August 3, 2005 template version

Assessment of Invasive Species in Indiana's Natural Areas

OFFICIAL Norway Maple (*Acer platanoides*) ASSESSMENT

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

Members of 5/25/07 assessment subcommittee: Ellen Jacquart (TNC), Hilary Cox (Leescapes Garden Design), Kate Howe (Midwest Invasive Plant Network)

Invasive Ranking Summary	**Score**	
Ecological Impacts	43	
Potential For Expansion	28	
Difficulty of Management	25	
Total Score:	**96**	**High**
Rankings: Low < 45, Medium 45 – 80, High > 80		

Contents of the Assessment:

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 10.

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.

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

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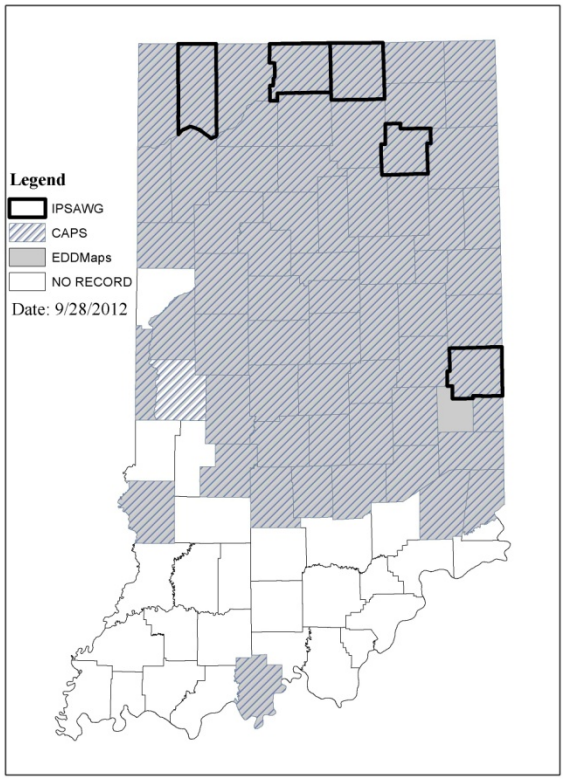
1-b <u>Invasion Status in Indiana</u>

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

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 to assess the species' potential for future invasion.

Reported Status of Norway Maple, Acer platanoides



Section II Ecological Impacts of Invasion Impact Index

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

Add up points for ALL impact statements (i through vi) that are true at the <u>worst affected site(s)</u> 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 states. In these cases assign 0.5 points.

Five survey reports from natural areas in four counties (Whitley, Elkhart, Porter, and St. Joseph) with 1-3 sites for each report – total of 8 sites.

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**

From Gomez-Aparicio and Canham, 2008 - "Our results showed that Norway maple and tree of heaven alter the functioning of temperate forest ecosystems even at relatively low densities by increasing cycling rates (i.e., net N mineralization, net nitrification, Ca mineralization) and nutrient availability (i.e., pH, Ca, Mg, K, N). At the neighborhood scale, the spatial extent of the impact of the two species varied strikingly among soil properties. Moreover, the neighborhood effects of the two invasive species were site dependent, with the magnitude of the impact increasing with soil fertility. At the community level, Norway maple and to a lesser extent tree of heaven had stronger effect on soils than any of the dominant native tree species considered. We conclude that the invasion of northeastern forests by Norway maple and tree of heaven is characterized by predictable, neighborhood-specific acceleration of nutrient cycling rates and localized increases in nutrient pools. These ecosystem alterations have enormous potential for the modification of competitive hierarchies in forest communities. In particular, Norway maple and tree of heaven may change relative abundances within the native community."

Good evidence trees cast heavier shade than native tree species (e.g., Acer rubrum, oaks) thus significantly decreasing light availability. It has been reported that it has been planted to reduce erosion in areas that are prone to erosion (Love, 2003), but not clear how that should be scored. In contrast, Donnelly suggests that erosion would be worse under Norway maple because of bare soil beneath the stand, thus leading to water quality problems. Fang (unpub.) measured higher rates of nitrification in soil beneath Norway Maple in Muttontown Preserve, Nassau County, which resulted in 80% of soil N being in the nitrate form, which can readily leach from the soil (unlike ammonium N). Fang's unpublished work needs to be verified in other locations. Fellows (2004) reports insignificant effects to ecosystem processes but the reference cited, Randall & Marinelli, 1996, does not address this issue in detail. Soil density may be increased, need sources or verification.

Sources of information: Donnelly, CIPWG undated; Abbey, 2000;Love, 2003; Fellows, 2004; Fang 2005; Fang unpublished; Swearingen et al., 2002; Weber, 2003; Gomez-Aparicio and Canham, 2008.

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**
Impacting Valerianella chemopodofolia at one site, which is >20% of known locations for this species.

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

Oftentimes will increase the density in the existing (tree) layer. It can also tolerate poor soils and extreme temperatures and thus leads to the creation of a new (tree) layer where one might not have developed (or at least not as fast) were succession left to native species. Norway maple also suppresses the understory and reduces or eliminates the shrub and herb layer, and saplings of native tree species.

Sources of information: Webb & Kaunzinger, 1993; Wyckoff & Webb, 1996; Webb et al., 2000;
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Love, 2003; Bertin et al., 2005; Reinhart et al. 2005; Martin & Marks, 2006; Galbraith-Kent & Handel. 2008.

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.

Two sites >50% cover that are 1-5 acres and one that is 10-20 acres – using midpoints that is 20 acres impacted. **12**

Reduces species richness and biodiversity, suppresses growth of saplings of native tree species, suppresses or eliminates native shrub and herb species, and may facilitate growth of non-native plants.
Sources of information:
Webb & Kaunzinger, 1993; Webb et al., 2000; Wyckoff & Webb 1996; Love, 2003; Reinhart et al. 2005; Fang 2005; Galbraith-Kent & Handel, 2008.

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**

Oftentimes will increase the density in the existing (tree) layer. It can also tolerate poor soils and extreme temperatures and thus leads to the creation of a new (tree) layer where one might not have developed (or at least not as fast) were succession left to native species.
Species serves as a preferential host of Asian long-horned beetle (Anoplophora glabripennis), and other pest insect species. Large stands of Norway maple support high populations of these insect pests, which then can lead to infestations on less preferred native tree species. Fang's unpublished work on altered nitrification suggests the possibility of impacts on soil microbial populations, but needs confirmation.
Sources of information:
Gilman & Watson, 2003; Love, 2003; Fellows 2004; Fang unpublished; Webb & Kaunzinger, 1993; Wyckoff & Webb, 1996; Webb et al., 2000;

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 10): **43**

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*

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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**) *Three common habitats = 3.*

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.

Plants that spread after introduction to new habitats can become problematic invaders, transforming the landscape and displacing or diminishing native plant populations (Elton, 1958; Williams, 1980; Baker, 1986; Groves, 1986; Mooney and Drake,1987 as cited in Webb & Kaunzinger, 1993). Although agricultural lands and remote islands are most susceptible to invasion (Elton, 1958; Baker, 1986; Orians, 1986; Usher, 1988 as cited in Webb & Kaunzinger, 1993), even continental forests can be invaded by exotic plant. (Drake, 1988 as cited in Webb & Kaunzinger, 1993)

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.
   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**

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

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

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**

v. Number of seeds per plant

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

Copious production of viable seeds (Webb & Kaunzinger, 1993; Webb et al., 2000; Fellows, 2004; Meiners, 2005; Reinhart et al., 2005).

vi. Dispersal ability

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

Per Matlack 1987 (Amer. J. Bot. 74(8):1150-1160) , mean lateral movement of Norway maple propagules in still air = .14 m. In a 10 km/hr breeze, = 50 m. For a wind-dispersed tree, this is a fairly large distance but still not what we would characterize as long-distance.

Seeds mainly fall within short distance from parent trees (less than 100 meters), but there is potential for long distance dispersal (100+ m.) by wind or water (Love, 2003; Fellows, 2004; Bertin et al., 2005; Invasive Species
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Specialist Group, 2006; author of New York Assessment (Moore's) personal observations).

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**

Experience in Indiana shows it is able to establish in full shade with no soil disturbance (Ellen Jacquart, Rich Dunbar).

viii. Competitive ability

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

Total points for questions i – viii (place in worksheet page 10): **28**

Ability to grow on infertile soils, fast growth, shade tolerant, perennial. Allelopathy has been suspected but research indicates it is absent or minimal (Rich, 2004).
Sources of information:
Love, 2003; Fellows, 2004; Bertin et al., 2005; Invasive Species Specialist Group, 2006; Meiners, 2005; Reinhart et al., 2005; Webb et al., 2000 & 2001; Webster et al. 2005; Wyckoff & Webb 1996; author of New York Assessment (Moore's) personal observations).
Norway maple is significantly more shade tolerant than sugar maple, allowing it to out-compete the native maple for light. It has also been suggested that Norway maple is allelopathic based on almost complete absence flora under it in the forest. Specifically, Epifagus appears unable to exist under Norway maple (Wyckoff and Webb, 2007, pg 203). Also, it has been suggested herbivory is less on this species due to milky latex sap (Wyckoff and Webb, 2007, pg 203). This combines to give Norway maple a strong competitive advantage in forest understories.

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.

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**

Individual stems are relatively easy to treat and mature stems are easily identifiable. However, it can be difficult to distinguish Norway maple from sugar maple at the seedling stage, requiring treatment of all small maples to eradicate the invader.

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**

Control costs would vary greatly by the age of the Norway maples to be treated. The

Indiana reports are of approx. 5-15 year old invasions and therefore estimates on control costs used this age invasion as an example. At that age, trees are 10-20 feet tall, and a 50% infestation of such trees would result in large amounts of downed wood to dispose of. This would greatly increase the cost/acre of treatment.

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. 5

The reports we've gotten are primarily of scattered individuals in natural areas; no further site restoration is necessary after control in such cases. In denser infestations, further site restoration would probably be necessary due to lack of seed sources nearby.

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 7 infestation sites reported

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**

Per Overlease et al 2002 it is reproducing outside of cultivation in 62 counties in Indiana.

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**

ix) Age at first reproduction is within first 10% of likely life-span and/or less than 3 months.

We estimate Norway maples can reach 200 years old. Bertin et al 2005 (J. Torrey Bot. Soc. 132(2), pp. 225-235) found that 30-40 year old Norway maples in forests were still pre-reproductive. Therefore we don't believe they reproduce within the first 10% of likely life span. 2

Total points (place in worksheet page 10): **25**

Large stands always present in disturbed landscapes, usually with other invasive species present. May be a function of time, with age, occurrences in natural areas may become dense stands.

Sources of information: Webb & Kaunzinger, 1993; Webb et al., 2000 & 2001; Fellows, 2004;

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
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 10):	**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

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

Section I:
Follow directions to different sections.
Section II:
Impacts Point Total: **39** X (1 or 1.5) = **43** **Impacts**
Section III:
Potential = High Medium or Low **28** **Potential for Expansion**
Section IV:
Difficulty of Management Point Total: **25** **Difficulty of Management**
Section V:
Commercial Value Point Total: **13** **Value**

Invasive Ranking Summary:

Invasive Ranking Summary	**Score**	
Ecological Impacts	43	
Potential For Expansion	28	
Difficulty of Management	25	
Total Score:	**96**	**High**
Rankings: Low < 45, Medium 45 – 80, High > 80		

Discussion-

While Norway maple has been used widely as a landscaping plant in the Midwest for several decades, it is only in the last several years that reports of invasion have occurred in Indiana. We attribute this at least in part to the long generation time of Norway maple, reportedly 30-40 years before seed is produced. On the east coast, there are significantly more and larger sites reported as invaded by Norway maple. This may be because it has been used more widely and for longer in landscaping there than in the Midwest.

Based on comments, reports, and photos sent in from around the state (a summary of this information is attached to the end of this report) it appears that Norway maple is just starting to invade forests in the northern part of the state. Most of the invasions are less than 15 years old but are already dominating the forest understory in a few cases.

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While many cultivars of Norway maple are produced, Dirr (Manual of Woody Landscape Plants,1998) notes that cultivars are budded on seedling understocks. That is, genetically identical cuttings are grafted onto the straight species stock. Therefore, should the cv. scion die, the straight species may express itself from the stock.

Also per Dirr, Norway maple is an "over-used and probably over-rated tree…species has escaped and in pockets is out-competing the native flora".

There is no data on differential reproduction among cultivars. That, combined with the fact that the cultivars are grafted onto the straight species, gives us no basis for recommending any specific cultivars that might be less invasive than the parent species.

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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).