Invasive Plants Field and Reference Guide:

An Ecological Perspective of Plant Invaders of Forests and Woodlands

NA-TP-05-04

Supplement 1, July 2006

Summary

Supplement 1 makes the following changes to the original guide, which was published in 2004.

- Replaces the title page.
- Corrects and clarifies information in the original guide for two species: *Microstegium vimineum* (Japanese stiltgrass) and *Rosa multiflora* (multiflora rose).
- Replaces the Species List.
- Adds descriptions with photos for five new species. These species are among a long list of priority species and were selected over others for one key reason—literature and research on them currently are relatively abundant.

  Herbs:

  Cirsium arvense (Canada thistle)
  Ranunculus ficaria (lesser celandine)
  Rumex acetosella (sheep sorrel)

  Vine: *Cynanchum louisea*e (black swallow-wort)

  Shrub: *Euonymus alatus* (winged burning bush)
- Replaces the Glossary.
- Adds Citation and Photograph Information pages for the five new species.
- Updates the USDA nondiscrimination statement.

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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 that picture may not be divided, which would mean the 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.

Again, we welcome any comments that you may have concerning this guidebook, and we thank all involved in making it possible (see original acknowledgements), with special thanks to Noel Schneeberger, Nancy Berlin, Roberta Burzynski, 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*
Oriental bittersweet – *Celastrus orbiculatus*

Shrubs

Amur honeysuckle, bush honeysuckle – *Lonicera maackii*
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.

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].

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 5,300 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].

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].

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

UGA1237104

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].

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% and 50%; seed bank not confirmed; seeds germinate in spring or fall[13]; seed production lower in shaded sites[5,18].

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 mycorrhizal 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].

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].

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 5-merous[10].

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); "mycorrhizae" 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.

Cirsium arvense (Canada thistle)

Text Citations:

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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 are used by permission; other use of these images requires permission of D. Tenaglia).

Ranunculus ficaria (Lesser celandine)

Text Citations:

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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:

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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 are used by permission; other use of these images requires permission of D. Tenaglia).

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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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.

Euonymus alatus (Winged burning bush)

Text Citations:

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Leaves; fall foliage and winged stem; fruit and leaves (photographer: James H. Miller, USDA Forest Service)
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