Weed Risk Assessment for *Sideritis montana* L. (Lamiaceae) – Mountain ironwort

United States
Department of
Agriculture

Animal and Plant
Health Inspection
Service

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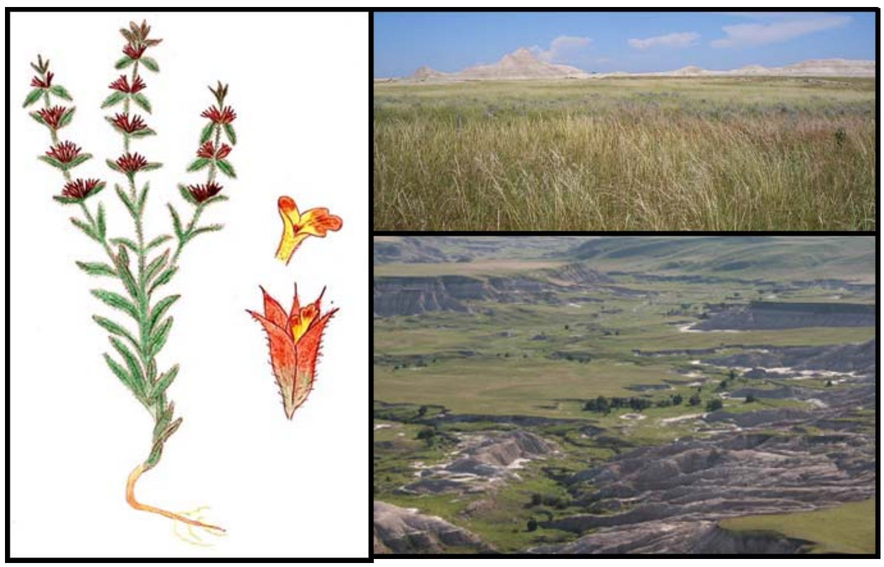
Version 1



Left: A drawing of *Sideritis montana* (source: http://www.agroatlas.ru/en). Right: The habitat and landscape in which *S. montana* occurs in the United States. The upper photograph is of Oglala National grassland in northwestern Nebraska (source: Brian Kell, http://en.wikipedia.org/). The bottom photograph is the grassland ecosystem of Conata Basin, South Dakota (source: http://www.nature.org/).

Agency Contact:

Plant Epidemiology and Risk Analysis Laboratory
Center for Plant Health Science and Technology

Plant Protection and Quarantine
Animal and Plant Health Inspection Service
United States Department of Agriculture
1730 Varsity Drive, Suite 300
Raleigh, NC 27606

Introduction Plant Protection and Quarantine (PPQ) regulates noxious weeds under the authority of the Plant Protection Act (7 U.S.C. § 7701-7786, 2000) and the Federal Seed Act (7 U.S.C. § 1581-1610, 1939). A noxious weed is "any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment" (7 U.S.C. § 7701-7786, 2000). We use weed risk assessment (WRA) —specifically, the PPQ WRA model[1]—to evaluate the risk potential of plants, including those newly detected in the United States, those proposed for import, and those emerging as weeds elsewhere in the world.

Because our WRA model is geographically and climatically neutral, it can be used to evaluate the baseline invasive/weed potential of any plant species for the entire United States or any area within it. We use a climate matching tool in our WRAs to evaluate those areas of the United States that are suitable for the establishment of the plant. We also use a Monte Carlo simulation to evaluate the consequences of uncertainty on the outcome of the risk assessment. For more information on the PPQ WRA process, please refer to the document, *Introduction to the PPQ Weed Risk Assessment Process*, which is available upon request.

***Sideritis montana* L. – Mountain ironwort**

Species Information

Family: Lamiaceae

Initiation: At the 14th annual South Dakota Weed and Pest Conference (February 23, 2012), Ron Moehring (South Dakota Department of Agriculture) told Anthony Koop (USDA-APHIS-PPQ) that *Sideritis montana* is a plant of concern to the state. The PERAL Weed Team initiated this assessment in response to that concern.

Foreign distribution: This species is native to some of the countries bordering the Mediterranean Sea (Algeria, France, Greece, Italy, Morocco, Spain, Tunisia), other countries in Southeastern Europe (Albania, Bulgaria, Romania, the former Yugoslavia), Middle Europe (Austria, the Czech Republic, Hungary), eastern Europe (Moldova, Russian Federation, Ukraine), and Middle Asia (Afghanistan, Armenia, Azerbaijan, Georgia, Iran, Lebanon, Pakistan, Syria, Turkey, Turkmenistan) (NGRP, 2012). It is a casual alien in the United Kingdom, Ireland, Norway, and Sweden (Clement and Foster, 1994; GBIF, 2012; Randall, 2012; Reynolds, 2002). It is also present in the Kashmir Valley of India (Kaul, 1986), but it is unclear if it native to that region.

U.S. distribution and status: *Sideritis montana* is known to be established in five counties across four U.S. states: Arkansas, South Dakota, Nebraska, and Montana. It has been present in Fulton County Arkansas since at least 1966 (Lang, 1966), with no reports of spread since then. However, since its initial discovery in South Dakota in Badlands National Park in the 1980s, it has appeared in Buffalo Gap National Grasslands and on lands protected by The Nature Conservancy in Conata Basin (Kostel, 2012); all three of these areas are in the same vicinity in Pennington County. It is also reported from Ft. Pierre

[1] Koop, A., L. Fowler, L. Newton, and B. Caton. 2012. Development and validation of a weed screening tool for the United States. Biological Invasions 14(2):273-294. DOI:10.1007/s10530-011-0061-4

National Grasslands in Lyman County, South Dakota, where it is naturalized but apparently not behaving as an invasive species (Korman, 2011, 2012). It is present in northwestern Nebraska in Dawes County in Oglala National Grassland (Kartesz, 2012; Kostel, 2012). Finally, it was recently discovered in Montana (Kostel, 2012).

WRA area: Entire United States, including territories

1. *Sideritis montana* L. analysis

Establishment/Spread Potential *Sideritis montana* is an annual herb that has naturalized in the United States (Kartesz, 2012; Korman, 2012; Kostel, 2012). Because it has established in several natural areas in South Dakota and Nebraska (see U.S. distribution), this species has demonstrated a capacity to spread. Based on evidence from Europe, it appears to readily disperse as a grain contaminant (Dunn, 1905; Jehlik and Dostalek, 2008; Reynolds, 2002), and one resource manager suggests it may also disperse on field equipment (Korman, 2012). However, it is not entirely clear which natural dispersal vectors, if any, have contributed to its spread in the United States, particularly in the natural areas described previously. *Sideritis montana* produces several thousand seeds per plant and does not require specialist pollinators (AgroAtlas, 2012; Persano Oddo et al., 2004). Because it can self-pollinate (Pinke and Pál, 2009), individual plants can found new populations. Because little is known about this species' biology, this risk element had greater than average uncertainty associated with it; several questions were answered as unknown.
Risk score = 10 Uncertainty index = 0.28

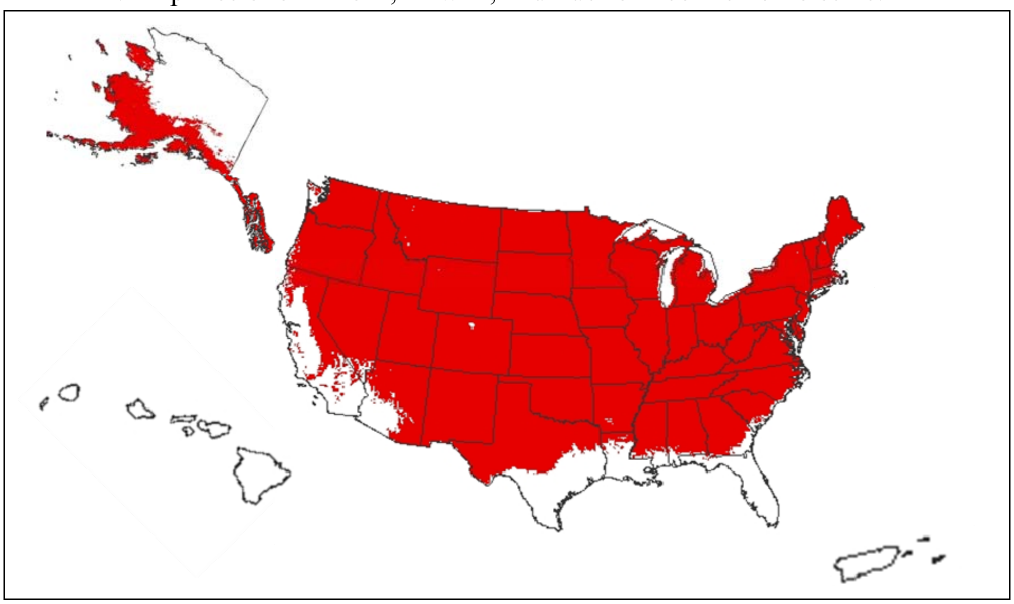
Impact Potential We found almost no information about the kind or degree of impacts this species has. Most information only states that it is considered a weed of cultivated crops, particularly cereals such as wheat (AgroAtlas, 2012; Dunn, 1905; Hanf, 1983; Keller et al., 1935). Because one source states it is susceptible to herbicides (Elkoca et al., 2005) and another states how to control it (AgroAtlas, 2012), we can reasonably assume that its impacts are significant enough to warrant some level of control. One study reports that it occurs at densities of about 2.2 plants per square meter in spring-sown wheat in Turkey (Bulut et al., 2010). This same study reports a yield loss in wheat due to weeds, including *S. montana*, but does not specify how much is attributable to each species. The genus *Sideritis* has been shown to contain various flavonoids that exhibit antifeedant, anti-inflammatory, and antimicrobial properties (Basile et al., 2011; Bondì et al., 2000). Thus, it may be unpalatable (Kostel, 2012), which would lower the grazing value of rangelands. *Sideritis montana* occurs in several national parks and grasslands in the badlands region of the United States. As these types of areas are set aside for the conservation of native species and landscapes, *S. montana* can be considered a weed of natural areas. However, what impacts, if any, it is having in these areas is unknown. Overall, there was a high level of uncertainty associated with this risk element.
Risk score = 2.2 Uncertainty index = 0.45

Geographic Potential Based on three climatic variables, we estimate that about 80 percent of the United States is suitable for the establishment of *Sideritis montana* (Fig. 1). This potential distribution is based on the species' known distribution elsewhere in the world and includes point-referenced localities and areas of occurrence (mostly from GBIF, 2012). The map shown in Fig. 1 represents the joint distribution of USDA Plant Hardiness Zones 3-9, areas with 0-100 inches of annual precipitation, and the following Köppen-Geiger climate classes: steppe, desert, mediterranean, humid subtropical, marine west coast, humid continental warm summers, humid continental cool summers, and subarctic.

The area estimated in Fig. 1 is likely a conservative estimate as it considers only three climatic variables. Other environmental variables such as soil and habitat type may further restrict where in the United States this species is likely to establish and spread. *Sideritis montana* is an annual herb that grows in dry stony, calcareous, carbonate, and sandy soils in its native range (AgroAtlas, 2012; Hanf, 1983). It grows in open habitats such as grasslands, prairies, limestone glades, and cereal fields (Hanf, 1983; Kostel, 2012; Lang, 1966). It is heat resistant and drought tolerant (AgroAtlas, 2012). The drier, more open habitats of the U.S. Midwest and West are likely to be the most ideal for its establishment.

Entry Potential *Sideritis montana* is already established in the United States (Kartesz, 2012; Korman, 2012; Kostel, 2012). We did not need to assess its entry potential.

Figure 1. U.S. regions potentially suitable for the establishment of *Sideritis montana*. Map insets for Alaska, Hawaii, and Puerto Rico are not to scale.



2. Results and Conclusion

Model Probabilities: P(Major Invader) = 38.8%
P(Minor Invader) = 56.6%
P(Non-Invader) = 4.6%

Risk Result = High Risk

Secondary Screening = Not Applicable

Figure 2. *Sideritis montana* risk score (black box) relative to the risk scores of species used to develop and validate the WRA model (other symbols). See Appendix A for the complete assessment.

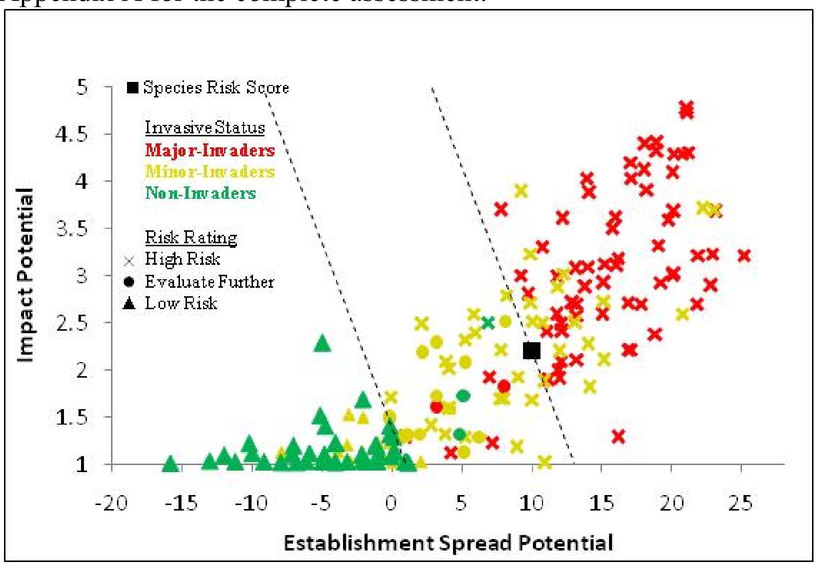
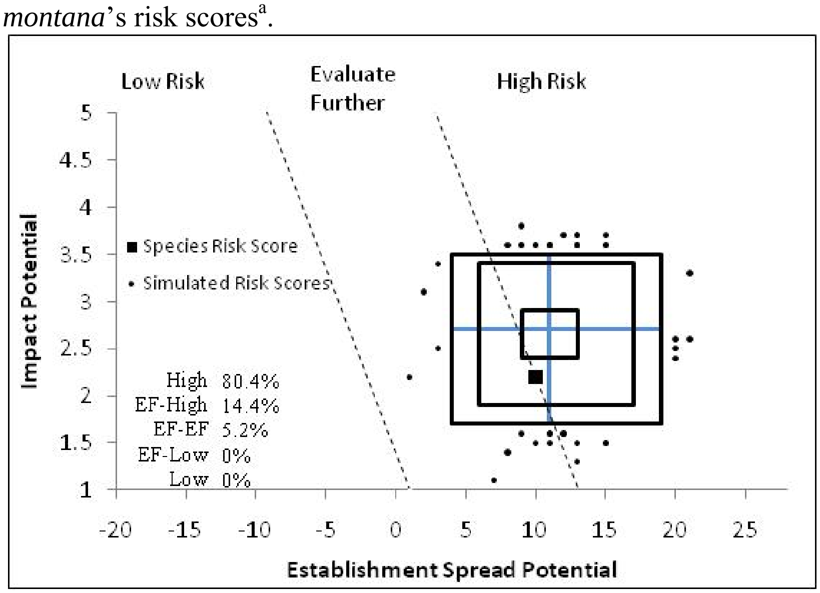


Figure 3. Monte Carlo simulation results (N=5000) for uncertainty around *Sideritis montana*'s risk scores[a].



[a] The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The result of the weed risk assessment for *S. montana* is High Risk, as it is located just inside the decision threshold for the high risk region (Fig. 2). Even if it had scored one point less on any of the questions, evaluation with the secondary screening tool would still have given a High Risk rating. Due to very limited information on this species, the overall uncertainty associated with the assessment was high, particularly for the impact risk element. Still, in our Monte Carlo uncertainty analysis, about 95 percent of the iterations resulted in a determination of High Risk (Fig. 3). For *S. montana*, more detailed qualitative information about the species' impacts in natural and agricultural areas would likely significantly reduce the uncertainty.

The limited information available about *S. montana* may suggest that this species' real risk potential is not very high, at least relative to the high-scoring U.S. major-invaders that were used to develop and validate this model (Fig. 2). There is often much less literature available about non-invasive species relative to invasive species (unpub. data). The concept of a limited risk potential is supported by the documented lack of impacts in places where *S. montana* has become established, even after being present in the flora for a hundred years (e.g., Ireland; Reynolds, 2002).

On the other hand, the foreign habitats where *S. montana* is established (Ireland, the United Kingdom, Finland, Sweden) may not represent ideal habitats and/or climates for it. *Sideritis montana* is native to regions with relatively dry climates from the Mediterranean eastwards into the steppes and grasslands of eastern Europe and Central Asia (AgroAtlas, 2012; GBIF, 2012). Because it has established in several conservation lands in the United States, suggests it has a strong capacity to establish and spread.

It is puzzling that *S. montana* was first reported from U.S. conservation areas. Given its demonstrated status as a grain contaminant, it seems more likely to have been found at waste and transportation sites handling grain, as occurred in Europe (Jehlik and Dostalek, 2008; Reynolds, 2002). Notably, though, some of the areas where *S. montana* occurs in South Dakota were farmed prior to the great Dust Bowl in the western United States (Korman, 2012). Grace Kostel, a botanist and collections managers for the Black Hills State University Herbarium, notes that even professionals who perform fieldwork in the Black Hills region mistakenly identify *S. montana* as the similarly looking native *Hedeoma hispida* (Kostel, 2012). Thus, *S. montana* may be more common and widespread in the region than previously anticipated.

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7 U.S.C. § 7701-7786. 2000. Plant Protection Act, Title 7 United States Code § 7701-7786.

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Appendix A. Weed risk assessment for *Sideritis montana* L. (Lamiaceae). The following information was obtained from the species' risk assessment, which was conducted on a Microsoft Excel platform. The information shown below was modified to fit on the page. The original Excel file, the full questions, and the guidance to answer the questions are available upon request.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Establishment/Spread Potential			
ES-1 (Invasiveness elsewhere)	f - high	5	This species is native to many countries from the Mediterranean region (e.g., Algeria, France, Italy, Morocco, Spain), eastward to some of the countries in middle Asia (Afghanistan, Iran, Lebanon, Pakistan, Syria, Turkey, Turkmenistan) (NGRP, 2012). It is a casual alien in the United Kingdom known from 5-14 localities with no modern records (Clement and Foster, 1994). In Ireland, it is a casual alien which appears to have been present since the late 1800s (Reynolds, 2002). Casual alien in Finland (Randall, 2012). Present in the Kashmir Valley of India (Kaul, 1986), but it is not clear from the text if it is native or exotic there. Present in at least five U.S. counties; there are multiple sites in the region encompassing south-central South Dakota and northwestern Nebraska (Kartesz, 2012; Korman, 2011; Lang, 1966). Information from two researchers familiar with this species in South Dakota indicates that it is naturalized, occurring occasionally and in scattered locations (Korman, 2011; Kostel, 2012). However, the distribution and number of U.S. sites where it is present suggest that this species is invasive (i.e., spreading in the region). Although *S. montana* may not form dense and extensive populations like many typical invasive species, together these references indicate that this species is capable of escaping, naturalizing, and spreading, the latter of which is the key criterion for choice F in this question. Thus answering F, but with high uncertainty. For the uncertainty simulation the alternate answer is E.
ES-2 (Domesticated to reduce weed potential)	n - negl	0	Some species of *Sideritis* are used and/or cultivated for tea (Mabberley, 2008; Page and Olds, 2001), including *S. montana*, which is used for herbal tea in Turkey (Kirimer et al., 2000). *Sideritis montana* is occasionally used as a source for unifloral honey in France (Persano Oddo et al., 2004). However, there is no evidence this species has been bred for traits associated with reduced invasive potential.
ES-3 (Weedy congeners)	n - low	0	*Sideritis* is a genus of about 140-150 species native to Europe and the Old World (Mabberley, 2008; Weakley, 2010). While some may have escaped elsewhere and may be considered weeds (Clement and Foster, 1994; Kartesz, 2012; Weakley, 2010), none seem be considered significant weeds (e.g., Holm et al., 1979; Randall, 2007).
ES-4 (Shade Tolerance)	n - low	0	No evidence. This plant occurs in open bright habitats such as croplands, pastures, roadsides, and prairies (AgroAtlas, 2012; Hanf, 1983; Korman, 2011).
ES-5 (Climbing or smothering growth form)	n - negl	0	Plant not a vine or with a tight basal rosette. Annual growing up to 30-35 cm tall (AgroAtlas, 2012; Hanf, 1983).
ES-6 (Dense Thickets)	n - low	0	No evidence.
ES-7 (Aquatic)	n - negl	0	Terrestrial plant (AgroAtlas, 2012; Hanf, 1983).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-8 (Grass)	n - negl	0	Plant not a grass. Plant is an herb/forb in the Lamiaceae (NGRP, 2012).
ES-9 (N2-fixer)	n - negl	0	*Sideritis montana* is in the Lamiaceae (NGRP, 2012), which is not one of the families known to contain members that fix nitrogen (Martin and Dowd, 1990).
ES-10 (Viable seeds)	y - negl	1	It reproduces by seeds (Keller et al., 1935). This species has spread to other places as a seed contaminant of grain (Dunn, 1905; Jehlik and Dostalek, 2008).
ES-11 (Self-compatible)	y - mod	1	The authors of a study of weeds of stubble cereals cite an inaccessible paper noting this species is self-pollinated (citation in Pinke and Pál, 2009).
ES-12 (Special Pollinators)	n - low	0	There is no evidence this species requires a specialist pollinator. Because it is used to produce unifloral honey (Persano Oddo et al., 2004), it must be visited (and likely pollinated) by honey bees, which are generalist pollinators. Furthermore, as a self-pollinated species (Pinke and Pál, 2009), it does not require pollinators.
ES-13 (Min generation time)	b - negl	1	Plant an annual (AgroAtlas, 2012; Hanf, 1983; Stace, 2010)
ES-14 (Prolific reproduction)	y - low	1	Plants, which grow to 30-35 cm tall, can produce up to 17,300 seeds (AgroAtlas, 2012). In one source about weeds of spring-sown wheat, this species has a mean density of 2.12 plants per square meter (Bulut et al., 2010). Thus, it satisfies the requirement of 5000 seeds per square meter.
ES-15 (Unintentional dispersal)	? - max	0	Unknown. Because it is a contaminant of grain (Dunn, 1905; Jehlik and Dostalek, 2008), it may be spread unintentionally by people via movement of farm equipment. A natural resource manager that worked in one of the infested sites in South Dakota speculates that it may have arrived in Ft. Pierre National Grasslands as a contaminant on people, machinery, or equipment (Korman, 2012).
ES-16 (Trade contaminant)	y - negl	2	Introduced into Slovakia via grain shipments imported by train (Jehlik and Dostalek, 2008). "Often noticed as a grain introduction in England" (Dunn, 1905). Alien collected around grain mills or distilleries in Ireland (Reynolds, 2002).
ES-17 (#Natural dispersal vectors)	0	-4	Characteristics of the fruit/seed relevant for ES-17a through ES-17e: Seeds are oval to triangular, about 1.5mm (Hanf, 1983; Rejdali, 1990). Plant produces a capsule with four nutlets that are 2-4 mm in diameter (Kaul, 1986).
ES-17a (Wind dispersal)	n - low		Seeds have no obvious adaptation for wind dispersal. Other members of the genus have wing-like appendages (Rejdali, 1990)
ES-17b (Water dispersal)	n - mod		No evidence.
ES-17c (Bird dispersal)	n - mod		No evidence. Seeds with no obvious reward for birds
ES-17d (Animal external dispersal)	? - max		Unknown. Seeds with no obvious mechanism for attaching to animals (Hanf, 1983; Rejdali, 1990). However, herbarium records from South Dakota (UW, 2012) describe the plants as being in the middle of prairie dog towns. It is possible that the prairie dogs either promote or spread this species. Consequently answering unknown.
ES-17e (Animal internal dispersal)	? - max		It may be possible that grazing animals such as deer would be able to disperse the seeds, as they do for other species, which do

Question ID	Answer - Uncertainty	Score	Notes (and references)
			not have any obvious mechanisms promoting endozoochory (Myers et al., 2004). However, the genus as a whole may be unpalatable (Basile et al., 2011; Bondì et al., 2000; Kostel, 2012).
ES-18 (Seed bank)	? - max	0	Unknown.
ES-19 (Tolerance to loss of biomass)	? - max	0	Unknown.
ES-20 (Herbicide resistance)	n - low	0	This plant was affected by herbicides applied in lentils (Elkoca et al., 2005).
ES-21 (# Cold hardiness zones)	7	0	
ES-22 (# Climate types)	8	2	
ES-23 (# Precipitation bands)	11	1	
Impact Potential			
General Impacts			
Imp-G1 (Allelopathic)	n - mod	0	No evidence for *S. montana*. One study using plant extracts found evidence of allelopathy for the congener *S. italica* (Basile et al., 2011).
Imp-G2 (Parasitic)	n - negl	0	The Lamiaceae is not one of the families known to contain parasitic plant species (Heide-Jorgensen, 2008; Nickrent, 2009)
Impacts to Natural Systems			
Imp-N1 (Ecosystem processes)	n - high	0	No evidence. Because this species is present in a natural areas (grasslands) in South Dakota (Korman, 2012; Kostel, 2012), using higher uncertainty for this subsection of the risk element.
Imp-N2 (Community structure)	n - high	0	No evidence.
Imp-N3 (Community composition)	n - high	0	No evidence.
Imp-N4 (T&E species)	? - max		Unknown.
Imp-N5 (Globally outstanding ecoregions)	? - max		Unknown.
Imp-N6 (Natural systems weed)	b - high	0.2	This species is present in several conservation grasslands in South Dakota and Nebraska that are managed by the U.S. Forest Service and the National Park Service (Korman, 2012; Kostel, 2012). Unfortunately, there is not very much information about its weed status in these areas. For Ft. Pierre National Grassland, it was reported as an occasional species (Korman, 2012). Because in general, these types of protected lands are set aside to conserve native species diversity, native communities, ecosystem services, and wild landscapes, we assume this species is or would be considered a weed simply because it is an exotic if evaluated by local resource managers. As such, answering B, but with high uncertainty. Alternate choice for Monte Carlo simulation is A.
Impact to Anthropogenic areas (cities, suburbs, roadways)			
Imp-A1 (Affects property, civilization, ...)	n - mod	0	No evidence.
Imp-A2 (Recreational use)	n - low	0	No evidence. Because it seems unlikely a low-stature terrestrial herb will affect recreational use of an area, using low uncertainty.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-A3 (Affects ornamental plants)	n - mod	0	No evidence.
Imp-A4 (Anthropogenic weed)	a - high	0	This species "occurs in fallow lands..., waste lands, along roads" (AgroAtlas, 2012); it is not clear from this reference if it is considered a weed in these areas. Alternate answer for the uncertainty simulation is B.
Impact to Production systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Crop yield)	y - high	0.4	Due to yield reduction of wheat from several species of weeds, including *S. montana*, the authors investigated the effect of different sowing times and sowing densities of wheat on weed density (Bulut et al., 2010). In spring-sown wheat, *S. montana* has a mean density of 2.12 plants per square meter (Bulut et al., 2010). Answering yes, but with high uncertainty, because it is not clear to what extent *S. montana* reduces crop yield.
Imp-P2 (Commodity Value)	? - max		Unknown. A botanist with the Black Hills State University Herbarium believes that cattle are unlikely to graze it due to the high concentrations of flavonoids in the genus; furthermore, she has never seen prairie dogs clipping the *S. montana* plants in the field (Kostel, 2012). In a study of the potential allelopathic impact of *S. italica*, the authors state "[p]lant species belonging to the genus *Sideritis* exhibit several biological activities: antifeedant, anti-inflammatory, analgesic, antilucerogenic, antihyperglycaemic and antimicrobial..." (Basile et al., 2011). Another study found a *Sideritis* flavonoids that deterred feeding by larvae of the insect *Spodoptera frugiperda* (Bondì et al., 2000). Together these sources suggest that *S. montana* may be unpalatable, which would tend to lower the value of rangelands and pastures since they would support lower stocking densities of cattle. However, without direct evidence, answering as unknown.
Imp-P3 (Affects trade)	? - max		Unknown. Based on the evidence in ES-16, this species moves in trade as a contaminant of grain (Dunn, 1905; Jehlik and Dostalek, 2008; Reynolds, 2002). There is no evidence it has impacted trade or is considered a quarantine pest, but this may simply be due to low awareness of this species. Because *Sideritis montana* is clearly considered a weed and is present in a variety of grains and legumes, including wheat, it may cause some concern for some importing countries, if anything as a quality pest.
Imp-P4 (Irrigation)	n - mod	0	No evidence.
Imp-P5 (Animal toxicity)	n - high	0	The Flora of China (Zhengyi et al., 2012) mentions this species is toxic, but the nature of the toxicity is not described. Because no other source mentions any toxicity, answering no, but with high uncertainty.
Imp-P6 (Production system weed)	c - low	0.6	"Weed of grain crops, Lucerne and cotton; occurs in fallow lands, orchards, vine-yards.... Control measures include stubbling, early under-winter plowing, harrowing of winter crops, chemical weeding" (AgroAtlas, 2012). Listed as an agricultural weed of cereals (Hanf, 1983) and irrigated crops (Keller et al., 1935). Casual alien in grains (Clement and Foster,

Question ID	Answer - Uncertainty	Score	Notes (and references)
			1994). Weed of cultivated fields in Europe (Dunn, 1905). A rare weed in lentils (Elkoca et al., 2005). Weed of spring-sown wheat in Turkey occurring at 2.12 plants per square meter (Bulut et al., 2010). Weed in chickpeas (Kantar et al., 1999). Listed as a weed of pastures and grasslands in Serbia, where this species is native (Momčiloa et al., 2001). There is no doubt this species is considered a weed (choice B). But because one study noted data on its response to herbicides in lentils, and another provided recommendations on how to control it, answering C with low uncertainty. Alternate choice for uncertainty simulation is B.
Geographic Potential			Note, below p.s. refers to point-source data, while occ. refers to occurrence data (i.e., presence/absence).
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	No evidence.
Geo-Z2 (Zone 2)	n - mod	N/A	No evidence.
Geo-Z3 (Zone 3)	y - high	N/A	Area surrounding lake in Kyrgyzstan (AgroAtlas, 2012).
Geo-Z4 (Zone 4)	y - low	N/A	Georgia (1 point; GBIF, 2012). Afghanistan (a few points; GBIF, 2012). Area surrounding lake in Kyrgyzstan (AgroAtlas, 2012).
Geo-Z5 (Zone 5)	y - negl	N/A	Norway and Armenia (GBIF, 2012). Pennington County South Dakota (UW, 2012 p.s.).
Geo-Z6 (Zone 6)	y - negl	N/A	Norway and Austria (GBIF, 2012 p.s.).
Geo-Z7 (Zone 7)	y - negl	N/A	France (GBIF, 2012 p.s.).
Geo-Z8 (Zone 8)	y - negl	N/A	France and Spain (GBIF, 2012 p.s.).
Geo-Z9 (Zone 9)	y - negl	N/A	Greece and Spain (GBIF, 2012 p.s.).
Geo-Z10 (Zone 10)	n - mod	N/A	No evidence.
Geo-Z11 (Zone 11)	n - negl	N/A	No evidence.
Geo-Z12 (Zone 12)	n - negl	N/A	No evidence.
Geo-Z13 (Zone 13)	n - negl	N/A	No evidence.
Koppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - negl	N/A	No evidence.
Geo-C2 (Tropical savanna)	n - negl	N/A	No evidence.
Geo-C3 (Steppe)	y - negl	N/A	Spain and Afghanistan (GBIF, 2012 p.s.). Pennington County South Dakota (UW, 2012 p.s.). In steppe in central region of Turkey (Fırıncıoğlu et al., 2007).
Geo-C4 (Desert)	y - low	N/A	Afghanistan (GBIF, 2012 p.s.).
Geo-C5 (Mediterranean)	y - negl	N/A	Greece (GBIF, 2012 p.s.).
Geo-C6 (Humid subtropical)	y - low	N/A	Serbia (Menkovic et al., 1993; occ.). Fulton County Arkansas (GBIF, 2012; Lang, 1966 p.s. and occ.).
Geo-C7 (Marine west coast)	y - negl	N/A	France and United Kingdom (GBIF, 2012 p.s.).
Geo-C8 (Humid cont. warm sum.)	y - low	N/A	Kyrgyzstan (AgroAtlas, 2012).
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	Germany, Austria, and Hungary (GBIF, 2012 p.s.).
Geo-C10 (Subarctic)	y - low	N/A	Norway, Germany, and Bulgaria (GBIF, 2012 p.s.).
Geo-C11 (Tundra)	n - high	N/A	1 point in Bulgaria (GBIF, 2012 p.s.). Answering no, as this climate seems extreme and this point may represent an error or

Question ID	Answer - Uncertainty	Score	Notes (and references)
			a plant in protected cultivation.
Geo-C12 (Icecap)	n - low	N/A	No evidence.
10-inch precipitation bands			
Geo-R1 (0-10")	y - low	N/A	Turkmenistan (AgroAtlas, 2012).
Geo-R2 (10-20")	y - negl	N/A	Spain (GBIF, 2012 p.s.). Grows in lentils under this amount of precipitation (Elkoca et al., 2005).
Geo-R3 (20-30")	y - negl	N/A	Spain and Germany (GBIF, 2012 p.s.).
Geo-R4 (30-40")	y - negl	N/A	Greece and Germany (GBIF, 2012 p.s.).
Geo-R5 (40-50")	y - negl	N/A	Norway and Germany (GBIF, 2012 p.s.). Fulton County Arkansas (GBIF, 2012; Lang, 1966 p.s. and occ.).
Geo-R6 (50-60")	y - negl	N/A	Norway and Austria (GBIF, 2012 p.s.).
Geo-R7 (60-70")	y - mod	N/A	1 point in Slovenia (GBIF, 2012 p.s.).
Geo-R8 (70-80")	y - mod	N/A	1 point in Norway (GBIF, 2012 p.s.).
Geo-R9 (80-90")	y - mod	N/A	A few points in Norway (GBIF, 2012 p.s.).
Geo-R10 (90-100")	y - mod	N/A	A few points in Norway (GBIF, 2012 p.s.).
Geo-R11 (100"+)	n - high	N/A	No evidence.
Entry Potential			
Ent-1 (Already here)	y - negl	1	This species is established in the United States (Kartesz, 2012; Korman, 2011; Lang, 1966).
Ent-2 (Proposed for entry)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	The phytochemical content of this species (Emre et al., 2011) and the genus in general have been studied for anti-oxidant capabilities (Tsibranska et al., 2011). Some species of this genus are cultivated and/or used to make herbal tea (Mabberley, 2008; Page and Olds, 2001). Dried flower spikes of *S. montana* subsp. *montana* are used as herbal tea in Turkey (Kirimer et al., 2000).
Ent-4 (Entry as a Contaminant)			
Ent-4a (In MX, CA, Central Amer., Carib., or China)	-	N/A	
Ent-4b (Propagative material)	-	N/A	
Ent-4c (Seeds)	-	N/A	
Ent-4d (Ballast water)	-	N/A	
Ent-4e (Aquaria)	-	N/A	
Ent-4f (Landscape products)	-	N/A	
Ent-4g (Container, packing, trade goods)	-	N/A	
Ent-4h (Commodities for consumption)	-	N/A	
Ent-4i (Other pathway)	-	N/A	
Ent-5 (Natural dispersal)	-	N/A	