United States Department of Agriculture

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Animal and Plant Health Inspection Service

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Version 1

Weed Risk Assessment for *Tripleurospermum inodorum* (L.) Sch. Bip. (Asteraceae) – Scentless mayweed

Left: Infestation of *T. inodorum* at Sherwood Park, Alberta (Photo ©Alec McClay). Top left inset: Flowers (Caleb Slemmons, National Ecological Observatory Network, Bugwood.org). Right top and bottom: Basal rosette and seeds (Bruce Ackley, The Ohio State University, Bugwood.org).

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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 a 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 were to change. Finally, we use Geographic Information System (GIS) overlays to identify 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 any type of system (production, anthropogenic, or natural) for the assessment, which results in a very broad evaluation. This is appropriate for the types of actions considered by our agency, such as Federal regulation. Risk assessment and risk management are distinctly different phases of pest risk analysis (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: *Tripleurospermum inodorum* (L.) Sch. Bip. (NGRP, 2018; The Plant List, 2018).

FAMILY: Asteraceae

SYNONYMS: *Matricaria chamomilla* sensu L. 1753, *M. inodora* L., *Matricaria perforata* Mérat, *Tripleurospermum perforatum* (Mérat) M. Laínz, *Tripleurospermum maritimum* subsp. *inodorum* (L.) Appleq., *T. perforatum* (Mérat) M. Laínz (NGRP, 2018), *Chrysanthemum inodorum* (L.) L. (The Plant List, 2018).

The classification of *T. inodorum*, and of *Matricaria* and *Tripleurospermum* species in general, has been a contentious issue. *Tripleurospermum inodorum* is the species name currently accepted by the Flora of North America (Brouillet, 1993), the National Plant Germplasm System (NGRP, 2018), and the Plant List (2018). Other major databases classify it as *T. maritimum* subsp. *inodorum* (Kartesz, 2018) and *T. perforatum* (NRCS, 2018). Until recently, the name *M. perforata* was also in regular use in the North American literature (McClay et al., 2002). Current consensus generally classifies *T. inodorum* and *T. maritimum* as separate species. Brouillet (1993+) wrote "from the standpoint of weed science, taxonomic merging of *T. inodorum* and *T. maritimum* has the inconvenience of grouping under a single specific name taxa that have different physiologies, ecologies, weed potentials, and, possibly, reactions to weed control measures." These species can be distinguished based on their seed morphology (Kay, 1969).

COMMON NAMES: Scentless or false mayweed, false chamomile (Brouillet, 1993), scentless chamomile, matricaire inodore (French; Darbyshire et al., 2000), scentless false mayweed (NRCS, 2018, mayweed (AAF, 2007).

BOTANICAL DESCRIPTION: *Tripleurospermum inodorum* is an erect, ascending, or prostrate annual, biennial, or short-lived perennial that typically grows 30-80 cm tall (Brouillet, 1993; Kay, 1994). Leaves are highly dissected and filiform. It produces daisy-like flowers with white rays and yellow centers, 3-4.5 cm in diameter (Kay, 1994). Seeds are achenes that are 1.2-2.2 mm long (Kay, 1994). For a more detailed botanical description, see Kay (1994). *Tripleurospermum inodorum* hybridizes with *T. maritimum* where their ranges overlap in the United Kingdom (Kay, 1994; Stace, 2010).

The species is phenotypically and genotypically variable and includes two cytotypes, 2n = 18 and 2n = 36 (Kay, 1994). In the United Kingdom, western Europe, and the Canadian prairie, populations are typically diploid (2n = 18), while in central, eastern, and northern Europe and in the Canadian maritime provinces, populations are usually tetraploid (2n = 4x = 36) (Kay, 1994). The presence of quadrivalents during meiosis suggests that the polyploid cytotype of *T. inodorum* is an autotetraploid (Arora and Madhusoodanan, 1981). Diploid and tetraploid plants fill the same ecological niche and are usually indistinguishable in the wild (Kay, 1969). When plants are cultivated side by side in identical environments, tetraploids often grow faster, more erect, and larger than diploids (Kay, 1969). In Europe, mixed-ploidy populations sometimes include triploids and other cytotypes ranging from 2x to 5x (Ćertner et al., 2017).

INITIATION: APHIS received several market access requests for wheat grain and seed from Europe. *Tripleurospermum inodorum* is a weed of cereals and may be able to follow the pathway in these commodities. In this document, we evaluate the weed risk potential of this species.

WRA AREA[1]: United States and Territories.

FOREIGN DISTRIBUTION: *Tripleurospermum inodorum* is native to Europe and western Asia, with a range extending from Spain, Italy, and the central Balkans, north through most of Scandinavia to about 66°20'N, and eastward through European Russia, the Caucasus, western Siberia, and parts of central Asia (Kay, 1994). It is a casual species in Iceland (Wasowicz et al., 2013) and has become naturalized throughout New Zealand, as well as in the Australian states of New South Wales, Victoria, and Tasmania (AVH, 2017). It is also naturalized in southern Chile (Matthei, 1995) and southern Argentina (GBIF, 2018) in the Patagonian region. It is considered invasive in Japan (NIES, 2018). In Canada, the earliest *T. inodorum* herbarium record dates from 1876 in New Brunswick, and the species was first collected in Saskatchewan in 1928 (Woo et al., 1991). It has since become a highly problematic weed throughout the country. It is present throughout the country but is most common in the eastern and prairie provinces (MAFF, 2002). *Tripleurospermum inodorum* is classified as a noxious weed in Alberta (Province of Alberta, 2010), Saskatchewan (Bjornerud, 2010), British Columbia (MAFF, 2002), Quebec (Darbyshire, 2003), and Manitoba (Government of Manitoba, 2018). The species is cultivated in Europe (Kay, 1994). We found some specialty seed suppliers selling *T. inodorum* in Europe under the synonym *Chrysanthemum inodorum* (B-and-T-world-seeds.com, 2017; Seemnemaailm.ee, 2017).

U.S. DISTRIBUTION AND STATUS: *Tripleurospermum inodorum* is naturalized in the United States and has primarily been reported in the western and northwestern states, including Washington, Oregon, Idaho, Montana, Wyoming, Utah, and Colorado (EDDMapS, 2018) (Fig. 1). It is also present in widely scattered counties through the upper Midwest and the northeastern states and is more frequent in the extreme northern latitudes of these regions, including North Dakota, Minnesota, and Maine (EDDMapS, 2018). In Alaska, *T. inodorum* is widely distributed in southern coastal, interior boreal forest, arctic, and alpine ecoregions and is considered "weakly invasive" (Carlson et al., 2008). It is regulated as a class C noxious weed in Washington state and is included on the B list of noxious weeds in Colorado (Kartesz, 2018). A cultivar of this species, 'Bridal Robe,' is listed on the Dave's Garden website (Dave's Garden, 2018), suggesting that the species is cultivated to a limited extent in the United States. We found one seed company selling the species under the name *T. inodorum* (GeoSeed, 2017) and another under the name *Chrysanthemum inodorum* (Hardyplants.com, 2017).

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

Control efforts for *T. inodorum* occur mainly in agricultural settings. In Colorado, landowners are required to take steps to control it because it is listed as a class B noxious weed. The Colorado Department of Agriculture recommends a combination of practices to prevent seed production in pastures and rangeland, including timely sowing of seeds for forage species; control of overgrazing; frequent, shallow tilling; and the application of several broadleaf herbicides during the early growth stage (i.e., rosette stage) of the weed (CDA, 2015). In Washington State, individual counties are allowed to enforce control measures because *T. inodorum* is categorized as a class C noxious weed. The Noxious Weed Control Board of Washington recommends control strategies for preventing *T. inodorum* from producing seed, including the cleaning of equipment and machinery used in infested areas and timely planting of competitive crop and forage species (WSNWCB, 2017).

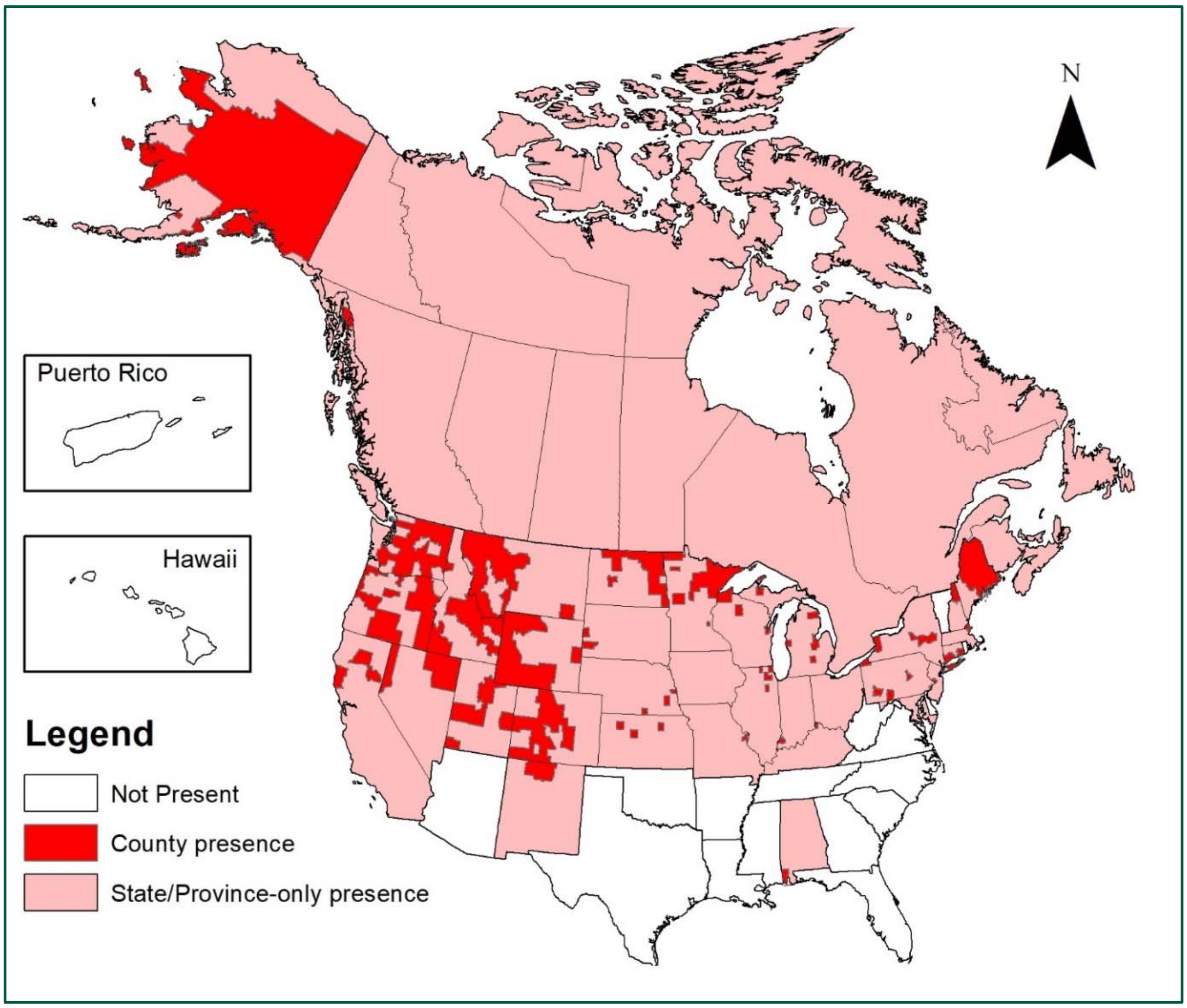

Figure 1. Known naturalized distribution of *T. inodorum* in the United States and Canada. The records shown here were obtained primarily from other species distribution databases (EDDMapS, 2018; NRCS, 2018) and were not independently verified by PERAL. Scales differ for Hawaii, Puerto Rico, and the continental United States and Canada.

3. Analysis

ESTABLISHMENT/SPREAD POTENTIAL

Tripleurospermum inodorum has already demonstrated a strong ability to establish and spread, as it has become naturalized in several temperate regions of North America, Oceania, and South America (GBIF, 2018; NGRP, 2018). Although this species generally requires cross-pollination for seed set (Kay, 1969), it has a very high fecundity rate, with some individual plants producing up to 300,000 seeds (Lutman, 2002). Dense populations may produce between 0.3 and 1.8 million seeds per square meter (Woo et al., 1991). Seeds are readily dispersed by water (AAF, 2007; Crisanti and Taffetani, 2015) and animals (Kay, 1994; Woo et al., 1991), as well as by people through both trade (Nadtochii, 2009; Woo et al., 1991) and agricultural activities (Ignatieva et al., 2011). *Tripleurospermum inodorum* has several other traits that contribute to its invasive potential, including formation of a long-lived seed bank in the soil (AAF, 2007; Kay, 1994; Nadtochii, 2009), tolerance to disturbance (Ignatieva et al., 2011; MAFF, 2002), and resistance or tolerance to herbicides (Heap, 2018; Salisbury, 1961). We had a low level of uncertainty for this risk element.

Risk score = 22 Uncertainty index = 0.10

IMPACT POTENTIAL

Tripleurospermum inodorum is primarily a weed of disturbed and agricultural areas and is particularly problematic in cereals such as wheat (Hanf, 1983; Kay, 1994; Nadtochii, 2009; Reiss et al., 2018). It reduces yields in cultivated crops, such as grain or seed, as well as in hayfields and pastures (MAFF, 2002; McClay et al., 2002). One researcher estimated yield losses in wheat field of 0.9 to 11 percent per unit weed density (plants per square meter) (Douglas et al., 1991). Because *T. inodorum* is unpalatable to livestock and is not very nutritious (MAFF, 2002; Woo et al., 1991), it seems likely that it would lower the value and yield of infested pastures and rangelands. In natural areas, this species forms dense patches that limit the growth of seedlings of other species (MAFF, 2002; Woo et al., 1991) and increase the density of the early successional herbaceous layer (Carlson et al., 2008). Various control recommendations are available (MAFF, 2002; Nadtochii, 2009). In the past 10 years, researchers have examined this species to determine how it responds to chemical treatments (de Mol et al., 2015; Sønderskov et al., 2012) and to support the development of decision-support tools for management (Ali et al., 2015; Berge et al., 2012). Several biological control agents have been released in Canada (MAFF, 2002; Winston et al., 2014). Due to the limited information about some types of impacts, we had very high uncertainty for this risk element.

Risk score = 2.9 Uncertainty index = 0.26

GEOGRAPHIC POTENTIAL

Based on three climatic variables, we estimate that about 67 percent of the United States is suitable for the establishment of *T. inodorum* (Fig. 2). This predicted distribution is based on the species' known distribution elsewhere in the world and includes point-referenced localities and general areas of occurrence. The map for *T. inodorum* represents the joint distribution of Plant Hardiness Zones 2-10, areas with 10 to 100 or more inches of annual precipitation, and the following Köppen-Geiger climate classes: steppe, Mediterranean, marine west coast, humid continental warm summers, humid continental cool summers, subarctic, and tundra. We had some uncertainty as to whether this species could survive in steppe habitats; however, we answered yes with high uncertainty, as it occurred in a few such locations in the United States (App. A).

The area of the United States shown to be climatically suitable (Fig. 2) for species establishment considered only three climatic variables. Other variables, such as soil and habitat type, novel climatic conditions, or plant genotypes, may alter the areas in which this species is likely to establish. For example, *T. inodorum* is intolerant of warmer summer temperatures or drought (Woo et al., 1991), which may limit its spread in regions east of the Rockies, particularly the southeastern United States. *Tripleurospermum inodorum* occurs in a variety of habitats, including shorelines, roadsides, fence lines, rangelands, croplands, field edges, pastures, meadows, hay fields, drainage ditches, sloughs, river banks, pond edges, kitchen gardens, wastelands, and industrial areas (AAF, 2007; MAFF, 2002; Nadtochii, 2009; Woo et al., 1991). In Europe, it occurs in heavy, rich, moist, acidic soils (Hanf, 1983).

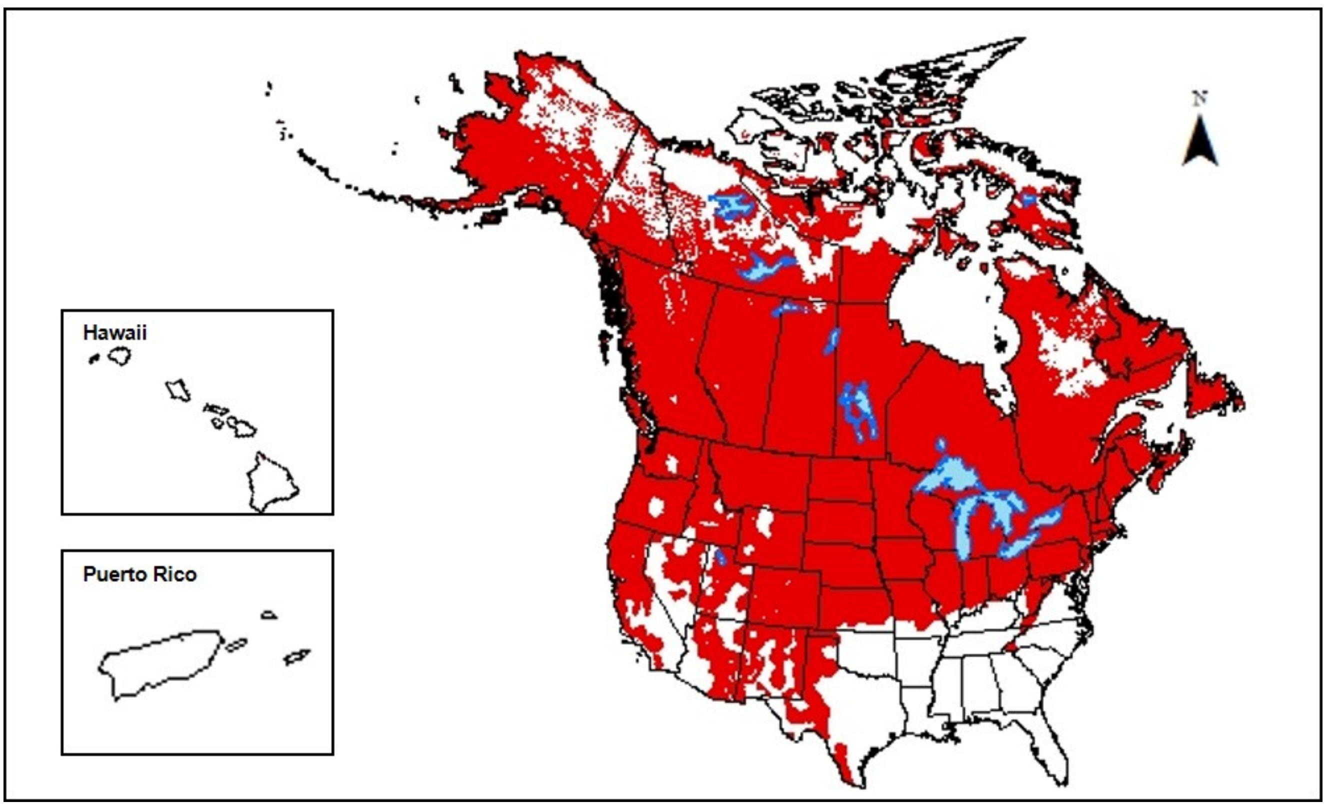

Figure 2. Potential geographic distribution of *T. inodorum* in the United States and Canada. Map insets for Hawaii and Puerto Rico are not to scale.

ENTRY POTENTIAL

Tripleurospermum inodorum is naturalized in the United States (Fig. 1) and has been reported primarily in the western and northwestern states, including Washington, Oregon, Idaho, Montana, Wyoming, Utah, and Colorado (EDDMapS, 2018). Because this species is well established in the United States, we did not evaluate its entry potential.

4. Predictive Risk Model Results

Model Probabilities: P(Major Invader) = 94.2%
P(Minor Invader) = 5.6%
P(Non-Invader) = 0.2%
Risk Result = High Risk
Secondary Screening = Not Applicable

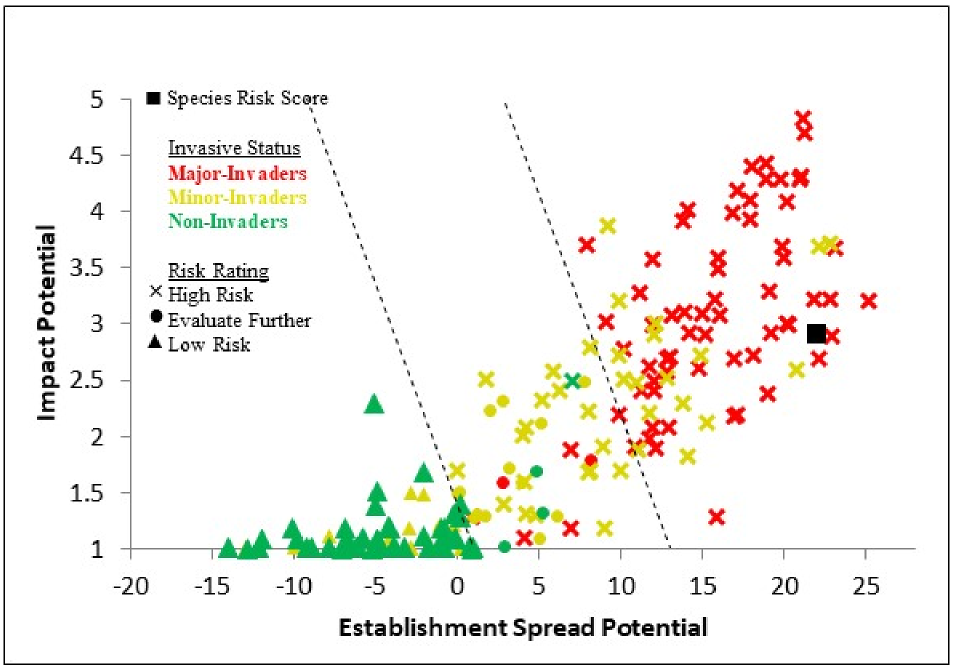

Figure 3. *Tripleurospermum inodorum* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

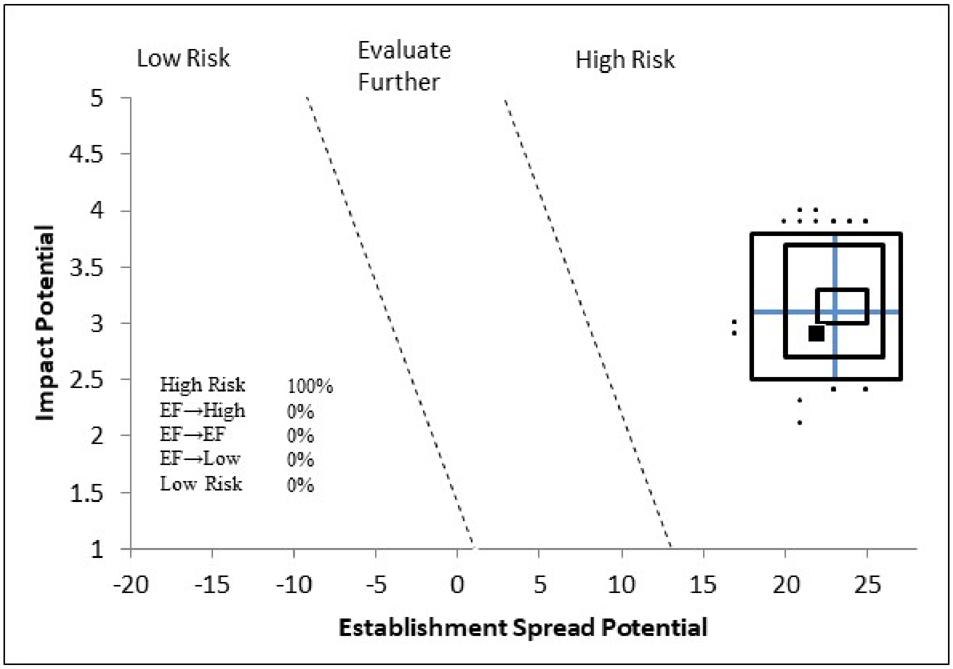

Figure 4. Model simulation results (N=5,000) for uncertainty around the risk score for *T. inodorum*. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

5. Discussion

The result of the weed risk assessment for *Tripleurospermum inodorum* is High Risk (Fig. 3) and is supported by the results of the uncertainty analysis (Fig. 4). *Tripleurospermum inodorum* is an herbaceous, annual or short-lived perennial that is generally distributed in northern latitudes in agricultural and disturbed habitats. It has become widely naturalized beyond its native range and readily spreads due to prolific reproduction and multiple dispersal mechanisms. Its small, light seeds (about 1.2-2 mm long) have been documented to disperse in trade. *Tripleurospermum inodorum* is generally considered a weed of agriculture and is particularly competitive in cereals. It causes significant yield losses in wheat. It is difficult to manage due to its long-lived seed bank, its tolerance and resistance to herbicides, and its extended germination period.

Tripleurospermum inodorum obtained a risk score of 47 out of 98 on an Alaskan WRA that evaluates the spread and impact potential of species in natural ecosystems (Carlson et al., 2008). Our analysis resulted in a higher risk result partially because the PPQ-WRA also considers impacts to agricultural systems.

6. Acknowledgements

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SUGGESTED CITATION

PPQ. 2018. Weed risk assessment for *Tripleurospermum inodorum* (L.) Sch. Bip (Asteraceae) – Scentless mayweed. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (PPQ), Raleigh, NC. 23 pp.

DOCUMENT HISTORY

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Appendix A. Weed risk assessment for *Tripleurospermum inodorum* (L.) Sch. Bip. (Asteraceae)

The following table includes 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 in which 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 - negl	5	*Tripleurospermum inodorum* is native to Europe and parts of western Asia (Kay, 1994) but is now found in many temperate regions of agricultural production worldwide, such as eastern Australia (including Tasmania), New Zealand, Japan, and southern Argentina and Chile (GBIF, 2018). Following its introduction to Canada, it quickly became a highly problematic agricultural weed and is now found in all provinces (reviewed in Woo et al., 1991). It was introduced to the eastern and western coasts of the United States by the late 19th or early 20th century (Brown, 1878; Nelson, 1917). Its range has since expanded across the conterminous states west of the Rockies (EDDMapS, 2018) and into Alaska (Carlson et al., 2008). In Alberta, Canada, it spreads quickly along roadsides and fencelines (AAF, 2007). This species expands its range rapidly because of prolific seed production (McClay et al., 2002). Over the last few decades, the frequency of this species has increased among Danish farms (Andreasen and Stryhn, 2012). Alternate answers for the uncertainty simulation were both "e."
ES-2 (Is the species highly domesticated)	n - negl	0	Although this species is cultivated to a minor extent (Dave's Garden, 2018), we found no evidence indicating that it is highly domesticated or has been bred for reduced weed potential. See Kay (1969) for a description of the probable origin of this species.
ES-3 (Significant weedy congeners)	n - low	0	The genus *Tripleurospermum* includes about 38 species (Mabberley, 2008). Although several of these have been reported as weeds, none appear to be significant weeds (e.g., Brouillet, 1993; Randall, 2017).
ES-4 (Shade tolerant at some stage of its life cycle)	n - mod	0	This species occurs in a variety of open habitats such as shorelines, roadsides, fence lines, rangelands, croplands, field edges, pastures, meadows, hay fields, drainage ditches, sloughs, river banks, pond edges, kitchen gardens, wastelands, and industrial areas (AAF, 2007; MAFF, 2002; Nadtochii, 2009; Woo et al., 1991). Seeds initially require light for germination, but as they age they lose that requirement (AAF, 2007). Flowering and seeding are most prolific under high light intensity (AAF, 2007). Based on the weight of this evidence, we answered no with moderate uncertainty.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-5 (Plant a vine or scrambling plant, or forms tightly appressed basal rosettes)	n - high	0	Although the plants form basal rosettes of leaves (Kay, 1994), because the leaves are not tightly appressed and do not form a solid "skirt" (leaves are bipinnately and tripinnately compound), they do not meet the criteria for this question.
ES-6 (Forms dense thickets, patches, or populations)	y - negl	2	This species forms dense patches in pastures and hay fields (cited in MAFF, 2002). In fields in Saskatchewan, it occurs at densities of 25 to 70 plants per square meter (McClay et al., 2002). In organic winter wheat in the United Kingdom, it grew at a density of 290 plants per square meter (Welsh et al., 1999). In Germany, Poland, and Denmark, this species is common and occurs at "considerable densities" (de Mol et al., 2015). The authors of another study report moderate densities of about four to six plants per square meter (Hamouz et al., 2014). Although the reported plant densities vary, we considered the evidence sufficient to support a yes response.
ES-7 (Aquatic)	n - negl	0	*Tripleurospermum inodorum* is an erect, ascending, or prostrate plant that typically grows 30 to 80 cm tall (Brouillet, 1993; Kay, 1994) and occurs in a variety of terrestrial habitats (Woo et al., 1991); it is not an aquatic species.
ES-8 (Grass)	n - negl	0	This species is not a grass; it is an aster (NGRP, 2018).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	We found no evidence. Furthermore, this species is not a member of a plant family typically associated with nitrogen fixation (Martin and Dowd, 1990; Santi et al., 2013) and it is not woody.
ES-10 (Does it produce viable seeds or spores)	y - negl	1	It reproduces by seed (AAF, 2007; de Mol et al., 2015; MAFF, 2002).
ES-11 (Self-compatible or apomictic)	y - high	1	In the United Kingdom, *T. inodorum* populations are typically strongly self-incompatible (Woo et al., 1991). Self-fertile populations, however, do occur occasionally and have been observed among both diploid and tetraploid cytotypes in England and continental Europe (Kay, 1969). Because the species has self-compatible populations, we answered yes, but with high uncertainty.
ES-12 (Requires specialist pollinators)	n - low	0	We found no specific evidence that plants require specialist pollinators. Plants are cross-pollinated by flies (Kay, 1969). Flowers are visited by bees and flies (Carlson et al., 2008; Wood et al., 2015). Near Moscow, plants are visited by hoverflies (Lysenkov, 2009). Based on this evidence and the fact that plants have become established well beyond their native range, it seems unlikely that it requires specialist pollinators.

Question ID	Answer - Uncertainty	Score	Notes (and references)
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	Plants are typically annuals, though sometimes biennials or perennials (Brouillet, 1993). In Canada, *T. inodorum* plants that emerge by early July typically flower and set seed that year, whereas those that emerge in late July and onwards typically overwinter as rosettes which bolt and flower the following season (McClay et al., 2002). Alternate answers for the uncertainty simulation were "c" and "a."
ES-14 (Prolific seed producer)	y - negl	1	*Tripleurospermum inodorum* has a high seed production rate and easily meets the threshold of 5000 seeds per square meter for this question. Plants typically produce 10 to 200 or more flowering heads, and can produce as many as 1200 (Brouillet, 1993; Kay, 1994) over an extended flowering period (AAF, 2007). Individual plants can produce 10,000 to 256,000 seeds per plant (Hanf, 1983; McClay et al., 2002) and perhaps even up to a million (AAF, 2007). When seeds of *T. inodorum* where planted with varying crops, researchers found that the average seed production per plant varied widely depending on crop (1344 in wheat, 6986 in beans, 10,902 in linseed, 34,586 in no crop, and 303,948 in wild populations) (Lutman, 2002). Dense patches of *T. inodorum* may produce between 0.3 and 1.8 million seeds per square meter (Woo et al., 1991). About 70 to 94 percent of seeds produced are able to germinate (AAF, 2007). A single individual plant growing without competition can grow to cover an area slightly larger than one square meter (AAF, 2007).
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - negl	1	Seeds of *T. inodorum* disperse on variety of agricultural equipment, including grain bins that are manufactured or stored in infested areas (AAF, 2007; MAFF, 2002). Seeds may be carried in mud or soil attached to farming implements and in hay or straw (Kay, 1994). The plant also spreads in soil mixtures and manure (Ignatieva et al., 2011). In the United States, plants were first detected in ballast dumps near ports (Brown, 1878; Nelson, 1917).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - negl	2	*Tripleurospermum inodorum* spreads as a contaminant of crop seed and animal feed (Kay, 1994; MAFF, 2002; Nadtochii, 2009). A significant number of achenes have been detected in Saskatchewan in lentil, mustard, and wheat grain (Woo et al., 1991). U.S. inspectors have detected this species about two dozen times in seed and grain cargo (AQAS, 2018). The U.S. Association of Official Seed Analysts classifies this species as a weed in seed lots (AOSA, 2014).
ES-17 (Number of natural dispersal vectors)	3	2	Seed and propagule traits for questions ES-17a through ES-17e: Seeds are achenes that are 1.2-2.2 mm long (Kay, 1994). Flowering heads usually shatter at maturity or else break off of the plant (Woo et al., 1991).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-17a (Wind dispersal)	n - high		The small light seeds are reported to be dispersed by wind (AAF, 2007); however, we found no evidence that they possess any specialized structures to facilitate wind dispersal, such as a feathery pappus (e.g., Bojňanský and Fargašová, 2007; Brouillet, 1993). Woo et al. (1991) describe the pappus as short and truncate. Because it seems unlikely that seeds would be dispersed any appreciable distances by wind, we answered no with high uncertainty.
ES-17b (Water dispersal)	y - negl		Seeds remain buoyant in water for 12 hours (Ridley, 1930). "Seeds float readily on water so that first infestations are often around watercourses" (cited in MAFF, 2002). Seeds will float and germinate on the surface of water (AAF, 2007). Following significant disturbance to a river corridor in northern Italy, this species became very abundant (Crisanti and Taffetani, 2015).
ES-17c (Bird dispersal)	? - max		Unknown.
ES-17d (Animal external dispersal)	y - mod		Seeds may be carried in animal fur or in mud or soil attached to animal feet (Kay, 1994).
ES-17e (Animal internal dispersal)	y - low		*Tripleurospermum inodorum* seed is dispersed through animal digestion and subsequent excretion in manure (Woo et al., 1991). As much as 26 percent of seed fed to cattle remains viable in manure (AAF, 2007).
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - negl	1	Seeds do not have a dormancy period, but buried seed has been shown to remain viable in the soil for periods of six to seven (Nadtochii, 2009), 10 (Kay, 1994), and 15 years (AAF, 2007). When seeds were buried at various depths in the soil and retrieved 13 months later, 44 to 72 percent of seeds buried 2 cm deep or deeper germinated by the end of the study period (Jensen, 2009).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	y - low	1	If mowed, plants produce new flowers below the level of the cutting blades. "Mowing will be effective only if the stands are mowed early and often, with each successive mowing lower than the previous one" (MAFF, 2002). Plants are also resistant to trampling (Ignatieva et al., 2011).
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	y - negl	1	Several herbicides are used to control *T. inodorum*, though most are only effective against seedlings (McClay et al., 2002). All mayweeds, including *T. inodorum* are "rather resistant to chemical herbicides" (Salisbury, 1961). In addition, the species has high innate resistance to synthetic auxins, including 2,4-D and MCPA (Kay, 1994). The species is susceptible to some types of herbicides (Woo et al., 1991). Since 2002, there have been seven reported instances of *T. inodorum* populations in Europe developing resistance to ALS inhibitor herbicides (Heap, 2018).
ES-21 (Number of cold hardiness zones suitable for its survival)	9	0	

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-22 (Number of climate types suitable for its survival)	8	2	
ES-23 (Number of precipitation bands suitable for its survival)	10	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - mod	0	We found no evidence that this species is allelopathic.
Imp-G2 (Parasitic)	n - negl	0	We found no evidence that this species is parasitic. Because it is not a member of a plant family known to contain parasitic plants (Heide-Jorgensen, 2008; Nickrent, 2016), we answered no with negligible uncertainty.
Impacts to Natural Systems			
Imp-N1 (Changes ecosystem processes and parameters that affect other species)	n - mod	0	We found no evidence of this impact.
Imp-N2 (Changes habitat structure)	y - mod	0.2	It forms monocultures near ponds and streams and in other frequently flooded areas (cited in MAFF, 2002). In Alaska, it increases the density of the early successional herbaceous layer (Carlson et al., 2008). Because we were unable to verify these statements with the original sources of information, we assigned a moderate uncertainty value.
Imp-N3 (Changes species diversity)	y - low	0.2	It competes with native herbs (NIES, 2018). "Spring-emerged seedlings will form a very dense carpet in low-lying areas and limit [the] growth of seedlings of other species" (Woo et al., 1991). "The flowers attract bees and flies ... and may alter the pollination ecology of native communities" (Carlson et al., 2008).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species?)	? - max		Although this species is reported to form dense stands and exclude other species (see evidence under Imp-N2 and Imp-N3), we answered unknown because it is primarily a weed of disturbed sites and agricultural areas.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions?)	? - max		Unknown.
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	This species is primarily a weed of disturbed areas and agricultural land (Woo et al., 1991); however, because it has been reported as a weed of the natural environment in Australia (Randall, 2007), we answered "b" with high uncertainty. Alternate answers 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 impact.
Imp-A2 (Changes or limits recreational use of an area)	n - mod	0	We found no evidence of this impact.
Imp-A3 (Affects desirable and ornamental plants, and vegetation)	n - mod	0	We found no evidence of this impact.
Imp-A4 [What is the taxon's weed status in anthropogenic systems? (a)	b - low	0.1	The species is a common weed in urban and suburban areas in Europe (Kelcey and Norbert, 2011) and occurs

Question ID	Answer - Uncertainty	Score	Notes (and references)
Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]			in such areas as playgrounds and cemeteries (Ignatieva et al., 2011). It is a weed of man-made habitats and waste places (Kay, 1969). We found no evidence that it is being actively controlled in these kinds of systems. Alternate answers for the uncertainty simulation were both "c."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - negl	0.4	*Tripleurospermum inodorum* reduces yield in cultivated crops such as grain and seed, as well as in hayfields and pastures, and is unpalatable to livestock (MAFF, 2002; McClay et al., 2002). In Saskatchewan, a study found that both the summer and winter annual forms of *T. inodorum* could be highly competitive with spring wheat in experimental plots and fields, though this result was highly dependent upon environment. Yield losses in fields ranged from 0.9 to 11 percent per unit weed density (plants per square meter). Research with experimental plots indicated that *T. inodorum* was more competitive in cooler, wetter seasons (Douglas et al., 1991). Another study, done in winter wheat, found that annual *T. inodorum* was generally not very competitive with wheat in Canadian prairies, though significant reductions in yield were observed in some seasons (Douglas et al., 1992). In England, Wilson and Wright (1990) found that *T. inodorum* decreased winter wheat yields by 1.3 percent per unit weed density. Another study also found a significant effect on wheat yield (Welsh et al., 1999). Nadtochii (2009) determined that a density of one to five plants per square meter represents an economic threshold. In Denmark, *T. inodorum* was one of the more frequent weed species in maize and, along with the other weed species, significantly reduced yield (Ali et al., 2015).
Imp-P2 (Lowers commodity value)	? - max		We found no direct evidence that this species lowers commodity value. Because it is unpalatable to livestock and because nutrient analysis has shown that its feed value is poor (MAFF, 2002; Woo et al., 1991), it seems likely that it would lower the value of infested pastures and rangelands. Consequently, we answered unknown.
Imp-P3 (Is it likely to impact trade?)	y - mod	0.2	This species is regulated as a Class 3 and Class 5 noxious weed seed in Canada under the Seed Act (Government of Canada, 2016), which sets tolerances for certain weed seeds in imported seed. It is also regulated by Mexico (APHIS, 2018). We found ample evidence that this species is able to move in trade as a contaminant of seed and grain commodities, but also as a hitchhiker of conveyances (see evidence under E/S-16).
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	? - max		Yield studies have shown that this species has a greater impact on wheat yield during periods of ample moisture than during drought years, suggesting that it is more stressed by drought than winter wheat is (Woo et al.,

Question ID	Answer - Uncertainty	Score	Notes (and references)
			1991). "Consumption of water by the Scentless Mayweed is 2 times more than that of oat and 1.5 times more than that of spring wheat" (Nadtochii, 2009). Because this evidence does not clearly establish that wheat yield is affected by competition for moisture with T. *inodorum*, we answered unknown.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - mod	0	We found no evidence that this species is toxic to animals (e.g., Bruneton, 1999; Burrows and Tyrl, 2013).
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	*Tripleurospermum inodorum* is a weed of many crops but particularly cereals (Hanf, 1983; Kay, 1994; Nadtochii, 2009; Reiss et al., 2018). In Europe, it is considered one of the "worst and most abundant" weeds of arable land (Salisbury, 1961). It is also considered an agricultural weed in Australia (Randall, 2007). Control measures include autumn plowing, pre-seeding cultivation, cleaning of sowing material, inter-row treatments, crop rotation, and the application of herbicides, if necessary (Nadtochii, 2009). Several biological control agents have been released in Canada (MAFF, 2002; Winston et al., 2014). Several other sources provide additional information on control strategies (MAFF, 2002; McClay et al., 2002). In the past 10 years, several researchers have examined this species to determine how it responds to chemical treatments (de Mol et al., 2015; Sønderskov et al., 2012) or to support the development of decision-support tools for management (Ali et al., 2015; Berge et al., 2012). 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, 2018).
Plant hardiness zones			
Geo-Z1 (Zone 1)	n - high	N/A	One point in Russia near Zone 2.
Geo-Z2 (Zone 2)	y - mod	N/A	Some points in Canada and the United States (Alaska).
Geo-Z3 (Zone 3)	y - low	N/A	Some points in Canada.
Geo-Z4 (Zone 4)	y - negl	N/A	Norway and Sweden. Some points in Austria and Russia.
Geo-Z5 (Zone 5)	y - negl	N/A	Norway and Sweden. Some points in Austria and Estonia.
Geo-Z6 (Zone 6)	y - negl	N/A	Germany, Norway, and Sweden.
Geo-Z7 (Zone 7)	y - negl	N/A	France, Germany, Norway, and Sweden.
Geo-Z8 (Zone 8)	y - negl	N/A	France, Spain, and the United Kingdom.
Geo-Z9 (Zone 9)	y - negl	N/A	France, Spain, and the United Kingdom.
Geo-Z10 (Zone 10)	y - mod	N/A	Some points in the United Kingdom and coastal Ireland. Two points in New Zealand and one in Australia.
Geo-Z11 (Zone 11)	n - high	N/A	A few points in New Zealand and two in Spain, in coastal areas and adjacent to cooler Zones. We answered no because these may represent ephemeral populations.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-Z12 (Zone 12)	n - low	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z13 (Zone 13)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C2 (Tropical savanna)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C3 (Steppe)	y - high	N/A	A few points in Spain and the United States.
Geo-C4 (Desert)	n - mod	N/A	We found no evidence that it occurs in this climate class.
Geo-C5 (Mediterranean)	y - low	N/A	France and Spain. A few points each in Argentina, Greece, Italy, and the United States.
Geo-C6 (Humid subtropical)	n - high	N/A	Although we found evidence that this species occurs in a few places in this climate class (a few points in Australia and Italy, two in Croatia, and one in Greece), we answered no because these occurrences are rare and may represent transients and because the species has been reported to be intolerant of warmer summer temperatures and drought (Woo et al., 1991).
Geo-C7 (Marine west coast)	y - negl	N/A	France, Germany, New Zealand, and the United Kingdom.
Geo-C8 (Humid cont. warm sum.)	y - mod	N/A	One to two points each in Armenia, Russia, Slovakia, and the United States (Massachusetts).
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	Germany, Norway, Russia, and Sweden.
Geo-C10 (Subarctic)	y - negl	N/A	Finland, Norway, and Sweden.
Geo-C11 (Tundra)	y - low	N/A	France. A few points each in Austria, Spain, Canada, and Norway.
Geo-C12 (Icecap)	n - high	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 - high	N/A	One point in the United States (Nevada) near the next precipitation band. One point in Iran. It seems unlikely that this species is well-adapted to this amount of precipitation. These two points may represent either transients or plants occurring in protected microhabitats.
Geo-R2 (10-20 inches; 25-51 cm)	y - high	N/A	Some points in Canada and the United States (Alaska). A few points in the western United States. Three points in Argentina.
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	The species is well distributed in western Europe in areas receiving 20-70 inches of annual precipitation.
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	The species is well distributed in western Europe in areas receiving 20-70 inches of annual precipitation.
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	The species is well distributed in western Europe in areas receiving 20-70 inches of annual precipitation.
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	The species is well distributed in western Europe in areas receiving 20-70 inches of annual precipitation.
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	The species is well distributed in western Europe in areas receiving 20-70 inches of annual precipitation.
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	Norway. Some points in Austria and Germany.
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	Norway. A few points in Austria, one in Slovenia, and some in the United Kingdom.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-R10 (90-100 inches; 229-254 cm)	y - negl	N/A	Norway. A few points in Austria, two in Slovenia, and a few in the United Kingdom.
Geo-R11 (100+ inches; 254+ cm)	y - low	N/A	Norway.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	*Tripleurospermum inodorum* is naturalized in the United States and has been primarily reported in the western and northwestern states, including Washington, Oregon, Idaho, Montana, Wyoming, Utah, and Colorado (EDDMapS, 2018). Because this species is well established in the United States, we did not evaluate its entry potential.
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
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]	-	N/A	
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	-	N/A	This species is well distributed in Canada (Woo et al., 1991).
Ent-4b (Contaminant of plant propagative material (except seeds))	-	N/A	
Ent-4c (Contaminant of seeds for planting)	-	N/A	The tetraploid form of this species may have been introduced into Canada as a contaminant of crop seed (Woo et al., 1991).
Ent-4d (Contaminant of ballast water)	-	N/A	*Tripleurospermum inodorum* seed was likely carried to the United States in ship ballast, as it was found among plant communities inhabiting ballast dumping sites in New York harbor (Brown, 1878) and on the shores of the Willamette River in Linnton, OR (Nelson, 1917). It is believed to have been introduced into Canada via ship ballast (Woo et al., 1991)
Ent-4e (Contaminant of aquarium plants or other aquarium products)	-	N/A	
Ent-4f (Contaminant of landscape products)	-	N/A	
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	-	N/A	
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	-	N/A	
Ent-4i (Contaminant of some other pathway)	-	N/A	

Question ID	Answer - Uncertainty	Score	Notes (and references)
Ent-5 (Likely to enter through natural dispersal)	-	N/A	