U.S. Fish & Wildlife Service

# Japanese Stiltgrass (*Microstegium vimineum*)

## Ecological Risk Screening Summary

**U.S. Fish & Wildlife Service, June 2015**
**Revised, April 2018**
**Web Version, 11/5/2020**

Organism Type: Plant
Overall Risk Assessment Category: High

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# 1 Native Range and Status in the United States

## Native Range

GISD (2018) lists *Microstegium vimineum* as native in China, India, Japan, the Korean Peninsula, Malaysia, Nepal, Philippines, Russian Federation, Taiwan, and Thailand.

From CABI (2018):

"*M. vimineum* is a cosmopolitan grass species native to India, Indo-China, Nepal, China, Korea, Far-east Russia, Philippines, and Japan."

CABI (2018) lists *Microstegium vimineum* as native in Bhutan, China, India, Iran, Japan, North Korea, South Korea, Malaysia, Myanmar, Nepal, Philippines, Taiwan, Thailand, Vietnam, and Russian Far East.

## Status in the United States

According to USDA, NRCS (2018), *Microstegium vimineum* is a Class C noxious weed in Alabama, an invasive, banned species in Connecticut, and a prohibited species in Massachusetts. *M. vimineum* is listed as a Prohibited plant in New York (New York State Senate 2019), and Maine (Maine Department of Agriculture, Conservation & Forestry 2017), an Invasive Plant in Ohio (Ohio Department of Agriculture 2018), and an Invasive Pest in Indiana (Indiana Department of Natural Resources 2020).

GISD (2018) lists *Microstegium vimineum* as alien, invasive, and established in Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Puerto Rico.

From GISD (2018):

"*M. vimineum* spread into New York from New Jersey, and has been collected from two sites along the Hudson River (Hunt and Zaremba, 1992)."

"Mehrhoff (2004) states that the firs [sic] record of *M. vimineum* in Pennsylvania was from 1938."

"*M. vimineum* has been ranked the most problematic weed in the United States Department of Energy Oak Ridge National Environmental Research Park."

"The first record of *M. vimineum* in Massachusetts was from West Springfield in 1998."

CABI (2018) lists *Microstegium vimineum* as introduced and invasive in Alabama, Arkansas, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Puerto Rico.

From CABI (2018):

"*M. vimineum* is a very serious invasive species and considered one of the most destructive introduced plants in the United States."

From Fryer (2011):

"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 [Fairbrothers and Gray 1972; Gleason and Cronquist 1991; Kartesz 1999]. […] Japanese stiltgrass is rare in Florida and other parts of the Southeast [Radford et al. 1968; Wunderlin 1998] but is rapidly increasing in Maryland, New York, and other northern states [Hunt and Zaremba 1992; Redman 1995; Barkworth et al. 2003]. It was introduced in New Jersey around 1959 and spread rapidly in that state in the 1990s and 2000s (review by [Ambrose and Bratton 1990])."

"Great Lakes and Northeast: Japanese stiltgrass occurs in pine (*Pinus*), oak (*Quercus*)-pine, oak-hickory (*Carya*), and mixed-hardwood woodlands and forests in these regions."

"In New Jersey, Japanese stiltgrass occurred in red oak-black oak-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."

"In Maryland, Japanese stiltgrass occurred in the ground layers of Virginia pine-southern red oak (*Pinus virginiana-Q. falcata*) communities. […] In Maryland and Virginia, Japanese stiltgrass was a component of mixed oak-sweetgum-swamp tupelo (*Quercus* spp.-*Liquidambar styraciflua-Nyssa sylvatica* var. *biflora*) communities on the inland coastal plain of Chesapeake Bay [Rheinhardt et al. 2000]."

"Appalachians: Japanese stiltgrass is common in low-elevation oak-pine forests of the Piedmont [Hunt and Zaremba 1992; Robertson et al. 1994; Romagosa and Robison 2003]. In Cumberland County, Pennsylvania, Japanese stiltgrass occurred in a red maple/spicebush/skunk cabbage-sphagnum (*Symplocarpus foetidus-Sphagum* spp.) swamp [Loeffler and Wegner 2000]. […] The federally endangered [USFWS 2011] glade spurge (*Euphorbia purpurea*) cooccurred with Japanese stiltgrass in the forest's groundlayer vegetation [Loeffler and Wegner 2000]."

"Japanese stiltgrass is reported in mixed-hardwood and riparian communities in Kentucky. […] At 9% to 35% cover, Japanese stiltgrass was the most common graminoid. […] Along the Blue River of Kentucky, Japanese stiltgrass occurred in a big bluestem-indiangrass (*Sorghastrum nutans*) prairie on gravel wash [Homoya and Abrell 2005]; the federally endangered [USFWS 2011] Short's goldenrod (*Solidago shortii*) also occurred in the gravel-wash prairie community [Homoya and Abrell 2005]."

"Southeast and South: In the Southeast, Japanese stiltgrass often occurs upland from or in dry portions of wet grasslands [Stocker and Hupp 2008]. On a North Carolina floodplain, Japanese stiltgrass and Japanese honeysuckle comprised nearly 100% of the ground layer and understory of a boxelder-green ash (*Acer negundo-Fraxinus pennsylvanica*)-sycamore forest [Barden 1987]."

"On the George Washington Memorial Parkway in Virginia, Japanese stiltgrass occurred in the ground layer of old-growth oak-hickory forest."

“Japanese stiltgrass dominates some deciduous forests of the South. In the Whitehall Experimental Forest, Georgia, Japanese stiltgrass formed a continuous lawn in the ground layer of a red maple-white oak-sycamore forest. The understory was depauperate [Bradford et al. 2010]. In surveys across west-central Georgia, Japanese stiltgrass was detected in 15 of 18 watersheds. Japanese stiltgrass and nonnative species in general were more common in or near urban-rural interfaces, but Japanese stiltgrass was also common in rural locations.”

“The Eastern Region of the USDA, Forest Service, lists Japanese stiltgrass as a Category 1 noxious weed: a nonnative, highly invasive plant that invades natural habitats and replaces native species [USDA-FS 2004].”

No records of *M. vimineum* in active trade in the United States were found.

## Means of Introductions in the United States

From Fryer (2011):

“Japanese stiltgrass was first noted in North America around 1918 in Tennessee [Barkworth et al. 2003; Ehrenfeld 2003], where it was probably introduced accidentally [Ehrenfeld 2003]. It was formerly used as packing material for imported Chinese porcelain, and discarded packaging material containing seeds might have been the source of introduction [Virginia Department of Conservation and Recreation, Division of Natural Heritage 2003].”

From CABI (2018):

“*M. vimineum* was introduced to North America from Asia in 1919. First collected in Tennessee, the species had spread to Atlantic coastal states from Florida to New Jersey (Tu, 2000). […] The Flora of the Southern and Mid-Atlantic States (Weakley, 2011) gives an indication of the establishment and spread of *M. vimineum* in the United States: "local" (Fernald 1950), "rarely introduced and possibly not established" (Gleason and Cronquist 1952), "sporadically naturalized" (Godfrey and Wooten 1979), "a rapidly spreading pernicious invader on moist ground, too common" (Wofford, 1989).”

## Remarks

No additional remarks.

# 2 Biology and Ecology

## Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2018):

“Taxonomic Status:
Current Standing: accepted”

Kingdom Plantae
  Subkingdom Viridiplantae
    Infrakingdom Streptophyta
      Superdivision Embryophta
        Division Tracheophyta
          Subdivision Spermatophytina
            Class Magnoliopsida
              Superorder Lilianae
                Order Poales
                  Family Poaceae
                    Genus *Microstegium*
                      Species *Microstegium vimineum*

From CABI (2018):

"The complex taxonomic history of *M. vimineum* produces 32 synonyms in five genera spread over more than 180 years. Adding to the potential for confusion are the four additional genera sometimes used synonymously: *Coelarthron*, *Ischnochloa*, *Leptatherum* and *Nemastachys* (Wunderlin and Hansen, 2008). First described in 1832 as *Andropogon vimineus* by the botanist Karl Bernhard von Trinius from a specimen collected by Nathaniel Wallich in Nepal, this epithet is considered a basionym (Trinius, 1832; Missouri Botanical Garden, 2012).

In 1836, the species was presented as the type *Microstegium willdenowianum* by the botanist and natural philosopher, Christian Gottfried Daniel Nees von Esenbeck based upon a specimen in the herbarium of C. L. Willdenow, a director of the Berlin Botanical Garden in the early nineteenth century (Nees von Esenbeck, 1836).

The genus name *Microstegium* is derived from Greek meaning small (in size, quantity, number or dignity) and roof. Nees, however, had failed to provide an authoritative circumscription, which was described in 1855 by Ernst Gottlieb von Steudel, the German authority on grasses (Steudel, 1855).

Adding to the nomenclature challenges was an earlier assignment of the species by Curtius (Kurt) Sprengel to the genus *Pollinia*, a catch-all or farrago of unrelated species (Sprengel, 1815). When the early vagaries of naming were added the sometimes indistinct morphology of the species, for example, the distinction between awned, *Microstegium vimineum* var. *imberbe*, and awnless, *Microstegium vimineum* var. *vimineum* phenotypes the result was a long list of additional species, varieties, and forms (Fairbrothers and Gray, 1972). More recentlly [sic], Shukla (1996) refers to the awned variety as var. *vimineum*, and the awnless as var. *willdenowianum*. In 1922, the French botanist Aimée Antoinette Camus circumscribed the present accepted binomial *Microstegium vimineum* (Camus, 1922; Whisenhunt, 2008)."

## Size, Weight, and Age Range

From Swearingen and Bargeron (2016):

"*Microstegium vimineum* is a delicate, sprawling, annual grass that is 0.5-3.5 ft. (0.2-1.1 m) in height."

From Fryer (2011):

"Aerial culms are 3 to 5 feet (1-1.5 m) long [Fernald 1950; Radford et al. 1968; Gleason and Cronquist 1991; Claridge and Franklin 2002]."

## Environment

From GISD (2018):

"It appears to be associated primarily with moist, acidic to neutral soils that are high in nitrogen."

"Tu (2000) observes that most sites invaded by *M. vimineum* in the United States have acidic soils (pH 5.8 to 4.8), but some populations are on soils derived from limestone or marble with surficial soil that is neutral or only slightly acidic in reaction. He further states that the overall acidity of the soils, however, may limit nutrient availability. Soils are usually moist, and are often well-drained silty loams, sandy loams, or loams. Clay was not a significant component of the upper soil horizons in any of the soils invaded by *M. vimineum* (Hunt and Zaremba 1992, in Tu, 2000). […] It can grow and produce seeds with as little as 5% full sunlight, but maximum growth and seed production occurs at 25-50% full sunlight (Winter et al.1982, Horton and Neufeld, 1998, in Tu, 2000)."

"Soils on which *Microstegium vimineum* occur are typically average in levels of potassium and phosphorus and high in nitrogen (Redman, 1995, in Tu, 2000)."

From CABI (2018):

"*M. vimineum* will not grow in areas with periodic standing water, nor in full, direct sunlight (Fairbrothers and Gray, 1972; Hunt and Zaremba, 1992; Redman, 1995; Flora of China Editorial Committee, 2012)."

From Fryer (2011):

"On mine spoils in Kentucky, Japanese stiltgrass grew on loamy soils with pH ranging from 4.6 to 6.3. It was absent from an extremely acidic site (pH 4.4) [Rafaill 1988]. In an Illinois study, soils supporting Japanese stiltgrass were generally acidic and nutrient poor [Gibson et al. 2002]."

"Some studies have found that Japanese stiltgrass was positively associated with basic soils [Cole and Weltzin 2004; Nord et al. 2010] or that it raises soil pH [Ehrenfeld et al. 2001]. In deciduous wetlands of New Jersey, Japanese stiltgrass was positively correlated with nonacidic soils ($P<0.05$) [Ehrenfeld 2008]."

"Based on limited studies, Japanese stiltgrass may prefer soils with high mineral content. In an oak-hickory-eastern white pine community in Pennsylvania, phosphorus level (P=0.01), potassium level (P=0.01) moist soil (P<0.001), and high pH (P=0.002) were positively associated with Japanese stiltgrass abundance, while ammonium was negatively associated with Japanese stiltgrass abundance and seed production (P<0001) [Nord et al. 2010]. Studies in Maryland and Washington, DC, found higher levels of nitrogen and average levels of potassium and phosphorus on Japanese stiltgrass-infested soils compared to soils without Japanese stiltgrass [Redman 1995]. In red maple forests of Arkansas, Japanese stiltgrass was positively correlated with high concentrations of soil boron (r=0.3) and zinc (r=0.5). In mixed-hardwood and oak-hickory forests of West Virginia, soils of interior plots with Japanese stiltgrass had significantly lower total carbon levels than plots without Japanese stiltgrass (P=0.07) [Huebner 2010]."

## Climate

From Fryer (2011):

"Japanese stiltgrass grows in temperate to warm continental climates. In North America, the coldest reported winter temperatures that Japanese stiltgrass survives are approximately -5.8 to -9.4 °F (-21 to -23 °C) [Redman 1995]."

From GISD (2018):

"No information was found regarding the optimal growing temperatures or the temperature limits of this species. The coldest winter temperature at which invasive populations of *M. vimineum* occur is approximately -21° to -23° C (Redman, 1995, in Tu, 2002)."

From CABI (2018):

"In mountainous regions, *M. vimineum* is found below elevations of 4000 feet (Evans et al., 2006)."

## Distribution Outside the United States

From CABI (2018):

"There are herbaria records, reports in floras and other documentation enumerating the presence of the species on every continent except Antarctica (ISSG, 2012; USDA-ARS, 2012a)."

CABI (2018) lists *Microstgium vimineum* as present in Turkey but gives no indication of native or introduced status.

### Native

GISD (2018) lists *Microstegium vimineum* as native in China, India, Japan, the Korean Peninsula, Malaysia, Nepal, Philippines, Russian Federation, Taiwan, and Thailand.

From CABI (2018):

"*M. vimineum* is a cosmopolitan grass species native to India, Indo-China, Nepal, China, Korea, Far-east Russia, Philippines, and Japan."

CABI (2018) lists *Microstegium vimineum* as native in Bhutan, China, India, Iran, Japan, North Korea, South Korea, Malaysia, Myanmar, Nepal, Philippines, Taiwan, Thailand, Vietnam, and Russian Far East.

### Introduced

GSID (2018) lists *Microstegium vimineum* as alien, established, but invasiveness unspecified in Turkey.

From GISD (2018):

"*Persicaria perfoliata* (=*Polygonum perfoliatum*), *Acalypha australis*, *Microstegium vimineum* were reported as a result of a roadside survey from the Trabzon region in North Eastern Turkey near a tea factory. It is supected [sic] that they were accidently introduced with the import of material for processing of tea (Brundu et al 2011)"

CABI (2018) lists *Microstegium vimineum* as present and introduced in Armenia, Azerbaijan, Republic of Georgia, and Congo Democratic Republic; and as present, introduced, and invasive in Costa Rica.

From Fryer (2011):

"It has invaded portions of Asia where it is nonnative, extending its range into Pakistan, Nepal [Goel and Uniyal 1983], and Turkey [Scholz and Byfield 2000]."

## Means of Introduction Outside the United States

From CABI (2018):

"With the discovery of *M. vimineum* in Turkey and southern Caucasus, the European and Mediterranean Plant Protection Organization (EPPO) added the species to the EPPO Alert List in 2008 and transferred it to the List of Invasive Alien Plants in 2012 labelling it as an emerging invasive species (EPPO Executive Committee, 2012)."

## Short Description

From GISD (2018):

"*Microstegium vimineum* is an annual grass which resembles a small bamboo plant. It can be recognised by its pale green lance shaped leaf with a distinctive silver midrib (Pennsylvania Field Guide, 2004). Young plants grow upright, but as the stem elongates, it becomes straggling and decumbent, with only the upper part of the stem upright and the lower part in contact with the ground, where the lower nodes root (Joan Ehrenfeld., pers.comm., 2005). Tu (2000) states

that *M. vimineum* is a shade tolerant, annual grass (family Poaceae). It is usually 6-10dm in height, and the reclining stems can grow up to 1.0m long. In unfavourable conditions, the plant can be as little as 1-2 dm tall, and is capable of flowering in this condition (Joan Ehrenfeld., pers. comm., 2005). Tu (2000) further states that its culms (stems) are typically branched, rooting at the lower nodes, and the nodes and internodes are smooth and hairless. The lanceolate leaf blades are 5-8cm long, 2-15mm wide, sparsely pubescent on both surfaces, and distinctly tapered at both ends. The ligules are membranous, usually ciliate, and are 0.5-2.0mm long. The terminal or axillary inflorescence is a raceme, 2-7cm long, with an elongate peduncle and an angled disarticulating rachis. The hirsute fertile spikelets are deciduous, and occur in pairs, with one spikelet sessile and the other pedicellate. The glumes are equal in length (4.5-5.0mm) and awnless. The first glume is flat and 2-3 veined. The second glume is keeled and 3-veined. There are two lemmas per spikelet, with the lower one sterile and the upper, fertile one awnless or often with a slender awn 4-8mm. Both cleistogamous (flowers closed at pollination) and chasmogamous (flowers open) conditions have been reported for *M. vimineum* in Japan, with the axillary flowers all being cleistogamous. Cleistogamous panicles are contained in the upper 1-2 leaf sheaths, and remain appressed to the stem; these seeds are apparently dispersed as a unit in pieces of dead litter. The plant produces a very sparse, short fibrous root system (Joan Ehrenfeld., pers.comm., 2005). The fruit or caryopsis (grain) is yellowish to reddish, and ellipsoid (2.8-3.0mm) in shape. *M. vimineum* can be distinguished from other grasses by its thin, pale green, tapered leaf blades, and by its multiple spikelets that may be either terminal or arising from leaf axils. The alternate leaves have a silvery stripe of reflective hairs down the middle of the upper leaf surface. In the fall, identification becomes somewhat easier after the plant develops a slight purplish tinge (Tu, 2000)."

From Swearingen and Bargeron (2016):

"The leaves are pale-green, alternate, lance-shaped, 1-3 in. (2.5-7.6 cm) long, asymmetrical with a shiny, off-center midrib. Upper and lower leaf surface is slightly pubescent. A silvery line runs down the center of the blade. Stems usually droop."

## Biology

From CABI (2018):

"*M. vimineum* produces abundant seed and relies entirely on its seed bank for its annual recruitment. The seeds may need a period of stratification (cool temperatures and high moisture) before they will germinate (Woods, 1989) and seeds stored in the soil may remain viable for as long as five years (Barden, 1991). The seeds may have low germination rates but many seeds are produced by each plant, resulting in an estimated 0.1– 4 million seeds per m² (Barden, 1987; Woods, 1989; Gibson et al., 2002; Judge et al., 2008; Warren et al., 2010). Each tiller of *M. vimineum* typically produces one terminal raceme and two to seven axillary racemes; each tiller may produce 100 to 1000 seeds per year (Cheplick, 2010).

It grows quickly in low light conditions, sometimes forming dense monocultures (monospecific stands), fruits within a single season, and is moved easily into disturbed habitats by natural means (e.g., flood scouring) and artificial means (e.g., mowing, tilling, foot traffic, and other soil disturbing activities) (Swearingen, 2000; EPPO Executive Committee, 2012). *M. vimineum* seeds

reportedly have short-term persistence in soil ranging from one to five years (Barden, 1987; Gibson et al., 2002; Vidra et al., 2007). There are few reports or studies on *M. vimineum* germination though open sites and little to no litter favour germination (Fryer, 2011).

*M. vimineum* seed matures until fall frosts followed by plant death (Gibson et al., 2002). Seeds are also able to survive submersion in water for periods of up to 10 weeks. Barden (1991) reports that seeds can germinate while under water, but the plants do not grow. If standing water is removed, more seeds will germinate shortly afterwards.

The plant is both cleistogamous and chasmogamous (self- and cross-pollinated) (Huebner, 2003; Kuoh, 2003)."

"*M. vimineum* shows "extreme plasticity" in morphology, producing both flowers and stolons under a wide range of nutrient and light conditions (Fryer, 2011). Flowering and fruiting occurs in late summer (August–November); senesces in early fall (Evans et al., 2006; Flora of China Editorial Committee, 2012).

The reproductive success and establishment of the plant in woodlands "may be due to high tolerance to a range of intraspecific densities and to an ability to set seed under shady conditions even when densities are high" (Cheplick, 2010).

It is a variable species, usually with apparently awnless spikelets, where in fact a weakly developed awn is enclosed within the glumes. Sometimes the awn is exserted and obvious; rarely is it completely absent (Flora of China Editorial Committee, 2012). This species variability may have led to attempts to circumscribe varieties, subspecies, forms and novel species leading to taxonomic confusion.

Being a shade tolerant plant, it is adapted for low-light conditions and uses the C4 pathway for photosynthesis (Barden, 1987; Horton and Neufeld, 1998). *M. vimineum* lacks the high density of minor veins found in most C4 grasses, and forms, instead, files of distinctive cells (Raghavendra, 2010).

*M. vimineum* community and species responses to a future carbon dioxide enriched atmosphere may be mediated by other environmental factors and will depend on individual species responses (Belote et al., 2008). High carbon dioxide levels may negatively affect *M. vimineum* compared to plant species better able to assimilate extra carbon dioxide (Fryer, 2011)."

From GISD (2018):

"Tu (2000) states that *M. vimineum* relies entirely on its seed bank for its annual recruitment. Seeds may need a period of stratification (cool temperatures and high moisture) before they will germinate (Woods, 1989, in Tu, 2000). Seeds stored in the soil may remain viable as long as five years (Barden 1991, in Tu, 2000). Seeds may have low germination rates (Woods, 1989, in Tu, 2000), but each plant produces many seeds. Seeds are also able to survive submersion in water for periods of up to 10 weeks. Seeds can germinate while under water, but the plants do not grow

(Barden, 1991, in Tu, 2000). If standing water is removed, more seeds will germinate shortly afterwards."

"Derr and Tech (2004) state that Japanese stiltgrass has a fibrous root system. Seeds gereminate [sic] in late spring, and plants reach flowering status in mid-autumn. Swearingen (1999) states that *M. vimineum* is a clonal species that spreads by rooting at nodes along the stem. New culms emerge from each node. Each plant can produce an estimated 100 to 1,000 seeds. Once established at a site, seed stored in the soil will ensure regrowth for several to many years."

"Swearingen (1999) states that *M. vimineum* occurs on stream banks, river bluffs, floodplains, emergent and forested wetlands, moist woodlands, early successional fields, uplands, thickets, roadside ditches, gas and power line corridors and home lawns and gardens. It readily invades and is most common in disturbed, shaded areas like floodplains that are prone to natural scouring, and areas subject to mowing, tilling and other soil disturbing activities."

"*M. vimineum* can also occur on upper forested slopes, particularly under disturbed canopy (including natural disturbances such as blowdowns); indeed, it often colonizes the bare soil of tree-throw mounds in otherwise uninvaded areas. It is also frequently found along hiking trails, despite dry and rocky conditions. A study of its distribution in several forested areas in New Jersey did not reveal a preference for any particular slope position, slope angle, or exposure direction (Kourtev et al. 1998), suggesting that it can occur on a very wide range of forested conditions."

## Human Uses

From GISD (2018):

"Tu (2000) cites that in the early 1900s, *M. vimineum* was used extensively as a packing material for porcelain, especially fine China porcelain, which may have contributed to its invasion into the United States. Culms of this grass have also been used for basket weaving. It has not been documented as being intentionally planted as an ornamental, for erosion control, or for forage."

From CABI (2018):

"*M. vimineum* has little to no current uses outside of the basket weaving craft (Tu, 2000)."

## Diseases

CABI (2018) lists *Balansia andropogonis*, *Bipolaris* sp., *Cerebella paspali*, *Meliola setariae*, *Phakopsora incompleta*, *Phyllachora ischaemi*, *Phyllachora leptotheca*, *Puccinia aestivalis*, *Puccina benguetensis*, *Puccina polliniae*, *Puccina polliniae imberbis*, *Puccinia polliniicola*, and *Ustilaginoidea polliniae* as pathogens of *Microstegium vimineum*.

Huang et al. (2017a,b) identified leaf blight disease caused by *Curvularia geniculate* and *Bipolaris maydis* on specimens of *Microstegium vimineum* in China.

## Threat to Humans

No information on threats to humans from *Microstegium vimineum* was found.

# 3 Impacts of Introductions

From GISD (2018):

"*Microstegium vimineum* may be responsible for altering natural soil conditions, creating an inhospitable environment for many native species. In areas that have been invaded by *M. vimineum*, both litter and organic soil horizons were thinner than in uninvaded areas, and the pH of soils in invaded sites was significantly higher than in uninvaded sites (Kourtev et al. 1998, in Tu, 2000)."

"Established populations of *Microstegium vimineum* usurp quality nesting habitat from wildlife (Tu, 2000)."

"Tu (2000) reports that *Microstegium vimineum* is capable of invading wildland areas and swiftly replacing natural communities with nearly monospecific stands. Once established, *M. vimineum* is able to crowd out native herbaceous vegetation in wetlands and forests within three to five years (Hunt 1992, Barden 1987, in Tu, 2000)."

"Research has shown that the presence of *M. vimineum* has an effect on the microbial community of the soil (Kourtev et al. 2002). Areas which have been invaded by *M. vimineum* have fewer oaks (*Quercus* spp.) in the canopy, lack native understorey shrubs (*Vaccinium* spp.), and the pH of the soil is higher in invaded areas (Kourtev et al. 1998)."

From CABI (2018):

"*M. vimineum* impedes regeneration of native woody species and lowers overall species diversity and stem densities (Oswalt et al., 2007). One study found that it inhibited the success of small-seeded trees and reduced tree survival after one growing season by more than 20%, negatively impacting on *Acer negundo* (box elder), *Platanus occidentalis* (sycamore) and *Liriodendron tulipifera* (tulip poplar) (Flory and Clay, 2010).

An infestation of *M. vimineum* documented in 2002 in Chapman State Park, Maryland, USA showed adverse impact on *Myosotis macrosperma* Engelm (largeseed forget-me-not), *Solidago bicolor* (white goldenrod), *Arisaema dracontium* (green dragon) and *Nemophila aphylla* (smallflower baby blue eyes) (Imlay, 2012)."

"The plant reduces indigenous herbaceous species productivity and diversity and decreases arthropod abundance and richness across multiple trophic levels (Simao et al., 2010). The northern pearly-eye butterfly, (Lethe anthedon) in New Jersey, on the other hand, has adapted to *M. vimineum* as a host plant (Swearingen, 2000; Stichte, 2011).

In North American [sic] it is a threat to eastern deciduous forests creating near monospecific stands that are highly resistant to re-colonization by native species (Oswalt et al., 2007; Flory and Clay, 2010)."

From Fryer (2011):

"Cover of Japanese stiltgrass and Chinese privet (*Ligustrum sinense*) was negatively correlated with overall species richness and overstory reproduction (r= -0.18, P=0.003) for both variables) [Loewenstein and Loewenstein 2005]."

"Japanese stiltgrass may provide important cover for white-footed mice. In loblolly pine-Virginia pine forests of Virginia, white-footed mice were more abundant on plots with than without Japanese stiltgrass. The author suggested that sites with Japanese stiltgrass may provide more nesting sites, nesting materials, and/or have decreased predation rates than sites without Japanese stiltgrass. White-footed mice were observed navigating through dense Japanese stiltgrass culms without difficulty, although they avoided areas with dense cover of native little bluestem. Among 6 other small mammal species, none were either positively or negatively associated with Japanese stiltgrass [Warchalowski 2006]."

"Japanese stiltgrass may reduce habitat quality of some tick species. In Indiana, experimentally introduced lone star ticks (*Amblyomma americanum*) and dog ticks (*Dermacentor variabilis*) showed higher mortality rates in Japanese stiltgrass-invaded plots than in plots without Japanese stiltgrass. In Japanese stiltgrass plots, mortality of lone star ticks and dog ticks increased 173% and 70%, respectively, compared to mortality in uninvaded plots. The authors attributed the higher death rates in Japanese stiltgrass plots to increased temperatures and decreased humidity at the soil surface and in litter compared to uninvaded plots [Civitello et al. 2008]."

"Japanese stiltgrass reportedly replaced existing ground vegetation in 3 to 5 years on sites in Great Smoky National Park [Southeast Exotic Plant Pest Council 2001], and it has formed "extensive and dense" infestations in Natural Areas and Parks, managed forests, wetlands, riparian areas, and rights-of-way in Alabama and adjacent states [Alabama Invasive Plant Council 2007]."

"For example, Kourtev and others [Kourtev et al. 1998] reported that Japanese stiltgrass-invaded areas in New Jersey had thinner litter and organic soil layers than sites without Japanese stiltgrass; they attributed these changes to high densities of nonnative earthworms on sites with Japanese stiltgrass. Sites invaded by Japanese stiltgrass have also shown lower levels of soil carbon, nitrogen, and net ammonification [Kourtev et al. 1999]; dissimilar soil enzymes; and had significantly higher soil pH compared to uninvaded areas [Kourtev et al. 2002a,b, 2003; McGrath and Binkley 2009]. In white oak forests of New York, Japanese stiltgrass-invaded sites had thinner organic soil horizons, higher soil pH values, and higher levels of available soil nitrate than adjacent uninvaded sites [Ehrenfeld 2003]. In a chestnut oak-black oak-red maple forest, an eastern white pine plantation, and an old field in Tennessee, soil beneath Japanese stiltgrass litter had significantly higher pH and phosphorus levels and lower aluminum levels than soil beneath litter from uninvaded plots, regardless of plant community type. Overall, soil invertebrate richness was lower in Japanese stiltgrass litter than in uninvaded litter in all community types,

although Japanese stiltgrass litter housed more mite species than litter from uninvaded plots. The authors surmised that in Japanese stiltgrass litter, overall diversity of forest-floor invertebrates may decrease, but mite populations may increase [McGrath and Binkley 2009]. In white oak and American beech forests of New Jersey, soil microbial communities differed in species composition in Japanese stiltgrass-invaded and uninvaded areas, and nonnative earthworms were more common on Japanese stiltgrass sites compared to uninvaded sites [Kourtev et al. 1998, 1999]. Kourtev and others [Kourtev et al. 2003] warn that such drastic changes to soils will likely persist and may encourage reinvasion by Japanese stiltgrass or invasions by other nonnative species."

"In a North Carolina wetland undergoing restoration, sites dominated by Japanese stiltgrass appeared to have decreased nitrogen cycling compared to sites where Japanese stiltgrass was removed. Decomposition and nitrogen release from Japanese stiltgrass litter was about half that of litter of native groundlayer species, and species richness was significantly less on invaded plots than on plots where Japanese stiltgrass was controlled [DeMeester 2009; DeMeester and Richter 2010]. DeMeester [DeMeester 2009] concluded that compared to native species, Japanese stiltgrass "is clearly superior in capitalizing resources and suppressing other vegetation". In oak-pine forest in Whitehall Experimental Forest, Georgia, carbon apparently cycled more quickly [sic] sites with Japanese stiltgrass than on sites without Japanese stiltgrass. Plots with Japanese stiltgrass showed reduced total organic carbon (24% decline, $P<0.09$), particulate organic matter (34% decline, $P<0.08$), mineralizable carbon (a measure of microbially-available carbon; 36% decline, $P<0.01$), and microbial-biomass carbon (72% decline, $P<0.05$). The authors suggested that Japanese stiltgrass may accelerate carbon cycling and deplete carbon levels in southern oak-pine forests [Strickland et al. 2010]. In mixed-hardwood and oak-hickory forests of West Virginia, interior forest plots with Japanese stiltgrass had significantly lower soil carbon levels than plots without Japanese stiltgrass ($P=0.07$) [Huebner 2010]."

"Japanese stiltgrass may favor insect guilds that use the ground layer as habitat. In a harvested white oak-yellow-poplar forest in Tennessee, there was significantly greater cover of all insect guilds (herbivores, omnivores, carnivores, and scavengers) on sites with than without Japanese stiltgrass ($P\leq0.05$), probably because there was 2.5 times more plant cover on sites with Japanese stiltgrass. Measurements were taken at the end of the growing season (mid-October) [Marshall 2007]."

"In an oak-yellow-poplar forest in Tennessee, density ($r^2=0.80$, $P<0.001$) and diversity ($r^2=0.31$, $P=0.02$) of native woody species was less in Japanese stiltgrass-infested compared to uninfested sites. The authors suggested that regeneration of woody species in southern forests will likely be reduced with Japanese stiltgrass invasion [Oswalt et al. 2007]. In a bottomland box elder-yellow-poplar-sycamore forest in Indiana, plots tilled and sown with native herbs and Japanese stiltgrass had significantly different groundlayer species composition than plots tilled and sown with only native herbs. Japanese stiltgrass plots showed 43% lower groundlayer species richness and 38% lower diversity than plots without Japanese stiltgrass. There was a strong negative correlation between Japanese stiltgrass presence and biomass of the sown native herbs ($P<0.0001$ for all variables) [Flory 2008; Flory and Clay 2010]. In urban riparian forests of North Carolina, Japanese stiltgrass presence was negatively correlated with presence of white oak, hickories,

flowering dogwood, and mapleleaf viburnum (*Viburnum acerifolium*) ($P<0.05$). The authors found that light and high soil nutrient levels were positively associated with cover of nonnative species in general ($P<0.05$), and they suggested that Japanese stiltgrass is competitively excluding woody species in urban riparian forests of the eastern United States [Vidra et al. 2006]. In sweetgum-sycamore and loblolly pine-white oak-sweetgum forests of Mississippi, Japanese stiltgrass presence was significantly associated with low species richness, and Japanese stiltgrass production was less in species-rich plant communities than in species-poor communities ($P<0.001$) [Brewer 2010a]. In mixed hardwood and oak-hickory forests of West Virginia, interior forest plots with Japanese stiltgrass had significantly lower herb, liana, and shrub diversity ($P=0.03$) and tree seedling richness ($P=0.02$) and diversity ($P=0.07$) than plots without Japanese stiltgrass [Huebner 2010]. In surveys within Chesapeake and Ohio Canal National Historic Park, Maryland, plots with Japanese stiltgrass had greater native species diversity than plots without Japanese stiltgrass until August, when Japanese stiltgrass overtopped associated groundlayer species. After that, native species diversity was greater on plots without than with Japanese stiltgrass [Adams 2007; Adams et al. 2009]."

"In areas with dense white-tailed deer populations, Japanese stiltgrass and white-tailed deer interactions may be altering forest structure, with attendant changes to wildlife populations. White-tailed deer avoid grazing Japanese stiltgrass because it is unpalatable […]. Heavy white-tailed deer browsing of palatable woody species can result in dense cover of Japanese stiltgrass and little woody species regeneration [Griggs et al. 2006; Baiser et al. 2008; Webster et al. 2008]. Royo and Carson [2006] termed this phenomenon a "recalcitrant understory"; such understories can persist for decades, altering forest structure and successional pathways. Baiser and others [Baiser et al. 2008] postulated that in eastern deciduous forests, decreases in bird guilds that nest on the ground, the understory, or the midstory may be partially due to decline of under- and midstory woody species that are subject to heavy white-tailed deer browsing and replacement of the woody species by Japanese stiltgrass."

"For example, in hardwood floodplain forests of north-central Mississippi, Japanese stiltgrass interfered with growth of native slender woodoats (*Chasmanthium laxum*), whitegrass, and white oak seedlings. Density of the native species was negatively correlated with that of Japanese stiltgrass ($P\leq0.03$) [Brewer 2010b]. Japanese stiltgrass may interfere with production of forage species on rangelands [Leicht et al. 2005]."

"Japanese stiltgrass may competitively exclude midstory species from germination and establishment sites. Based on germination and shade manipulation experiments conducted in a loblolly pine-red oak-black oak/flowering dogwood/mayapple (*Cornus florida*/*Podophyllum peltatum*) forest in Virginia, Shaw [Shaw 2009] suggested that Japanese stiltgrass may interfere with recruitment of midstory species such as eastern redbud (*Cercis canadensis*) and flowering dogwood (*Cornus florida*). There were significantly more eastern redbud (*Cercis canadensis*) germinants on plots without Japanese stiltgrass than on plots with Japanese stiltgrass ($P<0.001$). There were also more flowering dogwood germinants on plots without Japanese stiltgrass, but on all plots, recruitment of flowering dogwood was too scant for statistical analyses [Shaw 2009]."

"Japanese stiltgrass is identified as a potentially serious competitor on productive timber sites in the Southeast [Barden 1987; Simberloff 2000; Romagosa and Robison 2003]. It is implicated in

reducing growth of timber species and associated species growing under the canopy. […] In red oak-green ash forests of New Jersey, survival of planted red oak and American ash seedlings was less on sites with Japanese stiltgrass than on sites where Japanese stiltgrass was removed ($P<0.0001$), but survival of associated red maple was not significantly affected by Japanese stiltgrass. Relative growth rates of red oak and American ash were significantly reduced on plots with Japanese stiltgrass ($P<0.0001$). Overall herbaceous species richness was less on plots with than on plots without Japanese stiltgrass ($P=0.02$). The author speculated that Japanese stiltgrass interference and white-tailed deer browsing (deer density range: 58-77/km²) have a synergistic, negative effect on oak and ash regeneration in New Jersey forests [Aronson 2007] […]. On an oak plantation in southwestern Tennessee, Japanese stiltgrass presence was negatively correlated ($r= -0.82$) with growth of northern red oak seedlings."

"In the laboratory, the inhibitory effect of Japanese stiltgrass extracts on germination of radish (*Raphanus sativus*) seed was strong enough ($\beta= -0.37$) that the authors suspected Japanese stiltgrass may be allelopathic. They called for field studies testing Japanese stiltgrass's possible allelopathy [Pisula et al. 2010]."

According to USDA, NRCS (2018), *Microstegium vimineum* is a Class C noxious weed in Alabama, an invasive, banned species in Connecticut, and a prohibited species in Massachusetts. *M. vimineum* is listed as a Prohibited plant in New York (New York State Senate 2019), and Maine (Maine Department of Agriculture, Conservation & Forestry 2017), an Invasive Plant in Ohio (Ohio Department of Agriculture 2018), and an Invasive Pest in Indiana (Indiana Department of Natural Resources 2020).

# 4 History of Invasiveness

*Microstegium vimineum* is a plant native to large parts of Asia, which has successfully invaded parts of the United States, Africa, Turkey, and Central America via hitchhiking as a packing material. The plant is not known as a direct threat to humans, but does carry numerous plant diseases. The species is heavily regulated in the U.S., including possession bans, due to well documented impacts. These impacts include changes in soil characteristics and impacts to wildlife habitat and plant communities. For these reasons the history of invasiveness is classified as "High."

# 5 Global Distribution

**Figure 1**. Known global distribution of *Microstegium vimineum*. Map from GBIF Secretariat (2018). The location in Tanzania is from a valid record from 1931 (GBIF Secretariat 2018). However, with no other observations or references to a population established in Tanzania it was not used as a source point for the climate match.

# 6 Distribution Within the United States

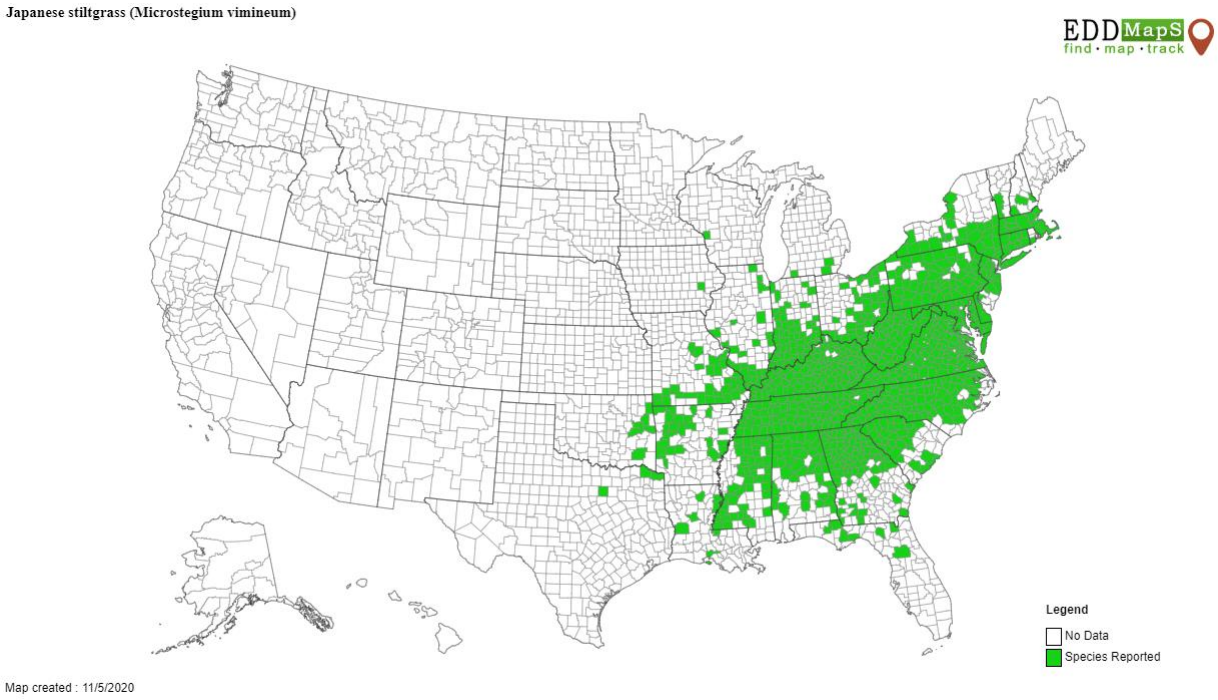


**Figure 2.** Distribution of *Microstegium vimineum* by county in the United States. Map from EDDMapS (2020).

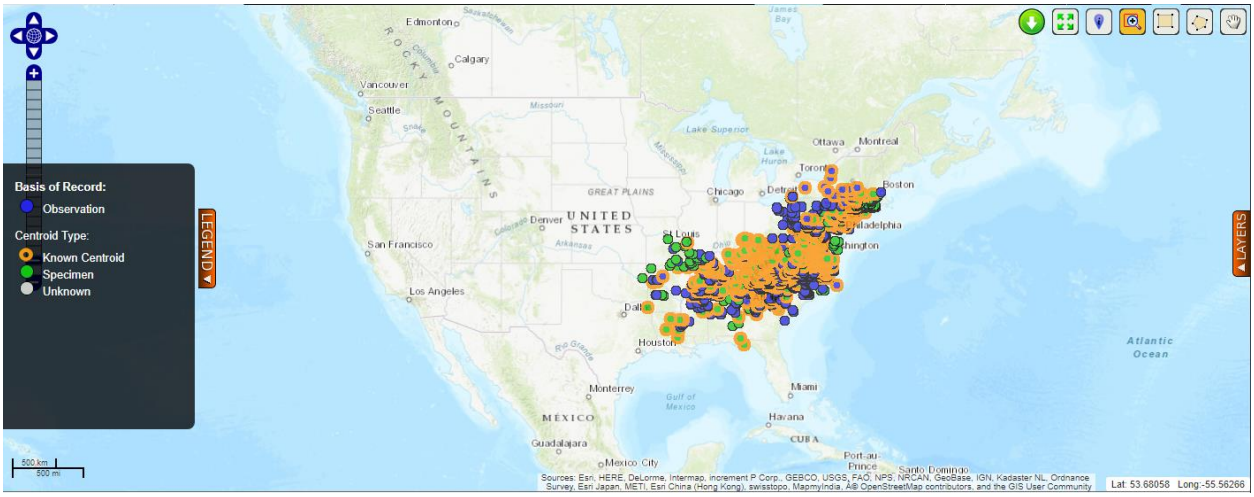


**Figure 3**. Known distribution of *Microstegium vimineum* in the contiguous United States. Map from BISON (2018).

# 7 Climate Matching

## Summary of Climate Matching Analysis

The climate match for *Microstegium vimineum* to the contiguous United States was high in the eastern half of the country except for small areas of eastern Florida and the Appalachian Mountains. Most of this areas already contains established populations of *M. vimineum*. The west coast had a low match and most of the mid-west had a medium match. The Climate 6 score (Sanders et al. 2014; 16 climate variables; Euclidean distance) for the contiguous United States was 0.590, high (scores 0.103 and greater are classified as high). Most States had high individual Climate 6 scores. Montana, North Dakota, and Wyoming had medium individual scores. Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington had low individual scores.

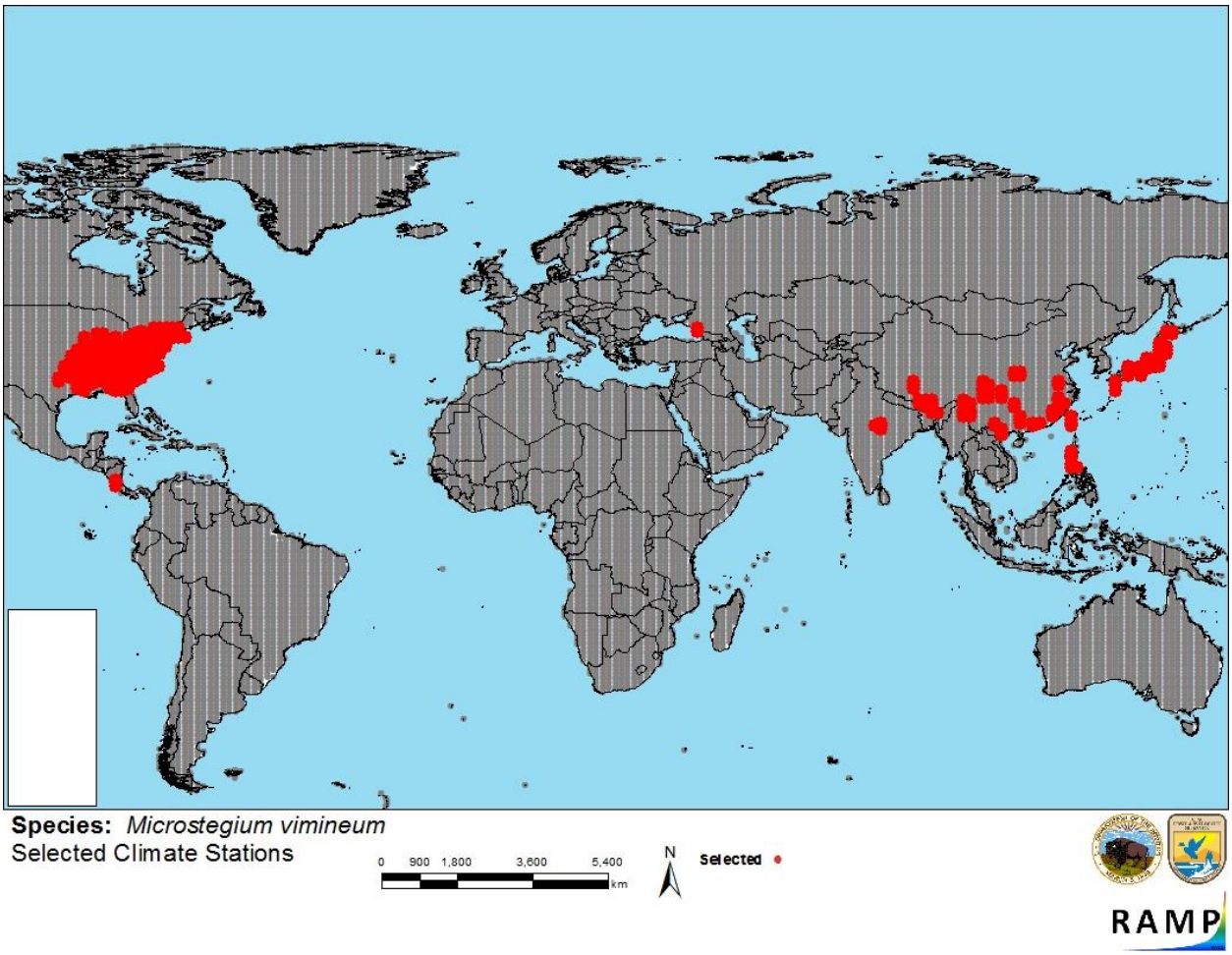


**Figure 4**. RAMP (Sanders et al. 2014) source map showing weather stations in North America, Costa Rica, Turkey, and Asia selected as source locations (red) and non-source locations (gray) for *Microstegium vimineum* climate matching. Source locations from BISON (2018), EDDMapS (2020), and GBIF Secretariat (2018). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

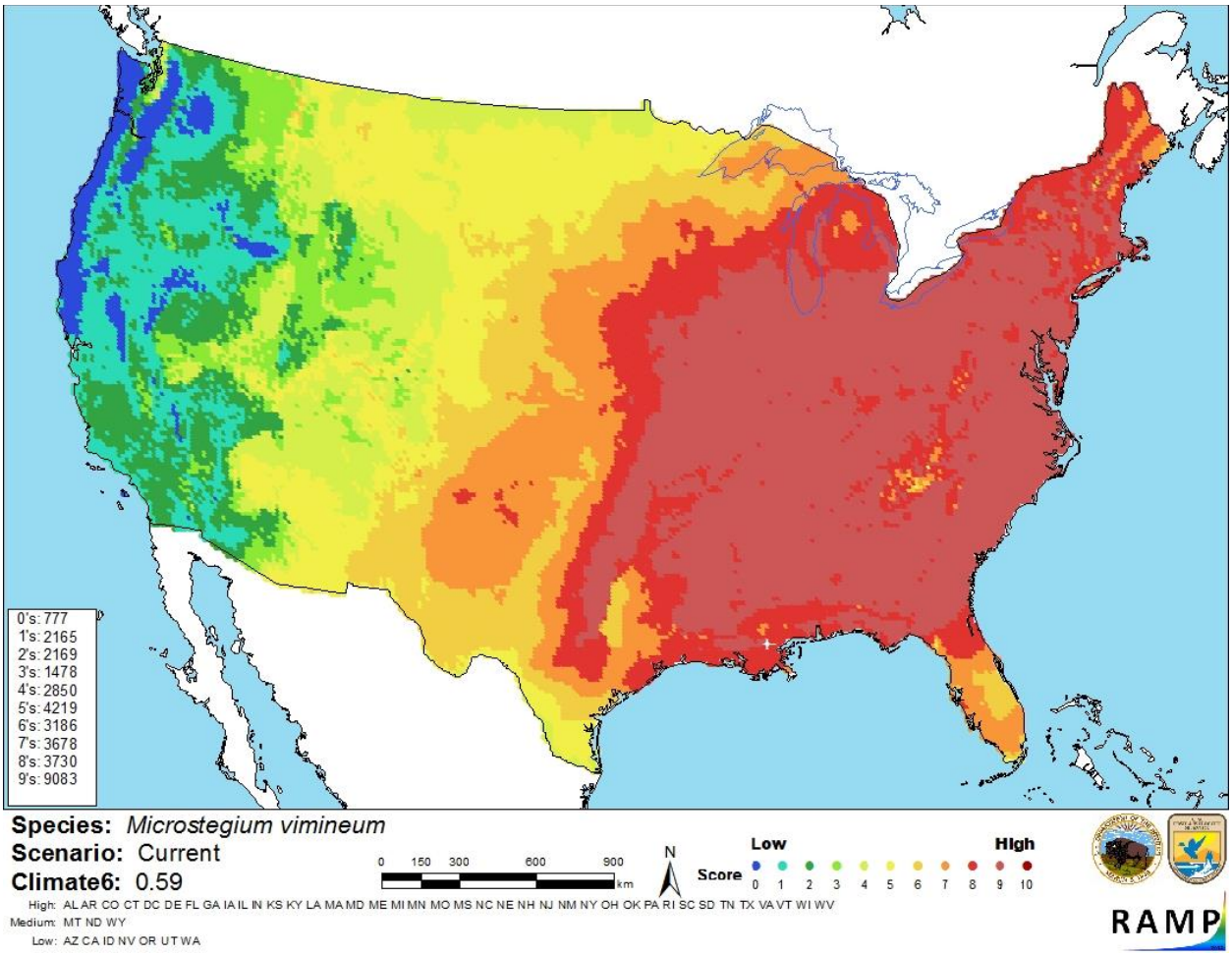


**Figure 5**. Map of RAMP (Sanders et al. 2014) climate matches for *Microstegium vimineum* in the contiguous United States based on source locations reported by BISON (2018), EDDMapS (2020), and GBIF Secretariat (2018). Counts of climate match are tabulated on the left. 0/Blue = Lowest match, 10/Red = Highest match.

The High, Medium, and Low Climate match Categories are based on the following table:

| Climate 6:<br>(Count of target points with climate scores 6-10)/<br>(Count of all target points) | Overall Climate Match Category |
|---|---|
| 0.000≤X≤0.005 | Low |
| 0.005<X<0.103 | Medium |
| ≥0.103 | High |

# 8 Certainty of Assessment

Certainty of this assessment is High. Information on the biology, invasion history and impacts of this species is available. The distribution is well documented and represented in the climate match. Peer-reviewed literature was available and summarized in scientific databases.

# 9 Risk Assessment

## Summary of Risk to the Contiguous United States

*Microstegium vimineum*, Japanese stiltgrass, is an annual grass native to Asia. The history of invasiveness for *M. vimineum* is classified as "High." It was introduced into the United States in the early 1900's as a packing material for porcelain in China and has since spread through natural dispersion from its initial introduction in Tennessee. *M. vimineum* spreads rapidly in disturbed areas and has a high potential to spread further throughout the eastern United States. The plant can form dense monocultures in forest understories, displacing native species and changing soil chemistry. Climate matching indicated the contiguous United States has a high climate match. The areas of highest climate match were concentrated where there are already established *M. vimineum* populations. The certainty of assessment is high. The overall risk assessment category is high.

## Assessment Elements

- **History of Invasiveness (Sec. 4): High**
- **Overall Climate Match Category (Sec. 7): High**
- **Certainty of Assessment (Sec. 8): High**
- **Remarks/Important additional information:** *Microstegium vimineum* is already established in much of the eastern contiguous United States.
- **Overall Risk Assessment Category: High**

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