Polygonum perfoliatum

INTRODUCTORY

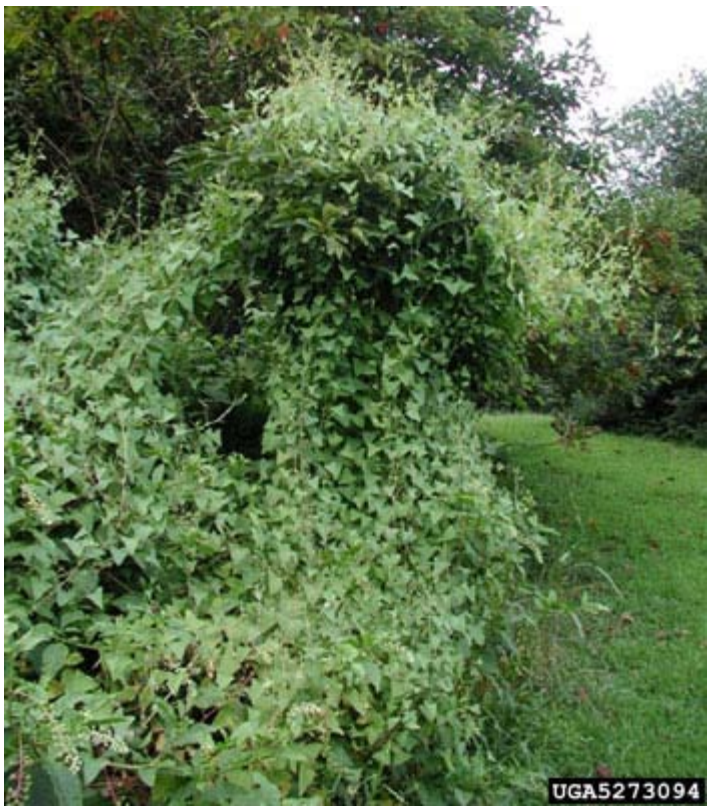

Photo by Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

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FEIS ABBREVIATION:
POLPEF

NRCS PLANT CODE [50]:

POPE10

COMMON NAMES:
mile-a-minute
mile-a-minute weed
mile-a-minute vine
Asiatic tearthumb
devil's tearthumb
devil's tail tearthumb

TAXONOMY:
The scientific name of mile-a-minute is *Polygonum perfoliatum* L. (Polygonaceae) [26].

SYNONYMS:
Persicaria perfoliata (L.) Gross [21,22,28]

LIFE FORM:
Vine-forb

DISTRIBUTION AND OCCURRENCE

SPECIES: Polygonum perfoliatum

GENERAL DISTRIBUTION:
Mile-a-minute has a limited distribution in North America. The distribution map provided by Plants Database shows mile-a-minute concentrated in the mid-Atlantic states, from Virginia north to New York and Connecticut and west to Ohio. Mile-a-minute has also been documented in Massachusetts [33], Rhode Island [35], Mississippi, Oregon, and British Columbia [26]. However, a 1994 review states that mile-a-minute has not been reported west of the Rocky Mountains since 1954 [39], suggesting that western populations documented in the past failed to persist.

Mile-a-minute is native to a wide area of eastern Asia, occurring from Japan west and south to the Philippines (review by [9]). In North America, mile-a-minute was first collected in Oregon (1890), apparently transported in ship ballast. This population did not persist. In the mid 1930s, mile-a-minute was introduced into a Pennsylvania nursery via contaminated seeds. All populations of mile-a-minute in the mid-Atlantic states are traced back to this introduction (review by [9]), with plants throughout the region lacking genetic variation [44].

Mile-a-minute's spread in the mid-Atlantic states is largely attributed to the dispersal of its buoyant seeds along water drainages. Mile-a-minute spread is also facilitated by contaminated nursery stock [41], soil, or hay; or seed transported by logging equipment (review by [39]) or migratory birds ([41], review by [39]) (see Seed dispersal). Though mile-a-minute spreads quickly in some areas [9], it appears that its establishment is limited by the need for seeds to undergo a period of cold stratification prior to germination. Therefore, it is unlikely that mile-a-minute will establish in warm temperate regions of North America [24].

HABITAT TYPES AND PLANT COMMUNITIES:
In its native range, mile-a-minute is commonly found along water or in moist areas (review by [41]). In North America, mile-a-minute's multiple means of dispersal facilitate its establishment in a variety of plant communities, including riparian or lowland areas as well as upland sites. All plant community descriptions presented here are from the mid-Atlantic states.

Riparian or lowland plant communities: In the mid-Atlantic states, mile-a-minute establishes along waterways [1,9,11,12,21] and wetlands [28], in swamps [31,41], and in moist woodlands [52]. Collection data from Maryland, Pennsylvania, and Washington, DC, documented mile-a-minute along creeks, on low ground, in shrub swamps, and on wooded floodplains. Extensive stands of mile-a-minute occurred in an alluvial black walnut (*Juglans nigra*) forest. Mile-a-minute was also reported flourishing along beaches and marsh strands in the estuaries of the upper Chesapeake Bay [41]. In Washington, DC, mile-a-minute occurred in riparian deciduous forests dominated by boxelder (*Acer negundo*), red maple (*A. rubrum*), yellow-poplar (*Liriodendron tulipifera*), and American sycamore (*Platanus occidentalis*) [11]. In Pennsylvania, mile-a-minute occurred on the edges of stands of the "globally rare" Darlington's glade spurge (*Euphorbia purpurea*), establishing in swamps bounded by upland forest. The swamp canopy was dominated by sweet birch (*Betula lenta*), red maple, yellow-poplar, black ash (*Fraxinus nigra*), and black tupelo (*Nyssa sylvatica*) [31]. In central New Jersey, mile-a-minute occurred in moist woodlands containing sugar maple (*A. saccharum*), red maple, sweet birch, shagbark hickory (*Carya ovata*), bitternut hickory (*C. cordiformis*), and American elm (*Ulmus americana*) [52].

Upland plant communities: Mile-a-minute may establish in upland plant communities in the mid-Atlantic states, including upland hardwood forests [1,9,24,52], conifer plantations [24,52], shrubby thickets [41,52], and disturbed open areas [12,24,41,52]. In West Virginia, mile-a-minute established at the edge of disturbed forests dominated by silver maple (*A. saccharinum*) [9]. In Pennsylvania and Virginia, mile-a-minute occurred along the edges of disturbed forests, man-made meadows, hiking paths, or roads. It established in both monospecific stands or was integrated with other vegetation, including native plants like goldenrod (*Solidago* spp.) and American pokeweed (*Phytolacca americana*) and a number of other nonnative species like garlic mustard (*Alliaria petiolata*) and Canada thistle (*Cirsium arvense*). In areas where it dominated, it grew over other nonnatives including multiflora rose (*Rosa multiflora*), Japanese honeysuckle (*Lonicera japonica*), and common reed (*Phragmites australis*) [12]. Collection data from Maryland, Pennsylvania, and Washington, DC, documented mile-a-minute in gullies, blackberry (*Rubus* sp.) thickets, and woodland borders [41]. In Maryland, mile-a-minute occurred in clearings in logged hardwood forests [1]. In Pennsylvania, mile-a-minute occurred in conifer plantations and mixed hardwood forests with white oak (*Quercus alba*), water oak (*Q. nigra*), northern red oak (*Q. rubra*), chestnut oak (*Q. prinus*), red maple, yellow-poplar, mockernut hickory (*Carya tomentosa*), shagbark hickory, and pignut hickory (*C. glabra*). Mile-a-minute also established in open areas such as fallow fields, clearcuts, and utility rights-of-way [24]. In central New Jersey, mile-a-minute occurred in several fragmented plant communities, including open hardwood forests, abandoned conifer plantations, and shrub thickets. Open hardwood forests contained white ash (*F. americana*), yellow-poplar, black walnut, northern red oak, black cherry (*Prunus serotina*), and flowering dogwood (*Cornus florida*). Abandoned conifer plantations contained white spruce (*Picea glauca*) and eastern white pine (*Pinus strobus*). Shrub thickets contained Allegheny blackberry (*R. allegheniensis*) and the nonnatives multiflora rose and Russian-olive (*Elaeagnus angustifolia*). Mile-a-minute was also reported in successional fields, along forest edges, and in the center and edges of large forest canopy gaps [52]. In New Jersey, mile-a-minute established in the full shade of a closed-canopy red maple-black tupelo forest (D. Snyder personal observation cited in [45]).

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: Polygonum perfoliatum

GENERAL BOTANICAL CHARACTERISTICS:

Botanical description: This description covers characteristics that may be relevant to fire ecology and is not meant for identification. Keys for identification are available (e.g., [27,39]).

Mile-a-minute is a glaucous, branching, vine-like herb. It grows from an herbaceous base that may become woody with age [41]. Vines may grow 10 to 12 feet (3-4 m) long [9] and climb or recline on other plants [41]. The angles of stems, petioles, and the principal veins on the undersurface of leaves have recurved prickles. Mile-a-minute leaves are distinctively triangular, 0.4 to 3 inches (1-8 cm) long, and light green, though they may appear reddish when young. Mile-a-minute has apetalous flowers that are borne in axillary or terminal fascicles and are well concealed among the upper leaves. The fruits are metallic blue in color, subglobose, fleshy, and berry-like, 4 to 6 mm in diameter. The solitary achene is black, spherical, and about 3.5 mm long [41].

Photo by Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Mile-a-minute roots are fibrous and shallow ([36], reviews by [3,27]).

Mile-a-minute is generally considered an annual [3,9,27,39,51,58], though some sources report it as a perennial [3,41,58]. One source reports that mile-a-minute behaves like an annual in North America (review by [58]) though it grows as a perennial in mild areas of its native range [56].

Raunkiaer [40] **life form:**
Therophyte

SEASONAL DEVELOPMENT:
In the mid-Atlantic states, mile-a-minute seeds germinate in early April (review by [37]). Seedlings are established by late April (review by [39]), reaching 4 to 8 inches (10-20 cm) in height by early May [21]. Flowering begins in early June or July. Fruits are produced from early August until plants die in mid-October (review by [3]). Fruits ripen from September to November (review by [39]). Dead stems may persist for as long as a year [24].

REGENERATION PROCESSES:

Pollination and breeding system: Mile-a-minute usually reproduces via self-fertilization ([14,22], reviews by [44,58]), though outcrossing occasionally occurs (review by [44]). One study reported bumblebees visiting mile-a-minute flowers in Delaware, though the authors noted that insect pollination was not required for seed set [22].

Seed production: Mile-a-minute seed production is highly variable. In Pennsylvania, seed production averaged 7.85 seeds/plant one year and 39.35 seeds/plant another year [23]. At field sites in Delaware, mile-a-minute plants produced approximately 3,500 seeds/plant by the end of the growing season [22]. An increase in light availability appears to improve seed production [22,24]. In Delaware, mile-a-minute plants in field cages produced >2,200 seeds in full light but <400 seeds in the shade (unpublished data cited in [22]). In New Jersey, seed production was limited by drought [52].

Seed dispersal: Mile-a-minute seeds are dispersed in several ways. Water dispersal is common ([9,14], reviews by [27,37,39]). Mile-a-minute's large, blue fruits have a waxy perianth that repels water and promotes floating; fruits retain buoyancy for 7 days [14]. Mile-a-minute seeds are also dispersed by birds ([14,52], reviews by [27,39]), and mammals (reviews by [27,39]), including chipmunks, squirrels, and white-tailed deer (review by [27]). Ants may disperse seeds short distances (review by [27]). Seeds may also be transported by logging equipment or in the rootballs of nursery stock (review by [38]). Seeds that remain on the parent plant may by dispersed when dead stems are moved in control efforts [18] or when mile-a-minute stems are transported while attached to nursery plants (review by [38]).

Seed banking: Mile-a-minute seeds may persist in the soil seed bank for several years; one review suggests that seeds persist for up to 4 years [3]. In New Jersey, wild-collected seeds were buried 1 inch (2 cm) below the soil surface in December. Seeds were removed at intervals over 3 years and placed in a germination chamber. Germination was highest after 1 year of burial (96.3%) but was still substantial after 3 years of burial (32.6%) [52]. In Pennsylvania, mile-a-minute seeds were buried in an old field and a 55-year-old red pine (*Pinus resinosa*) plantation. Over 2 years, seeds were removed at intervals and germinated in a laboratory. After 2 years, 50% to 95% of the seeds were viable, with higher viability in seeds from the red pine plantation compared to those from the old field. Germination rates were higher 18 months after burial compared to 6 months after burial [24].

Mile-a-minute seeds may be present in the soil seed bank even when established mile-a-minute stands are not present in the immediate vicinity. In Pennsylvania, sites with existing populations of mile-a-minute had abundant mile-a-minute seeds in the soil seed bank, but seeds were also sometimes found in areas adjacent to established mile-a-minute stands or in areas sharing no common border with mile-a-minute stands [24].

Germination: Mile-a-minute seeds need moisture ([24,58], reviews by [22,39]) and cold stratification ([14,24,39,58], review by [22]) to germinate. Several sources suggest that mile-a-minute seed germination improves in the presence of litter (e.g., leaves, decayed organic matter, brush) that keeps the soil moist ([36], reviews by [37,38]); however, laboratory tests in Virginia found no significant change in germination rates with varying moisture levels [14]. Seeds collected throughout eastern North America needed cold-wet stratification for 4 to 19 weeks to break dormancy, and germination rates improved as stratification time increased. Growth chamber germination rates for wild-collected mile-a-minute seeds following cold-wet stratification averaged 52.4% and ranged from 11% to 86% [58]. In laboratory germination tests in Pennsylvania, mile-a-minute seeds responded favorably to cold-wet stratification. A minimum of 6 weeks was needed for germination. Seeds germinated over a wide temperature range (50 to 68 °F (10-20 °C)) but germination was more consistent at 50 °F (10 °C) than at 68 °F (20 °C). Germination rates were highest (52.9%) at 50 °F (10 °C) after 6 weeks of stratification [24].

Scarification may improve germination rates ([8,24,39], review by [22]) and allow germination at a wider range of temperatures. In laboratory germination tests in Pennsylvania, acid scarification improved germination in weeks 6 to 12 of the trials [24]. In laboratory germination tests in Virginia, an 8-week cold stratification treatment was not required in acidic (pH 3.5) environments, whereas it was required in environments with higher pH. The author hypothesized that acidic litter in field settings could act as a scarifying agent and improve germination [14]. Though one source suggested that scarification may occur when seeds are ingested by mammals and birds (F. Johnson personal communication cited in [39]), ingestion by captive songbirds did not improve germination of mile-a-minute seeds collected in Virginia [14].

Disturbance may not impact mile-a-minute germination. In New Jersey, a field study found no significant difference in mile-a-minute seedling emergence in disturbed (removal of vegetation and loosening of the top 2 inches (5 cm) of soil) and undisturbed sites. Across 3 habitat types (forest, forest edge, successional fields), seedling emergence averaged 61.3% [52].

Seedling establishment and plant growth:

Seedling establishment: Mile-a-minute seedlings may establish in high densities; in mile-a-minute monocultures in Pennsylvania, seedling densities exceeded 500/m² (unpublished data cited in [22]).

Seedling survival may be higher in moist, light areas compared to dry, shaded areas. In New Jersey, one study examined seedling survival in 3 habitat types (forest, forest edge, and successional fields). Wild-collected seeds were stored over the winter and planted in field sites in the spring. Of the seedlings that emerged, overall survival was low (4.3%) but was highest in successional fields (11.3 %), low in forest edge (1.7%), and nonexistent in the forest interior. Soil moisture and light were highest in the field, followed by the edge, then the forest. Primary cause of seedling death appeared to be desiccation [52]. In Pennsylvania, one author observed that seedlings germinating in the understory of mixed hardwood forests did not produce fruit and eventually died by summer [24].

Plant growth: Mile-a-minute plants exhibit rapid growth (review by [3]), growing up to 6 inches (15 cm)/day (review by [45]) and up to 33 feet (10 m)/year [23].

Increased availability of light, moisture, and nutrients may improve mile-a-minute growth. In Maryland growth chamber experiments, seedlings from wild-collected seeds were exposed to several light and water treatments. Plants exposed to both high light and water developed 2.25 times the biomass compared to plants exposed to high light and low water, and 10 times the biomass of plants exposed to low light and either high or low water ($P<0.05$). Plants exposed to both high water and light had the greatest leaf area ($P<0.05$). Plants exposed to high light had higher growth rates than those exposed to low light ($P<0.05$) and also exhibited the greatest root mass; at harvest, root mass of high-light plants averaged 0.4 ounces (1.3 g), while low-light plants averaged 0.004 ounces (0.1 g) [1]. Another series of growth chamber experiments compared total biomass, root to shoot ratio, leaf weight ratio, and height of mile-a-minute seedlings at 4 resource combinations: high light-high nutrient, high light-low nutrient, low light-high nutrient, low light-low nutrient. Both high nutrient ($P<0.01$) and high light ($P<0.05$) treatments led to a significantly greater reproductive biomass. Manipulating nutrient and light levels led to changes in the allocation of resources to root or vegetative growth; low nutrient levels led to an increase in root growth over vegetative growth, while low light levels led to an increase in vegetative growth over root growth [52].

Vegetative regeneration: Mile-a-minute does not regenerate vegetatively in North America (review by [39]). In areas of China experiencing mild weather and lacking frost, there are reports of roots growing from the stem nodes of perennial mile-a-minute plants. It was suggested that these plants may eventually establish as separate plants [56].

SITE CHARACTERISTICS:

Sources report mile-a-minute establishing on a wide range of sites, though reviews suggest that it establishes best in areas with high light [34] and moisture [1,38], and abundant plant litter [1,34,37,38]. Mile-a-minute establishes in disturbed areas [1,3,13,38,41,54], particularly those associated with human activity, such as roadsides [1,3,13,23,27,38,41,51], railroad tracks [9,27], ditches [3,38,41,51], nurseries and orchards [3,27,38,51], powerline rights-of-way [3,27], regenerating logged areas [27,34,51], hedgerows [1,54], recreational areas [3], woodpiles [38], and open fields [3,13,23,27,38]. Mile-a-minute also establishes along forest edges [3,13,27,38,41], in openings in forested areas [1,3,9,38], on eroded banks [41], and in thickets [27,38,41], gullies [41], and meadows [27,39].

Climate: In North America, mile-a-minute is limited to areas with a temperate climate that experience cold winters (review by [58]). It is sensitive to freezing, with the first hard frost killing plants (F. Johnson personal communication cited in [39]). Mile-a-minute has been observed growing as a perennial in frost-free areas of China [58], leading one source to suggest the potential for mile-a-minute to expand its distribution to areas in North American with warm climates, like Florida [39]. However, other sources suggest that the need for cold stratification for germination precludes such a range expansion [24].

Soils: As of this writing (2010) there was little information available regarding soil preferences of mile-a-minute. In Maryland, mile-a-minute established on gravelly loam [1]. In Pennsylvania, mile-a-minute established on shallow, well-drained, channery loam [34]. In Virginia, mile-a-minute grew in areas with pH ranging from 5.5 to 6.4 [14]. A review [27] states that mile-a-minute prefers soil high in organic matter. Most sources suggest that mile-a-minute prefers moist conditions ([18,42,51], reviews by [13,38]), though it can tolerate low soil moisture (reviews by [13,27]). In Maryland, field sites where mile-a-minute occurred had soil moisture content ranging from 15% to 40% [1]. Some sources suggest that moist, well-drained sites are preferred [42,51].

SUCCESSIONAL STATUS:
Mile-a-minute is an early successional species (review by [3]).

Disturbance: Mile-a-minute frequently establishes on disturbed sites ([9,18], reviews by [3,14]) or in open areas (reviews by [3,13]). In its native range, it is largely restricted to riparian areas where frequent flooding creates open and disturbed areas for continuous population establishment [23]. Along the Delaware River, mile-a-minute populations survived frequent flooding, including a 100-year flood [21]. In eastern Pennsylvania, mile-a-minute established the season after severe floods deposited a thick layer of sandy silt on the floodplain, burying well-established forbs and grasses. Many weed species established following the flooding event. Mile-a-minute dominated the weed community the 1st postflood year, but was restricted in dominance the following year and subsequently failed to establish [18]. In North America, mile-a-minute establishes well in areas that have been treated with herbicides targeting other nonnative species (review by [27]). It also establishes well in forests following clearcutting (W. Mountain and L. McCormick personal communications cited in [39]).

Light: Mile-a-minute prefers full sun ([42,45,52], reviews by [27,39,51]). Plant growth [1,52], seedling survival [52], and seed production [24] may be higher in areas with more light compared to areas with more shade. Nevertheless, mile-a-minute can also establish in shaded areas ([1,9,14,45], reviews by [3,13,27,39,51]). In Maryland, mile-a-minute established in areas experiencing substantial shading for at least part of the day, with insolation at canopy level ranging from 7% to 60% of full light [1]. In Virginia, streamside populations of mile-a-minute experienced 32% to 100% light [14]. In New Jersey, mile-a-minute plants reproduced in the full shade of a closed-canopy red maple-black tupelo forest (D. Snyder personal observation cited in [45]). Plants establishing in shaded conditions often use the structure of other vegetation to reach areas where light is readily available ([14], review by [3]). In Maryland, mile-a-minute established in hardwood forest openings and spread into the forest understory a distance of approximately 23 feet (7 m) [24].

Successional role: Mile-a-minute may influence the successional trajectories of native plant communities where it establishes, particularly in areas where the dense, tangled mats of mile-a-minute vines lead to changes in native plant cover or diversity (see Impacts). Because mile-a-minute can either establish in monospecific stands or be integrated with other vegetation [12], its impact on plant community succession probably varies by location.

FIRE EFFECTS AND MANAGEMENT

SPECIES: Polygonum perfoliatum

FIRE EFFECTS:
Immediate fire effect on plant: As of this writing (2010), no information was available about the immediate effects of fire on mile-a-minute. It is likely that fire would kill entire plants. Information was also lacking on fire

effects on mile-a-minute seeds. One source reported that mile-a-minute seeds expand like popcorn when heated in a microwave (R. Westbrooks personal communication cited in [39]).

Postfire regeneration strategy [46]:
Ground residual colonizer (on site, initial community)
Initial off-site colonizer (off site, initial community)

Fire adaptations and plant response to fire:
Fire adaptations: As of 2010, there was no published information regarding mile-a-minute adaptations to fire. The information presented here is inferred from reported botanical traits.

In general, mile-a-minute appears to possess few adaptive traits for surviving fire or establishing after fire. It does not regenerate vegetatively (See Vegetative regeneration), so on-site plants would likely be killed. The consumption of litter by fire would likely create dry conditions that would inhibit mile-a-minute seed germination and establishment, despite other conditions (full sun, disturbance (see Successional status)) or botanical traits (persistence in the seed bank, long-distance seed dispersal) that may appear conducive to mile-a-minute establishment in burned areas. It is possible that mile-a-minute seeds present in the soil seed bank or dispersed from off-site sources could germinate in moist, burned riparian zones or as upland site conditions change during postfire succession.

Plant response to fire: As of 2010 there were no studies available documenting the response of mile-a-minute to fire.

FUELS AND FIRE REGIMES:
Fuels: As of 2010, little is known about the fuel characteristics of mile-a-minute. The density, spatial extent, and climbing nature of mile-a-minute populations suggest that they may alter fuel characteristics in invaded communities. One review suggests that mile-a-minute, along with several other nonnative species, may reduce the flammability of some oak-hickory forests in Virginia, largely through the production of "succulent, almost nonflammable vegetation" [10]. It is not clear whether the persistence of dead stems from year to year would represent an increased fire hazard.

Fire regimes: It is not known what type of fire regime mile-a-minute is best adapted to. The literature contains few descriptions of plant communities where mile-a-minute occurs. It is common in riparian areas in many parts of North America, and fire regimes in riparian areas are often related to fire regimes of adjacent upland communities. Mile-a-minute also occurs in upland areas. Thus fire regimes for plant communities with mile-a-minute could be quite variable. See the Fire Regime Table for further information on fire regimes of plant communities in which mile-a-minute may occur.

FIRE MANAGEMENT CONSIDERATIONS:
Potential for postfire establishment and spread: Postfire establishment and spread of mile-a-minute have not been documented as of 2010. The establishment of mile-a-minute following fire is likely limited by the consumption of litter and consequent lack of moisture in burned areas. However, the frequent dispersal of mile-a-minute seed via waterways suggests that mile-a-minute could establish in burned areas adjacent to riparian zones, particularly if those burned areas exhibit high moisture. It is also possible that seeds present in the soil seed bank could germinate several years following fire, once conditions conducive to germination develop on the site. Mile-a-minute plants adjacent to burned areas could possibly spread into the burned areas, taking advantage of high-light conditions there. However, none of these responses have been documented in the literature (2010).

Preventing postfire establishment and spread: Preventing invasive plants from establishing in weed-free burned areas is the most effective and least costly management method. This can be accomplished through early detection and eradication, careful monitoring and follow-up, and limiting dispersal of invasive plant seed into burned areas. Mile-a-minute's ability to persist in the soil seed bank for several years and/or long-distance seed dispersal suggest that long-term monitoring of burned areas may be necessary to prevent mile-a-minute establishment. Other recommendations for preventing postfire establishment and spread include:

- Incorporate cost of weed prevention and management into fire rehabilitation plans
- Acquire restoration funding
- Include weed prevention education in fire training
- Minimize soil disturbance and vegetation removal during fire suppression and rehabilitation activities
- Minimize the use of retardants containing nitrogen and phosphorus
- Avoid areas dominated by high priority invasive plants when locating firelines, monitoring camps, staging areas, and helibases
- Clean equipment and vehicles prior to entering burned areas
- Regulate or prevent human and livestock entry into burned areas until desirable site vegetation has recovered sufficiently to resist invasion by undesirable vegetation
- Monitor burned areas and areas of significant disturbance or traffic from management activity
- Detect weeds early and eradicate before vegetative spread and/or seed dispersal
- Eradicate small patches and contain or control large infestations within or adjacent to the burned area
- Reestablish vegetation on bare ground as soon as possible
- Avoid use of fertilizers in postfire rehabilitation and restoration
- Use only certified weed-free seed mixes when revegetation is necessary

For more detailed information on these topics see the following publications: [2,4,15,49].

Use of prescribed fire as a control agent: Because mile-a-minute appears to have few adaptations for surviving fire (see Fire adaptations), it is likely that prescribed fire would kill mile-a-minute plants. It is possible that mile-a-minute seeds present in the soil seed bank or dispersed from off-site sources may establish following prescribed fire, but short-term establishment rates may be limited by the need of mile-a-minute seed for moisture to germinate. The persistence of mile-a-minute seeds in the seed bank suggests that seeds could germinate as postfire conditions change.

Altered fuel characteristics: One review suggests that mile-a-minute, along with several other nonnative species, may reduce the flammability of some sites, largely through the production of "succulent, almost nonflammable vegetation" [10]. In sites dominated by mile-a-minute, this characteristic could limit the ability of managers to use prescribed fire to promote the regeneration of desirable native species (Gorman personal communication 2005 cited in [10]).

MANAGEMENT CONSIDERATIONS

SPECIES: Polygonum perfoliatum

FEDERAL LEGAL STATUS:
None

OTHER STATUS:
Mile-a-minute is listed as a noxious weed in several states. Information on state-level noxious weed status of mile-a-minute is available at Plants Database.

IMPORTANCE TO WILDLIFE AND LIVESTOCK:

Palatability and/or nutritional value: The prickly foliage of mile-a-minute is not attractive to herbivorous mammals [10]. However, more than 30 species of herbivorous insects were found on mile-a-minute foliage in Virginia and Pennsylvania [12]. Mile-a-minute fruits are consumed by birds, mammals, and insects (review by [27]).

Cover value: No information is available on this topic.

OTHER USES:
Mile-a-minute fruits are edible to humans and have a high potassium content (review by [12]). Mile-a-minute has been used in China as an herbal medicine for the relief of fever, inflammation, cough, and swelling (review by [58]). It has also been used to treat snakebites and dysentery (review by [7]). Mile-a-minute extracts may reduce blood sugar levels and inhibit cancer cell growth (review by [58]). Extracts from the whole plant have been used for insect pest control in China (review by [57]).

IMPACTS AND CONTROL:
Impacts: Several reviews report that mile-a-minute populations may reduce the abundance and diversity of native plants [3,13,45], largely through the formation of dense, tangled mats of vegetation [9,36]. These mats are thick enough to kill herbaceous vegetation underneath [36], and may even negatively impact other rapidly growing nonnative species like Japanese honeysuckle [9,36]. In laboratory germination experiments, extracts from mile-a-minute had allelopathic qualities [7].

Photo by Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Mile-a-minute may establish in both dense monocultures ([14,24,28,34], review by [19]) and mixtures with other plant species [24,28]. In Pennsylvania, mile-a-minute dominance ranged from 30% to 90% in a variety of site types, including hardwood forests, conifer plantations, and old fields [24]. In some areas of Pennsylvania, mile-a-minute stems reached a density of 300 stems/m² [23]. Mile-a-minute stands in New Jersey covered 1 acre (0.4 ha) or more [45].

The establishment of mile-a-minute at one site in New Jersey led to the demise of a population of the state-endangered manyflower flatsedge (*Cyperus lancastriensis*) in less than a decade (D. Snyder personal observation cited in [45]). In Pennsylvania, mile-a-minute establishing on the edges of stands of the "globally rare" Darlington's glade spurge has led to some concern over how it will impact Darlington's glade spurge in the future [31]. Mile-a-minute completely killed dense stands of Japanese honeysuckle, American black elderberry (*Sambucus canadensis*) and blackberry in a Pennsylvania nursery [36]. In Virginia, sites with established mile-a-minute populations experienced a reduction in vascular plant species richness over a 1-year period. The author suggested that the early spring emergence and rapid growth of mile-a-minute promoted its establishment and spread, even allowing it to limit the persistence of perennial species [14].

Mile-a-minute establishment has several other potential impacts. One review suggests that the changes in plant communities resulting from mile-a-minute establishment could reduce food availability and degrade habitat for wildlife [3]. In recently harvested forests, mile-a-minute establishment limits forest regeneration by shading or growing on top of tree seedlings (W. Mountain and L. McCormick personal communications cited in [39], reviews by [3,27]). In commercial forests where mile-a-minute has impacted tree regeneration, costs ranging from about $60 to

$500/ha may be incurred for site preparation, weed management, and labor to replant seedlings (Charles Brown personal communication cited in [56]). Mile-a-minute presents similar problems in orchards and nurseries (review by [27]). The tangled mats of mile-a-minute may impede the movement of heavy machinery (R. Westbrooks personal communication cited in [39]) or restrict human access to recreational areas [28].

Control: In all cases where invasive species are targeted for control, the potential for other invasive species to fill their void must be considered, no matter what control method is employed [5]. Control of biotic invasions is most effective when it employs a long-term, ecosystem-wide strategy rather than a tactical approach focused on battling individual invaders [32]. Information presented in the following sections may not be comprehensive and is not intended to be prescriptive in nature. It is intended to help managers understand the ecology and control of mile-a-minute in the context of fire management. For more detailed information on the control of mile-a-minute, consult the references cited here or local extension services. For reviews of control recommendations for mile-a-minute, see the following sources: [37,39,58].

Fire: For information on the use of prescribed fire to control mile-a-minute see Fire Management Considerations.

Prevention: To prevent establishment of mile-a-minute, several reviews recommend maintaining wide streamside forest buffers in riparian areas and stable vegetative cover in upland areas (i.e., not creating gaps or disturbances) [3,13,58].

It is commonly argued that the most cost-efficient and effective method of managing invasive species is to prevent their establishment and spread by maintaining "healthy" natural communities [32,43] (e.g., avoid road building in wildlands [48]) and by conducting monitoring several times each year [25]. Managing to maintain the integrity of the native plant community and mitigate the factors enhancing ecosystem invasibility is likely to be more effective than managing solely to control the invader [20]. Weed prevention and control can be incorporated into many types of management plans, including those for logging and site preparation, grazing allotments, recreation management, research projects, road building and maintenance, and fire management [49]. See the "Guide to noxious weed prevention practices" [49] for specific guidelines in preventing the spread of weed seeds and propagules under different management conditions.

Cultural control: Similar to prevention measures, cultural methods of mile-a-minute control include supporting the integrity of existing plant communities, such as maintaining wide streamside forest buffers in riparian areas and stable vegetative cover in upland areas [3,13,58].

Physical or mechanical control: Physical or mechanical methods may effectively control mile-a-minute, though such methods are complicated by the potential for human injury from mile-a-minute's sharp prickles (review by [13]). Hand-pulling is practical for small populations; plants are shallow-rooted and easy to pull (reviews by [3,37]). After seedlings emerge, they can be removed with a hoe (review by [37]). Hand-pulling of seedlings should be done prior to prickles hardening (review by [3]). Mowing or cutting plants with a scythe may be effective (reviews by [37,39]); repeated mowing and trimming may prevent flowering and reduce or eliminate seed production (review by [3]). All physical and mechanical control methods are most successful when done prior to seed set (reviews by [3,37,39]), generally in September and November (review by [39]). Following physical or mechanical treatments, clearing treated areas of debris or decaying plant material is recommended to inhibit mile-a-minute seed germination from the soil seed bank (reviews by [3,38,39]).

Biological control: Biological control of invasive species has a long history that indicates many factors must be considered before using biological controls. Refer to these sources: [53,55] and the Weed Control Methods Handbook [47] for background information and important considerations for developing and implementing biological control programs.

As of 2004, the mile-a-minute weevil, a native of China, was approved by the USDA for biocontrol of mile-a-minute [22,28]. Adult mile-a-minute weevils feed on foliage while larvae feed within stems at nodes. Damage from mile-a-minute weevils may cause enough damage to limit seed production [28]. In some areas, mile-a-minute populations

have completely collapsed 1 to 2 years following introduction of mile-a-minute weevils [21]. For information on the success of the mile-a-minute weevil as a biocontrol agent, see the following sources: [21,28]. For information on fungal associates that could be used as mile-a-minute biological control agents, see [58].

Chemical control: Herbicides are effective in gaining initial control of a new invasion or a severe infestation, but they are rarely a complete or long-term solution to weed management [6]. See the Weed Control Methods Handbook [47] for considerations on the use of herbicides in natural areas and detailed information on specific chemicals.

Herbicides are generally considered effective at controlling mile-a-minute [17,34,37], though the common establishment of mile-a-minute in riparian areas may limit the use of herbicides. For information regarding the use of both pre- and postemergent herbicides to control mile-a-minute, see the following sources: [17,34].

Integrated management: No information is available on this topic.

APPENDIX: FIRE REGIME TABLE

SPECIES: Polygonum perfoliatum

The following table provides fire regime information that may be relevant to mile-a-minute habitats based on descriptions in available literature. Follow the links in the table to documents that provide more detailed information on these fire regimes.

Fire regime information on vegetation communities in which mile-a-minute may occur. This information is taken from the LANDFIRE Rapid Assessment Vegetation Models [30], which were developed by local experts using available literature, local data, and/or expert opinion. This table summarizes fire regime characteristics for each plant community listed. The PDF file linked from each plant community name describes the model and synthesizes the knowledge available on vegetation composition, structure, and dynamics in that community. Cells are blank where information is not available in the Rapid Assessment Vegetation Model.

Northeast

Northeast

- Northeast Grassland
- Northeast Woodland
- Northeast Forested

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum interval (years)
Northeast Grassland					
Northern coastal marsh	Replacement	97%	7	2	50
	Mixed	3%	265	20	
Northeast Woodland					
	Replacement	4%	185		

Oak-pine (eastern dry-xeric)	Mixed	7%	110		
	Surface or low	90%	8		
Northeast Forested					
Northern hardwoods (Northeast)	Replacement	39%	≥1,000		
	Mixed	61%	650		
Northern hardwoods-eastern hemlock	Replacement	50%	≥1,000		
	Surface or low	50%	≥1,000		
Appalachian oak forest (dry-mesic)	Replacement	2%	625	500	≥1,000
	Mixed	6%	250	200	500
	Surface or low	92%	15	7	26
Beech-maple	Replacement	100%	>1,000		

*Fire Severities—
Replacement: Any fire that causes greater than 75% top removal of a vegetation-fuel type, resulting in general replacement of existing vegetation; may or may not cause a lethal effect on the plants.
Mixed: Any fire burning more than 5% of an area that does not qualify as a replacement, surface, or low-severity fire; includes mosaic and other fires that are intermediate in effects.
Surface or low: Any fire that causes less than 25% upper layer replacement and/or removal in a vegetation-fuel class but burns 5% or more of the area [16,29].

Polygonum perfoliatum: REFERENCES

1. Adler, Leon E., Jr. 1999. Water relations and growth of Polygonum perfoliatum in varying light environments. Towson, MD: Towson University. 39 p. Thesis. [78023]

2. Asher, Jerry; Dewey, Steven; Olivarez, Jim; Johnson, Curt. 1998. Minimizing weed spread following wildland fires. Proceedings, Western Society of Weed Science. 51: 49. Abstract. [40409]

3. Binion, Denise E. 2005. Pest alert: Mile-a-minute weed (Polygonum perfoliatum). NA-PR-01-05. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area, State and Private Forestry. 2 p. [77501]

4. Brooks, Matthew L. 2008. Effects of fire suppression and postfire management activities on plant invasions. In: Zouhar, Kristin; Smith, Jane Kapler; Sutherland, Steve; Brooks, Matthew L., eds. Wildland fire in ecosystems: Fire and nonnative invasive plants. Gen. Tech. Rep. RMRS-GTR-42-vol. 6. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 269-280. [70909]

5. Brooks, Matthew L.; Pyke, David A. 2001. Invasive plants and fire in the deserts of North America. In: Galley, Krista E. M.; Wilson, Tyrone P., eds. Proceedings of the invasive species workshop: The role of fire in the control and spread of invasive species; Fire conference 2000: 1st national congress on fire

ecology, prevention, and management; 2000 November 27 - December 1; San Diego, CA. Misc. Publ. No. 11. Tallahassee, FL: Tall Timbers Research Station: 1-14. [40491]

6. Bussan, Alvin J.; Dyer, William E. 1999. Herbicides and rangeland. In: Sheley, Roger L.; Petroff, Janet K., eds. Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State University Press: 116-132. [35716]

7. Chang, Chi-I.; Tsai, Fei-Jane; Chou, Chang-Hung. 2008. Natural products from Polygonum perfoliatum and their diverse biological activities. Natural Product Communications. 3(9): 1385-1386. [77503]

8. Colpetzer, K.; Hough-Goldstein, J. 2004. A rapid germination protocol for mile-a-minute weed, Polygonum perfoliatum L. Seed Science and Technology. 32(3): 749-757. [77507]

9. Cusick, Allison W.; Ortt, Marilyn. 1987. Polygonum perfoliatum L. (Polygonaceae): a significant new weed in the Mississippi drainage. SIDA. 12(1): 246-249. [77518]

10. Dibble, Alison C.; Zouhar, Kristin; Smith, Jane Kapler. 2008. Fire and nonnative invasive plants in the Northeast bioregion. In: Zouhar, Kristin; Smith, Jane Kapler; Sutherland, Steve; Brooks, Matthew L., eds. Wildland fire in ecosystems: fire and nonnative invasive plants. Gen. Tech. Rep. RMRS-GTR-42-vol. 6. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 61-90. [70902]

11. Fleming, Peggy; Kanal, Raclare. 1995. Annotated list of vascular plants of Rock Creek Park, National Park Service, Washington, DC. Castanea. 60(4): 283-316. [71991]

12. Fredericks, James G., III. 2001. A survey of insect herbivores associated with Polygonum perfoliatum L. (mile-a-minute weed) and comparisons of leaf damage and insect diversity between recently established and mature populations. Newark, DE: University of Delaware. 33 p. Thesis. [78024]

13. Gerlach Okay, Judith A.; Hough-Goldstein, Judith; Swearingen, Jil. 2010. Fact sheet: mile-a-minute weed--Persicaria perfoliata L., [Online]. In: Weeds gone wild: Alien plant invaders of natural areas. Plant Conservation Alliance's Alien Plant Working Group (Producer). Available: http://www.nps.gov/plants/alien/fact/pdf/pepe1.pdf [2010, April 29]. [62251]

14. Gerlach Okay, Judy Ann. 1997. Polygonum perfoliatum: a study of biological and ecological features leading to the formation of a management policy. Fairfax, VA: George Mason University. 135 p. Dissertation. [78018]

15. Goodwin, Kim; Sheley, Roger; Clark, Janet. 2002. Integrated noxious weed management after wildfires. EB-160. Bozeman, MT: Montana State University, Extension Service. 46 p. Available online: http://www.montana.edu/wwwpb/pubs/eb160.html [2003, October 1]. [45303]

16. Hann, Wendel; Havlina, Doug; Shlisky, Ayn; [and others]. 2008. Interagency fire regime condition class guidebook. Version 1.3, [Online]. In: Interagency fire regime condition class website. U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior; The Nature Conservancy; Systems for Environmental Management (Producer). 119 p. Available: http://frames.nbii.gov/frcc/documents/FRCC_Guidebook_2008.07.10.pdf [2010, 3 May]. [70966]

17. Hartwig, Nathan L.; Kuhns, Larry J.; McCormick, Larry H. 1995. Controlling mile-a-minute weed with pre- and postemergence herbicides. In: Proceedings, 49th annual meeting of the Northeastern Weed Science Society; 1995 January 2-5; Boston, MA. Boston, MA: Northeastern Weed Science Society: 27-29. [77526]

18. Hickman, James C.; Hickman, Carole S. 1978. Polygonum perfoliatum: a recent Asiatic adventive. Bartonia. 45: 18-23. [77521]

19. Hill, Robert J.; Springer, G.; Borer, L. B. 1981. Mile-a-minute, Polygonum perfoliatum L. (Polygonaceae), a new potential orchard and nursery weed. Regulatory Horticulture. 7(1): 25-28. [Harrisburg, PA: Pennsylvania Department of Agriculture, Bureau of Plant Industry, Weed Circular No. 1]. [79002]

20. Hobbs, Richard J.; Humphries, Stella E. 1995. An integrated approach to the ecology and management of plant invasions. Conservation Biology. 9(4): 761-770. [44463]

21. Hough-Goldstein, Judith; Mayer, Mark A.; Hudson, Wayne; Robbins, George; Morrison, Patricia; Reardon, Richard. 2009. Monitored releases of Rhinoncomimus latipes (Coleoptera: Curculionidae), a biological control agent of mile-a-minute weed (Persicaria perfoliata), 2004-2008. Biological Control. 51(3): 450-457. [77502]

22. Hough-Goldstein, Judith; Schiff, Megan; Lake, Ellen; Butterworth, Brian. 2008. Impact of the biological control agent Rhinoncomimus latipes (Coleoptera: Curculionidae) on mile-a-minute weed, Persicaria perfoliata, in field cages. Biological Control. 46(3): 417-423. [77513]

23. Hyatt, Laura A.; Araki, Sachiko. 2006. Comparative population dynamics of an invading species in its native and novel ranges. Biological Invasions. 8(2): 261-275. [77505]

24. Johnson, Chalmers Fagan. 1996. Achene germination requirements, temporal viability and germination when stored under natural conditions, and abundance in the soil seed bank for the exotic invasive mile-a minute (Polygonum perfoliatum L.). University Park, PA: Pennsylvania State University. 112 p. Thesis. [78022]

25. Johnson, Douglas E. 1999. Surveying, mapping, and monitoring noxious weeds on rangelands. In: Sheley, Roger L.; Petroff, Janet K., eds. Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State University Press: 19-36. [35707]

26. Kartesz, John T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. 1st ed. In: Kartesz, John T.; Meacham, Christopher A. Synthesis of the North American flora (Windows Version 1.0), [CD-ROM]. Chapel Hill, NC: North Carolina Botanical Garden (Producer). In cooperation with: The Nature Conservancy; U.S. Department of Agriculture, Natural Resources Conservation Service; U.S. Department of the Interior, Fish and Wildlife Service. [36715]

27. Kumar, V.; DiTommaso, Antonio. 2005. Mile-a-minute (Polygonum perfoliatum): an increasingly problematic invasive species. Weed Technology. 19: 1071-1077. [73346]

28. Lake, Ellen C. 2007. Dispersal, establishment, and impact of the mile-a-minute weevil, Rhinoncomimus latipes Korotyaev (Coleoptera: Curculionidae): a two-year study in southeastern Pennsylvania. Newark, DE: University of Delaware. 64 p. Thesis. [78021]

29. LANDFIRE Rapid Assessment. 2005. Reference condition modeling manual (Version 2.1), [Online]. In: LANDFIRE. Cooperative Agreement 04-CA-11132543-189. Boulder, CO: The Nature Conservancy; U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior (Producers). 72 p. Available: http://www.landfire.gov/downloadfile.php?file=RA_Modeling_Manual_v2_1.pdf [2007, May 24]. [66741]

30. LANDFIRE Rapid Assessment. 2007. Rapid assessment reference condition models, [Online]. In: LANDFIRE. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Lab; U.S. Geological Survey; The Nature Conservancy (Producers). Available: http://www.landfire.gov/models_EW.php [2008, April 18] [66533]

31. Loeffler, Carol C.; Wegner, Brett C. 2000. Demographics and deer browsing in three Pennsylvania

populations of the globally rare glade spurge, Euphorbia purpurea (Raf.) Fern. Castanea. 65(4): 273-290. [77538]

32. Mack, Richard N.; Simberloff, Daniel; Lonsdale, W. Mark; Evans, Harry; Clout, Michael; Bazzaz, Fakhri A. 2000. Biotic invasions: causes, epidemiology, global consequences, and control. Ecological Applications. 10(3): 689-710. [48324]

33. Massachusetts Introduced Pests Outreach Project. 2009. Pest alert: Mile-a-minute vine (September 23, 2009), [Online]. In: Massachusetts Department of Agricultural Resources--Crop and Pest Services. Boston, MA: Massachusetts Department of Agricultural Resources; University of Massachusetts Extension Agriculture and Landscape Program (Producers). Available: http://www.massnrc.org/pests/linkeddocuments/pestalerts/mileaminutepestalertsept2009.htm [2010, March 25]. [79419]

34. McCormick, Larry H.; Hartwig, Nathan L. 1995. Control of the noxious weed mile-a-minute (Polygonum perfoliatum) in reforestation. Northern Journal of Applied Forestry. 12(3): 127-132. [77516]

35. Mehrhoff, L. J.; Silander, J. A., Jr.; Leicht, S. A.; Mosher, E. S.; Tabak, N. M. 2003. IPANE: Invasive Plant Atlas of New England, [Online]. Storrs, CT: University of Connecticut, Department of Ecology and Evolutionary Biology (Producer). Available: http://nbii-nin.ciesin.columbia.edu/ipane/ [2008, May 28]. [70356]

36. Moul, Edwin T. 1948. A dangerous weedy Polygonum in Pennsylvania. Rhodora. 50: 64-66. [79001]

37. Mountain, Wilber L. 1989. Mile-a-minute, Polygonum perfoliatum L. (Polygonaceae) update--distribution, biology, and control suggestions. Regulatory Horticulture. 15(2): 21-24. [Harrisburg, PA: Pennsylvania Department of Agriculture, Bureau of Plant Industry, Weed Circular No. 15]. [79003]

38. Oliver, J. Douglas. 1996. Mile-a-minute weed (Polygonum perfoliatum L.), an invasive vine in natural and disturbed sites. Castanea. 61(3): 244-251. [73803]

39. Oliver, J. Douglas; Coile, Nancy C. 1994. Polygonum perfoliatum L. (Polygonaceae), the mile-a-minute weed. Botany Circular No. 29. Gainesville, FL: Florida Department of Agriculture & Consumer Services, Division of Plant Industry. 4 p. [77500]

40. Raunkiaer, C. 1934. The life forms of plants and statistical plant geography. Oxford: Clarendon Press. 632 p. [2843]

41. Riefner, Richard E., Jr. 1982. Studies on the Maryland flora VIII: Range extensions of Polygonum perfoliatum L., with notes on introduction and dispersal in North America. Phytologia. 50(2): 152-159. [77519]

42. Riefner, Richard E., Jr.; Windler, Donald R. 1979. Polygonum perfoliatum L. established in Maryland. Castanea. 44(2): 81-93. [77520]

43. Sheley, Roger; Manoukian, Mark; Marks, Gerald. 1999. Preventing noxious weed invasion. In: Sheley, Roger L.; Petroff, Janet K., eds. Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State University Press: 69-72. [35711]

44. Shuppert, David Allen. 2001. Assessment of genetic variation among populations of Polygonum perfoliatum using RAPD markers. Towson, MD: Towson University. 43 p. Thesis. [78020]

45. Snyder, David; Kaufman, Sylvan R. 2004. An overview of nonindigenous plant species in New Jersey. Trenton, NJ: New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Natural Heritage Program. 107 p. [71446]

46. Stickney, Peter F. 1989. Seral origin of species comprising secondary plant succession in Northern Rocky Mountain forests. FEIS workshop: Postfire regeneration. Unpublished draft on file at: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT. 10 p. [20090]

47. Tu, Mandy; Hurd, Callie; Randall, John M., eds. 2001. Weed control methods handbook: tools and techniques for use in natural areas. Davis, CA: The Nature Conservancy. 194 p. [37787]

48. Tyser, Robin W.; Worley, Christopher A. 1992. Alien flora in grasslands adjacent to road and trail corridors in Glacier National Park, Montana (U.S.A.). Conservation Biology. 6(2): 253-262. [19435]

49. U.S. Department of Agriculture, Forest Service. 2001. Guide to noxious weed prevention practices. Washington, DC: U.S. Department of Agriculture, Forest Service. 25 p. Available online: http://www.fs.fed.us/invasivespecies/documents/FS_WeedBMP_2001.pdf [2009, November 19]. [37889]

50. U.S. Department of Agriculture, Natural Resources Conservation Service. 2010. PLANTS Database, [Online]. Available: http://plants.usda.gov/. [34262]

51. Uva, Richard H.; Neal, Joseph C.; DiTomaso, Joseph M., eds. 1997. Weeds of the Northeast. New York: Cornell University Press. 397 p. [72430]

52. Van Clef, Michael. 2001. Early life stage performance of native and non-native congeners of Polygonum, Celastrus, and Parthenocissus: Assessing methods of screening new plant introductions for invasive potential. New Brunswick, NJ: Rutgers The State University of New Jersey. 166 p. Dissertation. [78017]

53. Van Driesche, Roy; Lyon, Suzanne; Blossey, Bernd; Hoddle, Mark; Reardon, Richard, tech. coords. 2002. Biological control of invasive plants in the eastern United States. Publication FHTET-2002-04. Morgantown, WV: U.S. Department of Agriculture, Forest Service, Forest Health Technology Enterprise Team. 413 p. Available online: http://www.invasive.org/eastern/biocontrol/index.html [2009, November 19]. [54194]

54. Weber, Ewald. 2003. Invasive plant species of the world: a reference guide to environmental weeds. Cambridge, MA: CABI Publishing. 548 p. [71904]

55. Wilson, Linda M.; McCaffrey, Joseph P. 1999. Biological control of noxious rangeland weeds. In: Sheley, Roger L.; Petroff, Janet K., eds. Biology and management of noxious rangeland weeds. Corvallis, OR: Oregon State University Press: 97-115. [35715]

56. Wu, Yun; Reardon, Richard C.; Jian-qing, Ding. 2002. Mile-a-minute weed. In: Van Driesche, Roy; Lyon, Suzanne; Blossey, Bernd; Hoddle, Mark; Reardon, Richard, tech. coords. Biological control of invasive plants in the eastern United States. Publication FHTET-2002-04. Morgantown, WV: U.S. Department of Agriculture, Forest Service, Forest Health Technology Enterprise Team: 331-341. Available online: http://www.invasive.org/eastern/biocontrol/26MileAMinute.html [2005, August 12]. [54259]

57. Yang, R. Z.; Tang, C. S. 1988. Plants used for pest control in China: a literature review. Economic Botany. 42(3): 376-406. [71936]

58. Yun, Wu. 2006. Fungal associates of mile-a-minute (Polygonum perfoliatum L.) and their potential as biological control agents. Houghton, MI: Michigan Technological University. 184 p. Dissertation. [78016]

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