

Microstegium vimineum

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INTRODUCTORY

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Understory infestation. Photo ©John M. Randall/The Nature Conservancy

AUTHORSHIP AND CITATION:

Howard, Janet L. 2005. *Microstegium vimineum*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis/> [2007, September 24].

FEIS ABBREVIATION:

MICVIM

SYNONYMS:

Eulalia viminea (Trin.) Kuntze

Eulalia viminea var. *variabilis* Kuntze [31]

Microstegium vimineum var. *imberbe* (Nees) Honda

Microstegium vimineum var. *vimineum* [50]

NRCS PLANT CODE [101]:

MIVI

COMMON NAMES:

Nepalese browntop

eulalia

Japanese stiltgrass

Japanese grass

Mary's grass

Nepal grass

TAXONOMY:

The scientific name for Nepalese browntop is *Microstegium vimineum* (Trin.) A. Camus (Poaceae) [39,50,52,66,69,75,109].

LIFE FORM:

Graminoid

FEDERAL LEGAL STATUS:

None

OTHER STATUS:

As of this writing (2005), Nepalese browntop is classified as an invasive species in 6 states and 2 Forest Service Regions. Missouri ranks Nepalese browntop in Category B: a plant species that either a) has occasional impact with low impact on native plant communities; or b) disrupts native plant communities in other states, in habitats similar to those found in Missouri [65]. Other state rankings are:

State	Status
Alabama	Noxious weed
Georgia	Noxious weed [37]
Kentucky	Rank 1, a severe threat [53]
Tennessee	Rank 1, a severe threat [89]
Virginia	Highly invasive [105]

The Eastern and Southern Regions of the U.S. Forest Service lists Nepalese browntop as a Category 1 noxious weed: a nonnative, highly invasive plant that invades natural habitats and replaces native species [98,99].

DISTRIBUTION AND OCCURRENCE

SPECIES: *Microstegium vimineum*

- [GENERAL DISTRIBUTION](#)
- [ECOSYSTEMS](#)
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- [BLM PHYSIOGRAPHIC REGIONS](#)
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- [SAF COVER TYPES](#)
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GENERAL DISTRIBUTION:

Nepalese browntop occurs in Asia and the United States. It is native to Japan, Korea, China, Malaysia, India, and the Caucasus [31,39,66,69]. It has invaded portions of Asia where it is not native, extending its Asian range into Pakistan, Nepal [40], and Turkey [84]. In the United States it is sporadically distributed throughout most of the East and in the Caribbean, from New York south to Texas, Florida, Puerto Rico, and the Virgin Islands [30,39,52]. It is rare in Florida and other parts of the Southeast [75,109] but is rapidly increasing in Maryland, New York, and other northern states [49,78]. Nepalese browntop was 1st noted in North America in 1917 in Tennessee, where it was probably introduced accidentally [26]. It was formerly used as packing material for imported Chinese porcelain, and discarded packaging material containing seeds was probably the source of introduction [105]. Rivers and ditches appear to be the primary corridors for population expansion [49]. [Plants database](#) provides a state distributional map of Nepalese browntop.

The following lists give biogeographic classifications where Nepalese browntop is known to be present or invasive, or is likely to be invasive based upon current knowledge of Nepalese browntop's habitat preferences. Precise distribution information is unavailable for all locations where Nepalese browntop may be invasive. The following lists are therefore speculative and not exhaustive, and Nepalese browntop may be present and possibly invasive in other vegetation types.

ECOSYSTEMS [36]:

FRES10 White-red-jack pine

FRES12 Longleaf-slash pine

FRES13 Loblolly-shortleaf pine
 FRES14 Oak-pine
 FRES15 Oak-hickory
 FRES16 Oak-gum-cypress
 FRES17 Elm-ash-cottonwood
 FRES18 Maple-beech-birch

STATES/PROVINCES: ([key to state/province abbreviations](#))

AL	AR	CT	DE	FL	GA	IL
IN	IA	KY	LA	MD	MS	MO
NJ	NY	NC	OH	PA	SC	TN
TX	VA	WV	DC	PR	VI	

BLM PHYSIOGRAPHIC REGIONS [[12](#)]:

None

KUCHLER [[59](#)] PLANT ASSOCIATIONS:

K081 Oak savanna
 K083 Cedar glades
 K084 Cross Timbers
 K089 Black Belt
 K098 Northern floodplain forest
 K099 Maple-basswood forest
 K100 Oak-hickory forest
 K101 Elm-ash forest
 K102 Beech-maple forest
 K103 Mixed mesophytic forest
 K104 Appalachian oak forest
 K106 Northern hardwoods
 K109 Transition between K104 and K106
 K110 Northeastern oak-pine forest
 K111 Oak-hickory-pine
 K112 Southern mixed forest
 K113 Southern floodplain forest
 K114 Pocosin

SAF COVER TYPES [[28](#)]:

17 Pin cherry
 19 Gray birch-red maple
 23 Eastern hemlock
 24 Hemlock-yellow birch
 25 Sugar maple-beech-yellow birch
 26 Sugar maple-basswood
 27 Sugar maple
 28 Black cherry-maple
 39 Black ash-American elm-red maple
 40 Post oak-blackjack oak
 42 Bur oak
 43 Bear oak
 44 Chestnut oak
 45 Pitch pine
 46 Eastern redcedar
 50 Black locust
 51 White pine-chestnut oak
 52 White oak-black oak-northern red oak
 53 White oak
 55 Northern red oak
 57 Yellow-poplar

58 Yellow-poplar-eastern hemlock
 59 Yellow-poplar-white oak-northern red oak
 60 Beech-sugar maple
 61 River birch-sycamore
 62 Silver maple-American elm
 63 Cottonwood
 64 Sassafras-persimmon
 65 Pin oak-sweetgum
 69 Sand pine
 70 Longleaf pine
 71 Longleaf pine-scrub oak
 72 Southern scrub oak
 73 Southern redcedar
 74 Cabbage palmetto
 75 Shortleaf pine
 76 Shortleaf pine-oak
 78 Virginia pine-oak
 79 Virginia pine
 80 Loblolly pine-shortleaf pine
 81 Loblolly pine
 82 Loblolly pine-hardwood
 83 Longleaf pine-slash pine
 84 Slash pine
 85 Slash pine-hardwood
 87 Sweetgum-yellow-poplar
 88 Willow oak-water oak-diamondleaf (laurel) oak
 89 Live oak
 91 Swamp chestnut oak-cherrybark oak
 92 Sweetgum-willow oak
 93 Sugarberry-American elm-green ash
 94 Sycamore-sweetgum-American elm
 95 Black willow
 96 Overcup oak-water hickory
 98 Pond pine
 102 Baldcypress-tupelo
 103 Water tupelo-swamp tupelo
 104 Sweetbay-swamp tupelo-redbay
 108 Red maple
 109 Hawthorn
 110 Black oak

SRM (RANGELAND) COVER TYPES [87]:

731 Cross timbers
 732 Cross timbers
 801 Savanna
 805 Riparian
 810 Longleaf pine-turkey oak hills
 812 North Florida flatwoods

HABITAT TYPES AND PLANT COMMUNITIES:

Nepalese browntop occurs in a variety of habitats in the eastern United States. Shade, low elevation, and moist to mesic soils are important features corresponding with successful Nepalese browntop invasion (see [Site Characteristics](#)). Overstory type is apparently less important in determining Nepalese browntop presence or absence.

In recently burned, mixed-mesophytic woodland of southern **Illinois**, Nepalese browntop has associated with Philadelphia fleabane (*Erigeron philadelphicus*), clammy groundcherry (*Physalis heterophylla*), fragrant bedstraw (*Galium triflorum*) and drooping woodreed (*Cinna latifolia*) in the understory. Overstory associates included river birch (*Betula nigra*), black walnut (*Juglans nigra*), sycamore (*Platanus occidentalis*), black cherry (*Prunus serotina*), and winged elm (*Ulmus alata*) [3]. Overstory associates in a southern Illinois black oak-post oak (*Quercus velutina*-*Q. stellata*) forest in early old-field

succession included eastern redcedar (*Juniperus virginiana*), flowering dogwood (*Cornus florida*), sassafras (*Sassafras albidum*), and common persimmon (*Diospyros virginiana*). Coralberry (*Symphoricarpos orbiculatus*), Japanese honeysuckle (*Lonicera japonica*), and poison-ivy (*Toxicodendron radicans*) were common woody understory associates. Herbaceous associates included big bluestem (*Andropogon gerardii*), golden alexanders (*Zizia aurea*), and blunt-lobe woodsia (*Woodsia obtusa*) [38].

In **New Jersey**, Nepalese browntop occurred in mixed red-black-chestnut-white oak (*Q. rubra-Q. velutina-Q. prinus-Q. alba*) and white ash-sweet birch-American beech (*Fraxinus americana-Betula lenta-Fagus grandifolia*) forests, but was less common on sites with high cover of overstory oaks and understory blueberries (*Vaccinium* spp.) [55]. Overstory associates of Nepalese browntop in a sugar maple-red maple (*Acer saccharum-A. rubrum*)-sweet birch forest in New Jersey included shagbark hickory (*Carya ovata*), bitternut hickory (*C. cordiformis*), and American elm (*U. americana*). The most common shrubs included multiflora rose (*Rosa multiflora*), black haw (*Viburnum prunifolium*), and spicebush (*Lindera benzoin*). Jack-in-the-pulpit (*Arisaema vimineum*) frequently co-occurred in the ground layer, although Nepalese browntop was the most common ground layer species [103].

Nepalese browntop occurs in the understories of Virginia pine-southern red oak (*Pinus virginiana-Q. falcata*) communities in **Maryland**. Yellow-poplar (*Liriodendron tulipifera*), red maple, hickories (*Carya* spp.), and black cherry are associates [16]. Nepalese browntop is also a component of mixed oak-sweetgum-swamp tupelo (*Quercus* spp.-*Liquidambar styraciflua-Nyssa sylvatica* var. *biflora*) communities on in inland coastal plain of Chesapeake Bay, off Maryland and Virginia [79]. On the George Washington Memorial Parkway in **Virginia**, Nepalese browntop occurs in the ground layer of old-growth oak-hickory (*Quercus-Carya* spp.) forest. Dominant trees include white, scarlet (*Q. coccinea*), and chestnut oaks, shagbark hickory, and mockernut hickory (*C. tomentosa*). Shrub associates include mountain-laurel (*Kalmia latifolia*), pink azalea (*Rhododendron periclymenoides*), and black huckleberry (*Gaylussacia baccata*). Ground-layer herbaceous associates are winter bent grass (*Agrostis hyemalis*), broomsedge bluestem (*Andropogon virginicus*), common velvet grass (*Holcus lanatus*), and white clover (*Trifolium repens*). Vines are common in the forest and include trumpet-creeper (*Campsis radicans*), Oriental bittersweet (*Celastrus orbiculatus*), Japanese honeysuckle, and summer grape (*Vitis aestivalis*) [107].

Nepalese browntop is very common in low-elevation oak-pine (*Quercus-Pinus* spp.) forests of the **Piedmont** [49,80,81], where it is an indicator of red clay soils [49]. Romagosa and Robinson [81] provide a comprehensive list of shrub, vine, and herbaceous associates of Nepalese browntop in upland loblolly pine (*P. taeda*)-mixed oak forest on Piedmont sites in Pennsylvania.

In mixed-hardwood forest in the Cumberland Mountains of **Kentucky**, overstory associates of Nepalese browntop have included northern red oak (*Q. rubra*), white oak, yellow-poplar, Virginia pine, sugar maple (*Acer saccharum*), basswood (*Tilia heterophylla*), American beech, and yellow buckeye (*Aesculus octandra*). Common shrubs and vines were strawberry-bush (*Euonymus americana*), hillside blueberry (*Vaccinium pallidum*), Virginia creeper (*Parthenocissus quinquefolia*), and common greenbrier (*Smilax rotundifolia*). At 9% to 35% cover, Nepalese browntop was the most common graminoid. Associated grasses and forbs included mannagrass (*Glyceria* spp.), slender muhly (*Muhlenbergia tenuiflora*), white snakeroot (*Ageratina altissima*), and panicleleaf ticktrefoil (*Desmodium paniculatum*) [76].

Nepalese browntop often associates with other invasive, nonnative species in the understory, with native species in the overstory. Japanese honeysuckle is a consistent understory associate of Nepalese browntop. On a North Carolina floodplain, Nepalese browntop and Japanese honeysuckle comprised nearly 100% of the understory of a boxelder-green ash (*Acer negundo-Fraxinus pennsylvanica*)-sycamore forest [5]. Japanese barberry (*Berberis thunbergii*) is another nonnative shrub that commonly co-occurs with Nepalese browntop across Nepalese browntop's distributional range [82]. In New Jersey, Nepalese browntop and Japanese barberry co-occurred in bottomland oak (*Quercus* spp.)-American beech-sweet birch forest. Hillside blueberry and black huckleberry were commonly associated native shrubs [27]. In southern Illinois oak-hickory forest, Nepalese browntop co-occurred with Japanese honeysuckle, sericea lespedeza (*Lespedeza cuneata*), and multiflora rose [38].

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: *Microstegium vimineum*

- [GENERAL BOTANICAL CHARACTERISTICS](#)
- [RAUNKIAER LIFE FORM](#)
- [REGENERATION PROCESSES](#)
- [SITE CHARACTERISTICS](#)
- [SUCCESSIONAL STATUS](#)
- [SEASONAL DEVELOPMENT](#)



James H Miller, USDA Forest Service,
www.ipmimages.org

GENERAL BOTANICAL CHARACTERISTICS:

This description provides characteristics that may be relevant to fire ecology, and is not meant for identification. Keys for identification are available (e.g. [[39](#),[50](#),[66](#),[69](#),[75](#),[109](#)]).

Morphology:

Nepalese browntop is a nonnative annual grass. It has a straggling to decumbent, loosely branched habit. Aerial culms are 3 to 5 feet (1-1.5 m) long. Nepalese browntop also produces short to long (depending upon shading), spreading stolons. Nepalese browntop populations often form dense lawns of intertwined stolons. Nepalese browntop leaves are cauline, with 0.5-inch- (1-cm) wide and 3- to 4-inch- (8- to 10-cm) long blades. The inflorescence is a 4.5 to 6 mm, terminal or axillary raceme bearing paired spikelets. The upper lemma is fertile; the lower lemma is sterile and often bears a 4- to 8-mm, twisted awn, although some fruits are awnless. The fruit is a 2.8- to 3.0-mm, ellipsoid caryopsis [[18](#),[31](#),[39](#),[75](#),[105](#)]. Root biomass of Nepalese browntop is "remarkably small" compared to its aboveground biomass [[26](#),[27](#)].

There has been confusion as to whether Nepalese browntop is sometimes perennial [[25](#),[26](#),[63](#)]. Mehrhoff [[63](#)] states that this confusion arose from misidentification of white grass (*Leersia virginica*), a morphologically similar native perennial, as Nepalese browntop. Nepalese browntop is distinguished from white grass, which it often co-occurs with, by its ciliate leaf sheath collar and paired spikelets (vs. white grass' glabrous to pubescent leaf sheath and 1-flowered spikelets) [[63](#)].

Physiology: Nepalese browntop is adapted to low-light conditions [[20](#),[47](#),[96](#)]. Nepalese browntop uses C₄ pathway photosynthesis. It is highly unusual for a C₄

grass to photosynthesize efficiently under low light conditions, but Nepalese browntop is very shade tolerant [[5](#),[8](#),[13](#),[47](#),[108](#)]. In the greenhouse, Winter and others [[108](#)] found Nepalese browntop grew well under 5% of full sunlight, and the photosynthetic rate of individual leaves was fully saturated at 25% of full sunlight. Dry-matter biomass production was similar under 18% to 100% of full sunlight. Nepalese browntop in the understory of a closed-canopy yellow-poplar-white oak forest in Great Smoky Mountains National Park took advantage of occasional, high-intensity sunflecks for optimal photosynthesis [[47](#)]. Best Nepalese browntop growth occurs on forest-grassland ecotones, where mean photosynthetically active radiation (PAR) is 35% [[20](#)]. Ueno [[102](#)] provides a description of Nepalese browntop's leaf physiology and cellular anatomy.

Species response to increased levels of atmospheric CO₂ can affect plant community composition. High CO₂ levels may negatively affect Nepalese browntop compared to other plants species that are better able to assimilate extra CO₂. In field experiments in Tennessee, Belote and others [[11](#)] found that in a wet year, Nepalese browntop produced twice as much biomass under ambient CO₂ levels compared to elevated CO₂ levels. In a dry year, there was no significant difference (p=0.07) in Nepalese browntop biomass between CO₂ treatments. In contrast, Japanese honeysuckle, a common associate of Nepalese browntop, produced 3 times as much biomass under elevated CO₂ levels in both wet and dry years.

RAUNKIAER [[77](#)] LIFE FORM:

[Therophyte](#)

REGENERATION PROCESSES:

As an annual, the success of Nepalese browntop invasion or persistence in a community depends solely on germination and seedling establishment every year [[38](#),[96](#)]. Within a growing season, it spreads vegetatively from stolons [[5](#),[18](#)]. Nepalese browntop appears adaptable in growing strategy (seed or stolon production), depending upon environmental conditions. In field and greenhouse studies near Memphis, Tennessee, Nepalese browntop showed "extreme plasticity" in morphology, producing stolons and flowers under a wide range of nutrient and light conditions. Unsurprisingly, a combination of infertile soil and low light conditions was least likely to promote production of flowers and seeds. However, with either a combination of infertile soil and high light, or fertile soil and low light, Nepalese browntop was able to compensate for the limited

resource, producing both flowers and stolons. Environmental conditions largely dictated the relative allocation of carbon to leaves and flowers vs. stolons. Allocation to leaves and flowers was greatest on shaded, fertilized plots, while allocation to stolons was greatest on open, fertilized plots [18].

Breeding system: In Japan and Taiwan, both [cleistogamy](#) and [chasmogamy](#) have been observed in Nepalese browntop, with cleistogamous flowers growing on axillary racemes and chasmogamous flowers growing on terminal racemes [60,94]. Nepalese browntop in the United States apparently also utilizes both breeding systems, although mechanisms controlling which breeding system is utilized are understudied. In a Nepalese browntop population near Charlotte, North Carolina, Barden [5] found about 10% of plants had chasmogamous flowers, with chasmogamous plants mostly growing in moist, open sites. All Nepalese browntop growing in heavy shade had cleistogamous flowers. This suggests that light conditions may affect flower development and breeding. In southern Illinois population with 80% overstory cover, flowers were mostly cleistogamous [38]. In New York, chasmogamous flowers were most common in shady forests interiors. The ratio of cleistogamous:chasmogamous flowers increased in the greenhouse; tillers were also larger in the greenhouse compared to closed-canopy forest [17]. Further studies are needed regarding breeding systems of Nepalese browntop.

Pollination: Nepalese browntop is both self- and cross-pollinated [48].

Seed production is reportedly high for Nepalese browntop [18,105]. A single Nepalese browntop culm produces from 100 to 1,000 seeds [105]. A southern Illinois study found a mean of 81.7 spikelets/Nepalese browntop culm. However, pooled seed viability for 4 Nepalese browntop populations was low (33%). Spikelet production varied significantly ($p < 0.001$) among populations. Nepalese browntop populations may fail to flower in drought years [38].

Wind, water, animals, and humans **disperse seed** [5,10,38,92,96]. Nepalese browntop fruits are light and easily float on water, so flooding is a common means of seed dispersal. Nepalese browntop readily invades floodplains where flooding is the only disturbance [5,38]. Highest cover typically occurs on disturbed floodplains (e.g., developed or frequently mowed) [5]; however, frequent, severe flood scouring can limit Nepalese browntop establishment and spread [38]. Nepalese browntop seeds may survive and germinate after "extended periods" of inundation [105]. The seed awns (of awned fruits) catch on animal hides, feathers, and human clothing [5,10,38,92,96]. Nepalese browntop fruits are small, so even awnless fruits can work their way into fur or clothing [96]. Machinery, deposition of fill dirt, and contaminated hay also disperse Nepalese browntop seed [5,10,38,92,96]. A Nepalese browntop population along a hiking trail in southern Illinois most likely established from seed dispersed by tractors used to grade the trail, and/or hikers [38].

Seed banking: Nepalese browntop builds a soil seed bank [5,38]. Estimates of seed longevity range from 3 to 5 years [5,96,105]. On a North Carolina site, soil-stored Nepalese browntop seed remained viable for at least 3 years. Barden [5] estimated the number of plants produced from 1983 to 1986 on a 2-m² study plot was 1,000 (in 1983), 256 (1984), 44 (1985), and 0 (1986), respectively. Another 2-m² study plot on the North Carolina site, measured from 1984 to 1986, produced 857, 47, and 29 Nepalese browntop plants, respectively [5].

Germination: Although seed production is reportedly high [18,105], few seed germination and viability studies have been conducted as of this writing (2005). A greenhouse study found that fresh seed was not immediately germinable, while seeds grown for 90 days showed 100% germination rates [51]. A southern Illinois study found poor seed germinability during a drought year (see Seed production above). Even so, mean seed rain was 24.6 seeds/m² ($n = 34$ seed traps). It is difficult to conclude that occasional seed failure is limiting for this species. Given a persistent seed bank, Nepalese browntop may establish in high densities the year following seed crop failure [38].

Seedling establishment/growth: In the southern Illinois study [38], Nepalese browntop seedlings established at a mean density of 43/m². Plant mortality was a greatest (50% or more) in early seedling establishment (mid-March), dropping to about 20% by July [38].

Nepalese browntop shows plasticity to its environment, allocating carbon resources for best growth and reproduction. On shaded sites, more carbon is allocated to leaves and aerial stems compared to stolons, maximizing photosynthetic tissues and output [18]. Nepalese browntop is well adapted to shady conditions. It can establish, grow, and produce seed in as little as 5% of full sunlight [105].

Barriers to reproduction:

In North Carolina, Nepalese browntop regeneration was negatively correlated with higher soil pH (5.5 vs. a median of 5.1); higher levels of soil potassium, zinc, and calcium; higher percent silt (18% vs. 10%); deeper litter (8.6 vs. 5.5 cm); greater cumulative PAR on an overcast day (0.72 vs. 0.57 mol/m²/day); and greater leaf area index (LAI) of other species (1.3 vs. 0.7) (see [Nepalese browntop and Japanese honeysuckle](#) for further information) [5]. In southern Illinois, reproductive success was

correlated with soil conditions and canopy cover. Reproduction increased with increasing availability of soil cations and soil sand content, and decreased with increased soil silt content and canopy cover. Late-season drought can greatly reduce or eliminate Nepalese browntop seed production for a cohort [38].

Deep litter, especially oak litter, may retard ability of Nepalese browntop to establish [5,26]. In a landscape-level study of 3 white oak-sweet birch forests in New Jersey, sites with Nepalese browntop had lower amounts of litter compared to adjacent uninvaded sites. Over 2 years, the on-site decay rate of white oak litter was slower (30% mass loss) than decay rates for sweet birch and Nepalese browntop litter (40%-50% for both spp.). Nepalese browntop may alter site conditions once it has established, impairing the ability of native plant species to establish. Other differences on Nepalese browntop-invaded sites included thinner organic soil horizons, higher soil pH values ($\mu=6.0$), and higher levels of available soil nitrate compared to adjacent uninvaded sites [26]. Other researchers have had similar findings (see [Impacts](#) for further discussion).

Asexual regeneration: During a growing season, Nepalese browntop increases vegetatively by tillers and stolons [49]. Because Nepalese browntop is an annual, these vegetative shoots do not survive through the next growing season [38]. Large vegetative biomass does, however, increase the likelihood of reproductive success by increasing photosynthate and thus, the potential for greater seed production.

SITE CHARACTERISTICS:

Nepalese browntop is favored on mesic to moist sites [5] such as wet Florida hammocks [109]. It is common in disturbed areas including roadsides, shorelines, and "waste places" [31,66]. It readily establishes on floodplains [5]. Best development occurs on sites that do not receive full sun [105]. For example, in Maryland, Nepalese browntop infestations were common on shaded roadside sites, but not open roadside sites [78]. Nepalese browntop transplanted into canopy gaps in a boxelder-green ash-sycamore forests showed better growth on the west side of the gaps compared to the east side [7].

Soils: Nepalese browntop is common on silty to sandy loams [5,38,76]. It is also reported on red clays [49]. Soil pH is generally acidic, although some populations occur on neutral, limestone- or marble-derived soils [96]. A survey in Maryland and Washington, DC, found that Nepalese browntop sites ranged from 4.8 to 5.8 in pH [78]. On mine spoils in Kentucky, Nepalese browntop grew on loamy soils ranging from 4.6 to 6.3 pH. It was absent from an extremely acidic site (pH 4.4) [76]. Nutrient content may vary. In an Illinois study, soils supporting Nepalese browntop were generally acidic and nutrient poor [38]. Other studies report high levels of nitrogen, and average levels of potassium and phosphorus, on Nepalese browntop-infested soils [78].

Nepalese browntop prefers damp to wet soils, although it does not tolerate standing water for "extended periods" of time [105]. It may also establish on drier, upland soils [92]. The Virginia Department of Conservation and Recreation [105] states that Nepalese browntop is common on disturbed soils and can rapidly spread onto undisturbed soils once established. Characteristics for undisturbed sites most vulnerable to invasion were not given.

Elevation: Nepalese browntop occurs from sea level up to 4,000 feet (1,000 m) elevation [64]. It is most common in low-elevation woodlands in the Mid-Atlantic states and the Piedmont and Appalachian mountains [75]. As of this writing (2005), it is not reported from higher-elevation red spruce-Fraser fir (*Picea rubens-Abies fraseri*) forests.

Climate:

Information on optimal growing temperature and temperature limits for Nepalese browntop were not available as of this writing (2005). The coldest reported winter temperatures that Nepalese browntop survived were approximately -5.8 to -9.4 °F (-21 to -23 °C) [78].

SUCCESSIONAL STATUS:

Nepalese browntop is a shade-tolerant grass that can occupy all stages of forest succession. It colonizes recently disturbed sites including hurricane-disturbed [95] and new burn sites [3,38]. On abandoned surface coal mines in Kentucky, Nepalese browntop was the most important understory herb in early mixed-mesophytic forest succession, forming 9% to 35% cover. It formed thick swards in open areas [76]. Nepalese browntop may establish following canopy disturbance. In Connecticut eastern hemlock (*Tsuga canadensis*) forests with high mortality from hemlock wooly adelgids, several nonnative species showed high cover including Nepalese browntop, Oriental bittersweet, Japanese barberry, and tree-of-heaven (*Ailanthus altissima*) [70]. Nepalese browntop may delay or stop canopy gap succession in eastern forests by establishing in gaps that were historically colonized by oaks, hickories, ashes, and other early seral tree species [74]. Nepalese browntop also invades sites with older disturbance histories including old fields, old clearcuts, old minespoils, and old burns [3,38,71,76].

Nepalese browntop can invade old growth forest understories. For example, it is a component of the understory in old-growth sweetgum-overcup oak (*Quercus lyrata*)-river birch bottomland forests of Tennessee [85]. It can form patches or dense,

continuous lawns in late-successional forests [26], but may not establish in very shady sites. Field experiments in an oak-hickory forest in Kentucky showed that Nepalese browntop was unable to establish under the understory canopy, which consisted of juvenile red maples and spice bushes (*Lindera bensoin*). The oak-hickory forest was in late succession, and PAR was 1% to 2.5% of full sunlight beneath the red maple and spice bush subcanopy [20].

Nepalese browntop recovers rapidly after flooding. A North Carolina study was initiated in 1982 on the Big Cross Creek floodplain. Big Cross Creek flooded the study plots in 1983, reducing Nepalese browntop cover. Nepalese browntop cover during the study period was [5]:

1982 (preflood)	1983 (postflood)	1985 (postflood)
48%	23%	55%

The input of silt and nutrients that accompanies short-term flooding can increase Nepalese browntop growth rate [5].

SEASONAL DEVELOPMENT:

Nepalese browntop sets seed later than most associated species [38,104], which can be important for control efforts. Nepalese browntop produces flowers in late summer (August-September), and seeds mature in November and December [60].

Phenology by state and region is:

Area	Event	Season
Carolinas	flowers	September-October [75]
Florida	flowers	Fall [109]
Illinois	seedlings establish	May [38]
	flowers	September-October [66]
	disperses seed and dies	October-November [38]
North Carolina	germinates	March
	stem expands	April
	flowers	September
	disperses seed and dies	October [5]
Virginia	germinates	March
	flowers	October [22]
Eastern U.S.	fruits	September-October [64,96]
	disperses seed and dies	September-December [64]

FIRE ECOLOGY

SPECIES: *Microstegium vimineum*

- [FIRE ECOLOGY OR ADAPTATIONS](#)
- [POSTFIRE REGENERATION STRATEGY](#)

FIRE ECOLOGY OR ADAPTATIONS:

Fire adaptations: Nepalese browntop is an invasive species that can colonize newly disturbed areas such as burns [3,38]. As an annual, its sole means of postfire establishment is through seed: either from on-site, soil-banked seed, or from off-site, transported seed. Postfire Nepalese browntop establishment from soil-stored seed is documented in the literature [2,3,5]. Given its ease of seed transport and ability to invade onto newly disturbed sites [5,10,38,92,96], Nepalese browntop probably also establishes from off-site seed transported to moist and mesic burns.

Fuels:

As an annual, mat-forming grass, Nepalese browntop produces large amounts of fine fuels. Nepalese browntop stems lodge soon after they die in autumn, creating a continuous fuelbed of matted straw that promotes surface and ground fires [5,16]. In a New Jersey study, Nepalese browntop litter decayed more slowly than litter of native hillside blueberry [27].

Fire regimes vary across Nepalese browntop's range. In northeastern maple-birch-beech (*Acer-Betula-Fagus* spp.) forests, historic fire return intervals were highly variable, depending upon microclimate, topography, and soil. Fires were mostly of mixed severity. Stand-replacing, medium-interval (~ 80-yr) fires were most common in forests dominated by birches, while long-interval (≥ 300 years), mixed-severity or stand-replacing fires occurred in forests dominated by maple and/or beech [29,33,45,83,106]. Oak-hickory (*Quercus-Carya* spp.), oak-pine (*Quercus-Pinus* spp.), and pine (*Pinus* spp.) forests of the Northeast and Southeast had mostly short-return interval, understory surface fires [91,106]. Nepalese browntop was not present in these forests while historic fire regimes were still operating. It is unclear how Nepalese browntop may affect or alter fire regimes in plant communities where it is present because as of this writing (2005), fire ecology studies are lacking for Nepalese browntop. Given Nepalese browntop's proclivity to invade early seral, disturbed sites [3,38], and its ability to produce abundant litter [16,27], Nepalese browntop probably increases fire frequency and severity on sites where it is abundant. Fire studies are needed on Nepalese browntop.

The following table provides fire return intervals for plant communities and ecosystems where Nepalese browntop is important. For further information, see the FEIS review of the dominant species listed below. This list may not be inclusive for all plant communities in which Nepalese browntop occurs. If you are interested in plant communities or ecosystems that are not listed below, see the complete [FEIS Fire Regime Table](#).

Community or Ecosystem	Dominant Species	Fire Return Interval Range (years)
maple-beech	<i>Acer-Fagus</i> spp.	684-1,385 [19,106]
silver maple-American elm	<i>A. saccharinum-Ulmus americana</i>	< 35 to 200
sugar maple	<i>A. saccharum</i>	> 1,000
sugar maple-basswood	<i>A. saccharum-Tilia americana</i>	> 1,000 [106]
birch	<i>Betula</i> spp.	80-230 [91]
sugarberry-America elm-green ash	<i>Celtis laevigata-U. americana-Fraxinus pennsylvanica</i>	< 35 to 200
beech-sugar maple	<i>Fagus</i> spp.- <i>A. saccharum</i>	> 1,000
black ash	<i>Fraxinus nigra</i>	< 35 to 200 [106]
cedar glades	<i>Juniperus virginiana</i>	3-22 [44,73]
yellow-poplar	<i>Liriodendron tulipifera</i>	< 35
shortleaf pine	<i>Pinus echinata</i>	2-15
shortleaf pine-oak	<i>P. echinata-Quercus</i> spp.	< 10
slash pine	<i>P. elliotii</i>	3-8
slash pine-hardwood	<i>P. elliotii</i> -variable	< 35
sand pine	<i>P. elliotii</i> var. <i>elliotii</i>	25-45 [106]
longleaf-slash pine	<i>P. palustris-P. elliotii</i>	1-4 [67,106]
longleaf pine-scrub oak	<i>P. palustris-Quercus</i> spp.	6-10 [106]
pitch pine	<i>P. rigida</i>	6-25 [14,46]
pocosin	<i>P. serotina</i>	3-8
pond pine	<i>P. serotina</i>	3-8
eastern white pine-northern red oak-red maple	<i>P. strobus-Q. rubra-A. rubrum</i>	35-200
loblolly pine	<i>P. taeda</i>	3-8
loblolly-shortleaf pine	<i>P. taeda-P. echinata</i>	10 to < 35
Virginia pine	<i>P. virginiana</i>	10 to < 35
Virginia pine-oak	<i>P. virginiana-Quercus</i> spp.	10 to < 35
sycamore-sweetgum-American elm	<i>Platanus occidentalis-Liquidambar styraciflua-U. americana</i>	< 35 to 200 [106]

eastern cottonwood	<i>Populus deltoides</i>	< 35 to 200 [73]
black cherry-sugar maple	<i>Prunus serotina-A. saccharum</i>	> 1,000
oak-hickory	<i>Quercus-Carya</i> spp.	< 35
northeastern oak-pine	<i>Quercus-Pinus</i> spp.	10 to < 35 [106]
oak-gum-cypress	<i>Quercus-Nyssa</i> -spp.- <i>Taxodium distichum</i>	35 to > 200 [67]
southeastern oak-pine	<i>Quercus-Pinus</i> spp.	< 10
white oak-black oak-northern red oak	<i>Q. alba-Q. velutina-Q. rubra</i>	< 35
bear oak	<i>Q. ilicifolia</i>	< 35 [106]
chestnut oak	<i>Q. prinus</i>	3-8
northern red oak	<i>Q. rubra</i>	10 to < 35
post oak-blackjack oak	<i>Q. stellata-Q. marilandica</i>	< 10
black oak	<i>Q. velutina</i>	< 35
eastern hemlock-yellow birch	<i>Tsuga canadensis-Betula alleghaniensis</i>	> 200 [106]
elm-ash-cottonwood	<i>Ulmus-Fraxinus-Populus</i> spp.	< 35 to 200 [24,106]

POSTFIRE REGENERATION STRATEGY [90]:

Ground residual colonizer (on-site, initial community)

Initial off-site colonizer (off-site, initial community)

Secondary colonizer (on-site or off-site seed sources)

FIRE EFFECTS

SPECIES: *Microstegium vimineum*

- [IMMEDIATE FIRE EFFECT ON PLANT](#)
- [DISCUSSION AND QUALIFICATION OF FIRE EFFECT](#)
- [PLANT RESPONSE TO FIRE](#)
- [DISCUSSION AND QUALIFICATION OF PLANT RESPONSE](#)
- [FIRE MANAGEMENT CONSIDERATIONS](#)

IMMEDIATE FIRE EFFECT ON PLANT:

As an annual, Nepalese browntop is killed by late-season fire. Spring and early summer fires may only top-kill Nepalese browntop [5,96] unless fire is severe.

DISCUSSION AND QUALIFICATION OF FIRE EFFECT:

No additional information is available on this topic.

PLANT RESPONSE TO FIRE:

Nepalese browntop can grow back from tillers and stolons following top-kill from early-season, moderate-severity fire [96]. It may also establish from on- or off-site seed sources following fire of any severity [2,3,5].

In North Carolina, a 9 April 1982 prescribed burn was conducted on an upland stand of Nepalese browntop seedlings. The previous year's cohorts left a dense mat of Nepalese browntop straw on the ground. Fueled with the dense Nepalese browntop litter and the current-year cohort of seedlings, the fire became a hot, smoldering ground fire that killed the Nepalese browntop seedlings. By mid-June, a 2nd cohort of Nepalese browntop established, covering the study site with a dense stand of grass. Since the study site was above the floodplain, the seedlings presumably established from soil-stored seed [5].

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE:

The LaRue-Pine Hills Research Natural Area of southern Illinois is a remnant prairie barren that was historically maintained by frequent fires. The fires, probably intentionally set by Native Americans [1,21,34,35,93], maintained the barren by pruning woody vegetation to a bushy, scrub form. Forest Service personnel intermittently managed the Research Natural Area with fire from 1969 to 1993. That period included a 16-year time of fire exclusion (1974-1989). Woody vegetation began invading

the barrens during the 16-year period without fire. Restoration thinnings of white oak, southern red oak, common persimmon, and other woody species began in 1988. Annual prescribed burning was resumed in woodland, barren, and woodland-barren transition sites in 1990; burning was blocked by the Circuit Court in 1993. Nepalese browntop was 1st noted on woodland study plots in 1992. The authors concluded that cutting and burning treatments promoted Nepalese browntop invasion in the woodland. Nepalese browntop was not found on similarly treated barren or woodland-barren transitional area plots [2,3].

FIRE MANAGEMENT CONSIDERATIONS:

To date (2005), prescribed burning for Nepalese browntop control has not been successful; however, there is potential for effective control using prescribed fire. Late-season autumn fire, when Nepalese browntop is flowering but before seed set, may help control Nepalese browntop. Early season fire does not control Nepalese browntop, as soil-banked seed can still establish and produce new seed by the end of the growing season [92,105]. Burning can also be used to help reduce litter and standing plant biomass prior to herbicide application for Nepalese browntop control [96]. General information on using prescribed fire on nonnative invasive plants such as Nepalese browntop is given below.

Preventing postfire establishment and spread:

More research is needed specific to fire tolerance and response of Nepalese browntop in specific sites and ecosystems in which it occurs. The USDA Forest Service's "Guide to Noxious Weed Prevention Practices" [100] provides several fire management considerations for weed prevention in general that apply to Nepalese browntop. Guidelines for determining burn severity, revegetation necessity, and establishing and managing competitive plants are available [41,42]. The following paragraphs provide some general guidelines for invasive species management after fire. See [Integrated Noxious Weed Management after Wildfires](#) for a more detailed source of this information.

When planning a prescribed burn, preinventory the project area to evaluate cover and phenology of any Nepalese browntop or other invasive plants present on or adjacent to the site, and avoid ignition and burning in areas at high risk for Nepalese browntop establishment or spread due to fire effects. Avoid creating soil conditions that promote weed germination and establishment. Areas of soil disturbance (e.g. those brought about by fire suppression activities) are especially susceptible to invasive plant establishment. Weed status, risks, and prevention must be incorporated in fire rehabilitation plans. Also, wildfire managers might consider including weed prevention education and providing weed identification aids during fire training; avoiding known weed infestations when locating fire lines; monitoring camps, staging areas, helibases, etc., to be sure they are kept weed free; taking care that equipment is weed free; and acquiring restoration funding. Additional guidelines and specific recommendations and requirements are available [42,100].

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 by limiting invasive plant seed dispersal into burned areas by [4,42,100]:

- re-establishing vegetation on bare ground as soon as possible
- using only certified weed-free seed mixes when revegetation is necessary
- cleaning equipment and vehicles prior to entering burned areas
- regulating or preventing human and livestock entry into burned areas until desirable site vegetation has recovered sufficiently to resist invasion by undesirable vegetation
- detecting weeds early and eradicating before vegetative spread and/or seed dispersal
- eradicating small patches and containing or controlling large infestations within or adjacent to the burned area

In general, early detection is critical for preventing establishment of large populations of invasive plants. Monitoring in spring, summer, and fall is imperative. Eradicate established Nepalese browntop plants and small patches adjacent to burned areas to prevent or limit seed dispersal into the site [4,42,100].

The need for revegetation after fire can be assessed on the basis of the degree of desirable vegetation displaced by invasive plants prior to burning, and on postfire survival of desirable vegetation. Revegetation necessity can also be related to invasive plant survival as viable seeds, root crowns, or rhizomes capable of reproduction. In general, postfire revegetation should be considered when desirable vegetation cover is less than about 30% [42].

MANAGEMENT CONSIDERATIONS

SPECIES: [Microstegium vimineum](#)

- [IMPORTANCE TO LIVESTOCK AND WILDLIFE](#)
- [OTHER USES](#)
- [IMPACTS AND CONTROL](#)

IMPORTANCE TO LIVESTOCK AND WILDLIFE:

To date (2005), little research has been conducted on the effects of Nepalese browntop on wildlife. Research is needed on the impacts of Nepalese browntop to native animal species.

Palatability:

Nepalese browntop is unpalatable to deer and all classes of livestock (A. Houston, personal communication cited in [6], [64]. White-tailed deer do not graze it, and may indirectly encourage Nepalese browntop spread by avoiding Nepalese browntop and foraging on more palatable species [92].

Nutritional value: No information is available on this subject.

Cover value:

Nepalese browntop mats create good hiding and nesting cover for rats, especially cotton rats. Conversely, Nepalese browntop degrades nesting habitat for northern bobwhite (A. Houston, personal communication cited in [6]). Since cotton rats are predators of the northern bobwhite, Nepalese browntop must doubly impact northern bobwhite by reducing high-quality native cover and increasing predation. No information is available on how Nepalese browntop affects cover value for other wildlife species.

OTHER USES:

Nepalese browntop has been used as packaging material and as basket-weaving material. Both historic uses probably contributed to its spread in the United States. Intentional plantings of Nepalese browntop for erosion control, as forage, or as an ornamental have not been reported [6].

IMPACTS AND CONTROL:

Impacts: Nepalese browntop is a serious weed on disturbed soils [9]. It is capable of altering ecosystem function [26,27,54,55,56,57,58] and reducing site diversity [38]. For example, Kourtev and others reported that Nepalese browntop-invaded areas in New Jersey had thinner litter and organic soil layers [55]; lower levels of soil carbon, nitrogen, and net ammonification [57]; dissimilar soil enzymes; and significantly ($p < 0.001$) higher soil pH compared to uninvaded areas [54,56,58]. Additionally, soil microbial communities differed in species composition in Nepalese browntop and uninvaded areas, and nonnative earthworms were more common on Nepalese browntop sites compared to uninvaded sites [55,57]. Such drastic changes to soils are likely to be long term, and may encourage reinvasion of Nepalese browntop or new invasions of other nonnative species [54]. Characteristics that contribute to Nepalese browntop invasion include [18,96]:

- rapid invasion of disturbed habitats
- reproductive plasticity to environmental conditions
- annual life history
- high seed production
- rapid clonal growth

In the southern Appalachian region, 8 of 35 federal, state, and private agencies ranked Nepalese browntop among their greatest ongoing or potential management problems (behind kudzu and multiflora rose) [61]. On the Oak Ridge National Environmental Research Park, Nepalese browntop was ranked the most "aggressively invasive" nonnative species based on distribution, abundance, relative difficulty of control, and ability to exclude native plant species. Japanese honeysuckle and Chinese privet (*Ligustrum sinense*) were ranked 2nd and 3rd, respectively [23]. Nepalese browntop reportedly replaced existing ground vegetation in 3 to 5 years on sites in Great Smoky National Park [89]. As of 2000, extent of infestations in Dixon State Park, Illinois, ranged from 2.3/m² to 16,706/m² in size [38].

Forestry: Nepalese browntop is identified as a potentially serious competitor on productive timber sites in the Southeast [5,81,88]. It interferes with forage production and reduces growth of silvicultural species. On an oak plantation in southwestern Tennessee, Nepalese browntop presence was negatively correlated ($r = -0.82$) with growth of northern red oak

seedlings. There was a strong negative correlation ($r=-0.74$) between Nepalese browntop biomass and mean northern red oak seedling height growth. Four silvicultural treatments were tested: clearcut (all stems >6 inches diameter removed); 2-aged cut (harvest to retain a stand basal area of 15-20 ft²/ac of residual oaks, hickories, and yellow-poplar); high-grade cut (all stems >14 inches dbh removed); and a control no-cut treatment. Mean biomass gain of Nepalese browntop was greatest with a 2-aged selection cut and least with the no-cut control [71]:

2-aged	Clearcut	High-grade	No cut
1,400 kg/ac	800 kg/ac	250 kg/ac	100 kg/ac

As an annual herb, Nepalese browntop productivity is more closely tied to yearly climate fluctuations compared to other perennial understory species. Annual variations in Nepalese browntop productivity can have important effects on forest understory species composition and diversity. On a sweetgum site on the Oak Ridge National Environmental Research Park, Tennessee, Nepalese browntop produced 64% as much biomass in a wet year compared to a dry year [11].

Disturbance ecology:

Nepalese browntop readily establishes following disturbances such as flooding, mowing, and tilling. Within 3 to 5 years it may form monotypic stands that crowd out native vegetation [92,105]. A survey (based on herbaria collections and remote-sensing data) of weed invasion patterns in West Virginia showed that Nepalese browntop was most likely to invade road- and streamside vegetation, although both Nepalese browntop and Oriental bittersweet showed relatively high occurrence in closed-canopy forests (23% and 31% of total collections, respectively) [48].

Barden [5] concluded that a history of disturbance was likely to improve Nepalese browntop's ability to invade a site. A relatively deep litter layer, greater LAI of other ground-dwelling species compared to Nepalese browntop, and high levels of sunlight (PAR) reduced reproductive success of Nepalese browntop. He found that soil fertility was relatively unimportant in determining invasive ability of Nepalese browntop. In Barden's North Carolina study, Nepalese browntop failed to regenerate on undisturbed, naturally fertile plots (high levels of soil nitrogen, potassium, calcium, and zinc; see [Barriers to Reproduction](#) for further details). On plots treated with a 15-16-17 N-P-K fertilizer, Nepalese browntop showed greater biomass gain compared to unfertilized control plots, but seed spike production was similar on fertilized vs. unfertilized plots [5].

Nepalese browntop may be less successful at invading undisturbed sites. Rates of Nepalese browntop spread onto undisturbed sites are unclear because study data are not available as of 2005. However, anecdotal evidence suggests that Nepalese browntop may not invade, or is slow to invade, undisturbed sites. For example, Nepalese browntop was absent from unmowed land next to a sewer line right-of-way in North Carolina, but did invade the annually mowed right-of-way [5]. Some sources suggest that Nepalese browntop may slowly spread onto undisturbed lands unless control measures are taken [96]. An inventory of Land Between the Lakes National Recreation Area, Kentucky and Tennessee, showed Nepalese browntop occurred both within and adjacent to the Recreation Area boundaries. It was more common on adjacent private lands than inside the Recreation Area, which has been protected from mining, logging, and grazing since 1963. The authors cautioned, however, that periodic flooding left the Recreation Area vulnerable to Nepalese browntop seed dispersal and invasion [62].

Other authors suggest that Nepalese browntop can spread rapidly onto undisturbed sites from adjacent disturbed sites where it is well established [105]. In a New Jersey survey, Nepalese browntop and garlic mustard (*Alliaria petiolata*) were the only 2 nonnative species that invaded undisturbed chestnut oak-red oak-pitch pine stands [9]. Because it was a presence-absence inventory, density and rates of spread were not available for Nepalese browntop. Long-term studies are needed to document Nepalese browntop's rate of colonization and expansion onto undisturbed sites.

Nepalese browntop and Japanese honeysuckle:

Nepalese browntop spreads more readily into disturbed, shaded mesic sites compared to Japanese honeysuckle. Although the 2 species commonly co-occur, Nepalese browntop shows limited ability to invade established Japanese honeysuckle stands. In a North Carolina study, more than 2,400 Nepalese browntop seeds/plot were sown into 40 "undisturbed," well-established Japanese honeysuckle study plots (2-m² plots). A year later, less than 1% of the Nepalese browntop seeds had germinated. Two years after the seeds were sown, 12 plots had no Nepalese browntop plants; 20 plots contained 20 or fewer Nepalese browntop plants. Only 1 plot produced more than 2,400 plants (the approximate number of seeds originally cast). For all 40 plots, the ratio of Nepalese browntop seeds originally cast to Nepalese browntop plants established 2 years later was 6:1. Reciprocal transplant experiments on cleared sites showed no interference in Japanese honeysuckle growth when Japanese honeysuckle was planted on soils that previously supported Nepalese browntop compared to Japanese honeysuckle grown on soils that previously supported Japanese honeysuckle. Similarly, Nepalese browntop showed no interference in growth when planted on soils that had supported Japanese honeysuckle compared to soils that supported Nepalese browntop. Study plots were weeded during the 2-year experiment to eliminate other vegetation [5].

Nepalese browntop may be more invasive than Japanese honeysuckle on disturbed, shaded sites. After the reciprocal transplant experiment had ended and plots were no longer being weeded, Nepalese browntop rapidly invaded study sites that had been cleared and planted to Japanese honeysuckle. Two years after weeding was discontinued, Nepalese browntop showed 63% LAI in Japanese honeysuckle plots compared to adjacent undisturbed Japanese honeysuckle stands. Cumulative PAR at the plots was 3% to 12% of full sunlight. Nepalese browntop invaded some undisturbed Japanese honeysuckle floodplain stands after several extreme weather events coincided. Early April frosts in 3 of 4 study years and a record January 1985 low of -4 °F (-20 °C) killed most Japanese honeysuckle leaves. Japanese honeysuckle is evergreen, so leaf loss in successive years is highly detrimental. As an annual, Nepalese browntop is much less affected by low winter and early spring temperatures [5].

Control of Nepalese browntop is difficult, and requires multiple treatments [23]. In order to locally control this annual, seed-banking plant, repeated annual efforts must be made to prevent flowering and seed set until the seed bank is exhausted [38]. Nepalese browntop resembles native white grass, so Nepalese browntop should be properly identified before control measures are undertaken [64].

Prevention:

The most efficient and effective method of managing invasive species such as Nepalese browntop is to prevent their invasion and spread [86]. Preventing the establishment of nonnative invasive plants in wildlands is achieved by maintaining native communities and conducting aggressive surveying, monitoring, and any needed control measures several times each year. Monitoring efforts are best concentrated on the most likely sites of invasion, particularly along potential pathways for Nepalese browntop invasion: waterways, roadsides, and adjacent old fields and woodlands. Uninvaded sites should be periodically surveyed to detect new invasions. The [Center for Invasive Plant Management](#) provides an online guide to noxious weed prevention practices.

Preventing the introduction of Nepalese browntop into uninfested areas, and early control of small infestations, should be a priority [92].

Removing Nepalese browntop plants late in the growing season, before Nepalese browntop seed set but after seed set of most associated species, is recommended [38,104]. Once established, Nepalese browntop requires major, long-term eradication and restoration efforts. The Nature Conservancy [6,96] reports high potential for successful control and management of Nepalese browntop if detected and controlled in the early stages of invasion, and moderate potential for Nepalese browntop control and large-scale wildland restoration in areas where Nepalese browntop is already well established.

Integrated management:

A combination of complementary control methods may be helpful for rapid and effective control of Nepalese browntop. Integrated management includes not only killing the target plant, but establishing desirable species and discouraging nonnative, invasive species over the long term. Nepalese browntop control is rarely successful with only 1 method of control [72], but a combination of control methods can be effective.

The best way to prevent large infestations is to control small patches. Small patches of Nepalese browntop in Great Smoky Mountains National Park have been controlled through a combination of herbicides, mowing, and hand pulling (Johnson, K. 2001, cited in [23]). Tu [96] provides a contact list of managers who have used control measures (successful or not) on Nepalese browntop in Natural Areas.

Physical/mechanical:

Hand-pulling, mowing, tilling, and flooding can control Nepalese browntop. Hand-pulling controls small Nepalese browntop infestations [23]. Nepalese browntop is shallow-rooted and prefers moist soils; hence, it is usually easy to pull. Hand-pulling is most effective in late summer (August-September) when plants are tall and branched. Plants pulled before seed set can be left on site; plants with fruits should be bagged and removed. Hand-pulling upturns soil, and is likely to create microsites favorable to seed-banked Nepalese browntop seed. Late summer pulling is advantageous in that seed-banked seed does not have a long enough growing season to establish. Pulling in July or earlier is not recommended. Hand-pulling needs to be continued until the seed bank is exhausted, which may take many years [92,96]. Floodplains and other sites subject to continual replenishment of the seed bank require hand-pulling treatments indefinitely [96].

Mowing is recommended late in the growing season (August-September), when plants are flowering but before seed set. Because Nepalese browntop is an annual, late-season mowing curtails regrowth. Early season mowing does not control Nepalese browntop because 1) seed-banked seeds can still establish and produce a new crop of seeds by the end of the growing season, and 2) plants cut in early summer respond with new growth and flower production soon after cutting [22,92,105].

Tilling also reduces Nepalese browntop [96]. Soil must be tilled late in the growing season to avoid establishment of soil-stored seed. However, tilling may not be appropriate in many Natural Areas and may damage desirable plants.

Flooding for 3 straight months, or intermittent inundation, may kill Nepalese browntop plants. It will not kill soil-stored seed [96].

Fire: See the [Fire Management Considerations](#) section of this summary.

Biological: Nepalese browntop has few natural predators and pathogens in North America [18]. No biological control agents were available for Nepalese browntop control as of 2005 [92,96].

Grazing is not recommended as a control measure, as deer and all classes of livestock avoid Nepalese browntop (A. Houston, personal communication cited in [6]).

Chemical:

Herbicides may provide initial control of a new invasion or a severe infestation, but used alone, they are rarely a complete or long-term solution to invasive species management [15]. Herbicides are most effective on large infestations when incorporated into long-term management plans that include replacement of weeds with desirable species, careful land use management, and prevention of new infestations. Control with herbicides is temporary, as it does not change the conditions that allowed the invasion to occur (e.g. [110]). See The Nature Conservancy's [Weed Control Methods Handbook](#) for considerations on the use of herbicides in Natural Areas and detailed information on specific chemicals.

Extensive infestations of Nepalese browntop can be controlled with systemic herbicides [92]. Herbicides may be the only practical method to effectively control large infestations. Glyphosate can effectively control Nepalese browntop, but since glyphosate is a nonselective herbicide, care must be taken to avoid drift onto desirable native species. Effective use of herbicides requires appropriate herbicide concentrations, application techniques, and timing [68,105]. The University of Tennessee reported good control of Nepalese browntop on their Ames Plantation, but also reported that managing for a desirable plant community after Nepalese browntop was controlled was "difficult." The University found "good control" with imazapic [6]. Since imazapic is selective for only a few plant species, it killed Nepalese browntop plants without killing associated native herbaceous species. Sethoxydim and fluazifop are grass-specific herbicides reported as giving some control for Nepalese browntop (Tu, personal communication, [97]). Barden [6] provides information on application rates for Natural Areas and suggestions for herbicide use in wetland areas. Studies reporting the efficacy of various herbicides used for Nepalese browntop control in Pennsylvania [43] are available.

It may be necessary to reduce litter build-up before herbicide can be successfully applied (see Fire Management Considerations). Successful herbicide control requires several treatments [23].

Cultural: No information is available on this topic.

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