United States Department of Agriculture

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Animal and Plant Health Inspection Service

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Version 2

Weed Risk Assessment For *Thymelaea passerina* (L.) Coss & Germ (Thymelaeaceae) – Spurge flax

Left: *Thymelaea passerina* flowers. Right: A group of *Thymelaea passerina* plants (source: Mrkvicka, 2007).

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1. 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 the PPQ weed risk assessment (WRA) process (PPQ, 2015) 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.

The PPQ WRA process includes three analytical components that together describe the risk profile of a plant species (risk potential, uncertainty, and geographic potential; PPQ, 2015). At the core of the process is the predictive risk model that evaluates the baseline invasive/weed potential of a plant species using information related to its ability to establish, spread, and cause harm in natural, anthropogenic, and production systems (Koop et al., 2012). Because the predictive model is geographically and climatically neutral, it can be used to evaluate the risk of any plant species for the entire United States or for any area within it. We then use a stochastic simulation to evaluate how much the uncertainty associated with the risk analysis affects the outcomes from the predictive model. The simulation essentially evaluates what other risk scores might result if any answers in the predictive model might change. Finally, we use Geographic Information System (GIS) overlays to evaluate those areas of the United States that may be suitable for the establishment of the species. For a detailed description of the PPQ WRA process, please refer to the *PPQ Weed Risk Assessment Guidelines* (PPQ, 2015), which is available upon request.

We emphasize that our WRA process is designed to estimate the baseline—or unmitigated—risk associated with a plant species. We use evidence from anywhere in the world and in any type of system (production, anthropogenic, or natural) for the assessment, which makes our process a very broad evaluation. This is appropriate for the types of actions considered by our agency (e.g., Federal regulation). Furthermore, risk assessment and risk management are distinctly different phases of pest risk analysis (e.g., IPPC, 2016). Although we may use evidence about existing or proposed control programs in the assessment, the ease or difficulty of control has no bearing on the risk potential for a species. That information could be considered during the risk management (decision-making) process, which is not addressed in this document.

2. Plant Information and Background

SPECIES: *Thymelaea passerina* (L.) Coss & Germ (NGRP, 2017)

FAMILY: Thymelaeaceae

SYNONYMS: *Stellera passerina* L. (NGRP, 2017). Other synonyms available from The Plant List (2017).

COMMON NAMES: Spurge flax (NGRP, 2017), annual Thymelaea (NGRP, 2017), and mezereon (NRCS, 2017).

BOTANICAL DESCRIPTION: *Thymelaea passerina* is an herbaceous annual with simple or branched stems that are 15-40 cm tall (Bojňanský and Fargašová, 2007; Hanf, 1983). Flowers are solitary or 2-3 in leaf axils (Hanf, 1983). Fruit (seed) are prolonged ovate to pyriform achenes, 2.3-2.6 x 1.2-1.4 mm in size (Bojňanský and Fargašová, 2007). For a full botanical description, see Holmes et al. (2000). *Thymelaea passerina* is difficult to identify in the field as it closely resembles some knotweed species (NWCB, 2017).

INITIATION: *Thymelaea passerina* is an exotic plant that was detected in South Dakota in 2008 (Haar, 2012; Kostel, 2008). In May 2012, Dr. Milton Haar, an ecologist with Badlands National Park in South Dakota, asked the Plant Epidemiology and Risk Analysis Laboratory (PERAL) to assess *T. passerina*. The PERAL Weed Team completed that assessment in 2012. In 2017, the PPQ Weeds Cross-Functional Working Group asked PERAL to develop a NAPPRA datasheet for *Thymelaea passerina*, and as part of that request we updated the WRA.

WRA AREA[1]: Entire United States, including territories.

FOREIGN DISTRIBUTION: *Thymelaea passerina* has a broad native distribution (Tan, 1980b), ranging from western and central Europe (e.g., Portugal, France) to southeastern Europe (e.g., Albania, Bulgaria, Slovenia) and on through western and central temperate Asia (e.g., Israel, Azerbaijan, Georgia, Turkmenistan, Uzbekistan, and parts of Russia) (NGRP, 2017). It is also native to Pakistan, India, China's Xinjiang province, and northern Africa (i.e., Algeria, Morocco, Tunisia) (NGRP, 2017). It has been introduced to and naturalized in Australia (NGRP, 2017; Tan, 1980b). It is also naturalized in Quebec and Ontario, Canada (Brouillet et al., 2017).

U.S. DISTRIBUTION AND STATUS: *Thymelaea passerina* was first collected in the United States in 1950 in Nebraska, where it was reported to have "almost completely taken over a pasture" (Pohl, 1955). Since then it has spread to other areas and is now present in eleven states and 28 counties (Fig. 1) (number of counties in parentheses): Alabama (1), Illinois (5), Iowa (5), Kansas (1), Mississippi (1),

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

Nebraska (7), Ohio (1), South Dakota (3), Texas (2), Washington (1), and Wisconsin (1) (Holmes et al., 2000; NRCS, 2017; Vincent and Thieret, 1987; Wofford and De Selm, 1988). In 1999, it was listed as a Class A state noxious weed in Washington when it was discovered infesting 600 acres (NWCB, 2017). Class A noxious weeds must be eradicated by Washington law. We found no evidence that *T. passerina* is cultivated in the United States (e.g., Bailey and Bailey, 1976; Dave's Garden, 2017; Page and Olds, 2001; Univ. of Minn., 2017).

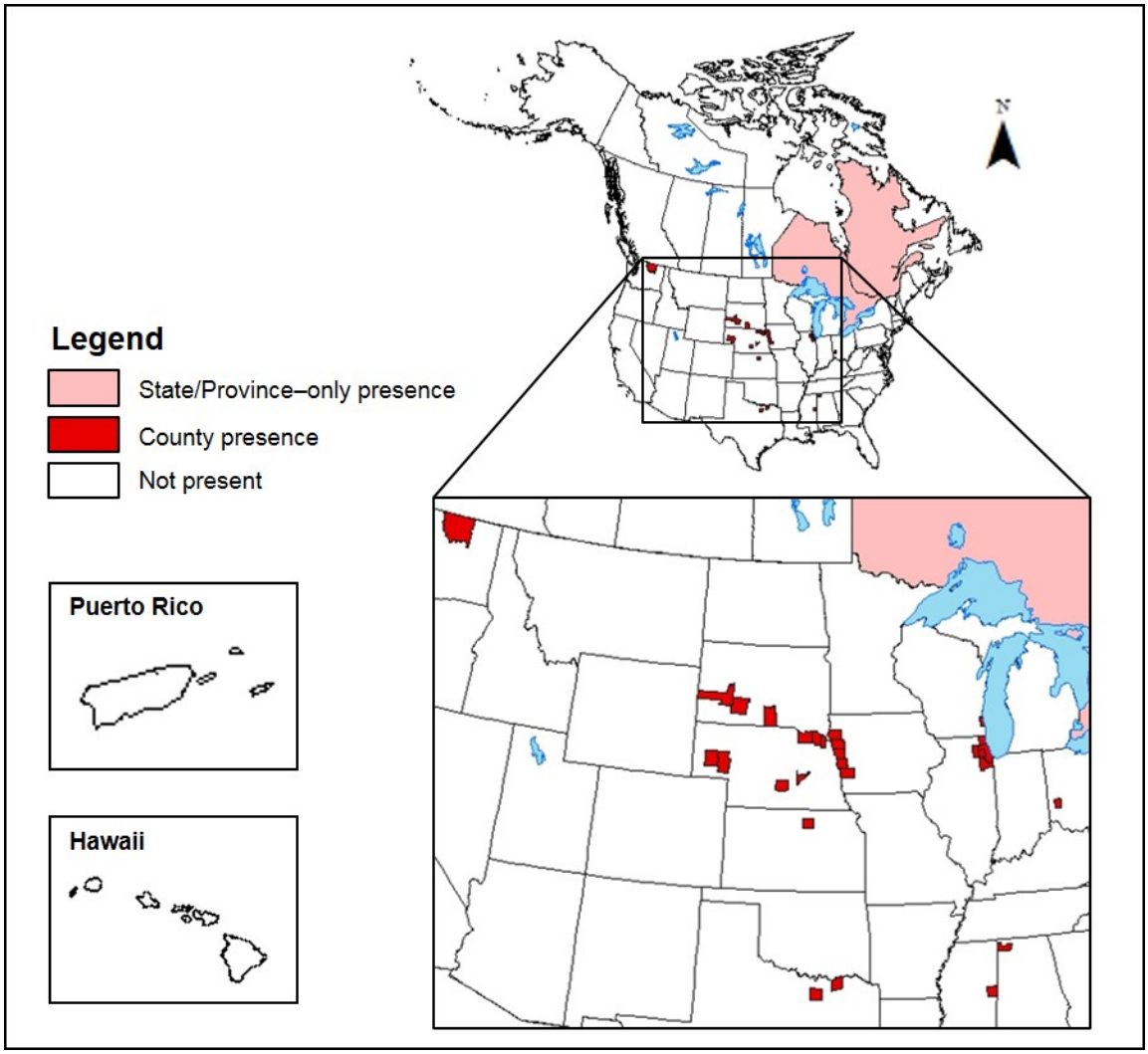

Figure 1. Known naturalized distribution of *Thymelaea passerina* in the United States and Canada. The records shown here were obtained from the following sources and were not independently verified by PERAL (Holmes et al., 2000; NRCS, 2017; Vincent and Thieret, 1987; Wofford and De Selm, 1988). Scales differ for Hawaii, Puerto Rico, and the continental United States and Canada.

3. Analysis

ESTABLISHMENT/SPREAD POTENTIAL

Thymelaea passerina is widespread in central and southern Europe, Russia, and central and southwest Asia. This plant has been introduced to Australia and North America (Tan, 1980b). It can self-pollinate (Tan, 1980b) and produce seeds that remain dormant for two years (Tan, 1980a). Seeds of *T. passerina* can spread as contaminants in agricultural products (e.g., hay, seeds) and hitchhikers on farm machinery (Holmes et al., 2000; Kostel, 2008). We had an average amount of uncertainty in this risk element.

Risk score = 9 Uncertainty index = 0.14

IMPACT POTENTIAL

Thymelaea passerina occurs near farmland and in livestock pastures (Pohl, 1955; Wang et al., 2007), but we found no evidence that it negatively impacts production systems other than the comment that it nearly took over a pasture when it was first discovered (Pohl, 1955). Because livestock do not graze *T. passerina* (Kostel, 2008), it may be reducing the carrying capacity of livestock fields. *Thymelaea passerina* is regulated by the state of Washington as a class “A” noxious weed (eradication is required by law) (NWCB, 1998, 2017) based on its spread potential and limited distribution in the state (Haubrich, 2012). Furthermore, because *T. passerina* is regulated by Washington (NWCB, 1998, 2017) and it is able to move as a contaminant, it may affect interstate trade. For example, any hay moving out of Washington under the North American weed free forage certification program must not contain any seed or propagative parts of *T. passerina* (NAISMA, 2016). We found no evidence that *T. passerina* impacts natural systems or urban/suburban settings. We had a very high level of uncertainty associated with this element due to limited information.

Risk score = 2.0 Uncertainty index = 0.33

GEOGRAPHIC POTENTIAL

Based on three climatic variables, we estimate that about 73 percent of the United States is suitable for the establishment of *T. passerina* (Fig. 2). 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 for *T. passerina* represents the joint distribution of Plant Hardiness Zones 4-10, areas with 10-60 inches of annual precipitation, and the following Köppen-Geiger climate classes: steppe, desert, Mediterranean, humid subtropical, marine west coast, humid continental warm summers, and continental cool summers.

The area of the United States shown to be climatically suitable (Fig. 2) for species establishment considered only three climatic variables. Other variables, for example, soil and habitat type, novel climatic conditions, or plant genotypes, may alter the areas in which this species is likely to establish.

In the United States, *T. passerina* occurs in pasture land, fallow fields, railroad tracks, and other disturbed environments (Harriman, 1979; Kostel, 2008; NWCB, 2017; Pohl, 1955; Wofford and De Selm, 1988). In the Carpathian Mountains of Europe, it is found on stony, calcareous slopes, moist sands, and in saline places of meadows and fields (Bojňanský and Fargašová, 2007).

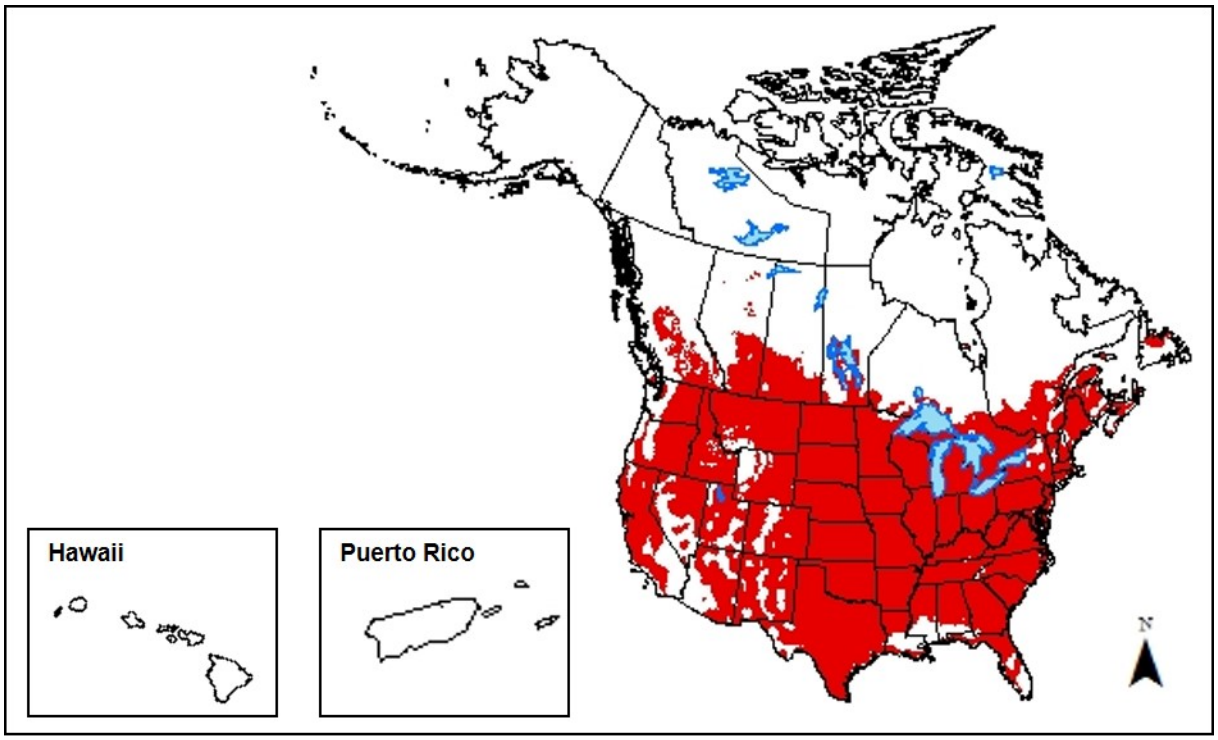

Figure 2. Potential geographic distribution (shown in red) of *T. passerina* in the United States and Canada. Map insets for Hawaii and Puerto Rico are not to scale.

ENTRY POTENTIAL

Thymelaea passerina is present in the United States in 11 states and 28 counties (Fig. 1). It was most likely introduced as a contaminant of agricultural material. Although it is already here, we categorized its entry potential to evaluate the overall likelihood of additional material entering the United States. On a scale of 0 to 1, where 1 represents the maximum likelihood, *T. passerina* obtained a value of 0.22 on our assessment scale. The most likely pathway by which additional material would enter the United States would be as a contaminant of fodder seed (Tan, 1980b) or spices (AQAS, 2017), or possibly as a contaminant of hay/straw (Kostel, 2008), equipment (Holmes et al., 2000), or railway cars (Harriman, 1979; Vincent and Thieret, 1987).

Risk score = 0.22 Uncertainty index = 0.08

4. Predictive Risk Model Results

Model Probabilities: P(Major Invader) = 30.8%
P(Minor Invader) = 62.9%
P(Non-Invader) = 6.4%
Risk Result = Evaluate Further
Secondary Screening = High Risk

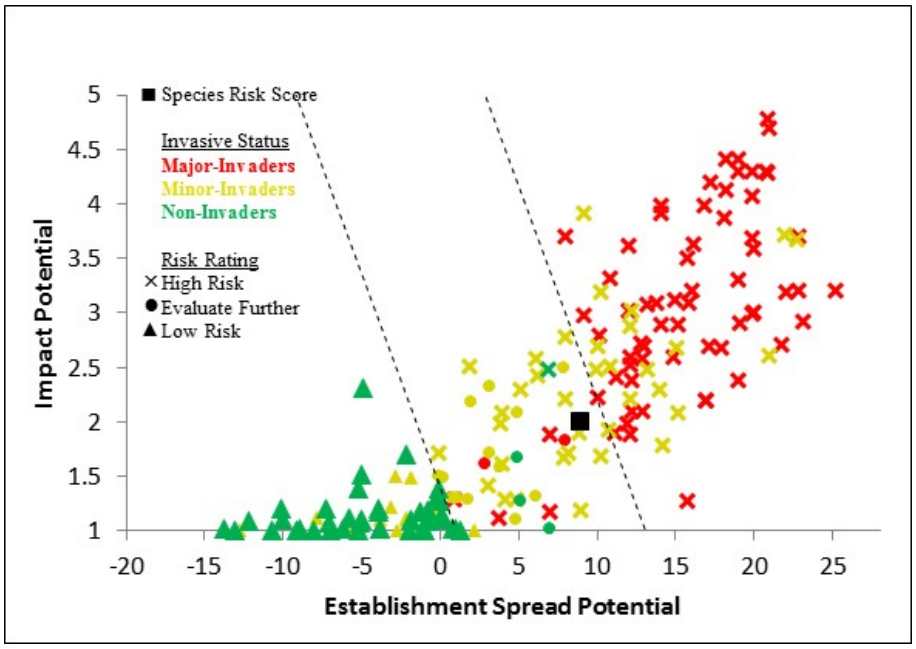

Figure 3. *Thymelaea passerina* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

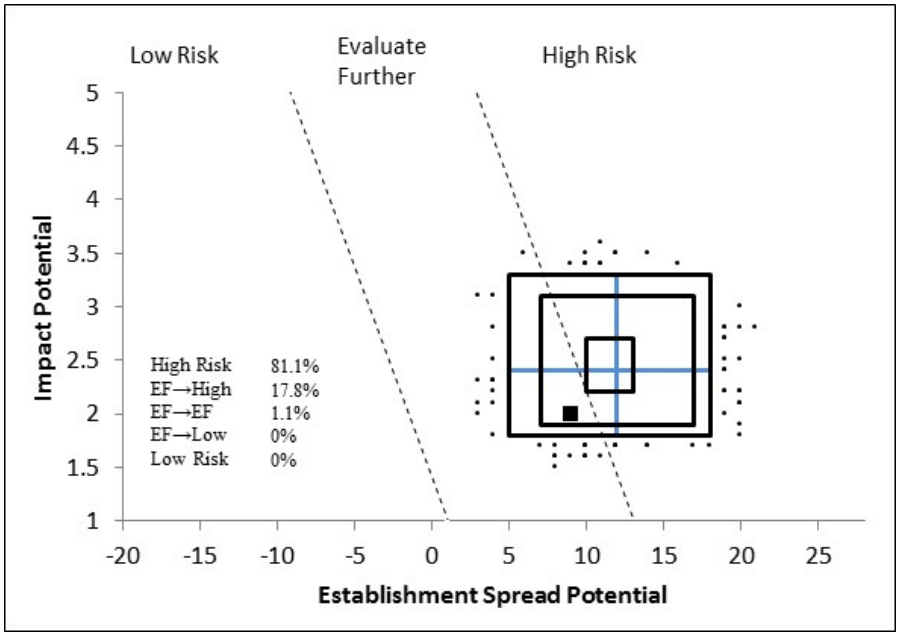

Figure 4. Model simulation results (N=5,000) for uncertainty around the risk score for *T. passerina*. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

5. Discussion

The result of the weed risk assessment for *T. passerina* is High Risk after secondary screening (Fig. 3). The secondary screening result of "High Risk" was mainly because we answered "f" (= invader) for question ES-1. We based that answer on the species having spread over 27,000 acres in the state of Washington (Haubrich, 2012), and to eleven different states across the United States (Kartesz, 2017). Our uncertainty simulation showed that 81 percent of the simulated risk scores resulted in High Risk outcomes as well (Fig. 4).

Thymelaea passerina seeds move to new regions as contaminants of agricultural commodities and equipment (Holmes et al., 2000; Kostel, 2008; Tan, 1980b), and it spreads quickly in pasture land, fallow fields, and other disturbed environments (Kostel, 2008; NWCB, 2017; Pohl, 1955). We found no direct evidence of impacts on other species, indicating either limited impacts or limited knowledge about this species. Because *T. passerina* it is not grazed by animals (Kostel, 2008; NWCB, 2017), it is likely reducing the livestock carrying capacity and yield of pastures. The state of Washington has listed *T. passerina* as a class "A" noxious weed (Haubrich, 2012) and is working to eradicate it from the state (NWCB, 1998, 2017). Management of *T. passerina* can be difficult, though, because the plants have small, leathery leaves, which makes them difficult to control with herbicides (NWCB, 1998).

6. Acknowledgements

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SUGGESTED CITATION

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Appendix A. Weed risk assessment for *Thymelaea passerina* (L.) Coss & Germ (Thymelaeaceae)

Below is all of the evidence and associated references used to evaluate the risk potential of this taxon. We also include the answer, uncertainty rating, and score for each question. The Excel file, where this assessment was conducted, is available upon request.

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 - low	5	*Thymelaea passerina* has a broad native distribution (Tan, 1980b) ranging from western and central Europe (e.g., Portugal, France) to southeastern Europe (e.g., Albania, Bulgaria, Slovenia) and on through western and central temperate Asia (e.g., Israel, Azerbaijan, Georgia, Turkmenistan, Uzbekistan) (NGRP, 2017). It is also native to Pakistan, India, the Xinjiang Province in China, and northern Africa (i.e., Algeria, Morocco, Tunisia) (NGRP, 2017). It has been introduced to (Tan, 1980b) and naturalized in (NGRP, 2017) Australia. It is also naturalized in Quebec and Ontario, Canada (Brouillet et al., 2017). *Thymelaea passerina* was first collected in the United States in 1950 in Nebraska (Pohl, 1955). Since then it has spread to other areas and is now present in 28 counties in eleven states (Fig. 1): Alabama (1)[2], Illinois (5), Iowa (5), Kansas (1), Mississippi (1), Nebraska (7), Ohio (1), South Dakota (3), Texas (2), Washington (1), and Wisconsin (1) (Holmes et al., 2000; NRCS, 2017; Vincent and Thieret, 1987; Wofford and De Selm, 1988). "In Okanogan County, WA, spurge flax covered 600 acres of native range land before it was noticed and identified" (NWCB, 1998). Later surveys in the county discovered the plant covered 82 acres over a 27,000-acre area (Haubrich, 2012). In Cedar County, Nebraska, *T. passerina* had almost completely taken over a pasture when it was first identified (Pohl, 1955). Alternate choices for the uncertainty simulation were both "e."
ES-2 (Is the species highly domesticated)	n - negl	0	We found no evidence that *T. passerina* is cultivated anywhere in the world (e.g., B&T World Seeds, 2017; Bailey and Bailey, 1976; Cullen et al., 2011; Dave's Garden, 2017; eBay, 2017; Page and Olds, 2001; PFAF, 2017; Univ. of Minn., 2017), other than Randall (2017) classifying it as an

[2] Numbers in parentheses correspond to the number of counties for that state.

Question ID	Answer - Uncertainty	Score	Notes (and references)
			ornamental. We also found no evidence that *T. passerina* has been selectively bred to reduce weediness. Based on the weight of the evidence, we answered no with negligible uncertainty.
ES-3 (Significant weedy congeners)	n - high	0	The genus *Thymelaea* is composed of about 30 species (Mabberley, 2008). In addition to *T. passerina*, *T. arvensis*, *T. gussonei*, and *T. hirsuta* are listed in the *Global Compendium of Weeds* (Randall, 2017) with only 1-4 references of weediness each. In contrast, the compendium cites 29 sources reporting that *T. passerina* is a weed. *Thymelaea hirsuta* is considered "a widespread invasive weed" in its native habitat of Tunisia (Ladhari et al., 2011), and it is toxic to cattle (Tan, 1980b). However, because we did not find additional information about its impacts or information about behavior beyond its native range, we did not consider this species to be a significant weed.
ES-4 (Shade tolerant at some stage of its life cycle)	n - low	0	We found no evidence of shade tolerance. *Thymelaea passerina* grows in sunny, open environments such as open pasture land and fallow fields (Pohl, 1955; Tan, 1980b).
ES-5 (Plant a vine or scrambling plant, or forms tightly appressed basal rosettes)	n - negl	0	This species is not a vine. "*Thymelaea* plants are slender, erect annuals" (Pohl, 1955). They are erect annual herbs (Wang et al., 2007).
ES-6 (Forms dense thickets, patches, or populations)	n - mod	0	In the sites where *Thymelaea passerina* has been detected, large numbers of plants have been recorded, such as in South Dakota where "the population of ca. 1000 individual plants [was] scattered throughout several acres of Conata Basin" (Kostel, 2008) and in Washington where "spurge flax covered 600 acres of native range land" (NWCB, 1998). However, none of these reports included information about the plant growing densely or forming monocultures. Additionally, *T. passerina* does not have a growth habit that lends itself to the formation of dense thickets; *T. passerina* is an erect herb with a slender stem and very few branches (Vincent and Thieret, 1987).
ES-7 (Aquatic)	n - negl	0	*Thymelaea passerina* is a terrestrial herb that grows "near farm fields, livestock farms, saline hillsides, dry river beds" (Wang et al., 2007).
ES-8 (Grass)	n - negl	0	This species is a member of the family Thymelaeaceae (Wang et al., 2007) and is not a grass.
ES-9 (Nitrogen-fixing woody plant)	n – negl	0	We found no evidence that *T. passerina* fixes nitrogen. Because it is not a woody plant (Wang et al., 2007), and because nitrogen-fixation is not a characteristic of the family Thymelaeaceae (Martin

Question ID	Answer - Uncertainty	Score	Notes (and references)
			and Dowd, 1990), we answered no with negligible uncertainty.
ES-10 (Does it produce viable seeds or spores)	y - negl	1	It reproduces by seed (NWCB, 2017). Seeds germinate in early spring (Kaul, 1986). Tan (1980a) studied seed germination of *Thymelaea passerina* in detail.
ES-11 (Self-compatible or apomictic)	y - low	1	"Presumably self-pollination occurs as the introrse [turned inward, toward the axis] anthers are situated above the stigma, and the stigmatic papillae are covered with pollen grains....*T. passerina*...appears to be adapted to inbreeding and has tiny hermaphrodite flowers, almost homomorphic pollen, a mechanism ensuring occurrence of self-pollination...and a lower pollen output than occurs in other species" (Tan, 1980b). See additional evidence in ES-12.
ES-12 (Requires specialist pollinators)	n - negl	0	*Thymelaea passerina* is adapted for self-pollination (Tan, 1980b), so specialist pollinators are not required for seed-set. Tan also observed that "the flowers [of *T. passerina* and other species in section *Ligia* of the genus *Thymelaea*] are rather small and insignificant....No insects were observed visiting cultivated material of *T. passerina* in the greenhouse, yet seed set is high" (Tan, 1980b).
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]	b - negl	1	*Thymelaea passerina* is an annual plant (Pohl, 1955; Wang et al., 2007). In India, the seeds germinate in early spring, and plants produce flowers and fruit May-August (Kaul, 1986). In China, flowers are produced from May-August, and fruit is produced from July-October (Wang et al., 2007). Based on this evidence, we answered "b" with negligible uncertainty. Alternate answers for the uncertainty simulation were both "a."
ES-14 (Prolific seed producer)	n - high	-1	Plants produce on average about 115 seeds per plant, and 72 percent of those seeds are viable (Kaul, 1986). In South Dakota, approximately 1,000 plants were found over "several acres" (Kostel, 2008). Assuming that these plants were all located in a single acre, then plant density would be about 0.24 plants per square meter, which represents approximately 20 seeds per square meter. This estimate is far below the threshold of 5,000 viable seeds per square meter required for a yes response. To meet our threshold, there would need to be about 60 plants per square meter. Based on the very limited information about seed production rates and plant density, we answered no with high uncertainty.
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - mod	1	*Thymelaea passerina* was thought to have been introduced into Texas on wheat harvesting equipment (Holmes et al., 2000). It is found along railroad tracks in Wisconsin (Harriman, 1979), which

Question ID	Answer - Uncertainty	Score	Notes (and references)
			could mean that the seeds contaminate railroad cars, or that contaminated grain shipped in those cars is lost along the transportation route.
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - negl	2	This species has been intercepted by U.S. officials in cumin, oregano, fennel, and other spice imports (AQAS, 2017). In Europe, this plant occurs "mainly in cereals and on stubble" (Hanf, 1983), indicating it has an opportunity to contaminate and disperse in farm equipment and agricultural products. "Introduced among fodder seed into Australia and N America" (Tan, 1980b). May have been introduced to South Dakota as seed in hay (Kostel, 2008).
ES-17 (Number of natural dispersal vectors)	0	-4	Propagule traits for questions ES-17a through ES-17e: Fruit are achenes, prolonged ovate to pyriform, apex obtuse with a small beak, base constricted, 2.3-2.6 x 1.2-1.4 mm. Surface dull, pubescent, furrowed, greyish-brown (Bojňanský and Fargašová, 2007).
ES-17a (Wind dispersal)	n - high		Kaul (1986) reports that "[t]he seeds are disseminated mostly by wind." Even though these small seeds could possibly be blown short distances of up to a meter from parent plants, because they lack specific adaptations for wind dispersal (e.g., wings, plumes, etc.) with a potential for long distance dispersal, we answered no with high uncertainty.
ES-17b (Water dispersal)	n - low		We found no information about seeds being buoyant in water, and *Thymelaea passerina* is found in dry soil and pastures (Pohl, 1955), areas where seeds would not be readily dispersed by moving water.
ES-17c (Bird dispersal)	? - max		One source speculates that birds may disperse seeds (NWCB, 1998). However, without specific evidence, we answered unknown.
ES-17d (Animal external dispersal)	n - mod		The seeds do not appear to have any adaptations to adhere to animals, but it is possible because of their size that they may get caught in animal fur.
ES-17e (Animal internal dispersal)	n - low		We found no evidence of this type of dispersal. *Thymelaea passerina* seeds are produced in a dry fruit (Tan, 1980a) that does not appear to offer any rewards for foraging animals, other than the seed itself. Furthermore, plants appear to be unpalatable to animals (Kostel, 2008; NWCB, 1998).
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - mod	1	Tan (1980a) studied seed germination of *T. passerina* in detail. "Seed of *Thymelaea passerina* less than three months old took 42 days to germinate, whereas two-year old seed took only 13 days. Such seed longevity and range in dormancy could be contributing factors to the success and spread of these annuals in open habitats" (Tan, 1980a). Based on this evidence, we answered yes, but because the two-year old seed was stored

Question ID	Answer - Uncertainty	Score	Notes (and references)
			under laboratory conditions, we used moderate uncertainty.
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	? - max	0	Unknown.
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - mod	0	*Thymelaea passerina* is "difficult to control [with herbicides] due to the lack of surface area of the small, leathery leaves" (NWCB, 1998) and "has proven to be aggressive and difficult to control in other regions" (Kostel, 2008), but we found no evidence of herbicide resistance in this species (e.g., Heap, 2017).
ES-21 (Number of cold hardiness zones suitable for its survival)	7	0	
ES-22 (Number of climate types suitable for its survival)	7	2	
ES-23 (Number of precipitation bands suitable for its survival)	5	0	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - high	0	We found no evidence that this species is allelopathic under field conditions, but greenhouse studies indicate it is phytotoxic (Ladhari et al., 2011).
Imp-G2 (Parasitic)	n - negl	0	We found no evidence to suggest that this species is parasitic. This plant is in the family Thymelaeaceae, which is not a family known to contain parasitic plant species (Heide-Jørgensen, 2008; Nickrent, 2009).
Impacts to Natural Systems			
Imp-N1 (Changes ecosystem processes and parameters that affect other species)	n - mod	0	We found no evidence that this species has this kind of impact.
Imp-N2 (Changes habitat structure)	n - mod	0	We found no evidence that this species has this kind of impact.
Imp-N3 (Changes species diversity)	n - high	0	At the sites where *Thymelaea passerina* has been detected, large numbers of plants have been recorded, such as in South Dakota where "[t]he population of ca. 1000 individual plants [was] scattered throughout several acres of Conata Basin" (Kostel, 2008) and in Washington where "spurge flax covered 600 acres of native range land" (NWCB, 1998). However, none of these reports included information about the plant outcompeting other species, and *T. passerina* is often found growing with many other plant species (Holmes et al., 2000; Vincent and Thieret, 1987; Wofford and De Selm, 1988).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species?)	n - mod	0	We found no evidence to suggest that this species is likely to have this type of impact.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-N5 (Is it likely to affect any globally outstanding ecoregions?)	n - mod	0	We found no evidence to suggest that this species is likely to have this type of impact.
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]	b - high	0.2	Randall (2017) cites two sources that categorize *T. passerina* as an environmental weed, one in Australia and one in America, which we were unable to independently confirm. However, because this species invades native rangeland in Washington (NWCB, 1998) and is present on an old farm in Ohio that has been a reserve for 50 years (Vincent and Thieret, 1987), we answered "b" with high uncertainty. Alternate choices for the uncertainty simulation were both "a."
Impact to Anthropogenic Systems (e.g., cities, suburbs, roadways)			
Imp-A1 (Negatively impacts personal property, human safety, or public infrastructure)	n - mod	0	We found no evidence of this type of impact.
Imp-A2 (Changes or limits recreational use of an area)	n - mod	0	We found no evidence of this type of impact.
Imp-A3 (Affects desirable and ornamental plants, and vegetation)	n - mod	0	We found no evidence of this type of impact.
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]	a - mod	0	*Thymelaea passerina* occurs along railroad embankments in Ohio (Harriman, 1979; Vincent and Thieret, 1987), but we found no evidence that it is generally regarded as a weed in these areas. Alternate answers for the uncertainty were both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	? - max		*Thymelaea passerina* is a weed of pasture land (McGregor et al., 1986; Pohl, 1955). It was first collected in the United States in 1950 in Nebraska where it was reported to have "almost completely taken over a pasture" (Pohl, 1955). Because it is not grazed by animals (Kostel, 2008; NWCB, 2017), it is likely reducing the livestock carrying capacity and yield of pastures; however, without direct evidence of this, we answered unknown.
Imp-P2 (Lowers commodity value)	n - high	0	We found no evidence of this type of impact. Because it is unpalatable, it may reduce the value of infested pastures.
Imp-P3 (Is it likely to impact trade?)	y - mod	0.2	*Thymelaea passerina* seeds can move as contaminants in seed and hay (Kostel, 2008; Tan, 1980b), and in spices such as cumin, oregano, and fennel (AQAS, 2017). We found no evidence that it is regulated by any foreign countries (e.g., APHIS, 2017). However, U.S. interstate trade could be

Question ID	Answer - Uncertainty	Score	Notes (and references)
			impacted because *T. passerina* is regulated as a noxious weed by the state of Washington (NWCB, 2017), which includes prohibiting this species from being sold in "seed packets of the seed, flower seed blends, or wildflower mixes...into or within the state of Washington" (Haubrich, 2012). Also, any hay moving out of Washington under the North American weed free forage certification program must not contain any seed or propagative parts of *T. passerina* (NAISMA, 2016).
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - mod	0	We found no evidence of this type of impact.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - high	0	We found no evidence that this species is toxic to animals (e.g., Bruneton, 1999; Burrows and Tyrl, 2013); however, it is unpalatable to animals (Kostel, 2008; NWCB, 1998). Because it is not clear why it is unpalatable, we answered no with high uncertainty. Tan (1980b) commented that the related species *T. coridifolia* is toxic to cattle.
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	*Thymelaea passerina* is a weed of cereals (Hanf, 1983; Randall, 2017) and is considered a weed in its native range [e.g., Morocco (Holm et al., 1979), Europe (Hanf, 1983), Serbia (Nestorovic and Konstantinovic, 2011)]. It is an occasional weed of wheat, orchards, and grasslands in India (Kaul, 1986). "In this pasture [in Iowa in 1954], the plant appeared to be quite aggressive as a weed…appears commonly as a weed in grain fields [in Europe]" (Pohl, 1955). Regulated as a class "A" noxious weed (eradication is required by law) by the state of Washington (NWCB, 2017). "In 2012 the Okanogan County Weed Board treated 82 acres spread out over 27,000 acres" (Haubrich, 2012). We answered "c" because *T. passerina* is regulated in Washington state. Alternate answers for the uncertainty simulation were both "b."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically referenced points obtained from the Global Biodiversity Information Facility (GBIF, 2012).
Plant hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence that it is present in this hardiness zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence that it is present in this hardiness zone.
Geo-Z3 (Zone 3)	n - mod	N/A	We found no evidence that it is present in this hardiness zone.
Geo-Z4 (Zone 4)	y - low	N/A	Afghanistan.
Geo-Z5 (Zone 5)	y - negl	N/A	Armenia and the United States (Nebraska).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-Z6 (Zone 6)	y - negl	N/A	Romania and the United States (Kansas, Ohio)
Geo-Z7 (Zone 7)	y - negl	N/A	Germany and Spain.
Geo-Z8 (Zone 8)	y - negl	N/A	France and Spain. Regional occurrence in the United States: Texas (Holmes et al., 2000) and Mississippi (Wofford and De Selm, 1988).
Geo-Z9 (Zone 9)	y - negl	N/A	Spain.
Geo-Z10 (Zone 10)	y - negl	N/A	Australia.
Geo-Z11 (Zone 11)	n - mod	N/A	We found no evidence that it is present in this hardiness zone.
Geo-Z12 (Zone 12)	n - low	N/A	We found no evidence that it is present in this hardiness zone.
Geo-Z13 (Zone 13)	n - low	N/A	We found no evidence that it is present in this hardiness zone.
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - low	N/A	We found no evidence that it occurs in this climate class.
Geo-C2 (Tropical savanna)	n - mod	N/A	We found no evidence that it occurs in this climate class.
Geo-C3 (Steppe)	y - negl	N/A	Spain and the United States (Nebraska and Washington).
Geo-C4 (Desert)	y - negl	N/A	Afghanistan.
Geo-C5 (Mediterranean)	y - negl	N/A	Australia.
Geo-C6 (Humid subtropical)	y - negl	N/A	Regional occurrence in the United States: Texas (Holmes et al., 2000) and Mississippi (Wofford and De Selm, 1988).
Geo-C7 (Marine west coast)	y - negl	N/A	France and Spain.
Geo-C8 (Humid cont. warm sum.)	y - negl	N/A	Points in the United States (Nebraska, Kansas, and Ohio).
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	Austria and Germany.
Geo-C10 (Subarctic)	n - low	N/A	We found no evidence that it occurs in this climate class.
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence that it occurs in this climate class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	n - mod	N/A	We found no evidence that it occurs in this precipitation band.
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	Australia, Turkey, and the United States (Nebraska).
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	France, Spain, and the United States (Kansas, Nebraska, and Washington).
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	France and the United States (Illinois). Regional occurrence in the United States (Texas) (Holmes et al., 2000).
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Australia and the United States (Ohio).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	Regional occurrence in the United States: Mississippi (Wofford and De Selm, 1988).
Geo-R7 (60-70 inches; 152-178 cm)	n - mod	N/A	We found no evidence that it occurs in this precipitation band.
Geo-R8 (70-80 inches; 178-203 cm)	n - mod	N/A	We found no evidence that it occurs in this precipitation band.
Geo-R9 (80-90 inches; 203-229 cm)	n - low	N/A	We found no evidence that it occurs in this precipitation band.
Geo-R10 (90-100 inches; 229-254 cm)	n - low	N/A	We found no evidence that it occurs in this precipitation band.
Geo-R11 (100+ inches; 254+ cm)	n - low	N/A	We found no evidence that it occurs in this precipitation band.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	n - negl	0	*Thymelaea passerina* has been present in the United States since 1950 (Pohl, 1955). However, to evaluate the likelihood additional material may enter the United States, we set this answer to no.
Ent-2 (Plant proposed for entry, or entry is imminent)	n - low	0	We found no evidence this species has been proposed for import.
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]	a - low	0	We found no evidence that this species is cultivated (e.g., Bailey and Bailey, 1976; Cullen et al., 2011; Dave's Garden, 2017; Page and Olds, 2001; Univ. of Minn., 2017) or positively valued.
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	y - negl		*Thymelaea passerina* is present in Quebec and Ontario, Canada (Brouillet et al., 2017).
Ent-4b (Contaminant of plant propagative material (except seeds))	n - mod	0	We found no evidence of this species being a contaminant of this type of material.
Ent-4c (Contaminant of seeds for planting)	y - low	0.08	*Thymelaea passerina* was introduced in fodder seed to Australia and the United States (Tan, 1980b).
Ent-4d (Contaminant of ballast water)	n - low	0	We found no evidence of this species being a contaminant of ballast water, and we think this pathway is unlikely.
Ent-4e (Contaminant of aquarium plants or other aquarium products)	n - low	0	We found no evidence, and think that this pathway is unlikely.
Ent-4f (Contaminant of landscape products)	? - max		We found no direct evidence of this species being a contaminant of this type of material. *Thymelaea passerina* grows in pastures, prairies, and cereal fields (Hanf, 1983; Pohl, 1955). Because straw (and hay to a lesser extent) are often used to cover bare

Question ID	Answer - Uncertainty	Score	Notes (and references)
			ground, it is possible it may be introduced and spread as a contaminant of these products (Kostel, 2008).
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	y - mod	0.04	*Thymelaea passerina* was thought to have been introduced into Texas on wheat harvesting equipment (Holmes et al., 2000). It is found along railroad tracks in Wisconsin (Harriman, 1979) and Ohio (Harriman, 1979; Vincent and Thieret, 1987), which could mean that the seeds contaminate railroad cars, or that contaminated grain shipped in those cars is lost along the transportation route.
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	y - negl	0.02	This species has been intercepted by U.S. officials in cumin, oregano, fennel, and other spices imported for consumption (AQAS, 2017).
Ent-4i (Contaminant of some other pathway)	e - high	0.08	It is suspected that this species was introduced to Tripp County, South Dakota as a contaminant of agricultural activity related to feeding cattle, e.g., contaminant of fodder (Kostel, 2008). Because this pathway is not likely to limit the establishment of the species in the landscape, we chose "e" with high uncertainty.
Ent-5 (Likely to enter through natural dispersal)	n - mod	0	Although this species is present in Canada, we found no evidence of a natural long-distance dispersal vector and think that this pathway is unlikely to be important.