miles apart). **3**

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 ¼ mile. **3**

Seeds remain viable over one year; no evidence for viability greater than ten years. According to D. Taylor 2007 "Some varieties appear to be sterile, especially a variety that keys to Miscanthus sinensis var. gracillimus in Hitchcock and Chase (Manual of Grasses)." Sources of information:
FuHsing, 2000; Shang, 2001

ix) Age at first reproduction is within first 10% of likely life-span and/or less than 3 months. *Life span is probably at least 50 years – but it takes a long time for it to mature and produce seeds.* 2

Total points (place in worksheet page 9): **17**

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 Categories
If response is **YES** then go to Section V-b

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.

	Points *M. sin.*	*M x gig*.
i) This species is sold in national or regional retail stores (e.g., WalMart, Home Depot, Publix).	**10**	10
ii) State-wide there are more than 20 commercial growers of this species . *Dave Gorden says this is probably the case for M. sinensis.*	**7**	7
iii) More than five growers in Indiana rely on this species as more than 10% of their production.	3	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	3
v) This species is utilized statewide.	**3**	3
vi) There are more than 100 retail seed outlets statewide	3	3
Total points (place in worksheet page 9):	**20**	0*

**While zero points are assigned based on these criteria, there is increasing use of M. x giganteus as a biofuel in the Midwest and elsewhere.*

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
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
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 for *Miscanthus sinensis*

Section I:
Follow directions to different sections.
Section II:
Impacts Point Total: __22____ X (1.5) = **33** **Impacts**
Section III:
Potential = High Medium or Low **22** **Potential for Expansion**
Section IV:
Difficulty of Management Point Total: **17** **Difficulty of Management**
Section V:
Commercial Value Point Total: **20** **Value**

Worksheet for Assessment of *Miscanthus x giganteus*

Section I:
Follow directions to different sections.
Section II:
Impacts Point Total: _____ X (1 or 1.5) = _____ **Impacts**
Section III:
Potential = High Medium or Low **10** **Potential for Expansion**
Section IV:
Difficulty of Management Point Total: _____ **Difficulty of Management**
Section V:
Commercial Value Point Total: **0** **Value**

Invasive Ranking Summary:

Miscanthus sinensis	**Score**	
Ecological Impacts	33	
Potential for Expansion	22	
Difficulty of Management	17	
Total Score:	**72**	**Medium**
Rankings: Low < 45, Medium 45 – 80, High > 81		

Miscanthus x giganteus	Score	
Ecological Impacts	0	
Potential for Expansion	10	
Difficulty of Management	0	
Total Score:	**10**	**Low**
Rankings: Low < 45, Medium 45 – 80, High > 81		

Literature Cited

Adati, S. and I. Shiotani. 1962 The syntaxonomy of the genus *Miscanthus* and its phylogenetic status. Bull. Fac. Agric. Mie Univ. 25: 1-24.

Darke, R. 1999. The color encyclopedia of ornamental grasses, sedges, rushes, restios, cat-tails and selected bamboos. Timber Press. Portland, OR.

FuHsing, H. 2000. Seed longevity of Miscanthus species. Journal of Taiwan Livestock Research 33(2): 145-153

Greef, J.M., M. Deuter, C. Jung, and J. Schondelmaier. 1997. Genetic Diversity of European *Miscanthus* species revealed by AFLP fingerprinting. Genetic Res. Crop Evol. 44: 185-195.

Greenlee, J. 1992. The encyclopedia or ornamental grasses: how to grow and use over 250 beautiful plants and versatile plants. Rodale Press. Emmaus, PA

Glenn, S. and G. Moore. 2010. Invasiveness ranking system for non-native plants of New York: *Miscanthus sinensis*. Unpublished. The Nature Conservancy, Cold Spring Harbor, NY; Brooklyn Botanic Garden, Brooklyn, NY; The Nature Conservancy, Albany, NY.

Hayashi, I. & Numata, Makoto, (ed.) 1979. Ecology, phytosociology and productivity of grasses and grasslands: The autecology of some grassland species. Ecology of grasslands and bamboolands in the world. Boston: Dr. W. Junk B. V.: 141-152.

Meyer, M. H. and C. L. Tchida. 1999. Miscanthus Anderss. produces viable seed in four USDA hardiness zones. Journal of Environmental Horticulture 17(3): 137-140.

Meyer, M. 2003. Fact Sheet and Management of *Miscanthus sinensis.* University of Minnesota.

Overlease, W. & E. Overlease. 2006. 100 Years of Change in the Distribution of Common Indiana Weeds. Purdue University Press, 270 pp.

Raghu, S., R.C. Anderson., C.C. Daehler., A.S. Davis., R.N. Wiedenmann., D. Simberloff., & R. N. Mack. 2006. Adding biofuels to the invasive species fire? *Science,* 313 (5794):1742

Stewart, J. Ryan; Toma, Yo; Fernandez, Fabian G.; Nishiwaki, Aya; Yamada, Toshihiko; Bollero, German. 2009. The ecology and agronomy of Miscanthus sinensis, a species important to bioenergy crop development, in its native range in Japan: a review. GCB Bioenergy. 1: 126-153.

Shang, G. F. 2001. Characteristics of soil seed bank and seedling bank of shrubland in Tiantong Range, Zhejiang Province. Acta Bot. Yunnanica. 23: 209-215.

Taylor, David. 2007. TNC Invasive Species Listserve Digest #152, Nov. 21, 2007. dtaylor@fs.fed.us

United States Department of Agriculture – Natural Resources Conservation Service. 2010. Cross Pollination Potential of PMC Miscanthus Grass (*Miscanthus sinensis* Andersson). (Study no: MIPMC-T-0704-CP). USDA-NRCS Rose Lake Plant Materials Center. East Lansing, MI.

Waggy, M. 2011. Miscanthus sinensis. In: Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). <http://www.fs.fed.us/database/feis/> [Accessed on Jun 15, 2012].

Glossary

***Anthropogenic disturbance*.** Human-induced disturbance (e.g., mowing) or human-induced changes in natural disturbance regime (e.g., changing the frequency, extent, or severity of fires).

Coverage. Visual or quantitative estimate of the relative amount of area in a stratum where the canopy of the non-native species intercepts the light that would otherwise be available for other species in or below that stratum. Estimated cover may be dispersed or continuous in a site. Cover is usually measured when foliage is fully expanded. In the case of species that form a dense, continuous mat of rhizomes or stolons, the percent of the soil surface or upper level occupied by that root mat can be estimated as soil, rather than canopy, cover.

***Disturbance*.** Mechanisms that limit biomass by causing its partial or total destruction.

Discrete sites. Disjunct habitat-types or fragments of habitats at least 1 mile apart that support invasive plant populations that likely arose by separate long-distance dispersal mechanisms.

Documentation of evidence. One publication including relevant, original research will suffice if data are specific to the taxon and zone(s) under evaluation. If such documentation is not available or needs to be up-dated, at least three individuals who have the expertise on the particular species and zone in question must be identified.

Federal- or Indiana -listed. Species that are listed by Federal laws or Indiana statutes or rules as threatened or endangered within the State of Indiana. This list with notes is available at http://www.state.in.us/dnr/naturepr/endanger/plant.htm

Formal Risk Benefit Analysis. Detailed economic studies of impact and management costs and commercial value for present and future infestations.

Invasive. A species that forms self-sustaining and expanding populations within a natural plant community with which it had not previously been associated (Vitousek *et al*. 1995).

Long-term alterations in ecosystem processes. Examples of ecosystem processes that could be altered: erosion and sedimentation rates; land elevation; water channels; water-holding capacity; water-table depth; surface flow patterns; rates of nutrient mineralization or immobilization; soil or water chemistry; and type, frequency, intensity, or duration of disturbance. For further explanation see Gordon (1998).

Native. Species within its natural range or natural zone of dispersal (i.e., within the range it could have, or would have, occupied without direct or indirect introduction and/or care by humans. Excludes species descended from domesticated ancestors) (Vitousek *et al*. 1995).

Natural areas. Natural areas: Areas with native plant communities supporting native plant and animal species, with long undisturbed soil systems, and hydrological regimes relatively intact or under restoration. Edges of historically or currently disturbed areas (roadsides, trails, adjacent to historically disturbed locations, etc.) should not be included in the assessment of invasion into natural areas. That invasion may have been facilitated by the edges, but has to have extended into the native communities for inclusion in this category.

Pollen or genetic invasion. When a native species is displaced by a non-native species through hybridization.

Stratum. A distinct layer in the architecture of vegetation (e.g., tree canopy or understory shrubs).