United States Department of Agriculture

Forest Service

Northern Research Station

Eastern Region

Northeastern Area State & Private Forestry

NA-TP-05-04

Reprinted July 2007

Invasive Plants Field and Reference Guide:

An Ecological Perspective of Plant Invaders of Forests and Woodlands

Cover photograph: *Berberis thunbergii* invading a disturbed forest (C. Huebner).

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An Ecological Perspective of Plant Invaders of Forests and Woodlands

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www.na.fs.fed.us

This reprint incorporates Supplement 1, July 1006.

INTRODUCTION

Purpose of This Field Guide:

There are many field guides available about invasive plants and their identification. The purpose of this particular field guide is to give a scientific synthesis of what is known about the behavior of such species in managed, disturbed, and pristine forested systems in addition to key information for accurate identification. Such information will be helpful when prioritizing research questions and choosing the best control strategies. Control methods for each species are not provided. The most successful control methods are most often site-specific; over-generalizing control methods might lead to poor management and frustrating outcomes. This is not to say that the information that is available should not be used; this guide just could not do it justice and still achieve its primary goals.

Four Goals:

1. While there is a great deal of publicly available information about many invasive plants, much of this information lacks corresponding citations for verification. The first goal of this guide is to help provide such information, using mostly peer-reviewed scientific publications and other primary sources. If information about a species provided in other guides or Web pages could not be verified by such sources, it was not included in the species description. As research and information about each species improve and increase in volume, it is likely that some of the research synthesis will need to be organized for each species in a separate reference book that will accompany this guide in the future.
2. Despite the scientific nature of Goal 1, the second goal is to make this guide accessible to a variety of people, including private landowners and managers as well as researchers. We do this by providing simple, cursory descriptions that can then be read about in more detail (if desired) using the corresponding citations. A glossary is provided to help explain some of the more botanical terms and phrases that could not be avoided.

3. The third goal is to emphasize the dynamic nature of invasions and science. Species will be added and updated on an annual basis. Because this can become quite costly in terms of complete hardcopy publications, new species will be provided on an individual basis rather than by printing new field guides annually.
4. The last goal is to provide a useful, true-to-form field guide that can be used extensively in field situations. This requires that the guide be small and weatherproof. In addition, not every species included will necessarily be of interest to each user at a given point in time, which is why we chose to have removable pages. This also allows one to easily add new pages to their guidebook, ordering one or many new pages at a time as they become available.

A Collaborative Effort:

The USDA Forest Service recognizes that the threat of invasive plant species to public and private forests is serious and that successful progress in prevention, control, research, and restoration from the negative impacts of such invasions is only possible using a concerted and organized effort. Thus, the Forest Service-Eastern Region (Region 9), the Northeastern Area (NA) State and Private Forestry, and the Northern Research Station have joined forces to put this guide together for the public. This guide would not have been possible without the guidance and funding provided by Nancy Berlin (Region 9) and several Region 9 botanists (see Acknowledgments) as well as Don Dagnan and Noel Schneeberger (NA State and Private Forestry).

This is a work in progress; information and comments from the users of this guide are very welcome.

Guide Organization:

This guide contains 15 species (see list after the Introduction) that are potential invaders of forests and woodlands. Such invaders pose a threat by invading forests of various ages, ranging from a recently harvested forest or woodland to an old-growth forest. New species will be added using a prioritized list of 50 species, which will likely grow in number. Currently, the next 15 species to

be included (in alphabetical order) are *Akebia quinata*, *Ampelopsis brevipedunculata*, *Cirsium arvense*, *Coronilla varia*, *Euonymus alatus*, *Euonymus fortunei*, *Euphorbia esula*, *Hesperis matronalis*, *Ligustrum obtusifolium*, *Lonicera morrowii*, *Rumex acetosella*, *Ranunculus ficaria*, *Rhamnus frangula*, *Vinca minor*, and *Vincetoxicum nigrum*.

Because this guide is dynamic in terms of new additions over time, there are no page numbers. Instead, this guide is organized by habit type (herb, vine, shrub, or tree) and then alphabetically by scientific name, making it easy to insert new species as they become available. A list of species by both scientific and common name is provided in this current guide and will be updated as new species are added. Notification of new species syntheses will be posted on the Web pages of the Northeastern Area State and Private Forestry, Forest Service-Eastern Region (Region 9), and Northern Research Station. You may also request to be placed on a list for such notifications by contacting Cynthia Huebner at chuebner@fs.fed.us.

Within each species description, the more common Latin synonyms are provided, but are not comprehensive. Also, the Natural Resources Conservation Service species code, which is commonly used by Forest Inventory and Analysis and other organizations, is also provided. Citations, which are referenced in the text with small numbers, are listed in the back (after the glossary) by habit and by species' Latin names. The order of the numbers in the descriptions reflects source importance.

Acknowledgments:

We greatly appreciate the comments of the following Region 9 botanists/ecologists: Marquita Sheehan, Erin Larson, April Moore, Harry Pawelczyk, Kirk Larson, Ian Shackleford, Jan Schultz, Jack Greenlee, and Mary Beth Deller. William McWilliams (Forest Inventory and Analysis) also provided useful comments and support for the project. We also thank Michelle Frank and Rick Turcotte (NA State and Private Forestry) for their comments and Victoria Evans, Nancy Lough, Sandy Fosbroke, Juliette Watts and Patty Dougherty (NA State and Private Forestry) for editing, layout, and printing of the guide.

CORRECTIONS

There are two corrections or clarifications concerning the original guide that should be addressed:

1. The mid-vein of *Microstegium vimineum* (Japanese stilt grass) is described as having hairs (which is in the literature). However, the hairs must be very difficult to see, if they indeed exist. Either way, we do not think this is a useful description for this species.
2. The fruit picture for *Rosa multiflora* (multiflora rose), which was borrowed from www.forestryimages.org, may be inaccurate. A closer look shows that the stipule in this picture may not be divided, which would mean these fruit belong to a different, native rose species. *Rosa multiflora* fruit may be somewhat glandular, but the picture below is a more accurate description of the fruit. The picture on www.forestryimages.org has since been replaced.

Photographer:
James H. Miller
(USDA Forest Service);
www.forestryimages.org.

Also, new literature and research has been published on a few of the first 15 species, but we have decided to wait one more year for new expected findings before updating any summaries. Thus, next year, we will have five new species and re-writes of three to five of the first 15 species.

Again, we welcome any comments that you may have concerning this guidebook and we thank all involved in making it possible (see original Acknowledgments), with special thanks to Noel Schneeberger, Nancy Berlin, Juliette Watts, Patty Dougherty, Don Dagnan, and Jan Schulze.

Species List

By Scientific Name

Herbs

Alliaria petiolata – Garlic mustard
* *Cirsium arvense* – Canada thistle
Fallopia japonica – Japanese knotweed
Heracleum mantegazzianum – Giant hogweed
Microstegium vimineum – Japanese stilt grass
* *Ranunculus ficaria* – Lesser celandine
* *Rumex acetosella* – Sheep sorrel

Vines

Celastrus orbiculatus – oriental bittersweet
* *Cynanchum louiseae* – black swallow-wort
Lonicera japonica – Japanese honeysuckle
Polygonum perfoliatum – mile-a-minute weed
Pueraria montana var. *lobata* – kudzu vine

Shrubs

Berberis thunbergii – Japanese barberry
Elaeagnus umbellata – Autumn olive
* *Euonymus alatus* – Winged burning bush
Lonicera maackii – Amur honeysuckle, bush honeysuckle
Rhamnus cathartica – Common buckthorn
Rosa multiflora – Multiflora rose

Trees

Acer platanoides – Norway maple
Ailanthus altissima – Tree of heaven

* Denotes new species added by Supplement 1, July 2006.

Species List

By Common Name

Herbs

***** Canada thistle – *Cirsium arvense*
Garlic mustard – *Alliaria petiolata*
Giant hogweed – *Heracleum mantegazzianum*
Japanese knotweed – *Fallopia japonica*
Japanese stilt grass – *Microstegium vimineum*
* Lesser celandine – *Ranunculus ficaria*
* Sheep sorrel – *Rumex acetosella*

Vines

* Black swallow-wort – *Cynanchum louiseae*
Japanese honeysuckle – *Lonicera japonica*
Kudzu vine – *Pueraria montana* var. *lobata*
Mile-a-minute weed – *Polygonum perfoliatum*
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Autumn olive – *Elaeagnus umbellata*
Common buckthorn – *Rhamnus cathartica*
Japanese barberry – *Berberis thunbergii*
Multiflora rose – *Rosa multiflora*
* Winged burning bush – *Euonymus alatus*

Trees

Norway maple – *Acer platanoides*
Tree of heaven – *Ailanthus altissima*

* Denotes new species added by Supplement 1, July 2006.

GARLIC MUSTARD
[*Alliaria petiolata* (M. Bieb.) Cavara & Grande*; A. officinalis* Andrz.]
ALPE4

UGA0580063

Habit: Erect, shade-tolerant,[4] biennial herb.[8]

Reproduction: By seed;[8] preferentially outcrosses but may self.[6]

Leaves: Lower leaves kidney shaped with palmate venation, 2-12 cm (¾ to 4¾ in) long, arranged in a basal rosette that forms the first year and persists through winter; upper leaves alternate, triangular, toothed.[15,8,4,7]

Stems: Up to about 1 m (3 ft); one flowering stem per rosette, but up to six;[4,17] may branch.[8,4,7]

Flowers: Second year; numerous; 5-7 mm (¼ in) in diameter, white, 4-petaled; mostly in a cluster at the top of the stalk but may occur in leaf axils;[8,4] bloom late April-June;[15,8] open from bottom to top; remain open for 2-3 days, but produce nectar primarily in day 1; pollinated by medium-sized, short-tongued bees and flies, which visit one or two flowers per plant.[6]

Fruits/Seeds: As many as 3,000 seeds per plant; seeds dark brown to black,[8,4] enclosed in long (4-7 cm; 1½-2¾ in), narrow capsules (siliques);[8,7] dispersed in late summer; cold stratification required to break dormancy;[2,10] germination best in dark, moist conditions and lower temperatures (1-5°C; 34-41°F); small seed banks are formed; large, persistent seed banks unlikely due to high germination rates[2] but may be more likely in drier conditions;[3] germinants do not compete well with second-year rosettes;[2,11] animal and water dispersed.[4]

GARLIC MUSTARD

UGA2307232

Alliaria petiolata (M. Bieb.) Cavara & Grande

Habitat: Native to Europe; first U.S. introduction in 1868;[12] in upland or floodplain forest, savannas, roadsides, trail edges, and disturbed areas; shady, mesic areas with alkaline soils[3,18] but found in high light, xeric areas with acidic soils.[3,1]

Comments: Nutritious;[9] rare native butterfly oviposits on it but larvae cannot feed;[13] herbivory defenses increase with wounding; levels vary among populations;[5] allelopathic impact documented,[14] possibly via effect on native plant mycorrhizae.[16]

Similar Native Species: Basal leaves of *Thaspium, Zizia, Senecio, Viola* spp; similar fruiting structures with several other mustards.[8]

CANADA THISTLE

[*Cirsium arvense* (L.) Scop.; *Carduus arvensis* (L.) Robson; *Cirsium setosum* (Willd.) Bess. ex Bieb.]

CIAR4

Habit: Herbaceous, clonal perennial up to 2 m (6 ½ ft) tall with a deep, creeping root system[16,11,9] that initially grows horizontally but eventually turns downward and grows 1 m (3 ft) or more; plants may be connected up to 12 m (39 ft) apart[3].

Reproduction: By seed[11, 9], root suckering[11,9,16,13], detached root fragments[13], and, less likely, stem segments[6]; imperfectly dioecious (11-15% in native range are hermaphrodites); seed set for selfed hermaphrodites low compared to out-crossed individuals[13]; progeny sex ratio biased towards females, but males abundant in the field[15].

Leaves: Alternate; oblong to lanceolate; glabrous to short-woolly on both surfaces (more so beneath) with spiny margin; most cauline leaves sessile, slightly decurrent with the stem[10,9]; shape varies, wavy-pinnatifid lobing or merely toothed[10].

Stems: Essentially glabrous[10], grooved[22], and very leafy[9,10].

Flowers: Heads discoid; ovoid-cylindric; clustered[10,9] in an open, branched inflorescence; involucre (leafy, weakly spine-tipped bracts enclosing multiple flowers) 2 cm (¾ in) high or less[20]; pinkish-purplish, occasionally white; plumose pappus[10]; female flower pappus surpasses corollas, but male corollas surpass their pappus[11]; female flowers insect pollinated mostly within 50 m (164 ft) of male plants; receptive for about 3 days, longer with low pollen amounts[15]; 14-16 hours of light needed to flower; may flower within one growing season; June-October[9,6].

HERB

CANADA THISTLE


Cirsium arvense (L.) Scop.

Fruits/Seeds: Achene (2.5-4 mm, 1/16-1/8 in) abortion rate high; larger achenes produced when pollen is limiting[15]; may produce 50 seeds per head[13] and 5300 seeds per plant; younger seeds germinate best in high light; most seed germinates the first year (seed bank unlikely)[6]; 2-year old stored seed has a 90% germination rate; 5-year old seed does not germinate[4]; cold stratification required[2]; long-distance wind dispersal possible but rare; pappus separates from achene early[18]; August-October[6].

Habitat: Native to Europe, Western Asia, Northern Africa[1]; likely introduced to U.S. in the 1600's in contaminated hay or seed; U.S. distribution primarily above 37° N latitude; growth limited by temperatures greater than 30°C (86°F); open areas, roadsides, streambanks, clearcuts, forest openings, and wet grasslands[18]; seedlings under 20% or less full sunlight do not survive; root grows 5-10 cm (2-4 in) before shoot emerges[6].

Comments: Small patches have high extinction rates[7]; genetic diversity high compared to other clonal species[21]; population growth more likely via new clone establishment than growth of existing clones[12]; not competitive against perennial nonnative grasses[8,1]; allelopathic properties demonstrated[6]; seed predation and herbivory by native and nonnative insects high but with minimal impacts[6,5]; biological control unlikely due to many native congeners[19]; negative impacts on native thistles by released exotic weevils documented[17]; rust fungus, *Puccinia punctiformis*, may be specific to this thistle[14].

Similar Native Species: Swamp thistle (*C. muticum*), biennial with larger flowering heads; spring thistle (*C. carolinianum*), biennial with fewer, narrower cauline leaves and fewer flowers[11].

JAPANESE KNOTWEED

[*Fallopia japonica* (Houtt.) Ronse Decraene; *Polygonum cuspidatum* Sieb. & Zucc.; *Reynoutria japonica* Houtt.]

POCU6

UGA1237056

Habit: Perennial, herbaceous shrub 3 m (10 ft) or taller;[8,20,21,7] shoots survive one season; rhizomes survive decades; circular clonal stands formed in native habitat, senescing centrally.[1]

Reproduction: Primarily vegetatively via rhizome or shoot fragments;[4,19,7,3] by seed;[8,20,6,7] dioecious;[8,6] or gynodioecious;[3,7] viable, fertile hybrid (*F.* x *bohemica*) result of cross with *F. sachalinensis* (also non-native and invasive).[11,3]

Leaves: Simple and alternate; broadly ovate, 8-15 cm long, 5-12 cm wide (3⅛-6 in x 2-4¾ in), with abruptly pointed tip, truncate base;[8,6] stipule (ocrea), a tubular, membranous sheath.[6,3]

Stems: Round, sometimes ridged,[8] glaucous, often mottled;[6] hollow internodes[7] with swollen nodes.[20,6]

Flowers: Mid-late summer; small (2-3 mm or ⅛ in),[3] greenish-white,[20,8,6] 1,000s/plant;[7] narrow inflorescences at middle/upper nodes;[20,8,6] fly and bee pollinated; copious nectar,[3] from which bees produce a dark, quality honey.[2,17]

Fruits/Seeds: Fruits 3-winged, 8-9 mm or ¼-⅜ in; seeds (3-4 mm or ⅛ in) dark, glossy;[8,20,6] germination rate 61-95% in light and room temperature; no apparent cold stratification requirement;[7] wind,[13] possibly water dispersed (like rhizome and shoot fragments); at least one bird species eats the seeds.[3]

HERB

JAPANESE KNOTWEED

Fallopia japonica (Houtt.) Ronse Decraene

Habitat: Native to Asia; introduced to the U.S. in the mid-late 1800s;[7] disturbed and riparian areas, roadsides, woodlands; shade intolerant;[3] native substrate volcanic[14] with low pH; grows in a variety of pH levels and soil types; preference for wet habitats;[3] seedling survival dependent on water; adults tolerate drier conditions;[13] USDA hardiness zones 4-8.[5]

Comments: Tetraploid, hexaploid, or octoploid;[12] polyploidy may increase genetic diversity;[10] translocates N to radial clones until clones take up own N;[1] most N in roots if N is limiting;[9] C remobilized to rhizomes prior to shoot senescence;[18] treatment for skin disorders, hepatitis, inflammations, natural estrogen substitute;[15] exudes large quantity of guttation fluid;[16] grazed by sheep, cattle, horses; *F. japonica* var. *compactum* also escapes.[3]

Similar Native Species: Virginia knotweed (*P. virginianum*); not a shrub; ocreae with bristles; inflorescence a slender spike.[8,20]

GIANT HOGWEED

[*Heracleum mantegazzianum* Sommier & Levier.]

HEMA17

UGA1460060

Habit: Biennial or perennial herb with a deep (40-65 cm or 16-26 in), branching tap root;[9] blooms once then dies (monocarpic);[4,9] some perennials have survived after flowering.[9]

Reproduction: By seed; cut stems may re-sprout; self-compatible, outcrossing, protandrous hermaphrodite.[9]

Leaves: Alternate;[4,8,9] up to 3 m (10 ft) long, three-parted and pinnate;[4] pubescent beneath;[8] petiole base enlarged, surrounding the stem;[4] upper leaves become gradually smaller.[8]

Stems: Often purple-mottled, 2-5 m (7-16 ft) tall, up to 10 cm (4 in) in diameter; hollow and ridged.[4, 8, 9]

Flowers: Compound umbel up to 1.5 m (5 ft) in diameter with 50 to 150 rays; white ;[4,9] most plants flower in third or fourth year;[2,9] June-August;[8,9] pollinated by a variety of insects, mostly bees and flies; self-pollination may occur between different umbels.[5,9]

Fruits/Seeds: Fruit elliptic, ridged, and winged, 8-15 mm (⅜-⅝ in) in length on elongate stalks; splits in half, each half with one seed; shed August-October;[4,8,9] over 100,000 seeds per plant possible;[9] water, wind, or human dispersed, mostly within 10 m (33 ft) of mother plant;[2,6,9] germination appears to require moisture and cold stratification[7,9] and will occur in light or dark; viability ranges between 2-15 years.[9]

GIANT HOGWEED

UGA1151039

Heracleum mantegazzianum Sommier & Levier.

Habitat: Native to southwestern Asia;[9] introduced as an ornamental;[2] waste places, roadsides, disturbed woodlands, and streambanks;[2,8] may invade a range of habitats,[3,10] but possible preference for open, mesic, and seasonally cold environments.[7,9]

Comments: Sap has secondary compounds (furanocoumarins) that may cause blistering and rashes on humans, with sun exposure;[3,9] some of the same substances inhibit insect herbivory by generalists but specialist insect herbivory is common;[1] cattle, sheep, goat, pig, mollusc, and snail grazing are common; fungal pathogens are noted;[9] an *H. mantegazzianum* x *H. sphondylium* (native to UK) hybrid with low fertility is rare in the UK.[5,6]

Similar Native Species: Cow-parsnip (*H. lanatum*); flower usually has only 15-30 rays and stem reaches only 3 m (10 ft).[4]

JAPANESE STILT GRASS

[*Microstegium vimineum* (Trin.) A. Camus; *Andropogon vimineus* Trin.; *Eulalia viminea* (Trin.) Kuntze]

MIVI

UGA2308020

Habit: Reclining, loosely branching annual to 1 m (3 ft).[16,8, 6,11]

Reproduction: By seed;[6,16, 8] may root at lower nodes.[10]

Leaves: Mid-vein of leaf blade offset from center; a line of silvery hairs runs down the mid-vein on upper surface; lanceolate, tapering at both ends, 5-10 mm (¼-⅜ in) wide, 3-8 cm (1⅛-3 3/16 in) long; pale green; leaf sheath collars with ciliate hairs.[16, 8,14]

Stems: Reclining and branching; nodes glabrous and slightly swollen.[6,8,14]

Flowers: Late summer/early fall; terminal spike-like, branching inflorescence up to 7 cm (2¾ in) long with paired, hairy spikelets; in one variety, one spikelet is awned; another variety both are awnless;[5] may have both cleistogamous and chasmogamous flowers;[18] chasmogamous flowers associated with populations in high light[1] and under water stress;[7] shade populations primarily cleistogamous; potentially highly selfed;[7] flowering plants tend to be larger than non-flowering plants.[7]

Fruits/Seeds: Ellipsoid grain 2.8-3.0 mm (⅛ in) long; abundant seed production may occur infrequently;[7] seed bank of at least 3 years;[1,7] seeds mature and are dispersed in late fall[16] when they appear to be dormant; cold stratification may be required for germination;[7] water and animal dispersed.[14]

JAPANESE STILT GRASS

UGA2308019

UGA2308028

Microstegium vimineum (Trin.) A. Camus

Habitat: Native to tropical Asia;[17,16,8] introduced into the U.S. in 1919;[5] shade tolerant;[19] preference for shady areas (closed canopy forests, especially riparian areas) but found in high light areas (roadsides, ditches, forest borders, and fields);[15] possible preference for bare ground, disturbed and acidic soil.[1,20, 11,15]

Comments: C_4 photosynthesis;[19,2,3] may acquire more light energy using sun flecks;[9] has a lower capacity to photosynthesize in high light;[19] forms a thick thatch of litter, which may prevent establishment of natives and itself;[7] may alter soil conditions to its benefit by increasing pH, nitrification, and nitrate;[1,4] association with non-native earthworms possibly due to increased litter decomposition or an agricultural connection.[12,13]

Similar Native Species: *Leersia virginica*; has hairy nodes, is a perennial, and flowers earlier.[14]

LESSER CELANDINE

[*Ranunculus ficaria* L.;*Ficaria verna* Huds; *F. ranunculoides* Moench]

RAFI

UGA0581057

Habit: Erect (diploid type) to reclining (tetraploid type), perennial herb and geophyte[11,14]; 30 cm (12 in) or less in height[14,6,5,11]; spring ephemeral[13,7].

Reproduction: By seed and vegetatively by tuberous, adventitious roots; clonal; usually hermaphroditic[14].

Leaves: Long-petioled with sheathing bases[14]; blade 5-50 mm (3⁄16-2 in) long and wide, fleshy, glabrous, shiny, dark green[5,14], sometimes with whitish mottling or black blotches[14]; cordate to oblong cordate, shape variable; entire, toothed, or wavy margin[6,5,11]; rosette of 2-4 basal leaves; 1-2 pairs of opposite, cauline leaves may have some lobing[14].

Stems: Glabrous and fleshy[5,14]; short internodes[6]; aerial bulblets may be at each node, usually in tetraploids; may branch[14]; first developmental stem is a spear shoot (one apparent cotyledon; the second is enclosed in the first)[12].

Flowers: Terminal and solitary on each stem, 2-3 cm (~1 in) diameter; 3-4 green sepals that fall off early; 8-12 bright, shining (on inside), yellow petals that fade to white; 5-72 stamens and carpels[14]; nectar produced; pollinators include short-tongued insects (bees, small beetles, and flies); flowering more likely on plants with large tubers and under high light[14]; March-May[14,3].

Fruits/Seeds: Fruit a beakless, glabrous or pubescent achene (2.5-4 mm; 1-1.5 in long)[2,6,5,11]; 10-15 achenes per flower[2]; about 60% of all diploid seed is viable; about 2% of tetraploid seed is viable due to low pollen viability; germinate in both light and dark; warm then cold stratification required; germination optimal at 5°C or 11°C (day)/4°C or 9°C (night) (41°F or 52°F/39°F or 48°F)[14,1]; seed bank undocumented; evidence for dispersal by deer (in excrement) in native environment[8]; May to early June[14].

LESSER CELANDINE

UGA0581056

UGA2308044

Ranunculus ficaria L.

Habitat: Introduced from Europe (Norway/Russia to the Mediterranean/Portugal)[14] to eastern U.S. in the mid 1700's[3]; shade-tolerant; flowers and fruits before forest leaf-out[12]; tolerates dry conditions, but prefers wetter conditions in the spring; often associated with seasonally wet sites; possible preference for alkaline soils; in native England, most common in mixed deciduous forests; diploid is associated with undisturbed, deciduous woodlands and permanent pastures; tetraploid is associated with disturbed ground[14]; vegetative growth less susceptible to dry conditions than flowering plants[17].

Comments: Plants with larger tubers develop more rapidly; vesicular-arbuscular mycorrhizal association present[14]; at least 9 cultivars[7]; possibly 100 varieties and 5 subspecies[4], 2 of which appear to predominate—var. or ssp. *ficaria* (diploid) and var. or ssp. *bulbifer* (tetraploid)[9,14]; fragmentation of root tubers results in extensive vegetative propagation[14]; used medicinally as an anti-inflammatory, astringent, and antibiotic,[16] but documented to cause acute hepatitis[13]; contains several flavonoid compounds[15]; documented reduction of its population in areas of increased soil acidification over 30 years[10].

Similar Native Species: Marsh marigold (*Caltha palustris*), multiple flowers per stem, flowers petaloid (petal-like sepals only), fruit a follicle, stems hollow, leaves larger and lighter green[6].

SHEEP SORREL

[*Rumex acetosella* L.; *Acetosella acetosella* (L.) Small; *Acetosella tenuifolia* (Wallr.) A. Löve]

RUAC3

Habit: Perennial herb up to 40 cm (16 in) in height[16]; male plants shorter than female plants[27].

Reproduction: By seed[13,35] and vegetatively by root sprouts producing clones[23]; dioecious[16,13,35]; most genet populations at a 1:1 sex ratio, ramet populations often female-biased[33,28].

Leaves: Hastate with 2 divergent basal lobes or linear-spatulate[16,13,35]; primarily a basal rosette with some alternate and petioled, cauline leaves of the same shape[35]; glaucous-green, thin with a bitter and slightly acid taste[27].

Stems: Erect or bending[35].

Flowers: Inflorescence a panicle of small, reddish yellow-green flowers[35,43] on jointed pedicels[13]; male plants flower first[28]; tendency for a greater overall allocation of resources to vegetative propagation in older (4 years or older) populations[9,8,7]; wind pollinated[27]; May-Sept[43].

Fruits/Seeds: Fruit a triangular achene[13]; fruit may require scarification; seeds tend not to germinate the first year[27]; warm stratification required; optimum germination at 15°C (59°F) or a fluctuating 20/30°C (68/86°F); germination rates higher in light[4,44,2]; adding heat (~80-100°C; 176-212°F), and drying then wetting increases germination; fire[17]and nitrogen addition may promote germination[19]; potential seed bank of 5[36,18,19] to 26 years[15,29]; less viable seed production as plants age[9]; June-Oct[13].

SHEEP SORREL

Rumex acetosella L.

Habitat: Native to Eurasia; preference for disturbed, open habitats[31] (plants smaller), but found in forest gaps[10] and closed canopy forests (plants larger)[12]; its fossil pollen deposits used as a disturbance or human-settlement indicator[30,34,40]; preference for acidic soils high in exchangeable phosphate[41]; calcifuge; unable to solubilize phosphate and iron[42,39]; avoids Al^{3+} toxicity by exuding oxalic acid[37]; distribution associated with N deposition[3]; typically non-mycorrhizal[13,14]; population may increase if soil symbiotic fungi decrease[32]; more competitive in areas with high light and nutrients[10]; sensitive to flooding[1] but drought tolerant[11]; males more drought-tolerant than females, depending on age[46,20,21].

Comments: North American (NA) populations primarily hexaploids[12] (subspecies *angiocarpus*); diploids, tetraploids and octoploids also found; genetic variation high, but NA populations less diverse than European populations[26]; ovaries, stamens, seed and pollen increase in size as ploidy level increases; hybridization between the ploidy types occurs but offspring usually sterile[27]; not palatable to livestock[6]; females initially smaller than males but often equal or larger at the end of the growing season[33;24]; males have higher reproductive cost than females at certain stages[28]; but overall cost to females is higher[25]; females respond more rapidly and positively to rich environments[20]; associated with appreciable amounts of nitrogen-fixation, presumably by rhizosphere bacteria[38]; cytokinins may trigger femaleness[5,22]; resource translocation among ramets unlikely[23]; documented 50% reduction in yield of a strawberry crop in sites with *R. acetosella* present[45].

Similar Native Species: Wild sorrel *(R. hastatulus*), but achene has wing-like valves; arrowhead violet (*Viola sagittata*), but leaves all basal and flowers violet-purple[16].

ORIENTAL BITTERSWEET
[*Celastrus orbiculatus* Thunb.]
CEOR7

UGA0016241

Habit: Deciduous, woody, twining vine.[6]

Reproduction: By seed and vegetatively[6] by root suckering;[3] dioecious; some perfect;[6] some plants monoecious.[8,3]

Leaves: Alternate, entire leaves with shallow teeth; shape variable but most often less than twice as long (5-12.5 cm; 2-5 in) as wide, round with an abruptly pointed tip.[6,2]

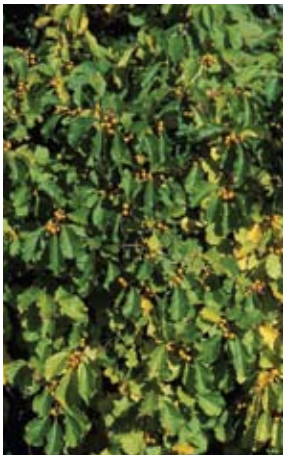
Stems: Light brown;[2] may reach up to 5-10 cm (2-4 in) in diameter and up to 18 m (59 ft) long;[2,9,4] may impact host species by reducing photosynthesis and causing structural damage.[3,11]

Flowers: Short, axillary inflorescences with only a few flowers (whitish-greenish); each inflorescence subtended by a leaf longer than the inflorescence;[6] May-June;[15] insect or wind pollinated.[1,21]

Fruits/Seeds: Fruit, adjacent to a vegetative bud, matures late summer/early fall, often remaining on the vines through winter; most fall to the ground by early winter;[7] yellowish outer skin covers a red, fleshy aril containing 3-6 seeds;[3] dispersal by humans, birds (131 m; 430 ft),[16] or small mammals;[3] most often ingested in winter; defleshed seeds have higher germination rates than scarified (due to ingestion) seeds;[7] no apparent seed bank.[19]

VINE

ORIENTAL BITTERSWEET



UGA0016097

UGA2307125

Celastrus orbiculatus Thunb.

Habitat: Native to Japan, China, and Korea; not a forest species in native habitat;[17] introduced into the U.S. in 1860;[7] open areas; early/late-successional forests;[3,17] USDA hardiness zones 4-7.[2]

Comments: "Sit and wait" strategy of invasion; germinates best in shade, but prolific growth may not take place without light;[7,13] hybridizes with the native *C. scandens*, producing a sparingly fertile hybrid[20] that is more vigorous than the native;[14] very low root pressure, but conducts water at rates equal to native vines with high root pressure; despite evident embolism, keeps leaves for ~1 month after first frost; greater rates of secondary growth than a native grape species;[18] may facilitate grape vine growth;[5] evidence of medicinal properties for rheumatoid arthritis[12] and reversing cancer cell resistance to treatment drugs.[10]

Similar Native Species: Bittersweet (*C. scandens*); leaves tend to be more than twice as long as wide; inflorescences terminal and not next to a vegetative bud.[8,15]

BLACK SWALLOW-WORT
[*Cynanchum louiseae* Kartesz & Gandhi; *Cynanchum nigrum* (L.) Moench.; *Vincetoxicum nigrum* (L) Moench.]
CYLO11

Habit: Herbaceous milkweed; perennial, twining, and climbing vine[9,16,8]; clonal[13]; tissue produces milky juice when broken[9,16,8].

Reproduction: By seed[9,13] and deep (50 cm, 19½ in) rhizomes; monoecious[18,5]; selfing occurs but fewer viable fruit produced[13,6].

Leaves: Opposite, entire, oblong to ovate, 5-10 cm (2-4 in) long; acuminate; round or subcordate base; petiole short[16,9,8,3]; glabrous, but veins and margin may have short curved hairs[15].

UGA1237104

Stems: Glabrous or with short curved hairs[15]; twining[13]; diploid and tetraploid races exist[17]; height typically 1-2 m (3-6½ ft)[13].

Flowers: Small (6-8 mm, ½ -5⁄16 in) 6-10 in an umbel-like cyme (central flower blooms first)[9,16,13]; cymes located at every node except the bottom 3-4[13]; corolla purple-black, 5 fleshy lobes with tiny hairs[9,16]; corona (outgrowths of tissue from corolla base) inconspicuous[9]; peduncles 1-3 cm (7⁄16 -1 3⁄16 in) long[17]; remain open 6-8 days; nectar smells of rotting fruit, strongest mid-day; pollinated primarily by flies[13]; May-Sept[16,9].

Fruits/Seeds: Fruit a smooth, slender follicle 4-7 cm (1 5⁄16 -2¾ in) long[16,9,13]; peduncles 1-3 cm (7⁄16-1 3⁄16 in) long[17]; each follicle contains many comose (tufts of long silky hairs) seeds, released in the fall after the fruit splits lengthwise; primarily wind dispersed[13,9] with most seed falling within a few meters of the parent plant[2]; seeds have multiple embryos (polyembryonic) that produce multiple seedlings[17,5]; seed viability of selfed flowers and open-pollinated flowers not significantly different; no dormancy period or stratification required; germination rates range between 30-50%; seed bank not confirmed; seeds germinate in spring or fall[13]; seed production lower in shaded sites[5,18].

VINE

BLACK SWALLOW-WORT

UGA05800011

Cynanchum louiseae Kartesz & Gandhi

Habitat: Introduced from southwestern (Mediterranean) Europe[13], earliest records in U.S. from Ipswich, MA in 1854; disturbed areas, roadsides, fence rows, old fields, barrens, and woodlands; preference for calcareous soils[17]; tolerates a wide range of soil moisture and full sun and closed canopy forests; forms monospecific populations under all light conditions[5].

Comments: The related nonnative *C. rossicum* and *C. vincetoxicum* may be invasive; *C. vincetoxicum* (yellowish, white flowers), native to Eurasia[9,12], is less common; *C. rossicum*, from Ukraine and Russia, is most abundant in the lower Great Lakes Basin[17]; *C. rossicum* (lighter colored flowers and longer peduncles[17]) forms monospecific populations, but can not spread by rhizomes[1]; *C. rossicum* reduces arbuscular mycorrizal fungi activity[10], perhaps due to allelopathic effects,[1] and its germination rates are as high as 72% with 71-100% survival[11]; monarch butterfly oviposits eggs on *C. louiseae* or *C. rossicum*, but prefers its native host plant[6,14]; monarch larvae that attempt to feed on *C. louiseae* or *C. rossicum* are unlikely to survive[14] ; presence of both species reduces invertebrate and vertebrate diversity in infested areas[5,7].

Similar Native Species: Sandvine (*C. laeve*), leaves cordate, smaller flowers white to green, corona lobes evident and erect; maroon Carolina milkvine (*Matelea carolinensis*), leaves cordate, flowers larger, fruit covered in small, sharp projections[9,3].

JAPANESE HONEYSUCKLE
[*Lonicera japonica* Thunb.]
LOJA

UGA2307154

Habit: Perennial, semi-evergreen to evergreen[9,3,5] vine that trails or climbs to 7 m (23 ft).[15]

Reproduction: Vegetatively; stem cuttings;[1] by seed;[12,21,11,3,30] may be pollinator limited;[1,16,5,22] obligatory outcrosser.[16]

Leaves: Opposite, entire, oblong, 4-8 cm (1½-3⅛ in); base round/triangular; may have lobes or teeth; lower surface often lighter green than upper; surfaces may have a few hairs. [9,15,5]

Stems: Young stems pubescent, reddish/light-brown;[9,15,12] climber internodes shorter in length than those of trailers.[28]

Flowers: May-June;[15,21,16] white-cream-pink,[15,12] yellows with age;[21,15] 2.5-3.8 cm (1-1½ in), 2 reflexed lips; stamens extend beyond lips; paired at each node;[15] fragrant,[19] tubular, pubescent inside[11] with glandular hairs bearing nectar;[22] open at dusk, maximizing visits from diurnal (bees) and nocturnal (moths) pollinators; nocturnal pollinators disperse pollen further;[19] may be best adapted for hawkmoths,[16,20] which are attracted to rhythmic linalool emission (highest first midnight of 2-day flowering period[20]); diurnal pollinators remove more pollen but with less efficiency than hawkmoths.[19]

VINE

JAPANESE HONEYSUCKLE

UGA2308104

UGA2307155

Lonicera japonica Thunb.

Fruits/Seeds: September-October;[15,21] black, glossy fruit 0.6 cm (¼ in) long[15,12] with 4-10 brown-black seeds;[15] viability may be low;[13] dispersed by deer, rabbits, bobwhites, turkeys,[10] and other birds.[15]

Habitat: Woods, fields, disturbed areas, roadsides, bottomlands, and fence rows;[12, 21, 27] tolerates shade but most growth in full sun; rarely flowers in low light;[23] not as shade tolerant as some native vines;[4] sensitive to dry conditions;[2] responds positively to an increase in CO_2;[24] USDA hardiness zones 4-9.[9]

Comments: Native to E. Asia;[12] introduced into the U.S. in mid 1800s [17,26] for horticultural purposes and soil stabilization;[15] negative impacts (lower leaf N, photosynthesis, growth) on a native host all primarily due to root competition;[6,7,8] diploid; less genetic diversity than *L. sempervirens* (tetraploid, native vine);[25] greater annual carbon gain than this native;[27] forage for deer,[31,29] but this native preferred; herbivory increases growth;[26] anti-inflammatory[18] and antibacterial/viral properties;[14] 6 cultivars.[9]

Similar Native Species: *L. sempervirens*; leaves glaucous (both surfaces), flowers terminal, and connate terminal leaves.[12,21]

MILE-A-MINUTE WEED

[*Polygonum perfoliatum* L.; *Ampelygonum perfoliatum* (L.) Roberty & Vautier; *Tracaulon perfoliatum* (L.) Greene[9]]

POPE10

UGA1237070

Habit: Annual, shallow and fibrous-rooted, climbing vine[4,15] to 6-8 m (20-26 ft);[10,15] may behave as a perennial (with a tap root) in subtropical climates.[12,15]

Reproduction: By seed;[12] perennials may root at the nodes.[15]

Leaves: Alternate, simple, entire, glaucous, and glabrous; with recurved prickles on lower veins and petioles;[5] triangular in shape and bright to pale green in color (sometimes reddish when young); 3-8 cm (1 3/16-3 3/16 in) long and 5-9 cm (2-3½ in) wide; peltate with the petiole;[3,4] sheathing stipule (ocrea) at petiole base encircles the stem (perfoliate).[4,3,9,2,12]

Stems: Wiry, slender, and armed with small, recurved prickles;[2,8] climbing or reclining on other plants;[12] becoming reddish with age.[8,15]

Flowers: Small (1.5 mm or 1/16 in);[15] 10-15 in terminal or axillary spike-like racemes 1-2 cm (⅜-¾ in) long; perfect, greenish-white to pink;[4,12] bloom early summer to fall.[6,5]

Fruits/Seeds: Round, shiny, black achene;[12,15] perianth

MILE-A-MINUTE WEED

UGA0581048

UGA0002111

Polygonum perfoliatum L.

3-5 mm (⅛-¼ in), persistent, thickening to a fleshy, berry-like, iridescent blue covering;[4,12] water, bird, small mammal, and human dispersed;[12,15,6] buoyant;[2,12] dispersed July-November;[9,12] germination mid-March to April;[6] cold stratification may be required in colder environments[1,8] but detrimental in warmer areas; scarification may promote germination;[8] persistent seed bank for at least 3 years.[13]

Habitat: Native to E. Asia;[2,4,6] introduced into the U.S. in 1890s[10] near Portland, OR, with no local spread;[13] found in Pennsylvania in the mid 1930s; along streams, in flood plains,[12] roadsides, disturbed sites (harvested forests), and open woodlands;[7,11] possible preference for moist soils.[5]

Comments: Easily spread in nursery stock;[5] relatively shade tolerant compared to native congeners;[5] performs better in open areas;[9] numerous native insects feed on it with little effect.[9,14]

Similar Native Species: *P. sagittatum* and *P. arifolium*; leaves not glaucous, peltate, or triangular and ocreae not perfoliate.[5,11,12]

KUDZU VINE

[*Pueraria montana* (Lour.) Merr. var. *lobata* (Willd.) Maesen & Almeida; *P. lobata* (Willd.) Ohwi.] PUMOL

UGA0016124

Habit: Perennial, twining vine[2] that trails or climbs to 30 m (98 ft);[10,5,19] legume (with nitrogen-fixing bacteria).[9]

Reproduction: Tubers, root suckers,[15] and runners that root at the nodes;[8,15] by seed;[8,10,5] successful seed production rare in cold climates;[19,16] stem cutting propagation not successful.[16]

Leaves: Alternate, trifoliate, up to 18 cm (7-8 in) long with long petioles; dark green and a pubescent underside; leaflets with smooth or lobed margin; middle leaflet usually with three lobes and equal base; side leaves 1-2 lobes and unequal bases.[19,10, 5]

Stems: Up to 2.5 cm (1 in) diameter (some 10 cm (4 in));[15] brownish; young stems with tan/bronze hairs;[10,19,5,15] may grow 30 cm (12 in)/day; die back in fall/winter;[15] some overwinter.[28]

Flowers: In leaf axils in elongate, branching racemes to 20 cm (8 in) long; up to 2.5 cm (1 in) wide; papilionaceous, reddish-purple, upper petal base yellow;[4,15] grape-scented odor;[10,19,5,15] May-November on vertically growing plants[8] in direct sunlight.[15]

KUDZU VINE

UGA2307164

UGA2307165

Pueraria montana (Lour.) Merr. var. *lobata* (Willd.) Maesen & Almeida

Fruits/Seeds: Early/late fall; flat, pubescent pod 4-5 cm (1½-2 in) long;[10,15] seeds kidney shaped, 3-4 mm (⅛-3⁄16 in);[30] germination at 15-35°C (59-95°F), in light or darkness, and best after scarification[24] (mechanical[27] or sulfuric acid[25]); cold stratification not required;[25] mammal and bird dispersed.[8]

Habitat: Native to China, E. Asia;[11,19] introduced into the U.S. in late 1800s;[11] forest edges, roadsides, old fields, and disturbed areas; shade intolerant,[2] but found in forests;[6,7] not tolerant of cold;[3] tolerant of compacted, nutrient-poor soils,[26] though P is limiting;[14] older plants with deep roots are more drought tolerant;[23] positive growth response to increasing CO_2.[21]

Comments: Uses include erosion control,[19,15] feed,[14,4] fiber,[29] ornamental,[11] starch,[1] and treatment for alcoholism,[18,13] colds, asthma, diarrhea, fever, and anemia;[23] used to improve soil in South American humid tropics;[20] high genetic diversity in the U.S.;[17] continental U.S. has this variety; *P. montana* var. *chinensis* is in Hawaii; variety hybridization occurs;[12] isoprene emission possible ozone source;[22] shading reduces root growth.[9]

Similar Native Species: *Dioclea multiflora*; fruit 2-winged along upper suture; flower smaller.[10]

JAPANESE BARBERRY
[*Berberis thunbergii* DC.]
BETH

UGA0580076

Habit: Spiny, deciduous shrub, to 2.5 m (8 ft) tall and wide.[7,2,10]

Reproduction: By seed;[7] cut stumps and stems;[2,16] may self or cross.[2]

Leaves: Alternate, simple, entire, spatulate, 1.3-2 cm (½-¾ in) long; bright green above, lighter below;[2,7,6] in clusters at each node;[2,10] fall color red to purple depending on the cultivar.[2]

Stems: Numerous, reddish-brown, angled or grooved, glabrous, usually with stiff, short, single spines 1.3 cm (½ in) long at the nodes;[2,17] older stems gray; inner bark yellow;[17,10] may be replaced every few years.[16,4]

Flowers: Small, perfect, 6 yellow petals, stalked; 1-4 in umbel-like clusters at the nodes; April–May;[7,2,10] nectaries located on both sides of the 6 stamens, which have a tripping mechanism; the first visit removes over 50% of the sticky pollen;[11] pollinated by bees.[12]

Fruits/Seeds: Early to late summer; bright red, dry, oblong to rounded berry 1-1.3 cm (⅜-½ in); 1 seeded;[6,10,7] may remain on the shrubs through winter;[2] production highest in high-intermediate light levels;[16] cold stratification and alternating temperatures improve germination;[1,14,16] over 90% of fruit falls within 1 m (3 ft) of each shrub but has been mapped as far as 80 m (262 ft); dispersed by birds (not a preferred food[16]), deer, turkey, and grouse;[3] fruit removal may be highest in low light.[16]

JAPANESE BARBERRY

Berberis thunbergii DC.

Habitat: Introduced into the U.S. between 1864-1879[2,16] from Japan; full sun to full shade; most soil types and habitats; dry ridgetops to wetlands and roadsides to closed canopy forests.[13,4]

Comments: Growth minimal in low light; survival of seedlings drops from 90% in intermediate-high light to 40% in low light, but survivors persist; leafs out before canopy and retains leaves after canopy leaf fall;[16] deer herbivory minimal,[3] but severe winter damage from rabbits;[18] mortality of stems or shrubs not related to population density;[4,16] at least 47 cultivars;[2] may alter soil conditions to its benefit by increasing pH, nitrification, and nitrate;[5] association with non-native earthworms possibly due to increased litter decomposition or an agricultural connection.[8,9]

Similar Native Species: American barberry (*B. canadensis*); toothed leaves and usually 3-pronged spines.[15]

AUTUMN OLIVE
[*Elaeagnus umbellata* Thunb.]
ELUM

Habit: Deciduous, shrub or small tree up to 6 m (20 ft) tall and up to 9 m (30 ft) wide;[8,13,12,4] nitrogen-fixing actinorhizal (by the actinomycete *Frankia*[9]) root nodules present.[15]

Reproduction: Primarily by seed;[8] propagation by stump sprouting, by roots, and, for the Ellagood cultivar, by cuttings.[16]

Leaves: Alternate, simple, oval, entire and wavy; gray-green, silvery scaly beneath, with a shimmering appearance;[12,8,13] young leaves may be silvery on both sides.[4]

Stems: Twigs silvery or golden brown; often thorny[12,8,13] with brownish scales, giving a speckled appearance.[4,12]

Flowers: Clusters of 1-8 in leaf axils; fragrant, tubular, cream to light yellow;[12] April-June;[12,8,13] exterior silvery-scaly; 4 petals and stamens.[13,12]

Fruits/Seeds: Fruit 6-8 mm (¼ in), fleshy, silvery with brown scales when immature, ripening to a speckled red[12,8,13] or yellow;[6] September-November;[13,12] edible (bitter to semi-sweet);[12] one seeded;[8,12,13] dispersed by birds (not preferentially eaten[14]) and water;[11] fruit high in lycopene;[6] cold stratification improves germination; optimal germination at alternating temperatures of 20-30/10°C (68-86/50° F);[1] persistent seed bank possible (seeds of *E. angustifolia*, a related non-native species, remain viable for 3 years in the lab and have a dormancy period[10]); one study found that despite relative abundance of the species (compared to 31 years ago), *E. umbellata* seeds were not in the seed bank.[3]

AUTUMN OLIVE

UGA0016045

UGA0016043

Elaeagnus umbellata Thunb.

Habitat: Native to Asia; open woods, forest edges, roadsides, riparian areas, fence rows, meadows, pastures, sand dunes, mine spoils, other disturbed areas;[12,13,3,14,11] possibly shade tolerant; tolerant of infertile and dry soils;[5] acidic soils may reduce survival of seedlings;[2] USDA hardiness zones 4-8.[4]

Comments: At least 5 cultivars;[16] increases soil nitrogen, which may be beneficial to black walnut[7] or have a negative impact by increasing invasion of other exotics or by changing ecosystem properties, neither of which is confirmed for this species yet.

Similar Native Species: Silver-berry (*E. commutata*); but thornless with egg-shaped, shorter leaves that are silver-brown and scaly on both sides.[8]

WINGED BURNING BUSH
[*Euonymus alatus* (Thunb.) Sieb.]
EUAL13

UGA2307066

Habit: Shrub typically to 2.5 m (8 ft)[10,20] or possibly 7 m (23 ft) and equal in spread[15,5]; size depends on cultivar of which there are at least 10[5].

Reproduction: By seed[10,20,15] and stem cuttings, success greater with the addition of the plant hormone IBA[3,5,21]; possibly by root suckers[18], though not confirmed in horticultural literature.

Leaves: Opposite, subsessile, elliptic to obovate, to 8 cm (3 7/16 in) long, sharply serrulate; upper surface dark green, turning bright red in autumn; deciduous[10,15,20]; may be downy beneath[15,5].

Stems: Opposite with 2-4 conspicuous corky wings[10,5,20,15] that run the length of the stem[21] and apparently serve no function[2]; corky wings may not be present or as pronounced on the 'Compactus' cultivar[4].

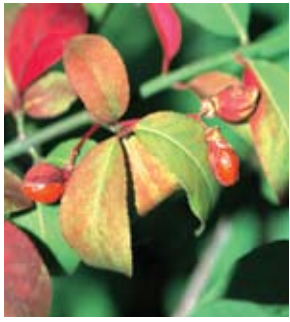
Flowers: Small, 6-8 mm (~¼ in) wide, inconspicuous yellow-green flowers with four petals; April to June[15,5]; stamens are opposite the petals and very short[10].

Fruits/Seeds: Fruit smooth, purplish; 1-4-lobed capsule[10,15]; 3-5 locules with 1-6 seeds per locule; fruit matures September-October at which time the fruit lobes split revealing the orange aril[15,10,20], releasing seeds through January[18]; cold moist stratification of the seeds is required for 1-3 months[5]; seeds are dispersed by birds[5].

SHRUB

WINGED BURNING BUSH

UGA2307068



UGA2307067

Euonymus alatus (Thunb.) Sieb.

Habitat: Indigenous to northeastern Asia and central China[10,20,5]; escaped cultivation and established in open areas, such as prairies[1] and woodlands[6,19,8,9, 5, 7]; appears to prefer sunny conditions, though it does well in deep shade with no effect on fall's red foliage; prefers well-drained soils but is sensitive to drought; USDA plant hardiness zones 4-9[5], with a possible preference for the more northern of these zones due to dormancy requirements[12].

Comments: Used extensively in ornamental plantings; the 'Compatus' cultivar is among the most popular[5,4]; tends to grow slowly and in short spurts[5]; may dominate the understory of mature forests[6]; possible medicinal properties include cytotoxic activity against tumor cells[14,17] and treatment against stomach aches[11]; a few pathogens, such as two-spotted-mites[16,5] and nematodes may minimally affect it[5]; dieback may be caused by the fungus *Whetzelinia sclerotiorum*; overwintering host of the bean aphid (*Aphis fabae*)[22].

Similar Native Species: Wahoo (*E. atropurpureus*), autumn leaf color is yellow; strawberry bush (*E. americanus*), flowers are numerous[10].

AMUR HONEYSUCKLE

[*Lonicera maackii* (Rupr.) Herder; *L. maackii* (Rupr.) Maxim.]

LOMA6

UGA2307091

Habit: Deciduous shrub up to 5 m (16 ft) tall and wide.[6,12,5,19,16]

Reproduction: By seed; main stem may re-sprout; cut young stems and bare roots may root.[6,5,22]

Leaves: Opposite, inverted egg-shaped; broadest in middle, tapering at both ends, 3.5-8.5 cm (1½-3½ in) long, tip abruptly pointed; petiole short, pubescent;[6,12,19] margin entire, fringed with hairs; upper surface dark green, paler below; both surfaces have hairs on the veins;[6,12,2] leaf-out before most woody deciduous species;[12] senescence later than several species.[4]

Stems: Grayish-brown, with short hairs on young stems; broad ridges and grooves appearing striped on older stems; internodes hollow; nodes and young stems may have white-tan pith.[12,5]

Flowers: Usually two at a node; 15-20 mm (½-¾ in) long;[6,12] May-June; on 5- to 8-year-old plants;[3] white, aging to yellow;[6,12,19] flower stems shorter than leaf petioles;[12,19] two lipped, anthers longer than the lips;[12] nectar mostly sucrose, attracting primarily bees; ~21,000 flowers/shrub, ~34 g sugar/day/shrub.[21]

SHRUB

AMUR HONEYSUCKLE

UGA0016079

UGA1237033

Lonicera maackii (Rupr.) Herder

Fruits/Seeds: Bright red at maturity in late summer-fall;[19,12] pulpy berry with 1-6 seeds (pers. obs.); may require cold, warm, or no stratification; optimal germination at 25 or 15°C (77 or 59°F) in light;[1,9] 54-81% germinate in warm, moist conditions in light (30-55% in dark); seed bank unlikely;[15,14] bird dispersed; the lipid-poor fruit not preferred;[11,23] small mammals consume seeds despite bitter seed coat; not a significant part of diet.[24,25]

Habitat: Native to Eurasia; introduced into the U.S. late 1850s;[5,13] urban areas, old fields, flood plains, upland/lowland forests (early-late successional), disturbed ground, wood edges, and roadsides;[12,19] USDA hardiness zones 3-8.[5]

Comments: Stratification inconsistencies may be cultivar-dependent (rem-red requires cold; cling-red does not);[22] higher growth rates and fitness in high light;[10,14,17,13] removal tests show increased survival/fecundity of associated natives;[8,7,18] American robins preferentially nest in *L. maackii* despite higher predation rates (nests are lower) compared to native shrubs.[20]

Similar Native Species: *L. canadensis;* smaller; flowers not strongly bilabiate; leaves not abruptly pointed.[6]

COMMON BUCKTHORN
[*Rhamnus cathartica* L.]
RHCA3

Habit: Deciduous shrub or tree to 8 m (26 ft) and as wide.[7,17,4,3]

Reproduction: Primarily by seed; may sucker from base; dioecious.[7,17,4]

Leaves: Elliptic to oblong/obovate, 3-7 cm (1¼-2¾ in); twice as long as wide; pinnately veined, lateral veins curving upward;[7,14,17] opposite, some alternate, often abruptly pointed with rounded teeth (each bearing a gland[14,18]) on the margin;[7,17] upper surface dark green, lower light green;[7,14,3] yellow/brown in fall;[3,8] downy beneath if young;[8] early leaf-out,[9] late senescence; leaf lifespan exceeds that of native shrubs by 58 days.[9,1,3]

Stems: Branches opposite (or nearly) at right angles to trunk;[8] some twigs end in a short thorn;[7,17,8,3,14] grayish/yellowish-brown, glabrous;[3,14] trunk becomes scaly with age.[18,14]

Flowers: Male 2-6 per cluster with 4 yellowish-greenish petals and sepals, 4 stamens; female 2-15 per cluster, usually without petals, if present, linear and yellowish-brown, 4 vestigial stamens, 4 green sepals shorter than those in the male;[14,7,8] April-June;[14] appear with the leaves;[7,17] females at a 6 to 1 ratio to males; honey-scented; calyx tube with nectarial lining; insect pollinated (bees and flies).[8]

SHRUB

COMMON BUCKTHORN

Rhamnus cathartica L.

Fruits/Seeds: Glossy black at maturity in late summer/early fall; fruit 0.5 cm (¼ in) in diameter; drupe contains 3-4 seeds;[8,4,7,3,17] cold stratification may[2] or may not[1] be required; optimal germination at 20 or 30°C (68 or 86°F);[2] most fruit falls beneath females; bird dispersed, but not preferred (even in native habitat);[8] seedling establishment more likely on ground with little herb cover;[6] dormancy and seed bank still unclear.[1,13]

Habitat: Native of Eurasia; introduced into the U.S. in 1880s;[21,1] on calcareous soils in native habitat;[8,1] open/shaded areas, roadsides, woodlands, riverbanks (not flooded[5]), pastures,[1,12,17,19] and mature forests;[9] tolerates various soil conditions.[1]

Comments: An alternate host for oat crown/leaf rust[15] and an overwintering host of soybean aphid;[20,16] early leaf-out more important than late senescence for carbon gain;[9] growth rates higher in light;[10] leaves decompose more rapidly than some natives and are high in nitrogen;[11] USDA hardiness zones 3-7.[3]

Similar Native Species: *R. caroliniana*; flowers perfect and in parts of 5; leaves alternate.[7,17]

MULTIFLORA ROSE
[*Rosa multiflora* Thunb.]
ROMU

UGA0016092

Habit: Perennial, deciduous shrub up to 5 m (16 ft) and as wide; long, slender, arching branches.[11,16,15]

Reproduction: By seed; stem sprouts,[11,16] shallow root sprouts, and layering (rooting cane tips that touch the ground);[23] colonial;[16] may self-fertilize or outcross (also with other roses, i.e., *R. wichuraiana* (non-native tetraploid)); male-donor-tetraploid crosses have larger fruit, more seeds.[17]

Leaves: Alternate, pinnately compound with 5-11 elliptic to obovate leaflets 2.5 cm (1 in) long with fine teeth;[16,23,31] underside of leaflets with hairs and paler than upper surface;[23,31] base of leaves have a fringed stipule.[16,23,31]

Stems: Flexible, green-red; rigid, recurved thorns with a wide base;[23] thornless cultivar exists.[8,4]

Flowers: White or slightly pink, numerous, arranged in terminal panicles; 1-4 cm (⅜–1½ in) wide; May-June.[15,23,16]

Fruits/Seeds: Clustered, hard, maturing to red; 5-7 mm (¼ in) wide, egg-shaped; glossy, smooth; September-October,[23,11] lasting into winter;[11] yellowish seeds;[23] dispersed by turkeys, deer mice,[36] birds (some migratory);[27,28] seed bank[24] active up to 20 years;[21,25] cold stratification required;[1,4] germinates best in light (~60%); less than 10% in dark;[37] optimum germination at 10-20°C (50-68°F)[38] or 5°C (41°F)[1,38] after a long period.[38]

MULTIFLORA ROSE

UGA0016232

UGA2307113

Rosa multiflora Thunb.

Habitat: Streambanks, pastures, roadsides,[9] forest canopy gaps, disturbed areas, and mature forests;[20,31] introduced into the U.S. from Asia ~1886;[25] promoted in 1930s and '40s by government agencies as a 'living fence,' a soil stabilizer, and wildlife food/cover;[9,12,19] tolerates a variety of soils;[11,33,26] USDA hardiness zones 5-8.[11]

Comments: Used as rootstock for other roses[32,34] but not the best choice for longevity and flower production;[22] repeated herbivory lethal;[3,25] rose rosette disease (also affects other cultivated and native roses;[5,14]) may be lethal;[10,13,19] responds well to mycorrhizal inoculation;[6,7,30] preferential nest site for veeries,[18] other birds,[35] and mammals, such as rabbits;[2] at least 3 cultivars;[11] 371 rose species considered its progeny.[29]

Similar Native Species: *R. carolina* (pasture rose) and *R. blanda* (smooth rose); stipules not fringed.[16]

NORWAY MAPLE
[*Acer platanoides* L.]
ACPL2

UGA0008373

Habit: Deciduous tree reaching 30 m (98 ft) in height.[4,2]

Reproduction: By seed;[4] can be propagated from roots[9] or cuttings.[2, 9]

Leaves: Opposite, green to bronze, smooth, 5-7 lobed with few teeth and broad bases up to 18 cm (7 in) wide; wider than long; petioles with milky juice, best seen at base of petiole;[4,3] fall leaf color tending to be bright yellow.[2]

Stems: Trunk with widely spreading branches (cultivar-dependent; some have narrow canopies) and close bark;[3] twigs are olive brown and leaf scars meet to form a sharp angle; buds are plump, fleshy, and green to maroon.[2]

Flowers: Stalked, yellow-green, and perfect; appearing before[2] or with the leaves in spring, in loose clusters (corymbs).[3]

Fruits/Seeds: Fruits appear in late spring through summer; two-winged (double samaras) with the wings almost horizontally (180° angle) divergent;[3] seeds are wind dispersed with low fall rates (estimated dispersal distance of 50 m or 164 ft);[7] germination with cold stratification for 90-120 days;[2,1] seed bank potential.[5]

NORWAY MAPLE

UGA0008102

UGA0008225

*Acer platanoide*s L.

Habitat: Introduced into the U.S. from Europe in 1756[11] and planted extensively in urban and suburban areas;[2] now also found on roadsides and waste places, in hedgerows and roadside thickets;[3] also spreading into early[4] and some late-successional forests;[6,11,10] withstands sandy, clayey, and acidic and calcareous soils; somewhat resistant to drought and tolerates ozone and sulfur dioxide; overplanted tree with a splitting bark problem; USDA hardiness zones 4 to 7.[2]

Comments: Shade tolerant;[11,8] leaves hold late in autumn and root system tends to be shallow;[8,2] at least 36 cultivars; susceptible to wilt, anthracnose, tar spot, and leaf scorch;[2] regenerates prolifically under its own canopy, possibly reducing overall diversity;[6,11] greater investment in foliage than stem and roots may make it less competitive in drier, open environments.[8]

Similar Native Species: Sugar maple (*A. saccharum*); does not produce milky juice; samara wings are at an angle, and leaf scars do not meet.[4,3,2]

TREE OF HEAVEN
[*Ailanthus altissima* (Mill.) Swingle, *A. glandulosa* Desf.]
AIAL

UGA0016005

Habit: Deciduous tree to 30 m (98 ft) in height.[4]

Reproduction: By seed and vegetatively via root suckering.[8]

Leaves: Pinnately compound to 1 m (3 ft) in length with 11-41 leaflets, each with a 'thumb' or lobe at the base; leaflet teeth have glands.[8]

Stems: Bark gray and smooth; younger twigs covered with a light brown to reddish brown pubescence; thick or chubby tips; may grow up to 2 m (6½ ft) in one season.[4]

Flowers: Dioecious; hermaphrodites exist;[8] bloom June to July; may flower as early as 6 weeks after germination;[6] typically insect pollinated by a variety of pollinators, including bees.[3]

Fruits/Seeds: Two-winged samara (180°) with one central seed; sets late summer; over 300,000 seeds per tree documented;[1] seeds may remain on the tree through winter;[4,14] wind dispersed; cold stratification not required for germination;[11] seed bank formation thought unlikely,[16] though found as part of an urban forest seed bank.[15]

Habitat: Native to China; several introductions into the U.S. since 1784;[7] found in poor and rich soil on steep and shallow slopes, urban areas, open fields and woodlands, and closed canopy forests; often associated with disturbed habitats;[12,14] USDA hardiness zones 4-8.[4]

TREE OF HEAVEN

UGA2307007

UGA2307009

UGA1150029

Ailanthus altissima (Mill.) Swingle

Comments: Extensive cloning;[16] at least 5 cultivars;[4] crushed leaves, stems, and roots smell of rancid peanut butter; allelopathic properties present,[13] though negative effects may be less severe if previously exposed;[17] tolerant of several air pollutants;[10,18,20] seedlings are drought resistant;[21] quassinoid compounds may deter some insect herbivory[9] and frugivory,[19] but seeds and tissue may be preyed upon by deer, mice, and voles,[5,19,2] even preferentially in the case of some invertebrates.[2]

Similar Native Species: Sumacs (*Rhus glabra, R. typhina*); walnuts (*Juglans nigra, J. cinerea*); none of the crushed leaves or broken stems of these have the same odor; fruits not samaras.[8]

GLOSSARY

Achene: dry fruit that is usually one-seeded and closed at maturity.

Acidic: pH less than 7; releases protons (hydrogen ions, H+) in water.

Actinorhizal: symbiotic relationship of nitrogen-fixing bacteria with plant roots; less common than the rhizobia (*Rhizobium* and *Bradyrhizobium*) nitrogen-fixing bacteria that are often associated with legumes.

Adventitious: growing from mature tissue of a different type, as in roots developing on a stem.

Alkaline: pH greater than 7; releases hydroxyl ions (OH-) in water.

Allelopathic: ability to inhibit the growth of another plant species using toxic chemical substances.

Annual: a plant that completes its life cycle in 1 year—germinating from seed, flowering, setting seed, and dying in one growing season.

Anther: enlarged terminal pollen-bearing portion of the stamen.

Aril: fleshy, often brightly colored, tissue covering some seeds.

Asexual: reproduction without union of gametes (i.e., union of sperm (in the pollen) and egg (in the ovule) in plants); includes vegetative and clonal growth.

Awn: bristle-like structure; often associated with grass flowers.

Axillary: the point where the leaf base or leaf petiole meets the stem.

Beak: extension of style on achene, may be straight or curved; used to differentiate some *Ranunculus* species.

Biennial: grows vegetatively for the first year, then flowers and dies the next.

Bilabiate: 2-lipped (petals of a flower); bilaterally symmetrical in shape.

Bract: a modified or reduced leaf-like structure located at the base of a flower or inflorescence.

Bulblet: bulb-like structure produced in leaf axils or in place of flowers.

C_4: photosynthetic pathway that uses CO_2 more efficiently (at a higher energy cost) by allowing storage of CO_2 in bundle sheath cells and reducing photorespiration; there is less need for gas exchange and open stomates; C_4 plants are well adapted to high light, high temperatures, and low moisture.

Calcifuge: plant not usually found in calcareous soil.

Cauline: arising from the stem located above the soil surface, not basal.

Chasmogamous flower: open; may outcross.

Cleistogamous flower: closed; must self-fertilize.

Clonal: producing vegetative offshoots that can survive on their own from the same parent.

Collar: the leaf margin at the intersection of blade and sheath surrounding the stem.

Compound: two or more similar parts of the same structure (such as flowers or leaflets).

Congener: belonging to the same genus.

Connate: united or fused parts.

Corymb: a flat-topped inflorescence with outer flowers on longer pedicels compared to the inner flowers; central flower is the youngest.

Cultivar: a variety of a plant species occurring only under cultivation (though they may escape into the wild).

Cuneate: wedge shaped (or triangular), narrowing to the point of attachment.

Cyme: a flat- or round-topped (or scorpioid) inflorescence where the central (or upper) flowers are older and the outer (or lower) flowers are youngest.

Cytokinins: class of plant hormones that promote cell division.

Deciduous: all leaves shed each year.

Decurrent: wing or margin (as on a leaf petiole) continuing downward on a stem.

Dioecious: male and female unisexual flowers on separate plants.

Diploid: having two complete chromosome sets (2n).

Discoid: in Asteraceae, having disk flowers that make up all or part of the flowering head; disk flowers are tubular in shape that have both male and female parts or are just functionally male; the central flowers in a sunflower head; compare to ray flowers in Asteraceae.

Dormancy (for seeds): arrested growth, requiring either further embryo development or an environmental cue for germination to occur.

Drupe: fleshy, one- to several-seeded fruit with a stony inner layer.

Embolism: filling of vascular tissue (vessels and tracheids) with air after water columns rupture (cavitation); such air pockets prevent the flow of water.

Evergreen: with leaves that persist for more than one growing season.

Fecundity: ability to reproduce; number of offspring produced.

Fertilization: two reproductive haploid cell nuclei (each with one chromosome set or 1n) fuse together, forming a zygote (with two sets of chromosomes or 2n).

Flavonoid: any group of aromatic compounds, including common pigments such as anthocyanins and flavones; antioxidant that may reduce cancer or other health risks.

Follicle: a dry fruit derived from a single carpel that opens at maturity along the seed-bearing suture.

Frugivory: consumption of fruit.

Fruit: the mature ovary of a plant containing seeds.

Generalist: an organism seeking a broad range of resources, such as in pollination of flowers, herbivory, or frugivory by insects.

Genet: the genetic individual; may be composed of several individuals (or ramets) but only one genetically distinct organism; a clone.

Geophyte: a perennial plant that bears its perennating buds below the soil surface.

Germination: beginning or resumption of growth (usually in reference to a seed).

Glabrous: smooth, no hairs.

Glaucous: waxy, bluish green.

Grain: dry, one-seeded fruit, characteristic of grasses.

Guttation: water expelled from leaf tissue, often along the margins, caused by root water pressure.

Gynodioecious: female flowers and perfect flowers on separate plants.

Habit: general look or growth form of a plant.

Hastate: shaped like an arrow but with diverging basal lobes.

Herbivory: consumption of live plant tissue.

Hermaphrodite: one flower having both functional sexes; same as perfect.

Hexaploid: having 6 complete chromosome sets (6n).

Inflorescence: a flower cluster**.**

Internode: section of stem between two nodes.

Leaf scar: scar left on a twig from a fallen leaf.

Limiting: scarce resource, i.e., N limiting, means nitrogen is scarce.

Linalool: a fragrant liquid alcohol.

Locule: seed-containing cavity of an ovary or fruit.

Lycopene: red carotenoid pigment; an antioxidant; commonly found in tomatoes.

Mesic: wet or moist.

Monocarpic: flowering and fruiting once, then dying; also called semelparous; opposite is polycarpic or iteroparous, where organisms reproduce more than once before dying.

Monoecious: male and female unisexual flowers contained on one plant.

Mycorrhiza: a fungus and plant root mutually beneficial association (symbiosis); 'mycorrizae' is plural.

N: nitrogen (nitrate, nitrite, ammonium).

Native: plant species naturally occurring in a given range, not introduced to an area by humans.

Nectaries: glands that secrete nectar.

Nitrate: NO_3-; one of the preferred forms of nitrogen for uptake by plants.

Nitrification: oxidation of ammonium ions (NH_4+) or ammonia (NH_3) to nitrate (NO_3-) by free-living soil bacteria.

Nitrogen fixation: conversion of gaseous nitrogen (N_2) into nitrogen compounds by free-living and symbiotic bacteria; more appropriately called dinitrogen fixation.

Node: place of attachment of leaf to stem.

Nodule: swellings on the roots of legumes and other plants inhabited by nitrogen-fixing bacteria.

Oblong: sides parallel with ends rounded; longer than broad.

Obovate: egg-shaped but connected at the narrow end.

Ocrea: stipular stem sheath above the leaf base; 'ocreae' is plural.

Octoploid: having 8 complete chromosome sets (8n).

Outcrosser: an individual (i.e., plant) that may be fertilized by another individual of the same species (but not of the same clone), receiving new genetic material.

Palmate: radiating out from a central axis.

Panicle: a branching inflorescence with pediceled flowers; flowers mature at the base first, then upwards.

Papilionaceous: butterfly-shaped; common in pea or bean flowers.

Pappus: typical of the Asteraceae; modified calyx composed of bristles, scales, awns, or hairs, located at each achene apex.

Pedicel: stalk that bears a single flower.

Peltate: petiole attached at or near the middle of the underside of a leaf, but not going through the leaf.

Perennial: living 2 years or longer.

Perfect: bisexual, having both male and female reproductive organs; usually referring to flowers.

Perfoliate: leaf surrounds the stem or petiole; stem or petiole goes through the leaf blade.

Perianth: petals and sepals of a flower collectively; most often used when petals and sepals look very similar.

Petiole: leaf stalk.

pH: measure of acidity and alkalinity that is the negative logarithm of the effective hydrogen ion concentration.

Pinnate: arranged on opposite sides of a central axis; i.e., a column of leaflets or veins on each side.

Pollination: pollen transferred from an anther to a stigma (or archegonium neck of gymnosperms); may lead to fertilization.

Polyploidy: having three or more complete chromosome sets.

Protandrous: with male reproductive organs maturing prior to those of the female (pollen dispersing before female structure is receptive).

Pubescent: with hairs.

Raceme: unbranching, prolonged inflorescence producing stalked flowers, maturing from the base upward or outward.

Ramet: physiologically separate (at least potentially) individual of a genet (clone).

Ray (Apiaceae): one of the branches of an umbel.

Ray (Asteraceae): ligule or ligule (lip-like extension) bearing flower; the outer flowers in a sunflower head.

Recurved: curved backwards.

Reflexed: bent backwards.

Rhizomatous: with rhizomes (underground stems that can send up new shoots).

Rosette: radiating cluster of leaves at ground level.

Samara: closed, dry fruit with wings.

Scarification: seed coat degradation that often facilitates germination.

Seed: fertilized ovule with a hard coat, embryo, and sometimes endosperm (food storage for embryo).

Seed bank: seeds present in the soil and persisting for various time periods (longer than one season).

Self-compatible: individual that is capable of fertilizing itself.

Selfed: self-fertilized.

Senescence: life cycle stage from full maturity to death; can be used to describe a whole plant or parts of a plant (such as the leaves).

Serrulate: having sharp, forward pointing teeth on leaf margins.

Shade intolerant: grows well or preferentially in high light conditions and less well in low light conditions.

Shade tolerant: grows well or preferentially in low light conditions.

Sheath: leaf base surrounding the stem.

Silique: dry fruit, splitting with each half or valve separating from the other and leaving a central thin septum.

Simple: only one, or not divided.

Spatulate: spatula-shaped; with rounded, broad top portion and narrowing to the base.

Specialist: an organism seeking a specific resource (narrow range), such as in pollination of flowers, herbivory, or frugivory by insects.

Spike: unbranched inflorescence with flowers without pedicels (sessile).

Spikelet: a small, prolonged spike subtended by one or two bracts (in grasses and sedges).

Spring ephemeral: plants that flower and reproduce before leaf-out in early spring, taking advantage of the higher light levels, and that persist in a resting state during the summer until the following winter, when root tubers begin to elongate.

Stamen: male sex organ of a flower that produces pollen; composed of anther and filament.

Stock: a plant part united with another plant part (the scion) of the same or a different species and supplying mostly underground parts; uniting stocks to scions is grafting.

Stomates: openings in plant epidermal tissue used for gas exchange in photosynthesis but may also be a source of water loss.

Stratification: seed exposure to different (often colder) temperatures to promote germination.

Successional: directional pattern of plant community regeneration or colonization; i.e., going from bare ground or old field to young forest (early successional) to mature forest (late successional).

Sucker: root or stem offshoot emerging from beneath the soil to produce a new plant.

Suture: the line or seam where a mature fruit splits.

Tendril: modified leaf in the form of a narrow, coiling structure, providing climbing support for a plant.

Tetraploid: having 4 complete chromosome sets (4n).

Translocate: to transport over a long distance water, minerals, or food within one individual or among ramets (individuals) of a clone.

Truncate: straight or flat-based as if cut off.

Tuber: in the case of lesser celandine, a tuberous root; true definition is the thickened part of a rhizome (underground stem) serving in food storage and possibly reproduction.

Umbel: flowers of a flat-topped or rounded inflorescence with equal length pedicels arising from a single point.

Variety: in the taxonomic hierarchy, a lower than species division being either equivalent to subspecies level or less; naturally formed (not cultivated).

Vegetative: propagation using asexual means; non-reproductive plant parts.

Venation: vein pattern found in leaves.

Vesicular-arbuscular mycorrhizae (VAM): an association (often mutualistic) between a fungus and a plant root in which the fungus enters the host cells and may also extend widely into the surrounding soil; fungus benefits by using plant photosynthates; plant benefits because the fungus increases uptake of nutrients, like phosphorus.

Viability: possibility of survival (i.e., of a seed to form a plant).

Xeric: dry.

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NA-TP-05-04

Citations and Photograph Information Section

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Citations and Photograph Information
Alphabetized by Habit and Species Latin Name

Herbs

Alliaria petiolata (Garlic mustard)

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Photograph Information:
Basal leaves (photographer: Jil M. Swearingen, USDI National Park Service); flowers (photographer: John Randall, The Nature Conservancy); plant (photographer: Dan Tenaglia, www.missouriplants.com); mature fruit (photographer: Britt Slattery, USFWS). Photographs reproduced from www.forestryimages.org or www.invasive.org (mature fruit).

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Photograph Information:
Plant (photographer: Mary Ellen Harte); photograph reproduced from www.forestryimages.org. Leaf, stem, flowers, flower in fruit (photographer: Dan Tenaglia, www.missouriplants.com; photographs are copyrighted and may not be used without permission of D. Tenaglia).

Fallopia japonica (Japanese knotweed)

Text Citations:

1. Adachi, N. 1996. Nitrogen translocation via rhizome systems in monoclonal stands of *Reynoutria japonica* in an oligotrophic desert on Mt. Fuji: Field experiments. Ecological Research 11: 175-186.
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Photograph Information:
Leaves (Jack Ranney, University of Tennessee); leaves and flowers (Britt Slattery, U.S. Fish and Wildlife Service). Photographs reproduced from www.invasive.org.

Heracleum mantegazzianum (Giant hogweed)

Text Citations:

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Photograph Information:

Leaves (photographer: Donna R. Ellis, University of Connecticut), inflorescence (photographer: Terry English, USDA APHIS PPQ), and seeds (photographer: USDA APHIS Archives). Photographs reproduced from www.invasive.org.

Microstegium vimineum (Japanese stilt grass)

Text Citations:

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Photograph Information:
Flower, leaf, and sheath close up (photographer: David. J. Moorehead, The University of Georgia); population (photographer: Chuck Bargeron, the University of Georgia). Photographs reproduced from www.invasive.org.

Ranunculus ficaria (Lesser celandine)

Text Citations:

1. Baskin, C.C. and J.M. Baskin. 2001. Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press. San Diego, CA. 666 p.
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Photograph Information:
Population example (Photographer: Jil M. Swearingen, USDI National Park Service); leaves (Photographer: Jil M. Swearingen, USDI National Park Service); flowers (Photographer: Leslie J. Mehrhoff, Invasive Plant Atlas of New England, University of Connecticut). Photographs reproduced from www.forestryimages.org or www.invasive.org.

Rumex acetosella (Sheep sorrel)

Text Citations:

1. Banga, M. E. J. Slaa, C.W.P.M. Blom and L.A.C.J. Voesenek. 1996. Plant Physiology 112: 229-237.

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Rumex acetosella (continued)

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Photograph Information:

Dried leaf example from herbarium specimen (photographer: Cindy Huebner, USDA Forest Service), Leaves/plant; flowers; fruit (photographer: Dan Tenaglia, www.missouriplants.com; photographs are copyrighted and may not be used without permission of D. Tenaglia).

Vines

Celastrus orbiculatus (Oriental bittersweet)

Text Citations:

1. Brizicky, G. 1964. The genera of Celastrales in the Southeastern United States. Journal of Arnold Arboretum. 45: 206-218.
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Photograph Information:
Leaves, plant with fruit, and close up fruit (photographer: James H. Miller, USDA Forest Service, SE Research Station). Photographs reproduced from www.forestryimages.org.

Cynanchum louiseae (Black swallow-wort)

Text Citations:

1. Cappuccino, N. 2004. Allee effect in an invasive alien plant, pale swallow-wort *Vincetoxicum rossicum* (Asclepiadaceae). Oikos 106: 3-8.
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15. Photograph: http://gallery.cs.umb.edu/gallery/Black-Swallow-wort/CynNigLibrary4).

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Photograph Information:

Stem, leaves and flowers of *C. louiseae* (upper dark flower) and *C. rossicum* (lower, pale pink, windmill shape flower) (photographer: Leslie J. Mehrhoff, Invasive Plant Atlas of New England, University of Connecticut); flower and fruit (photographer: Richard A. Casagrande, University of Rhode Island). Photographs reproduced from www.forestryimages.org and www.invasive.org.

Lonicera japonica (Japanese honeysuckle)

Text Citations:

1. Andrews, E.F. 1919. The Japanese honeysuckle in the Eastern United States. Torreya 19: 37-43.
2. Bell, D.J., I.N. Forseth and A.H. Teramura. 1988. Field water relations of three temperate vines. Oecologia 74: 537-545.
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Lonicera japonica (continued)

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Photograph Information:
Leaves (photographer: Ted Bodner, Southern Weed Science Society); leaves and flowers (photographer: Chuck Bargeron, University of Georgia); fruit (photographer: Ted Bodner, Southern Weed Science Society). Photographs reproduced from www.invasives.org.

Polygonum perfoliatum (Mile-a-minute weed)

Text Citations:

1. Baskin, C.C. and J.M. Baskin. 2001. Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press. San Diego, CA.
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Photograph Information:
Leaves (photographer: Britt Slattery, U.S. Fish and Wildlife Service); flowers inside ocrea (photographer: Jil M. Swearingen, USDI National Park Service); fruit (photographer: Yun Wu, USDA Forest Service). Photographs reproduced from www.forestryimages.org and with permission of Yun Wu.

Pueraria montana var. *lobata* (Kudzu vine)

Text Citations:

1. Achremowicz, B., R.D. Tanner, A. Prokop and R.D. Grisso. 1994. The effect of frost on the starch yield from kudzu (*Pueraria lobata*) roots of various ages grown in northern Alabama. Bioresource Technology 47(2): 149-151.
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Pueraria montana var. *lobata (continued)*

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Photograph Information:
Leaves, flowers and fruit (photographer: Ted Bodner, SE Research Station, USDA Forest Service). Photographs reproduced from www.invasive.org.

Berberis thunbergii (Japanese barberry)

Text Citations

1. Davis, O.H. 1927. Germination and early growth of *Cornus florida, Sambucus canadensis*, and *Berberis Thunbergii*. The Botanical Gazette 84(3): 225-263.
2. Dirr, M.A. 1998. Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses, 5th ed. Stipes Publishing LLC. Champaigne, IL.
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15. Rhoades, A.F. and T.A. Block. 2000. The Plants of Pennsylvania. University of Pennsylvania Press. Philadelphia, PA.
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Photograph Information:
Plant (photographer: Jil M. Swearingen, USDI National Park Service); Leaves and flowers (photographer: Leslie J. Mehrhoff, University of Connecticut); fruit (photographer: Barry Rice, sarracenia.com). Photographs reproduced from www.invasive.org.

Elaeagnus umbellata (Autumn olive)

Text Citations:

1. Baskin, C.C. and J.M. Baskin. 2001. Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press. San Diego, CA.
2. Carpenter, P.L. and D.L. Hensley. 2004. Utilizing N_2-fixing woody plant species for distressed soils and the effect of lime on survival. Botanical Gazette 140 (Supplement): S76-S81.
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13. Rhoades, A.F. and T.A. Block. 2000. The Plants of Pennsylvania. The University of Pennsylvania Press. Philadelphia, PA.
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16. USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center. Baton Rouge, LA 70874-4490. USA.

Photograph Information:
Shrub in flower, leaves, and flowers, (photographer: James H. Miller, USDA Forest Service, SE Research Station); fruit (USDA, NRCS). Photographs reproduced from www.invasive.org.

Euonymus alatus (Winged burning bush)

Text Citations:

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Photograph Information:
Leaves; fall foliage and winged stem; fruit and leaves (photographer: James H. Miller, USDA Forest Service) Photographs reproduced from www.forestryimages.org.

Lonicera maackii (Amur honeysuckle, bush honeysuckle)

Text Citations:

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Photograph Information:
Leaves and stems (photographer: James H. Miller, USDA Forest Service, SE Research Station), fruit (photographer: Chuck Bargeron, The University of Georgia). Photographs reproduced from www.invasive.org.

Rhamnus cathartica (Common buckthorn)

Text Citations:

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Photograph Information:
Leaves (photographer: J.S. Peterson, USDA NRCS NPDC, Missouri Botanical Garden, www.plants.usda.gov); flowers (photographer: M.H. Brand et al., University of Connecticut, www.hort.uconn.edu); fruit (photographer: Gary Fewless, www.uwgb.edu/biodiversity/herbarium/trees/).

Rosa multiflora (Multiflora rose)

Text Citations:

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Photograph Information:
Fringed stipule and flowers (photographer: James H. Miller, USDA Forest Service, SE Research Station); fruit (photographer: David J. Moorhead, University of Georgia). Photographs reproduced from www.invasive.org.

Acer platanoides (Norway maple)

Text Citations:

1. Baskin, C.C. and J.M. Baskin. 2001. Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press. San Diego, CA.
2. Dirr, M.A. 1998. Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation, and Uses, 5th ed. Stipes Publishing LLC. Champaigne, IL.
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Photograph Information:
Leaf and flowers (photographer: Paul Wray, Iowa State University), and samara (photographer: Bill Cook, Michigan State University) Photographs reproduced from www.forestryimages.org.

Ailanthus altissima (Tree of heaven)

Text Citations:

1. Bory, G. and D. Clair-Maczulajtys. 1980. Production, dissemination et polymorphisme des semences d'*Ailanthus altissima* (Mill.) Swingle, Simarubacees. Revue Generale de Botanique 88: 297-311.
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Photograph Information:
Leaves and twig with mature fruit (photographer: James Miller, USDA Forest Service, SE Research Station); fruit with reddish color, not all cultivars have this color (photographer: Chuck Bargeron, University of Georgia). Photographs reproduced from www.forestryimages.org.