Weed Risk Assessment for *Falcaria vulgaris* Bernh. (Apiaceae) – Sickleweed

United States Department of Agriculture

Animal and Plant Health Inspection Service

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Version 1

Falcaria vulgaris in Ft. Pierre National Grassland in South Dakota (Source: Ron Moehring, South Dakota Department of Agriculture).

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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 defined as "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 (Koop et al., 2012) - 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 the PPQ 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 for any area within it. As part of this analysis, we use a stochastic simulation to evaluate how much the uncertainty associated with the analysis affects the model outcomes. We also use GIS overlays to evaluate those areas of the United States that may be suitable for the establishment of the plant. For more information on the PPQ WRA process, please refer to the document, *Background information on the PPQ Weed Risk Assessment*, which is available upon request.

Falcaria vulgaris **Bernh. – Sickleweed**

Species Information

Family: Apiaceae

Initiation: At the 14th Annual South Dakota Weed and Pest Conference (February 23, 2012), Ron Moehring (South Dakota Department of Agriculture) told the PERAL Weed Team (USDA-APHIS-PPQ) that *Falcaria vulgaris* has become a plant of concern to the state due to a change in its invasive behavior. The PERAL Weed Team initiated this assessment in response to that concern.

Foreign distribution: This species is native to southern and middle Europe (Austria, Belarus, Bulgaria, Hungary, Italy, Poland, Romania) and eastwards through central Asia (the European portion of the former USSR, Iran, Kazakhstan, Kyrgyzstan, Turkmenistan, and western Siberia) and the Middle East (AgroAtlas, 2012; NGRP, 2012). It has been introduced to several countries in northern Europe (Denmark, Finland, Ireland, Norway, Sweden, the United Kingdom) (DAISIE, 2012; Reynolds, 2002; Stace, 2010).

U.S. distribution and status: *Falcaria vulgaris* is known to occur in 30-35 counties across 16 U.S. states (IA, IL, KS, LA, MA, MO, NE, NY, OK, PA, SD, VA, WI, WV, WY, MD) (Kartesz, 2012; Korman, 2011; NRCS, 2012). This species was first reported in 1923 (as *Falcaria rivini*) from a farm in Franklin County, Pennsylvania (Gress, 1923). It had been present on the farm since 1918 and was only reported when the usual crop rotation did not control it (Gress, 1923). It was reported from northeastern Kansas in 1940, as a weed spreading from the north to the south (Gates, 1940). It has been present in South Dakota grasslands since the 1940s but has only recently become problematic (USDA FS, 2012). It currently infests over 3,200 ha in Fort Pierre National Grassland in South Dakota (Korman, 2011). In 2006, it was detected in Buffalo Gap National Grassland in South Dakota. *Falcaria vulgaris* is recommended for eradication when possible in Nebraska (Decker, 2012) and Wisconsin (WFC, 2012).

WRA area: Entire United States, including territories

1. *Falcaria vulgaris* analysis

Establishment/Spread Potential

Falcaria vulgaris has already demonstrated a strong ability to establish and spread beyond its native range, such as in several countries in northern Europe (Clement and Foster, 1994; Duistermaat, 1998; Gudzinskas, 2009; Hand, 2004; Reynolds, 2002; Stace, 2010). Its distribution has expanded eastward in the Urals along railroads (Tret'yakova, 2010). Finally, in the United States, it has spread within and across several states, particularly South Dakota in recent years (Gates, 1940; Korman, 2011; Thomas and Raymond, 1987). *Falcaria vulgaris* produces thousands of viable seeds per square meter, forms dense populations, and readily regenerates from root fragments (AgroAtlas, 2012; Korman, 2011, 2012). It is dispersed unintentionally by people, both through human activity and trade (e.g.; along railroad tracks; Fröberg, 2012; Salisbury, 1961; Tret'yakova, 2010). Plant infructescences form an abscission zone at the base that allows them to break off and be dispersed by wind along with their seeds (Korman, 2011; Ode, 2012). Plants will also produce new stems up to one meter away from parent stems (Korman, 2011). The level of uncertainty associated with this risk element was about average.
Risk score = 14 Uncertainty index = 0.14

Impact Potential

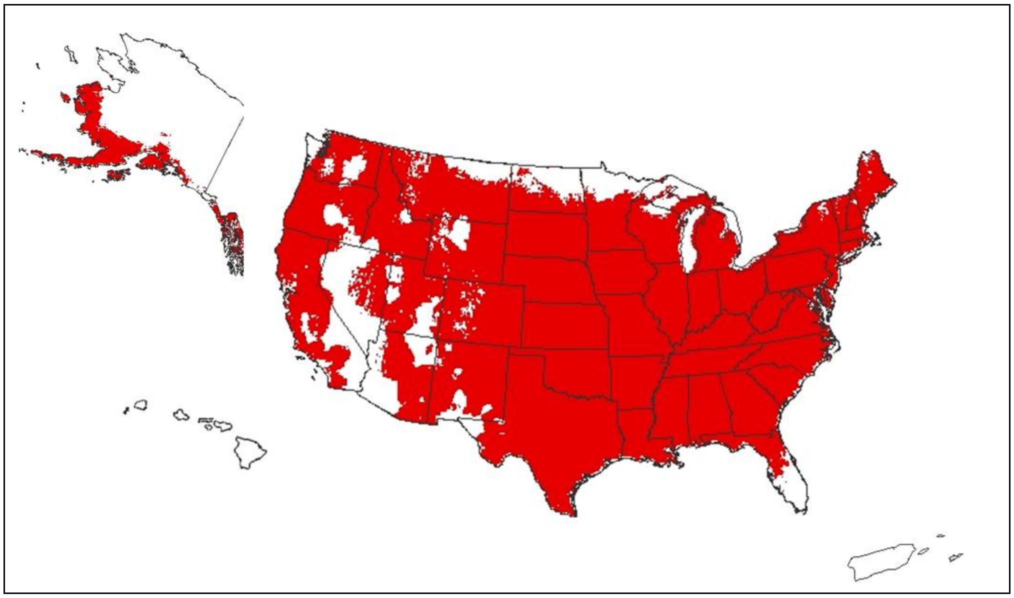
Falcaria vulgaris is a weed and is controlled to some extent in natural, anthropogenic, and production systems (Gudzinskas, 2009; Holm et al., 1991; Korman, 2011, 2012; SDDA, 2009). However, there is very little information explicitly documenting the types of impacts this species is having in these systems. Based on its behavior in Ft. Pierre National Grassland in the United States, *F. vulgaris* alters plant community composition and structure when it invades perennial grasslands (see picture on cover page; Korman, 2011, 2012). Because this species is not toxic and may even be palatable to livestock (Korman, 2012), it is not clear whether it would reduce the livestock yield of rangelands and pastures. However, it is considered a weed of a variety of crops in Europe (AgroAtlas, 2012; Dunn, 1905; Erman et al., 2004; Holm et al., 1991; Lososová et al., 2003). Reports of U.S. farmers switching to different crops to indirectly help manage the weed (Gress, 1923; Korman, 2011) suggest *F. vulgaris* reduces crop yield. Due to limited information on impacts, the level of uncertainty for this risk element was high.
Risk score = 3.6 Uncertainty index = 0.31

Geographic Potential

In its native range, *F. vulgaris* occurs in riverbanks, forest clearings, dry grasslands, waste places, fallow land, stony arable land, and meadows (AgroAtlas, 2012; Hanf, 1983). We estimate that about 75 percent of the United States is suitable for the establishment of *F. vulgaris* (Fig. 1). This predicted distribution is based on the species' known distribution elsewhere in the world and includes point-referenced localities and areas of occurrence. The map represents the joint distribution of Plant Hardiness Zones 4-9, areas with 10-70 inches of annual precipitation, and the following Köppen-Geiger climate classes: steppe, mediterranean, humid subtropical, marine west coast, humid continental cool summers, humid continental warm summers, and subarctic. The estimated area likely is a conservative estimate. Other environmental variables, such as soil and habitat type, may further limit its distribution in the United States.

Entry Potential We did not evaluate this risk element because *F. vulgaris* is already present in the United States (Kartesz, 2012; NRCS, 2012).

Figure 1. Predicted distribution of *Falcaria vulgaris* in the United States. Map insets for Alaska, Hawaii, and Puerto Rico are not to scale.



2. Results and Conclusion

Model Probabilities: P(Major Invader) = 79.1%
P(Minor Invader) = 20.1%
P(Non-Invader) = 0.8%

Risk Result = High Risk
Secondary Screening = Not Applicable

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

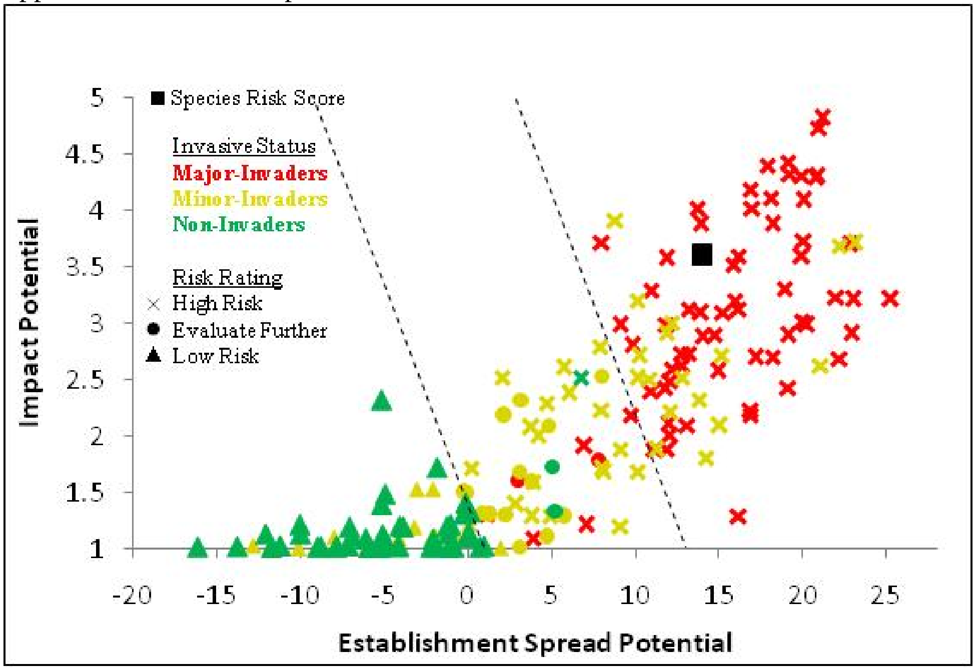
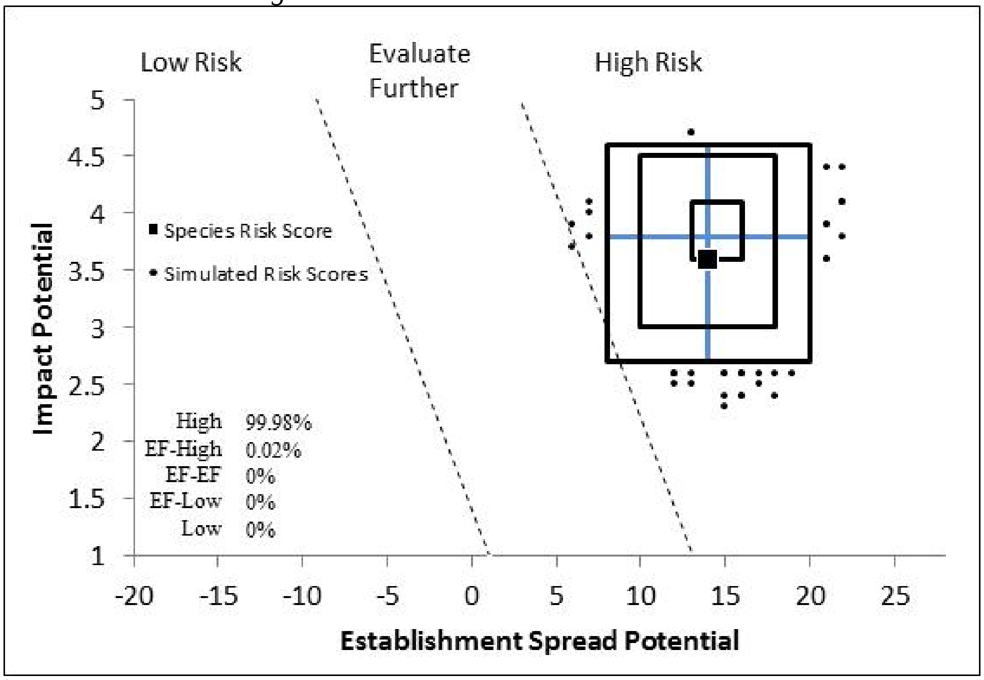


Figure 3. Monte Carlo simulation results (N=5,000) for uncertainty around the risk scores for *Falcaria vulgaris*[a].



[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 *F. vulgaris* is High Risk. Based on its behavior in the United States and elsewhere, we are confident in our assessment of this species' ability to establish and spread (Fig. 2). This species has several traits that enhance its ability to establish and spread, and has already demonstrated its invasive potential in the United States (Gates, 1940; Korman, 2011; Thomas and Raymond, 1987). *Falcaria vulgaris* scored high for impact because it is actively managed in natural, production, and anthropogenic systems. It is recommended for eradication when possible in Nebraska (Decker, 2012) and Wisconsin (WFC, 2012). Our Monte Carlo simulation indicated that our conclusion of High Risk is robust to uncertainty (Fig. 3).

In this weed risk assessment, the risk potential of *F. vulgaris* was to some extent driven by human perception of risk rather than evidence of impact. This is demonstrated by the fact that 61 percent of the impact risk score is derived from our three indices of perceived risk (Imp-N6, Imp-A4, and Imp-P6; see Appendix A). However, even if this species had scored one point less on its impact risk score, it would have still received a conclusion of High Risk because of its ability to establish and spread (Figs. 2 and 3). We point this out to highlight that documented evidence of impacts is lacking, and probably lagging behind efforts to manage this species.

Of particular concern for managers is *F. vulgaris*' ability to reproduce vegetatively from rootstocks, even up to one meter away from the parent plant (AgroAtlas, 2012; SDDA, 2009). This ability is similar to that of other major U.S. invaders in Midwestern grasslands (Korman, 2011). Greenhouse studies have shown that root fragments as short as 4 cm can readily resprout (Korman, 2011). Hence, pocket gophers (*Geomys* spp.) in Midwestern grasslands may be promoting the abundance and density of this plant as they burrow through soil (Korman, 2011).

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Appendix A. Weed risk assessment for *Falcaria vulgaris* Bernh. (Apiaceae). The following information was obtained from the species' risk assessment, which was conducted using the Microsoft Excel. The information shown in this appendix 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 - negl	5	The status of this species varies widely depending on location; however, we are answering invasive for this question based on its behavior in the United States where it is expanding or has expanded its range (LA, KS, SD) (Gates, 1940; Korman, 2011; Thomas and Raymond, 1987). Because it has spread greatly in South Dakota in the last 1-2 decades (Korman, 2012), we are using negligible uncertainty. *Falcaria vulgaris* is native from southern and central Europe eastwards to central Asia (Hanf, 1983). It has been introduced to North and South America (Hanf, 1983), northern Africa (AgroAtlas, 2012), and elsewhere. It has become established in Denmark, Finland, Norway, and Sweden (DAISIE, 2012). It is considered a casual alien in Finland (Kurtto and Lahti, 1987), Cyprus (Hand, 2004), and Ireland (Reynolds, 2002). In Cyprus, it may prove to be a naturalized invader later (Hand, 2004). It was detected in the Netherlands and expected to become naturalized (Duistermaat, 1998). Naturalized for many years at a single site in Northern Ireland (FNI, 2012). Naturalized in Lithuania (Gudzinskas, 2009). In the United Kingdom, it is naturalized and possibly invasive, as it is present in 50-499 sites where it is locally abundant (Clement and Foster, 1994; Stace, 2010). Distribution expanded eastward in the Urals along railroads (Tret'yakova, 2010). The alternate answers for the Monte Carlo simulation are both "E".
ES-2 (Domesticated to reduce weed potential)	n - negl	0	In western Iran, it grows near farmlands, is consumed as a vegetable, and is used to treat a variety of ailments (Khazaei and Salehi, 2007). Seeds are sold online by B & T World Seeds (Sleigh, 2012). However, there is no evidence it has been bred (domesticated) for reduced weed potential, or even cultivated.
ES-3 (Weedy congeners)	n - negl	0	This genus is composed of 4-5 species from Central Europe and the Mediterranean region (Mabberley, 2008). No other species of *Falcaria* is listed as a significant weed (Holm et al., 1991).
ES-4 (Shade Tolerance)	n - low	0	Grows in sun-exposed habitats (Fröberg, 2012). In the United States, it has been reported from grasslands and other open, sunny sites (Korman, 2011).
ES-5 (Climbing or smothering growth form)	n - negl	0	Plant is not a vine or an herb with a basal rosette of leaves (Fröberg, 2012). It is a perennial herb from 30-90 cm tall (Hanf, 1983); 3-5 feet tall (SDDA, 2009).
ES-6 (Dense Thickets)	y - negl	2	In South Dakota grasslands, this species forms dense stands of up to 40 stems per square meter (Korman, 2011). Korman also mentions unpublished data from the USDA Forest Service where "density was reduced [with herbicide applications] from 645 stems/m^2 to 24 stems/m^2" (Korman, 2011). Based on this evidence, and photographs of the species from the Ft. Pierre National Grasslands in South Dakota (see cover page), answering yes with negligible uncertainty.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-7 (Aquatic)	n - negl	0	Terrestrial herb, not an aquatic (Stace, 2010).
ES-8 (Grass)	n - negl	0	Plant not a grass as it is in the Apiaceae (Stace, 2010).
ES-9 (N2-fixer)	n - negl	0	No evidence. Plant is in the Apiaceae (Stace, 2010), which is not one of the families known to fix nitrogen (Martin and Dowd, 1990). Furthermore, it is not a woody plant.
ES-10 (Viable seeds)	y - negl	1	Reproduces by seed (Korman, 2011; SDDA, 2009). Germination rates of 70-90% in the lab and 24-54% in the greenhouse are reported (Korman, 2011). Seeds are also sold by an online distributor (B & T World Seeds; Sleigh, 2012). Consequently, answering "yes". But it should be noted that there may be some variation in seed viability, as one soil seed bank germination study, using soil obtained from a *F. vulgaris* site, did not obtain any germinating seedlings of this species (Korman, 2011).
ES-11 (Self-compatible)	? - max	0	Unknown.
ES-12 (Special Pollinators)	n - high	0	Based on abundant seed production and the variety of pollinators that visit the flowers, it is unlikely it requires specialist pollinators (Korman, 2012). Because this is based on personal insight by an expert, rather than evidence, using high uncertainty.
ES-13 (Min generation time)	b - mod	1	There appears to be some variation for the life history cycle of this species (Korman, 2011). It has been described as a perennial (Hanf, 1983; Korman, 2011), biennial that can develop as a perennial (AgroAtlas, 2012), and an annual (cited in Korman, 2011). This species flowers in June-August, sometimes beginning in the first year of its life, and bears fruits in July-September (AgroAtlas, 2012). However, even if it is perennial, because it can produce seed in the first year of its life, and because populations appear to expand vegetatively from adventitious shoots (Korman, 2011), answering "B" with mod uncertainty. The alternate choices for the Monte Carlo simulation are "C" and "A".
ES-14 (Prolific reproduction)	y - low	1	"Maximum productivity is up to 900 achenes" (AgroAtlas, 2012), but the reference does not indicate how many plants per square meter. Germination rates of 70-90% in the lab and 24-54% in the greenhouse are reported (Korman, 2011). Plants produce several thousand seeds (Korman, 2011), but it is unclear what constitutes a plant in the reference. Based on stem densities of 24 to 40, to possibly 645 per square meter (Korman, 2011), production of hundreds of achenes, and pictures of plant populations in South Dakota, it very likely this herbaceous species produces more than 5000 seeds per square meter. A researcher and manager who has studied *Falcaria* believes it produces more than 5000 seeds per square meter (Korman, 2012).
ES-15 (Unintentional dispersal)	y - mod	1	This species is reported to occur and spread along railroads (Fröberg, 2012; Tret'yakova, 2010); consequently, answering "yes". However, because it is unclear whether spread is due to railroad construction and maintenance activities, or because of contaminants in shipped items escaping (which applies to ES-16), or both, using "mod" uncertainty.
ES-16 (Trade contaminant)	y - mod	2	Fruits of F. *vulgaris* occur with lucerne (*Medicago* sp.) and clover (*Trifolium* sp.) seeds from eastern Europe (Salisbury, 1961). Among other habitats, it occurs around mill areas in Nordic countries (Fröberg, 2012). This evidence indicates it is a contaminant of seeds and grains, but it is unknown how readily it

Question ID	Answer - Uncertainty	Score	Notes (and references)
			contaminates these products or to what degree. Using moderate uncertainty because there isn’t any documented evidence of trade contamination, but the evidence strongly suggests that it is a contaminant of some products.
ES-17 (#Natural dispersal vectors)	1 -	-2	Characteristics of the fruit/seed relevant for ES-17a through ES-17e: Each flower produces two 1-seeded mericarps (Korman, 2011). Fruit is an achene 3-4 mm long (AgroAtlas, 2012; Hanf, 1983).
ES-17a (Wind dispersal)	y - low		Plant infructescences form an abscission zone at the base, which allows them to readily break off and be dispersed by wind along with their seeds (Ode, 2012). "The plant can reach a height of 1 m, and during fall senescence, the stem naturally abscises at the nodes and the plant segments tumble in the wind to disperse the seeds" (Korman, 2011). Old infructescences break off and tumble in the wind (Moechnig et al., 2007).
ES-17b (Water dispersal)	n - mod		No evidence.
ES-17c (Bird dispersal)	n - mod		No evidence.
ES-17d (Animal external dispersal)	n - mod	0	Feeding and burrowing activity by pocket gophers in grasslands is associated with increased density of *Falcaria vulgaris*, most likely because this leads to root fragments that can readily sprout to produce a new plant (Korman, 2011). It is possible then, that gopher tunneling activities may result in some spread of plant propagules, but this won't be very far (Korman, 2012). Thus answering no, but with mod uncertainty.
ES-17e (Animal internal dispersal)	n - mod		No evidence.
ES-18 (Seed bank)	? - max	0	"The results of the 18-month trial are consistent with the findings of Thompson et al. (1997, as cited by Kew Gardens Seed Information Database) who reported that sickleweed seed persisted for less than 1 year in the soil" (Korman, 2011). But this same author states "My germination work, showing that seed begins losing viability after 1 year, indicates that in areas where sickleweed behaves as an annual or biennial, a few successive years of mowing or grazing would be enough to control the plant", suggesting that at least some seeds can persist for a year or two (Korman, 2011, 2012).
ES-19 (Tolerance to loss of biomass)	y - low	1	Plants produce a deep taproot (at least 35 cm; Gress, 1923). Experiments where the taproot was cut into 4 cm long portions and buried at 5 cm soil depth showed, had high shoot regeneration rates (62-82%) (Korman, 2011). This species has survived near a greenhouse at South Dakota State University since the 1970's despite repeated mowing (Korman, 2011). In South Dakota, plant densities are higher in areas with pocket gopher tunnels, possibly due to their foraging activity breaking roots and creating new vegetatively produced plants (Korman, 2011).
ES-20 (Herbicide resistance)	n - mod	0	Early studies demonstrated tolerance to some common herbicides, but applications of other types of herbicides can control it (Moechnig et al., 2007). Based on the description of the response of plants to herbicides, it appears this is a case of herbicide tolerance, and not resistance. However, answering ‘no’ with "mod" uncertainty, nonetheless.
ES-21 (# Cold hardiness zones)	6	0	

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-22 (# Climate types)	7	2	
ES-23 (# Precipitation bands)	6	0	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	? - max		In a field experiment from South Dakota, data from control (no *F. vulgaris*), clipped *Falcaria*, and unclipped *Falcaria* plots suggest that *Falcaria vulgaris* may be producing allelopathic compounds that reduce the biomass of native species, particularly grasses (Korman, 2011); however, there are other factors that could explain the results (Korman, 2012).
Imp-G2 (Parasitic)	n - negl	0	No evidence. Plant is in the Apiaceae (Stace, 2010), which is not one of the plant families known to contain parasitic plants (Heide-Jorgensen, 2008; Nickrent, 2009).
Impacts to Natural Systems			
Imp-N1 (Ecosystem processes)	? - max	0	Unknown. Brian Korman studied this plant for several years as part of his thesis, and believes it may be changing ecological processes such as fire regime due to differences in seasonal biomass and fuel load distribution. *Falcaria* vulgaris emerges earlier in the spring, and flowers and senesces earlier than grasses, potentially affecting fire regime. Also, because it has roots that grow deeper than grasses, it may affect other abiotic factors. However, this is all conjecture and he has no evidence to support this (Korman, 2012). Consequently, answering “unknown”.
Imp-N2 (Community structure)	y - mod	0.2	The plant changes community structure because it replaces habitats dominated by perennial grasses with perennial forbs. Furthermore, because *Falcaria vulgaris* has a different phenology than the grasses, there is also a change in the temporal structure of the communities (Korman, 2012).
Imp-N3 (Community composition)	y - low	0.2	Reduces biomass of native species and grasses in Ft. Pierre National Grassland in South Dakota (Korman, 2011).
Imp-N4 (T&E species)	y - low	0.1	Because it alters community composition and forms dense stands in natural habitats (Korman, 2011), it will most likely affect T&E species.
Imp-N5 (Globally outstanding ecoregions)	y - mod	0.1	This species already occurs in a region of the United States that is considered a globally outstanding ecoregion (portion of the Midwest) (Ricketts et al., 1999). Based on its behavior in South Dakota (Korman, 2011), it is more likely than not to affect this globally outstanding ecoregion.
Imp-N6 (Natural systems weed)	c - low	0.6	Infests 3200 ha in Ft. Pierre National Grassland in South Dakota (Korman, 2011). Controlled by resource managers to prevent and diminish impacts on grassland species diversity (Korman, 2011). Listed on the Lithuanian Invasive Species database; by their definition, invasive means naturalized and a threat to native species in the natural environment (Gudzinskas, 2009). Alternate answers for the Monte Carlo simulation are both "B".
Impact to Anthropogenic areas (cities, suburbs, roadways)			
Imp-A1 (Affects property, civilization, ...)	n - low	0	No evidence.
Imp-A2 (Recreational use)	n - low	0	No evidence.
Imp-A3 (Affects ornamental plants)	n - mod	0	No evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-A4 (Anthropogenic weed)	c - low	0.4	Weed of roadsides in South Dakota (SDDA, 2009) and railroads in Louisiana (Thomas and Raymond, 1987). Occurs in chalk pits, gravel workings, and roadsides in the United Kingdom (Clement and Foster, 1994). A ruderal weed that "grows along roads and ditches and uncultivated lands" (AgroAtlas, 2012). Rare plant in disturbed areas of VA and WV (Weakley, 2010). A weed of roadsides of Eurasia (Dunn, 1905). On an ongoing basis, managers treat roadside infestations of this weed in Nebraska with herbicides (Korman, 2012) with the goal of eradication (Korman, 2011). Alternate answers for the Monte Carlo simulation are both "B".
Impact to Production systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Crop yield)	y - high	0.4	It is not clear whether this species reduces yield in rangelands. However, because an alfalfa field in the eastern United States had to be converted to an entirely different cropping system in order to control the weed, it is reasonable to conclude that it must have significantly impacted crop yield (Korman, 2012). Using high uncertainty.
Imp-P2 (Commodity Value)	? - max		Unknown.
Imp-P3 (Affects trade)	n - high	0	Unknown. Evidence indicates this species is a seed and grain contaminant and thus likely to follow a pathway. However, there is no indication it is regulated by any country, or state.
Imp-P4 (Irrigation)	n - mod	0	No evidence.
Imp-P5 (Animal toxicity)	n - low	0	Cattle will consume it; humans eat it as a vegetable in the Middle East (Korman, 2012).
Imp-P6 (Production system weed)	c - mod	0.6	Numerous sources classify this species as an agricultural weed, however, as there is only some evidence for control in production systems, answering "C", but with mod uncertainty. Evidence: Weed in Kansas (Gates, 1940) and weed of pastures in South Dakota (SDDA, 2009). An agricultural and grain alien in the United Kingdom occurring in fields (Clement and Foster, 1994). A weed of minor importance in southern and central Europe (Williams, 1982), however from the reference it is unclear to which systems this applies. Minor weed of lentils in Turkey (Erman et al., 2004) and vineyards in the Czech Republic (Lososová et al., 2003). A principle weed of agriculture in Lebanon (Holm et al., 1991). A weed of cultivated places in Eurasia (Dunn, 1905). "F. *vulgaris* most often infests perennial grasses, and also grain and tilled crops.... Control measures include shallow plowing followed by deep plowing, thorough pre-sowing soil treatment, mowing of weed before it flowers" (AgroAtlas, 2012). An infestation in an alfalfa field in the United States was eliminated when the field was converted to row crops and herbicides were used (Korman, 2011). Alternate answers for the Monte Carlo simulation are both "B".
GEOGRAPHIC POTENTIAL			Unless otherwise stated all geographic information used below was obtained from GBIF (2012) and is based on point-source data (geo-referenced data points).
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	No evidence.
Geo-Z2 (Zone 2)	n - negl	N/A	No evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-Z3 (Zone 3)	n - low	N/A	1 point at the very edge.
Geo-Z4 (Zone 4)	y - mod	N/A	South Dakota.
Geo-Z5 (Zone 5)	y - negl	N/A	Armenia, Turkey, Nebraska, Wisconsin.
Geo-Z6 (Zone 6)	y - negl	N/A	Sweden.
Geo-Z7 (Zone 7)	y - negl	N/A	Germany.
Geo-Z8 (Zone 8)	y - negl	N/A	France.
Geo-Z9 (Zone 9)	y - low	N/A	NW France, Lebanon, and Israel. Cyprus (presence data; Hand, 2004).
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.
Köppen-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	Cyprus (presence data; Hand, 2004), Azerbaijan, and South Dakota (GBIF, 2012). Occurs in steppes and dry grasslands (Hanf, 1983; Yunusbaev et al., 2003).
Geo-C4 (Desert)	n - high	N/A	No evidence.
Geo-C5 (Mediterranean)	y - low	N/A	Lebanon, Israel.
Geo-C6 (Humid subtropical)	y - low	N/A	Italy.
Geo-C7 (Marine west coast)	y - negl	N/A	France, the United Kingdom.
Geo-C8 (Humid cont. warm sum.)	y - negl	N/A	Armenia, Nebraska, Iowa, South Dakota.
Geo-C9 (Humid cont. cool sum.)	y - mod	N/A	Sweden, Germany.
Geo-C10 (Subarctic)	y - mod	N/A	A few points in a high-altitude region in France.
Geo-C11 (Tundra)	n - negl	N/A	No evidence.
Geo-C12 (Icecap)	n - negl	N/A	No evidence.
10-inch precipitation bands			
Geo-R1 (0-10")	n - high	N/A	No evidence.
Geo-R2 (10-20")	y - negl	N/A	Armenia, Azerbaijan, Turkey, Israel, South Dakota (GBIF, 2012). Occurs in a steppe region of Russia receiving an average of 334 mm per year (Yunusbaev et al., 2003).
Geo-R3 (20-30")	y - negl	N/A	Germany, Nebraska.
Geo-R4 (30-40")	y - negl	N/A	France, the United Kingdom, Kansas.
Geo-R5 (40-50")	y - negl	N/A	The United Kingdom, Pennsylvania.
Geo-R6 (50-60")	y - low	N/A	The United Kingdom (a few points).
Geo-R7 (60-70")	y - high	N/A	One point in, and one point on the edge in the United Kingdom.
Geo-R8 (70-80")	n - mod	N/A	No evidence.
Geo-R9 (80-90")	n - negl	N/A	No evidence.
Geo-R10 (90-100")	n - negl	N/A	No evidence.
Geo-R11 (100"+)	n - negl	N/A	No evidence.
ENTRY POTENTIAL			
Ent-1 (Already here)	y - negl	1	*Falcaria vulgaris* is present in the United States occurring in 30-35 counties across 16 states (IA, IL, KS, LA, MA, MO, NE, NY, OK, PA, SD, VA, WI, WV, WY, MD) (Kartesz, 2012; Korman, 2011; NRCS, 2012).

Question ID	**Answer - Uncertainty**	**Score**	**Notes (and references)**
Ent-2 (Proposed for entry)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	
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	