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Weed Risk Assessment for *Persicaria nepalensis* (Polygonaceae) – Nepal knotweed

Top left: habit of *Persicaria nepalensis* (source: Meier, 2006). Bottom left: inflorescence (source: Verloove, 2011). Right: *Persicaria nepalensis* forming dense population in maize crop (source: Vibrans and Hanan Alipi, 2008)

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Executive Summary

The result of the weed risk assessment for *Persicaria nepalensis* is High Risk of spreading or causing harm in the United States. *Persicaria nepalensis* is an annual herb that is a weed of agriculture and natural areas. It is naturalized in about ten counties, mostly in the northeastern states but also in Florida. It has been reported from Arizona, New Mexico, and Washington, but it is not known to be established in those states. We found no evidence of regulation or control in the United States. It is spreading in Mexico and the United States (New York) and can form dense mats and carpets. Seeds can be dispersed by human activity and as contaminants of seed for planting and bird seed. They have been observed to retain some viability in soil after four years. The species invades natural areas in Mexico and is considered a potential invader in Poland and Belgium. The dense populations increase the total biomass of the herb layer, changing the habitat structure. *Persicaria nepalensis* is also an agricultural weed that can cause yield loss in a variety of crops, particularly wheat. It is reported to obstruct access to water in South Africa. It is regulated in Australia, Honduras, and Brazil and is controlled or recommended for control in several countries. We estimate that 38 to 78 percent of the United States is suitable for establishment of this species. A few nurseries in the United Kingdom sell the plant as an ornamental; if they ship to the United States, that would be the most likely means of entry. It could also spread as a seed contaminant.

Plant Information and Background

PLANT SPECIES: *Persicaria nepalensis* (Meisn.) H. Gross (Polygonaceae) (NGRP, 2021)

SYNONYMS: Basionym: *Polygonum nepalense* Meisn.; other synonyms: *Persicaria alata* (Buch.-Ham. ex D. Don) Nakai, *Polygonum alatum* (Buch.-Ham. ex D. Don) Spreng. (NGRP, 2021)

COMMON NAMES: Nepal knotweed, Nepal persicaria (NGRP, 2021)

BOTANICAL DESCRIPTION: *Persicaria nepalensis* is an annual herb with decumbent to ascending stems (eFloras, 2014, 2021) that grow 15-50 cm tall (CABI, 2014; eFloras, 2021). Its leaves, which often have a pair of dark blotches on each side of the mid-rib, can grow up to 5 cm in length; the flowers are 2-3 mm long and are usually pink but can be white (CABI, 2014). For a full botanical description, see eFloras (2014, 2021) or Flora of North America Editorial Committee (2005).

INITIATION: APHIS received a market access request from South Africa for corn seeds for planting in the United States (South Africa Department of Agriculture Forestry and Fisheries, 2012). During the development of that commodity risk analysis, *P. nepalensis* was identified as a weed of potential concern to the United States. Consequently, this was followed by a weed risk assessment, which was finalized in 2015. In this version, we reviewed the literature and updated the assessment with new information.

WRA AREA[1]: United States and Territories

FOREIGN DISTRIBUTION: *Persicaria nepalensis* is native to temperate and tropical areas of Asia (NGRP, 2021; POWO, 2021), eastern Africa (Ivens, 1967; Meier, 2006; POWO, 2021), Indonesia, Philippines, Papua New Guinea, Yemen, Madagascar, and South Africa (NGRP, 2021; POWO, 2021). It has naturalized in parts of central and southern Africa, Europe (Belgium, Italy, Germany, Russia, United Kingdom), North America (Mexico, Canada) (CABI, 2014; Kartesz, 2015; Meier, 2006; NGRP, 2021; Stace, 2010), and South America (Colombia, Ecuador, Venezuela) (Vibrans and Hanan Alipi, 2008). It is also present in Turkey (POWO, 2021). The species is considered invasive in Italy (Celesti-Grapow et al., 2009) and Poland (Kowalczyk et al., 2014) and is regulated in Australia (Vibrans and Hanan Alipi, 2008), Honduras, and Brazil (APHIS, 2021). The plant is eaten as a vegetable in Ethiopia and India (Alemneh, 2020; Ronald et al., 2019; Singh and Teron, 2015) and sold in Indian markets (Ronald et al., 2019).

U.S. DISTRIBUTION AND STATUS: *Persicaria nepalensis* is naturalized in a few counties in Pennsylvania and New York, and in one county each of Connecticut, Florida, Maine, and Massachusetts (EDDMapS, 2021; eFloras, 2021; Kartesz, 2015; NRCS, 2021). In Massachusetts, it

[1] The “WRA area” is the area in relation to which the weed risk assessment is conducted (definition modified from that for “PRA area”) (IPPC, 2017).

is reported as naturalized but uncommon (Sorrie, 2005). It has also been found in southwestern ponderosa pine ecosystems (in Arizona and New Mexico) in the United States (Friederici, 2003), and one report places it in Washington state near the shore of Squalicum Lake in Whatcom County (GBIF, 2021), but we do not know if it has established in these states. We found no evidence of when and how it may have been introduced to the country. Furthermore, we found no evidence that this species is sold commercially in the United States (Amazon, 2021; Plant Information Online, 2021), though it is sold by a nursery in the United Kingdom (Growild Nursery, 2021; The Plantsman's Preference, 2021). It may be cultivated privately to some extent, as four people indicated that they have or want the plant on the gardening forum, Dave's Garden (2021). We found no evidence that this species is regulated or listed as a noxious weed by any U.S. state (NPB, 2021).

Analysis

ESTABLISHMENT/SPREAD POTENTIAL: *Persicaria nepalensis* is closely related to other important invasive *Persicaria* species such as *P. orientalis, P. capitata*, and *P. perfoliata* (Alien Plant Working Group, 2010; CISEH and NPS, 2011; NISIC, 2011; Randall, 2007). Beyond its native range it has established in Africa, Europe, North America (Kartesz, 2015; NGRP, 2014; Stace, 2010), and South America (Vibrans and Hanan Alipi, 2008). It is spreading in Mexico and the United States (New York) (Vibrans, 2012; Vibrans and Hanan Alipi, 2008; Weldy et al., 2021). The species is an annual (eFloras, 2021) and appears to be pollinated by a variety of bee species (Inoka et al., 2005). It is an erect herb that can spread very quickly (Vibrans and Hanan Alipi, 2008), is shade tolerant (Meier, 2006), forms dense mats (Vibrans and Hanan Alipi, 2008), reproduces by seed (Everaarts, 1981), and forms a persistent seed bank (Plaza and Pedraza, 2007; Sahoo et al., 1994). Propagules can be dispersed as seed contaminants in trade (Meier, 2006; PestID, 2021), by grazing cattle that consume the seeds (Woldu and Mohammed Saleem, 2000), and probably also by birds (Lu et al., 2011) and unintentionally by people (Moore, 2011). We had low uncertainty for this risk element because it is well-documented, and information is readily available.

Risk score = 18.0 Uncertainty index = 0.09

IMPACT POTENTIAL: *Persicaria nepalensis* is a weed of multiple crops, including potato, soybean, rice, corn, and strawberry (Ishikawa and Takenaka, 2002; Moody, 1989; Radosevich and Holt, 1984; Zhang and Hirota, 2000). It is a major weed of wheat in Ethiopia (Kassahun et al., 2005; Tessema et al., 1999), resulting in reduced crop yield (Gebre et al., 1987) and increased weed control measures (Vibrans and Hanan Alipi, 2008). It also reduces yield of wheat, coffee, and other crops in other parts of Africa (Kowalczyk et al., 2014). Because it is a quarantine or regulated pest for multiple countries (PestID, 2021; Vibrans and Hanan Alipi, 2008) and can be dispersed as a contaminant, it could impact trade. It is perceived as an environmental weed, resulting in control efforts in natural areas (Verloove, 2011). In those areas, it can increase the density of the herb layer (Moore, 2011), but we found no evidence of it replacing other species. In anthropogenic systems in South Africa, it can

obstruct access for water sports (Wells et al., 1986). In India, it can be a weed of flower gardens and lawns (Datta and Banerjee, 1954) and has been reported as a weed in botanical gardens in Indonesia and the United Kingdom (Clement and Foster, 1994; Wibowo and Iskandar, 2013). We had average uncertainty for this risk element.

Risk score = 3.8 Uncertainty index = 0.17

RISK MODEL RESULTS: The risk scores for establishment/spread and impact potential were used to estimate the probabilities of invasiveness and overall risk result (Fig. 1).

Model Probabilities: P(Major Invader) = 91.6%
P(Minor Invader) = 8.1%
P(Non-Invader) = 0.3%
Risk Result = High Risk
Risk Result after Secondary Screening = Not Applicable

GEOGRAPHIC POTENTIAL: Using the PPQ climate-matching model for weeds (Magarey et al., 2017), we estimate that about 38 to 78 percent of the United States is suitable for the establishment of *P. nepalensis* (Fig. 2). This area represents the joint distribution of Plant Hardiness Zones 3-13, areas with 10-100+ inches of annual precipitation, and the following Köppen-Geiger climate classes: tropical rainforest, tropical savannah, steppe, desert, Mediterranean, humid subtropical, marine west coast, humid continental warm summers, and humid continental cool summers. The area of the United States shown to be climatically suitable was determined by using only these three climatic variables. Other factors, such as soil, hydrology, disturbance regime, and species interactions may alter the areas in which this species is likely to establish. Habitats of this plant include wetland areas (Shin et al., 2008), shores of rivers and lakes (NEWFS, 2014), and non-aquatic environments, including roadsides, dirt roads, grassland, meadow, woodlands, cliffs, and cultivated areas such as cereal fields and row crops (GBIF, 2021; Meier, 2006; Reed, 1977; Vibrans and Hanan Alipi, 2008; Weldy et al., 2021). It apparently thrives in high altitude tropics (CABI, 2014) and in humid, partially shaded slopes and valleys (Kowalczyk et al., 2014).

ENTRY POTENTIAL: *Persicaria nepalensis* is already present in the United States, but we evaluated its entry potential to determine the likelihood for additional material to enter the country. Because the species is cultivated as ornamental outside the United States (i.e., the United Kingdom, Growild Nursery, 2021; The Plantsman's Preference, 2021), it is possible that some may seek to import it. The seeds could also enter as contaminants of seeds for planting, particularly wildlife plant mixes (Meier, 2006), or of birdseed (Clement and Foster, 1994; Meier, 2006). Out of a possible score of 0 to 1, we estimate its entry risk score to be 0.62, with intentional introduction as ornamental being the most likely pathway for entry.

Risk score = 0.62 Uncertainty index = 0.03

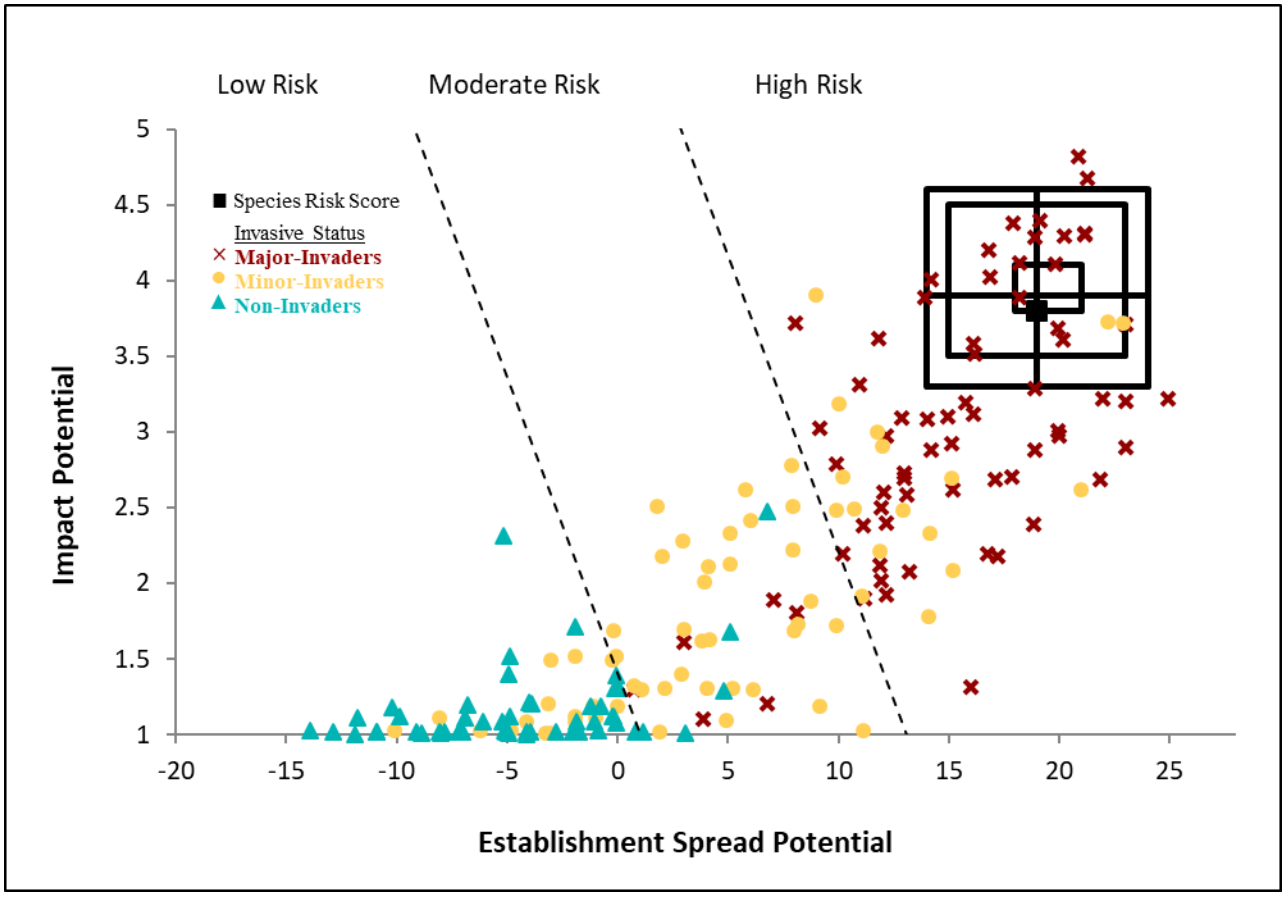

Figure 1. Risk and uncertainty results for *Persicaria nepalensis*. The risk score for this species (solid black symbol) is plotted relative to the risk scores of the species used to develop and validate the PPQ WRA model (Koop et al., 2012). The results from the uncertainty analysis are plotted around the risk score for *P. nepalensis*. The smallest black box contains 50 percent of the simulated risk scores, the second 95 percent, and the largest 99 percent. The black vertical and horizontal lines in the middle of the boxes represent the medians of the simulated risk scores (N=5000). For additional information on the uncertainty analysis used, see Caton et al. (2018).

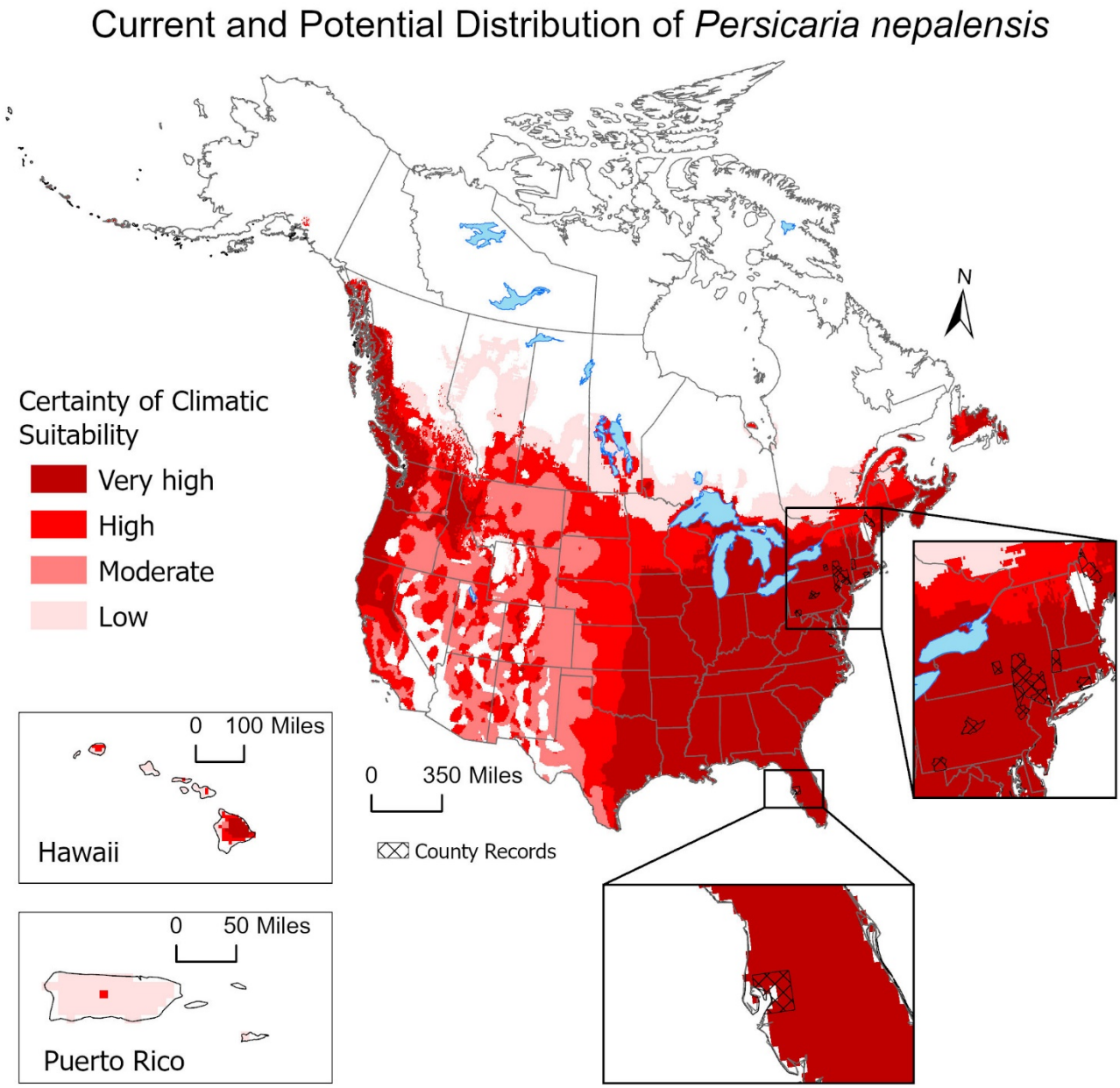

Figure 2. Current and potential distribution of *Persicaria nepalensis* in the United States. Climatic suitability was determined using the APHIS-PPQ climate matching tool for invasive plants (Magarey et al., 2017). The known distribution of *P. nepalensis* was based on county distribution records from online databases (see text). Map components are shown at different scales.

Discussion

The result of the weed risk assessment for *Persicaria nepalensis* is High Risk of spreading or causing harm in the United States. In Mexico, where it arrived in 2004, it has been found mainly in crops but also in pine forests and grasslands, and it has spread very quickly (Vibrans, 2012; Vibrans and Hanan Alipi, 2008). Populations in natural areas of Belgium are monitored and controlled (Verloove, 2011). We found no evidence of it causing significant impacts or of it being controlled where it occurs in the United States. In the Catskills region of New York, however, it is becoming very common; it is "potentially a highly invasive plant" (Weldy et al., 2021). The state of New York assessed *P. nepalensis* by using their ranking system for invasiveness (Moore, 2011), which assesses impact on native species and natural ecosystems in that state (Jordan et al., 2012). The final New York Invasiveness Rank for *P. nepalensis* was "unknown" because of a lack of sufficient information on the species (Moore, 2011). Our uncertainty analysis shows that, even if some of our answers were to change, the result would still be High Risk. More complete documentation about the reproductive and dispersal mechanisms of the species would reduce the uncertainty, as would a more thorough understanding of its impact on species diversity in natural areas. *Persicaria nepalensis* tolerates a variety of environmental conditions (NEWFS, 2014; Shin et al., 2008; Vibrans and Hanan Alipi, 2008) and could establish throughout most of the United States.

Suggested Citation

PPQ. 2021. Weed risk assessment for *Persicaria nepalensis* (Meisn.) H. Gross (Polygonaceae) – Nepal knotweed (Ver. 2). United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (PPQ), Raleigh, NC. 26 pp.

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Appendix. Weed risk assessment for *Persicaria nepalensis* (Meisn.) H. Gross (Polygonaceae)

The following table includes the evidence and associated references used to evaluate the risk potential of this taxon. For each question, we also include the answer, uncertainty, and score ratings, respectively.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 [What is the taxon's establishment and spread status outside its native range? (a) Introduced elsewhere =>75 years ago but not escaped; (b) Introduced <75 years ago but not escaped; (c) Never moved beyond its native range; (d) Escaped/Casual; (e) Naturalized; (f) Invasive; (?) Unknown]	f - negl	5	*Persicaria nepalensis* is native to temperate and tropical areas of Asia (NGRP, 2021) and has naturalized in Africa, Europe, North America (Kartesz, 2015; NGRP, 2021; Stace, 2010), and South America (Colombia, Ecuador, Venezuela) (Vibrans and Hanan Alipi, 2008). It originated in the Himalayas and is now "quite widespread" in Asia, Africa, and the Americas (CABI, 2014). It is reported as a "garden escape" (Randall, 2012). In New York, Connecticut, and Pennsylvania, it "occasionally escaped into relatively stable habitats" (Gleason and Cronquist, 1991). Discovered in Belgium in 2010, it "is increasingly recorded in neighbouring countries as well" (Verloove, 2011). It was first collected in Colombia in 1943 and today appears to be widely distributed across different locations (e.g., corn fields, potato fields, roadsides) (Meier, 2006). In Mexico, where it arrived in 2004, it has spread very quickly; two populations that appeared to be in expansion were detected by 2008 (Vibrans and Hanan Alipi, 2008), and an additional population was found in 2012 (Vibrans, 2012). In New York, it "spreads rapidly in damp shade, along roadsides, dirt roads in forests, logging areas, thickets" (Dave's Garden, 2021). In the Catskill region of New York, it is "[b]ecoming very common" (Weldy et al., 2021). The alternate answers for the Monte Carlo simulation were both "e."
ES-2 (Is the species highly domesticated)	n - low	0	We found some evidence that this species is cultivated but no evidence it has been bred to reduce its likelihood of becoming a weed. It is "cultivated" (NGRP, 2021; Randall, 2012) and important as an ornamental (as ground-cover) (NGRP, 2021). It is sold in the UK for ground-cover (Exclusive Plants, 2013; The Plantsman's Preference, 2021), and regarded as a good ground-cover for tea production (CABI, 2014; Eden and Bond, 1945). For *Persicaria* species, germplasm collections and breeding programs are not known to exist (van Valkenburg and Bunyapraphatsara, 2001).
ES-3 (Significant weedy congeners)	y - negl	1	The following species are listed as "Category 5" in Randall (2007): *Persicaria orientalis* and *P. capitata* (definition of "Category 5": "This plant has been recorded as an invasive species. This is the most serious criterion

Question ID	Answer - Uncertainty	Score	Notes (and references)
			that can be applied to a plant and is generally used for serious high impact environmental and/or agricultural weeds that spread rapidly and often create monocultures."). Also, *P. perfoliata* (common name: mile-a-minute) is a serious invasive weed in the United States and elsewhere (Alien Plant Working Group, 2010; CISEH and NPS, 2011; NISIC, 2011; Sanchez et al., 2011). *Persicaria wallichii* is a weed that can be difficult to manage in the United States (Bartoszek et al., 2006) and is considered to be invasive in Poland (Kowalczyk et al., 2014).
ES-4 (Shade tolerant at some stage of its life cycle)	y - mod	1	Multiple sources state that it grows in shade (Exclusive Plants, 2013; Gleason and Cronquist, 1991; Meier, 2006; Vibrans and Hanan Alipi, 2008). "[S]hade tolerant" (Moore, 2011; Srithi et al., 2017; The Plantsman's Preference, 2021). "[It]s predominance in tea must suggest that it has some shade tolerance" (CABI, 2014). It also occurs in sun (Exclusive Plants, 2013; Ohwi, 1984) and prefers open or lightly shaded situations (CABI, 2014). Eden and Bond state that it is "not particularly tolerant of shade" (Eden and Bond, 1945). Considering its apparent preference for sun or light shade and the statement by Eden and Bond, we used moderate uncertainty.
ES-5 (Plant a vine or scrambling plant, or forms tightly appressed basal rosettes)	n - negl	0	It is neither a vine nor an herb with a basal rosette. It is an erect herb (Kak, 1984; Wells et al., 1986). It is a forb/herb (Kartesz, 2015; NRCS, 2021) with a decumbent [= "lying along the ground or along a surface, with the extremity curving upward"] to ascending stem (eFloras, 2014) and growing 15-50 cm high (CABI, 2014; eFloras, 2021).
ES-6 (Forms dense thickets, patches, or populations)	y - negl	2	It is reported "forming carpets" in eucalyptus plantations (Meier, 2006). In Mexico, it forms "dense populations" and "mats" in corn fields (Vibrans and Hanan Alipi, 2008) and "densely" covers the ground in potato crops (Vibrans, 2012). "[D]ense infestations...can occur under suitable conditions" (CABI, 2014).
ES-7 (Aquatic)	n - negl	0	It is not an obligate aquatic species. Although it is a "wetland plant" (Shin et al., 2008), having a high tolerance for flooding (Li-Min et al., 2009) and growing along shores of rivers and lakes (NEWFS, 2014), its habitats also include non-aquatic environments (e.g., roadsides, dirt roads, grassland, meadow, woodlands, cliffs, cultivated areas) (GBIF, 2021; Meier, 2006; Reed, 1977; Vibrans and Hanan Alipi, 2008; Weldy et al., 2021). In India, its habitats include subalpine forest and alpine meadow (Rai et al., 2012).
ES-8 (Grass)	n - negl	0	This plant is not a grass ; it is an herb in the Polygonaceae family (NGRP, 2021).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	This plant is not a woody plant. It is not in a plant family known to contain nitrogen-fixing species (NGRP, 2021; Santi and Franche, 2013).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-10 (Does it produce viable seeds or spores)	y - negl	1	It reproduces by seed (Kassahun et al., 2005; Wells et al., 1986; Zhang and Hirota, 2000). "Reproduction is solely by seeds" (CABI, 2014). Reproduces mainly by seed (Everaarts, 1981).
ES-11 (Self-compatible or apomictic)	y - high	1	We found no information on *P. nepalensis*' breeding system or whether it is self-compatible or apomictic. However, all flowers of this species have both carpels and stamens (New England Wild Flower Society, 2013). Also, other related species such as *P. scabra, P. pensylvanica, P. minor*, and *P. maculosa* are self-compatible (UFZ, 2011). The related species *P. perfoliata* (mile-a-minute weed) "is primarily a self-pollinating plant (supported by its inconspicuous, closed flowers and lack of a detectable scent), with occasional out-crossing" (Alien Plant Working Group, 2010). Stanford (1925) indicates that *Persicaria* flowers often open only briefly or not at all and are fertilized through cleistogamy, but no information specific to *P. nepalensis* is provided. Based on this information, we answered "yes" with high uncertainty.
ES-12 (Requires specialist pollinators)	n - mod	0	We found no evidence of *P. nepalensis* requiring specialist pollinators. In a field study in Sri Lanka, flowers of *P. nepalensis* were visited by multiple bee species [*Apis cerana*, *Braunsapis* sp., *Lasioglossum alphenum*) (Inoka et al., 2005)]. The related species *P. chinensis* is pollinated by a wide range of dipteran pollinators (Mitra et al., 2005), and *P. perfoliata* produces viable seed without the assistance of pollinators (Alien Plant Working Group, 2010).
ES-13 [What is the taxon's minimum generation time? (a) less than a year with multiple generations per year; (b) 1 year, usually annuals; (c) 2 or 3 years; (d) more than 3 years; or (?) unknown]	a - low	2	*Persicaria nepalensis* is an annual (CABI, 2014; Eden and Bond, 1945; eFloras, 2021; Gleason and Cronquist, 1991; Kak, 1984; Kassahun et al., 2005; Ohwi, 1984; Stace, 2010; Tessema et al., 1999; Vibrans and Hanan Alipi, 2008; Wells et al., 1986). It is a "short cycle annual with a duration of some 4-5 months only" (Eden and Bond, 1945), and "the plant lives only a single year or less" (New England Wild Flower Society, 2013). However, it is also reported as a perennial (Kartesz, 2015; NRCS, 2021), and in Venezuela, it "appears" that the climate allows several generations per year (Meier, 2006). Alternate answers for the Monte Carlo simulation were "c" and "a."

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-14 (Prolific seed producer)	n - mod	-1	Over 15 million seeds per acre have been recorded (Eden and Bond, 1945), which translates to approximately 3,706 seeds per square meter (given that 1 acre equals 4,047 square meters). In one study on weed seed populations in different crop fields, the viable seed population in the soil did not exceed 4,000 per meter square "under normally weeded plots," according to the graphs presented (Sahoo et al., 1994). It has "[e]xtensive production of seeds (1000s) on individual plants" (Moore, 2011). Seeds are "produced in great abundance" (CABI, 2014). One study from Japan indicated 50 percent viability of seed (Watanabe, 1978). Royal Botanic Gardens Kew (2008) reports germination rates of 75-100 percent. While it appears to have relatively abundant seed production, we did not find evidence that it produces >5,000/m2 crown area per year.
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - low	1	"Small seeds could easily be spread indirectly by humans....Weldy suggest it may be spreading along logging roads" (Moore, 2011, citing Weldy personal communication and personal observation). In England, it is found in waste dumps (Meier, 2006), indicating people are moving it. Although it mainly reproduces by seed, stem fragments left on the soil can root at the nodes and establish in soil (Everaarts, 1981; Medley, 1961).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - negl	2	It was introduced to England in birdseed (Clement and Foster, 1994; Hanson and Mason, 1985; Meier, 2006), and it is thought to have been introduced to Germany as a contaminant in seed mixtures that were planted for wildlife (Meier, 2006). "Several recent German records were associated with birdseed (for gaming) ... This most likely is the vector of introduction in Averbode [Belgium] as well" (Verloove, 2011). At U.S. ports of entry, *P. nepalensis* has been intercepted in imported seed of *Raphanus* sp., and there have been interceptions of seed of other species in the genus *Persicaria* in permit cargo (commercial plant products) (PestID, 2021).
ES-17 (Number of natural dispersal vectors)	2	0	Information relevant for ES-17a through ES-17e: The fruit is an achene, which is dry, indehiscent, usually one-seeded (New England Wild Flower Society, 2013), dark brown to black (Flora of North America Editorial Committee, 2005), and 1.5-2 mm by 1-2 mm in size (eFloras, 2021; Flora of North America Editorial Committee, 2005).
ES-17a (Wind dispersal)	n - mod		We found no direct evidence of wind dispersal. Fruit possesses no obvious adaptations for wind dispersal. Datta and Banerjee (1954) stated that in the hill area of Darjeeling (India) the "seeds disperse far and wide from their numerous dry flowers towards the beginning of winter and germinate again when the first rain falls on the hills," but with no mention of how exactly it is dispersed.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-17b (Water dispersal)	? - max		Unknown. We found no direct evidence that this species is dispersed by water, or that the propagules are buoyant. Plus, there are no obvious fruit/seed adaptations for water dispersal, and the plant lives in a variety of environments, not just by water. However, this plant is often reported to occur by water bodies (eFloras, 2021; NEWFS, 2014; Reed, 1977; Wells et al., 1986); it is even described as a wetland plant (Shin et al., 2008; Tropicos.org, 2014) with high tolerance for flooding (Li-Min et al., 2009), which suggests it may likely be dispersed by water. Van Valkenburg and Bunyapraphatsara (2001) say all *Persicaria* spp. are dispersed by water, but they provide no supporting information. Also, Swearingen et al. (2010) report that for the related species *Persicaria perfoliata* (mile-a-minute weed), "water is an important mode of dispersal as fruits can remain buoyant for seven to nine days."
ES-17c (Bird dispersal)	y - mod		In a field study, *Polygonum nepalense* (synonym of *Persicaria nepalensis*) was one of three herbaceous species constituting the majority of the diet of pink-rumped rosefinch (*Carpodacus eos*) nestlings (Lu et al., 2011). Also, Polygonaceae are often dispersed by birds (Vibrans and Hanan Alipi, 2008). For instance, the seeds of the related species *P. chinensis* (Goodland and Healey, 1996; Royal Botanic Gardens Kew, 2008) and *P. perfoliata* (Swearingen et al., 2010) are dispersed by birds eating the seed (Goodland and Healey, 1996; Royal Botanic Gardens Kew, 2008). Although we did not find direct evidence that the seed of *P. nepalensis* are dispersed by birds, based on the evidence that birds do consume the seed plus the congeneric evidence for dispersal, we answered yes with moderate uncertainty.
ES-17d (Animal external dispersal)	n - low		We found no evidence that the propagules of *P. nepalensis* are dispersed externally by animals, or that they have any particular adaptations to be dispersed in this manner.
ES-17e (Animal internal dispersal)	y - low		In a field study in Ethiopia, *P. nepalensis* was one of many species that were grown from the manure of grazing cattle in grasslands (i.e., it was part of the manure seed bank) (Woldu and Mohammed Saleem, 2000). Other *Persicaria* species are dispersed by mammalian animals that consume the seeds, such as *P. longiseta* (U.S. Forest Service, 2011) and *P. perfoliata* (Alien Plant Working Group, 2010). The achenes of *Persicaria* species are eaten by wildlife such as rabbits and are viable after passage through the digestive tract (Moore, 2011).
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - low	1	In a one-year study on weed seed populations in different crop fields (Sahoo et al., 1994), *P. nepalensis* "maintained a fairly high proportion of viable seeds in the soil seed bank" throughout the study, with a loss of viable seed between 13.8 and 25.4 percent in frequently weeded plots. Seeds were germinated from the seed bank in a

Question ID	Answer - Uncertainty	Score	Notes (and references)
			study in Ethiopia (Reubens et al., 2007). The species has a "large reservoir of seed present in the soil" (Eden and Bond, 1945) and its seeds "survive for long periods in the soil" (Plaza and Pedraza, 2007). *Persicaria* species in general have seed that germinate within the first year but may remain viable for a few years (Moore, 2011). For instance, seed of the related species *P. perfoliata* can persist in the soil up to four (U.S. Forest Service, 2011) or six years (Yun Wu, 2009), and *P. longiseta* "forms a persistent seed bank" (U.S. Forest Service, 2011).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	n - low	-1	*Persicaria nepalensis* is not likely to grow back extensively after removal of aboveground parts (Moore, 2011, citing author's personal observation). As noted in ES-15, stem fragments left on the soil can root at the nodes and establish in soil (Everaarts, 1981; Medley, 1961); however, considering it reproduces predominantly by seed (see ES-10), we do not consider this sufficient evidence that the species resprouts more vigorously than most other species. In Ethiopia, its cover is reduced by about 75 percent in areas of intensive soil burning (Pulschen and Koch, 1990).
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - low	0	Heap et al. (2021) do not list any species in the genus *Persicaria* as having herbicide resistance; however, multiple species of *Polygonum* are reported as having herbicide resistance, although not *Polygonum nepalense* (the synonym of *Persicaria nepalensis*).
ES-21 (Number of cold hardiness zones suitable for its survival)	11	1	
ES-22 (Number of climate types suitable for its survival)	9	2	
ES-23 (Number of precipitation bands suitable for its survival)	10	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - low	0	We found no evidence that this species is allelopathic.
Imp-G2 (Parasitic)	n - negl	0	*Persicaria nepalensis* does not belong to a family known to contain parasitic plants (Heide-Jorgensen, 2008; NGRP, 2011; Nickrent, 2009). It is not parasitic (New England Wild Flower Society, 2013).
Impacts to Natural Systems			
Imp-N1 (Changes ecosystem processes and parameters that affect other species)	n - mod	0	We found no evidence of it having this type of impact.
Imp-N2 (Changes habitat structure)	y - low	0.2	"Aggressive growth increases the density of the herb layer" in natural areas (Moore, 2011, citing Meier, 2006 and personal observation by Troy Weldy). Moore (2011, citing Meier, 2006) states that "[p]lants can have a...somewhat smothering growth habit, the weak stems

Question ID	Answer - Uncertainty	Score	Notes (and references)
			lying on the surrounding vegetation." Also, as noted in ES-6, it forms dense populations or mats/carpets.
Imp-N3 (Changes species diversity)	? - max		Unknown. Although this type of impact has not been studied or reported, "large stands probably at least result in reduction of numbers of native plants" (Moore, 2011).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species?)	y - high	0.1	Although this plant occurs in a range of disturbed situations, particularly in cultivated areas (CABI, 2014; Meier, 2006), it invades natural vegetation (Vibrans and Hanan Alipi, 2008), that occurs in various environments, e.g., forests/woodlands (Friederici, 2003; Kantachot et al., 2010; Reed, 1977), lake and river edges (GBIF, 2021), streambanks (Wells et al., 1986), grassland (Vibrans and Hanan Alipi, 2008), and freshwater wetland areas (NEWFS, 2014; Shin et al., 2008; Tropicos.org, 2014). Therefore, this plant could likely survive in various natural environments in the United States. Also, we found evidence that it can affect community structure (see Imp-N2). Based on this evidence, we answered “yes”, but indicated a high uncertainty because of the lack of evidence of it affecting community composition.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions?)	n - high	0	Its predicted distribution in the United States includes globally outstanding ecoregions as defined by Ricketts et al. (1999, p. 34, Fig. 3.1), and it has demonstrated an ability to change habitat structure by increasing the density of the herb layer (Imp-N2). However, because we found no evidence that it can change ecosystem processes and parameters (Imp-N1) or evidence that it forms extensive populations in natural areas, and because of our uncertainty of whether it impacts biodiversity (Imp-N3), we answered “no” with high uncertainty.
Imp-N6 [What is the taxon’s weed status in natural systems? (a) Taxon not a weed; (b) taxon a weed but no evidence of control; (c) taxon a weed and evidence of control efforts]	c - negl	0.6	It is “invasive” in natural vegetation (Vibrans and Hanan Alipi, 2008). "In several parts of the world [it] is increasingly reported as an invasive environmental weed, especially in the Americas” (Verloove, 2011, citing Vibrans and Hanan Alipi, 2008 and Meier, 2006). After *P. nepalensis* was reported as new to Mexico, where it has been found mainly in crops but also in natural areas (pine forest, grassland), an eradication effort was recommended (Vibrans and Hanan Alipi, 2008). Because of reports of it being an invasive environmental weed elsewhere, its populations in Belgium, which occur in natural areas (woodland), are “now monitored and controlled but its eradication does not seem successful so far" (Verloove, 2011). It is a recent introduction to Poland, where it is recommended for control and appears to be invasive and a possible threat to natural areas (Kowalczyk et al., 2014). The alternate answers for the Monte Carlo simulation were both "b."
Impact to Anthropogenic Systems (e.g., cities, suburbs, roadways)			
Imp-A1 (Negatively impacts personal property, human	n - low	0	We found no evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
safety, or public infrastructure)			
Imp-A2 (Changes or limits recreational use of an area)	y - mod	0.1	In South Africa, it is listed as a "recreational (water-sport)" weed, and one of its undesirable characteristics is obstruction of access (Wells et al., 1986), but no other details were given. Although it is not an aquatic plant, it does tolerate flooding and grows around shorelines (Li-Min et al., 2009; NEWFS, 2014), which could cause it to block access to bodies of water.
Imp-A3 (Affects desirable and ornamental plants, and vegetation)	? - max		In India, it is a "a regular menace" of flower gardens (Datta and Banerjee, 1954), but no information was given on whether it affects other plants in these settings.
Imp-A4 [What is the taxon's weed status in anthropogenic systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	c - mod	0.4	It is "recreational (water-sport)" weed (Wells et al., 1986). It is a weed of grassy areas in the Cibodas Botanical Garden in Indonesia (Wibowo and Iskandar, 2013). In the United Kingdom, it has appeared as a weed in nurseries and in the Edinburgh Botanical Gardens (Clement and Foster, 1994). In India, it is a "regular menace" of flower gardens and lawns (in addition to cultivation) in the Darjeeling hill area "so it has become a necessity, that some suitable method should be evolved in order to check the propagation of [this weed] in the...gardens and lawns"; laboratory tests of herbicides for the control of *P. nepalensis* were conducted (Datta and Banerjee, 1954). Since only one of these references mentions control efforts, we used moderate uncertainty. The alternate answers for the Monte Carlo simulation were both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - low	0.4	In a study in Ethiopia, it was one of three most common and aggressive weeds in wheat plots, and the results of the study indicated that weed competition was one of the major constraints on crop yield (along with poor soil fertility and wheat variety); this competition (from all the weeds) caused a 26 percent reduction in yield (Gebre et al., 1987). In field trials in Colombia studying the impact of weeds on the cultivation of carrot, *P. nepalensis* was identified as one of the ten principal weeds, and "weeds caused a yield decrease of 60%" (Mena et al., 1984). In the Nilgiris district of India, it is one of the most abundant weed species in potato crops; weeds in this area have been reported to cause an average of 20 percent or more reduction in tuber yield (Nimje, 1988). Although None of these sources state that *P. nepalensis* specifically caused yield loss; however, because it was one of the most important weeds, it seems highly likely that *P. nepalensis* contributed to at least some of the yield loss. Kowalczyk (2014) reports that it reduces yield of wheat, coffee, and other crops in Africa.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-P2 (Lowers commodity value)	y - mod	0.2	*Persicaria nepalensis*, along with three other weed species in potato crops, “necessitate[s] great efforts in weeding" (Kuwabara, 1955). In Mexico, its presence complicates the management of crops (potato and corn) and often requires changes in control measures (Vibrans and Hanan Alipi, 2008). There are multiple other reports of control efforts for this weed in crops (e.g., Ishikawa and Takenaka, 2002; Medley, 1961; Mukasa, 2002). We assume such control efforts can increase the cost of production and therefore lower commodity value. We found no specific information, however, on lowering commodity value, hence the moderate uncertainty rating.
Imp-P3 (Is it likely to impact trade?)	y - low	0.2	*Persicaria nepalensis* is listed as a quarantine or regulated pest for Honduras (APHIS, 2021; Puerto, n.d.), Australia (Vibrans and Hanan Alipi, 2008), and Brazil (APHIS, 2021). Because it is a quarantine pest for multiple countries and can be dispersed in trade as a contaminant (see ES-16) we answered “yes”. This species is likely to affect exports such as ornamental plants and grains (Vibrans and Hanan Alipi, 2008
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - mod	0	We found no evidence for this type of impact. It grows along irrigation canals in Pakistan (Vibrans and Hanan Alipi, 2008), but this source does not state that it affects the quality or availability of irrigation.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - mod	0	There is conflicting evidence. Cattle do not like to consume it because of its acid taste (Everaarts, 1981). Meier (2006) states that in Colombia it is considered poisonous to cattle, but without any supporting evidence. In Bhutan, it is allowed to grow in barley fields because it is an important winter fodder (Numata, 1987), and in India, it is part of the fodder used during the rainy season (Nautiyal et al., 2018). It is listed in the "International Poisonous Plants Checklist" (Wagstaff, 2008) based on it being toxic to fish when crushed and added to water (Kulakkattolickal, 1987), not because of toxicity to mammals or birds. In a field study in Ethiopia, *P. nepalensis* seeds were found in the manure of grazing cattle in grasslands (Woldu and Mohammed Saleem, 2000), suggesting that it can be consumed by cattle. Alemneh (2020) reports that it is commonly used as cattle fodder in Ethiopia. Also, the plant is used in traditional Chinese and Indian medicine (Vibrans and Hanan Alipi, 2008), raw leaves and seed being edible (Naturalmedicinalherbs.net, 2014). Since it is used as fodder in several countries, it is unlikely to be toxic to livestock. We therefore answered "no" with moderate uncertainty since the question is intended to apply to animals that are relevant to production systems.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-P6 [What is the taxon's weed status in production systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	c - negl	0.6	It is listed as a "serious weed", "principal weed", and "common weed" of crops (Holm et al., 1991). There are numerous reports of *P. nepalensis* being a weed of crops, such as wheat, potato, soybean, rice, corn, strawberry, coffee, sugar beet, cape gooseberry, tobacco (Ishikawa and Takenaka, 2002; Meier, 2006; Moody, 1989; Plaza and Pedraza, 2007; Radosevich and Holt, 1984; Vibrans and Hanan Alipi, 2008; Wen et al., 2013; Zhang and Hirota, 2000). It is a major weed species of wheat (Kassahun et al., 2005; Tessema et al., 1999) and a weed of potatoes in Bhutan (Roder et al., 2009). Herbicides are recommended for the control of *P. nepalensis* in sugar beet cultivation (Mukasa, 2002). Weed management treatments such as herbicides, hand weeding, and tillage have been studied for *P. nepalensis* in crops (Asres and Das, 2011; Ishikawa and Takenaka, 2002; Kassahun et al., 2005). The alternate answers for the Monte Carlo simulation were both "b."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically referenced points obtained from the Global Biodiversity Information Facility (GBIF, 2021).
Plant hardiness zones			
Geo-Z1 (Zone 1)	n - low	N/A	1 point in India
Geo-Z2 (Zone 2)	n - high	N/A	3 points in India, 2 in Pakistan. Because this is the only evidence we found for this zone and because it is not clear if these points represent established populations, we answered "no".
Geo-Z3 (Zone 3)	y - high	N/A	5 points in India, 2 in China, 1 in Afghanistan and North Korea
Geo-Z4 (Zone 4)	y - low	N/A	8 points in North Korea; 6 in India; 4 in Japan; 2 in Afghanistan; 1 in Pakistan, Russia, and China
Geo-Z5 (Zone 5)	y - negl	N/A	Many points in Japan; a few in the United States (New York, Vermont, and New Hampshire); 5 in India; 4 in Pakistan and South Korea; 3 in Afghanistan; 2 in North Korea; 1 in Italy, China, and Russia
Geo-Z6 (Zone 6)	y - negl	N/A	Many points in South Korea and Japan; a few in Germany
Geo-Z7 (Zone 7)	y - negl	N/A	Many points in South Korea and Japan; 8 in China; 6 in Afghanistan and Nepal; 5 in India; 3 in Switzerland; 2 in Germany; 1 in Italy, Afghanistan, and Russia
Geo-Z8 (Zone 8)	y - negl	N/A	Many points in Belgium, South Korea, and Japan
Geo-Z9 (Zone 9)	y - negl	N/A	Many points in Japan and Taiwan; a few in South Korea and Mexico
Geo-Z10 (Zone 10)	y - negl	N/A	Many points in Taiwan and Colombia; a few in Ethiopia and Papua New Guinea
Geo-Z11 (Zone 11)	y - negl	N/A	Many points in Taiwan and Colombia; some in Papua New Guinea; a few in Cameroon
Geo-Z12 (Zone 12)	y - low	N/A	Some points in Taiwan; a few in Colombia; 2 in Cameroon, Kenya, and Ecuador; 1 in DRC, Malaysia, Indonesia, Papua New Guinea, and Costa Rica

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-Z13 (Zone 13)	y - high	N/A	4 points in Madagascar, 2 in Indonesia, 1 in Equatorial Guinea and Colombia
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	y - negl	N/A	Many points in Colombia and Papua New Guinea; some in Indonesia; a few in Cameroon
Geo-C2 (Tropical savanna)	y - negl	N/A	A few points in Thailand; 5 in Uganda and Madagascar; 3 in Ethiopia, Kenya, Rwanda, and Burundi; 2 in Venezuela, Colombia, and Cameroon; 1 in Ecuador, DRC, and Zambia
Geo-C3 (Steppe)	y - mod	N/A	4 points in Pakistan and Ethiopia, 3 in Afghanistan, 2 in China, 1 in Venezuela
Geo-C4 (Desert)	y - low	N/A	Some points in India, 5 in Pakistan, 2 in Afghanistan, 1 in Egypt. Many of the points in India and Pakistan are in or very near the Himalayas
Geo-C5 (Mediterranean)	y - negl	N/A	Many points in Colombia; 9 in Ecuador; 5 in Afghanistan; 4 in Ethiopia; 1 in the United States (Washington), Kenya, and Turkey
Geo-C6 (Humid subtropical)	y - negl	N/A	Many points in Taiwan, Japan, and South Korea
Geo-C7 (Marine west coast)	y - negl	N/A	Many points in Belgium; some in Colombia; a few in Mexico, China, and India
Geo-C8 (Humid cont. warm sum.)	y - negl	N/A	Many points in Japan and South Korea, 7 in Pakistan, 5 in North Korea and Pakistan, 3 in China, 1 in India
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	Many points in Japan, 9 in North Korea and Germany, 8 in the United States (New York, Pennsylvania, Connecticut, Vermont, and New Hampshire) and China, 4 in Russia, 3 in Italy, 2 in India, 1 in Sweden
Geo-C10 (Subarctic)	n - mod	N/A	1 point in Italy and Switzerland; these are in the mountains, and the plant may be able to tolerate some cold mountain habitats. We did not find evidence, however, that it could tolerate this habitat in the latitudinal extremes.
Geo-C11 (Tundra)	n - high	N/A	2 points in Colombia, 1 in Bhutan and Italy; these are in the mountains, and the plant may be able to tolerate some cold mountain habitats. We did not find evidence, however, that it could tolerate this habitat in the latitudinal extremes.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence of presence in this climate class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	n - high	N/A	1 point in Egypt, Afghanistan, Pakistan, and Colombia; we answered “no” with high uncertainty because the small number of points does not provide enough evidence.
Geo-R2 (10-20 inches; 25-51 cm)	y - low	N/A	A few points in India; 5 in Afghanistan; 4 in Pakistan; 2 in South Africa, Tanzania, Ethiopia, and Colombia; 1 in China
Geo-R3 (20-30 inches; 51-76 cm)	y - low	N/A	6 points in Nepal; 5 in Russia; 4 in Pakistan and India; 3 in Switzerland, South Africa, and Ethiopia; 2 in Italy and Afghanistan; 1 in Tanzania, China, and Ecuador

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Many points in Belgium; 8 in North Korea; 6 in Kenya and China; 5 in Pakistan and India; 4 in Nepal; 3 in Germany and Tanzania; 2 in Italy, Ethiopia, and South Korea; 1 in Sweden, the United Kingdom, Switzerland, Turkey, Zambia, Burundi, Uganda, Russia, Ecuador, and the United States (New York)
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Many points in South Korea and Japan; a few in India and the United States (New York, Pennsylvania, Connecticut, Vermont, New Hampshire); 5 points in Kenya and China; 4 in Uganda and Taiwan; 3 in Pakistan, Nepal, North Korea, and Colombia; 2 in Germany, Burundi, Georgia, and Afghanistan; 1 in Italy, South Africa, Tanzania, DRC, Ethiopia, and Ecuador
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	Many points in South Korea and Japan; a few in Germany; 5 in Canada; 4 in China and North Korea; 3 in Kenya and Thailand; 2 in the United Kingdom, Rwanda, Ethiopia, Taiwan, Colombia, and the United States (New York and Washington); 1 in Madagascar, Malawi, Tanzania, Pakistan, Nepal, Ecuador, and Mexico
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	Many points in South Korea and Japan; 5 in China and Colombia; 4 in Madagascar and Pakistan; 2 in Thailand and Brazil; 1 in Kenya, Ethiopia, India, and Mexico
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	Many points in Japan; 6 in Colombia; 5 in Madagascar; 4 in China; 3 in Thailand; 1 in Italy, Cameroon, Rwanda, Uganda, Ethiopia, Georgia, India, Taiwan, Papua New Guinea, Brazil, Ecuador, and Venezuela
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	Many points in Japan; a few in Taiwan; 4 in Colombia; 3 in Ethiopia; 2 in Thailand; 1 in India
Geo-R10 (90-100 inches; 229-254 cm)	y - negl	N/A	Many points in Japan; some in Colombia; a few in Taiwan; 2 in Indonesia; 1 in Italy, Tanzania, Pakistan, India, Bhutan, Thailand, Ecuador, and Venezuela
Geo-R11 (100+ inches; 254+ cm)	y - negl	N/A	Many points in Japan, Taiwan, Papua New Guinea, and Colombia; a few in Cameroon, Indonesia, and Mexico; 8 in Ecuador; 7 in China; 3 in Venezuela; 1 in Equatorial Guinea, Malawi, DRC, Ethiopia, Nepal, Myanmar, Vietnam, Malaysia, and Costa Rica

ENTRY POTENTIAL			
Ent-1 (Plant already here)	n - negl	0	Although this species is naturalized in the United States (Florida, Pennsylvania, New York, Massachusetts, Connecticut, Maine) (eFloras, 2021; Kartesz, 2015), we answered "no" to this question in order to assess the entry potential of additional material.
Ent-2 (Plant proposed for entry, or entry is imminent)	n - negl	0	We found no evidence that this species has been proposed for import.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Ent-3 [Human value & cultivation/trade status: (a) Neither cultivated or positively valued; (b) Not cultivated, but positively valued or potentially beneficial; (c) Cultivated, but no evidence of trade or resale; (d) Commercially cultivated or other evidence of trade or resale]	d - negl	0.5	*Persicaria nepalensis* is sold by nurseries in the United Kingdom (Growild Nursery, 2021; The Plantsman's Preference, 2021)
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	y - negl		Its native range includes China (NGRP, 2021); it is naturalized in Mexico (Vibrans and Hanan Alipi, 2008).
Ent-4b (Contaminant of plant propagative material (except seeds))	n - low	0	We found no evidence that the species could enter the country through this method.
Ent-4c (Contaminant of seeds for planting)	y - mod	0.08	It is thought to have been introduced to Germany as a contaminant in seed mixtures that were planted for wildlife (Meier, 2006), and it has been intercepted at U.S. ports of entry with radish seed (PestID, 2021). We have moderate uncertainty because we found no other evidence for this dispersal method, and it is unclear whether the seed mixtures were the true pathway for this species.
Ent-4d (Contaminant of ballast water)	n - low	0	We found no evidence that the species could enter the country through this method.
Ent-4e (Contaminant of aquarium plants or other aquarium products)	n - low	0	Although *P. nepalensis* is a wetland plant (Shin et al., 2008), we found no evidence that it has spread as a contaminant of aquarium plants or products.
Ent-4f (Contaminant of landscape products)	n - low	0	We found no evidence that the species could enter the country through this method.
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	? - max		Moore (2011) indicates that it may be spreading along logging roads, which would suggest that it is carried on vehicles. We found no other evidence; consequently, we answered "unknown."
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	n - low	0	We found no evidence that the species could enter the country through this method.
Ent-4i (Contaminant of some other pathway)	c - low	0.04	It was introduced to the United Kingdom in birdseed (Clement and Foster, 1994; Meier, 2006)
Ent-5 (Likely to enter through natural dispersal)	n - negl	0	Although *P. nepalensis* is present in Mexico, it is not close enough to the U.S. border to enter the country through natural dispersal (GBIF, 2021).