United States Department of Agriculture

United States
Department of
Agriculture

Animal and Plant
Health Inspection
Service

August 16, 2016

Version 1

Weed Risk Assessment for *Rumex confertus* Willd. (Polygonaceae) – Russian dock

Left: *Rumex confertus* in Poland (Barbara Tokarska-Guzik, University of Silesia, Bugwood.org).
Right: *Rumex confertus* in Latvia (AfroBrazilian, Creative Commons).

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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 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, 2015). 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.

***Rumex confertus* Willd. – Russian dock**

Species Information

Family: Polygonaceae

Synonyms: None.

Common names: Russian dock (NGRP, 2014), Asiatic dock (NGRP, 2014), mossy sorrel (Piesik, 2006).

Botanical description: *Rumex confertus* is a perennial herb that grows to approximately 50 cm tall (Bojňanský and Fargašová, 2007; eFloras, 2011). It occurs mainly in riparian areas, meadows, and forests, and on roadsides and other anthropogenic areas (Misiewicz and Stosik, 2000; Raycheva, 2011; Wallentinus, 2002).

Initiation: PPQ received a market access request for corn kernels for human and animal consumption from the government of Ukraine (Government of Ukraine, 2013). An import risk analysis determined that seeds of *R. confertus* are likely to be associated with this commodity from Ukraine. In this WRA, we evaluated the weed risk potential of this species to the United States to help policy makers determine whether it should be regulated as a Federal Noxious Weed.

Foreign distribution and status: *Rumex confertus* is native to Russia, Kazakhstan, China, eastern Europe, Hungary, Slovakia, Romania, and possibly Italy (Kołodziejek and Patykowski, 2015). It is moving westward into central Europe (Jehlik et al., 2001; Misiewicz and Stosik, 2000; Raycheva, 2011) and has recently established in Finland (Kulju et al., 2015), Norway, Sweden (Wallentinus, 2002), Lithuania (Tokarska-Guzik, 2005), and Great Britain (Stace, 2010). It is introduced in Canada (Kartesz, 2014).

U.S. distribution and status: *Rumex confertus* occurs in Billings County, North Dakota (Kartesz, 2014). We found no evidence that it is being controlled or regulated in North Dakota. It does not appear to be of interest for cultivation in the United States (e.g., Dave's Garden, 2015; GardenWeb.com, 2015; University of Minnesota, 2015).

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

1. *Rumex confertus* analysis

Establishment/Spread Potential

Rumex confertus is a common weed in Asia and eastern Europe and is rapidly spreading westward into central Europe (Jehlik et al., 2001; Misiewicz and Stosik, 2000; Raycheva, 2011). It grows quickly, reproduces from rhizomes and seed, and produces large quantities of viable seed (Bojňanský and Fargašová, 2007; eFloras, 2011; Kołodziejek and Patykowski, 2015). Its seed is adapted for wind and water dispersal and exhibits a high rate of germination (Kołodziejek and Patykowski, 2015;

[1] "WRA area" is the area in relation to which the weed risk assessment is conducted (definition modified from that for "PRA area") (IPPC, 2012).

Raycheva, 2011; Tokarska-Guzik, 2005). *Rumex confertus* seed can germinate immediately as well as undergo secondary dormancy to form a persistent seed bank (Kołodziejek and Patykowski, 2015). In Europe, *R. confertus* frequently occurs in riparian zones as well as along roadsides and railways tracks (Kołodziejek and Patykowski, 2015; Tokarska-Guzik, 2005). It is thought to have been unintentionally introduced into one region via livestock fodder (Jehlik et al., 2001). We had a high level of uncertainty for this risk element due to a lack of information about the biology of this species.
Risk score = 18 Uncertainty index = 0.22

Impact Potential *Rumex confertus* is considered an aggressive invasive species that changes community species composition, decreases biological diversity, and reduces the quality of hay, pasture lands, and natural areas in Europe (Kołodziejek and Patykowski, 2015; Misiewicz and Stosik, 2000; Raycheva, 2011). It is a weed of grass seed crops in Belarus (AGRIS, 2015); however, we found little additional evidence about its impacts on agricultural systems. We had a high level of uncertainty for this risk element due to a lack of information about this species' impacts in Europe.
Risk score = 2.7 Uncertainty index = 0.21

Geographic Potential Based on three climatic variables, we estimate that about 75 percent of the United States is suitable for the establishment of *Rumex confertus* (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 for *Rumex confertus* represents the joint distribution of Plant Hardiness Zones 3-9, areas with 10-60 inches of annual precipitation, and the following Köppen-Geiger climate classes: steppe, humid subtropical, marine west coast, humid continental, subarctic, and tundra.

The area of the United States shown to be climatically suitable (Fig. 1) is likely overestimated since our analysis considered only three climatic variables. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish. *Rumex confertus* occurs in a variety of habitat types, including ruderal areas, roadsides, riparian zones, meadows, steppe, and forests (eFloras, 2011; Kulju et al., 2015; Misiewicz and Stosik, 2000; Raycheva, 2011; Wallentinus, 2002), and is consequently widespread in its known range (Raycheva, 2011).

Entry Potential We did not assess the entry potential of *Rumex confertus* because it is already present in the United States in one county in North Dakota (Kartesz, 2014).

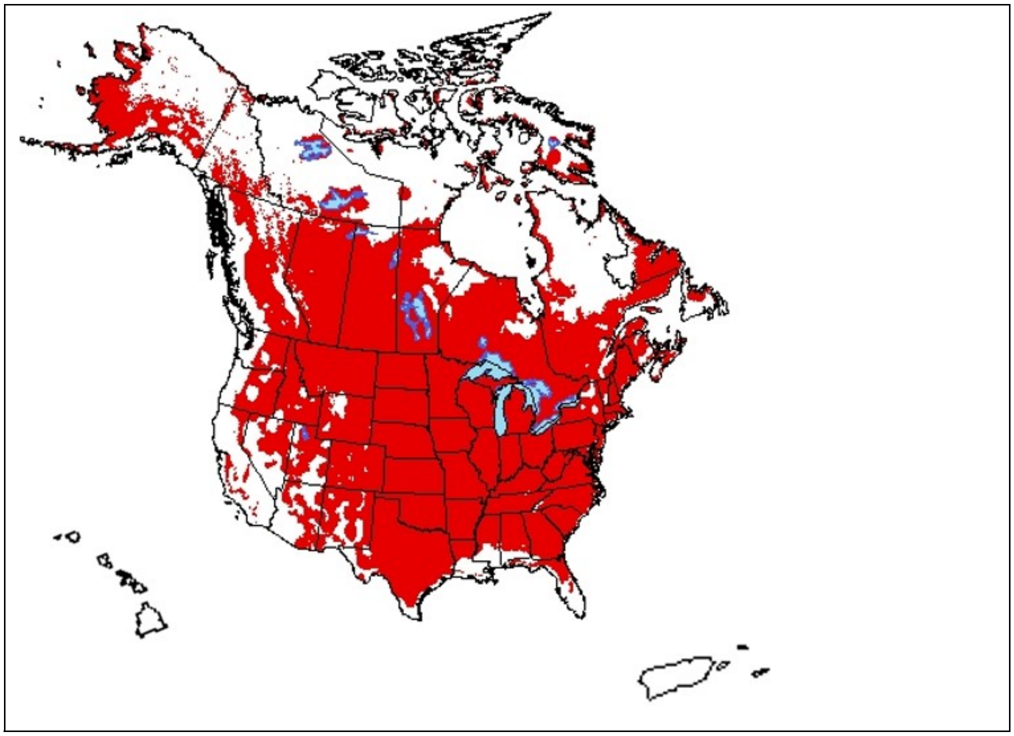

Figure 1. Potential geographic distribution of *Rumex confertus* in the United States and Canada. Map insets for Hawaii and Puerto Rico are not to scale.

2. Results

Model Probabilities: P(Major Invader) = 85.0%
P(Minor Invader) = 14.5%
P(Non-Invader) = 0.5%

Risk Result = High Risk

Secondary Screening = Not applicable

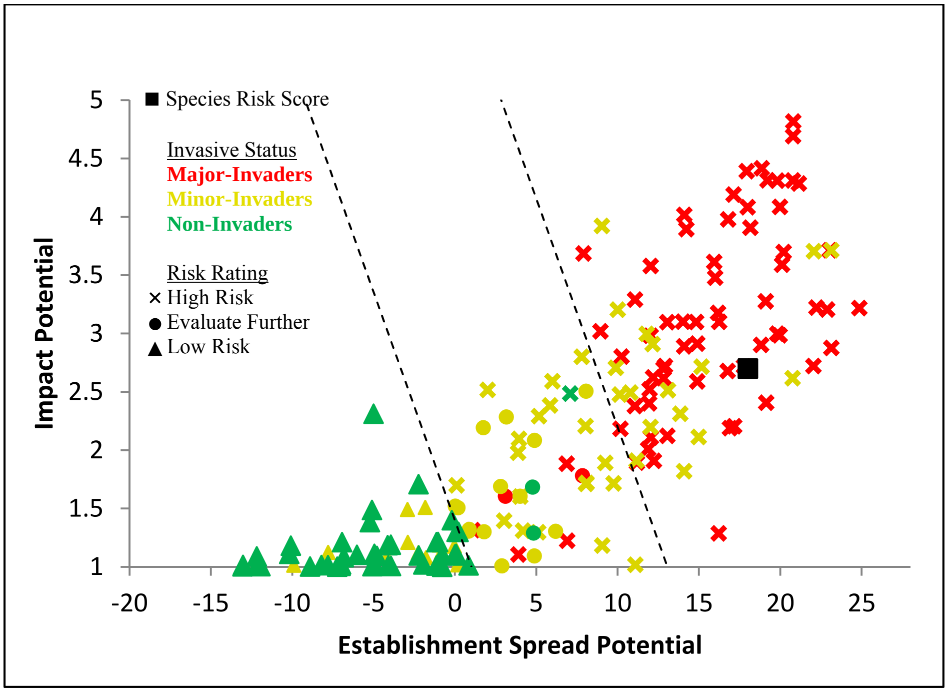

Figure 2. *Rumex confertus* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

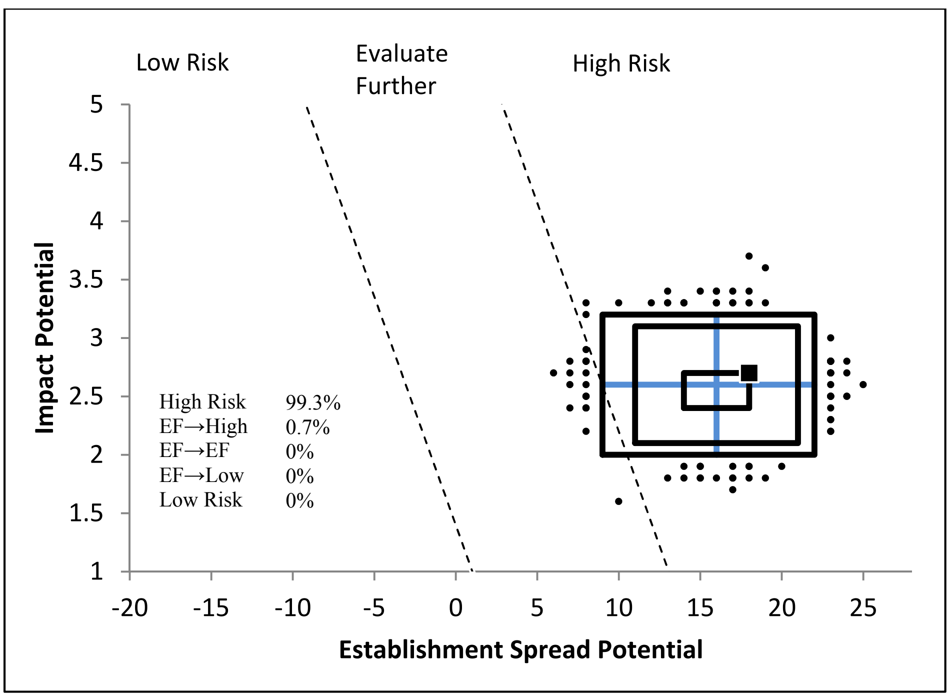

Figure 3. Model simulation results (N=5,000) for uncertainty around the risk score for *Rumex confertus*. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The result of the weed risk assessment for *Rumex confertus* was High Risk. When compared with species used to validate the WRA model, *R. confertus* ranked among other High Risk weeds (Fig. 2), and this categorization is well supported by the uncertainty analysis (Fig. 3). *Rumex confertus* is a common, widespread weed in Europe (Raycheva, 2011). It produces up to 30,000 seeds per plant (Raycheva, 2011), and its fecundity and dispersal abilities contribute to its rapid spread (Kołodziejek and Patykowski, 2015). It is known to hybridize with other *Rumex* species (Kulju et al., 2015; Valta, 1975), the progeny of which may be more competitive than either parent species (Hujerová et al., 2013). Despite its ubiquity, the biology of this species is not well known. *Rumex confertus* is difficult to control because it is rhizomatous and is able to resprout after chemical and physical management, and it can form a persistent seed bank (Kołodziejek and Patykowski, 2015; Piesik, 2006).

The genus *Rumex* contains several species that are significant weeds in the United States. For example, *Rumex acetosella*, *R. conglomeratus*, *R. crispus*, and *R. obtusifolius* are weeds of turf, pasture, and ruderal areas (Lorenzi and Jeffery, 1987; Royer and Dickinson., 1999). Mature plants of these species develop large taproots that must be manually removed below the soil surface for effective control (Lorenzi and Jeffery, 1987). *Rumex acetosella* is also an agricultural and nursery weed that produces abundant seed and spreads vegetatively (Holm et al., 1979). *Rumex crispus* seed has been shown to remain viable in soil for 80 years in dry conditions (Burnside et al., 1996). Toxicity of the genus *Rumex* varies, but *R. crispus* vegetation and seed is toxic to poultry (Royer and Dickinson., 1999) and has caused documented mortalities of sheep (Stubbendieck et al., 2003). *Rumex acetosella* can cause hay fever and contact dermatitis in humans, and it is thought to be toxic to sheep (Stubbendieck et al., 2003). The plants and seed of *Rumex* spp., *R. acetosella*, *R. crispus*, *R. obtusifolius*, and others are restricted or prohibited in several states (NRCS, 2014; USDA-AMS, 2014). *Rumex confertus* exhibits many of the same traits as these known invasive species and may become a problematic weed if introduced into the United States.

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Appendix A. Weed risk assessment for *Rumex confertus* Willd. (Polygonaceae). 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	*Rumex confertus* is native to Russia, Kazakhstan, China, eastern Europe, Hungary, Slovakia, Romania, and possibly Italy (Kołodziejek and Patykowski, 2015). It is rapidly moving westward into central Europe (Jehlik et al., 2001; Misiewicz and Stosik, 2000; Raycheva, 2011) and has recently established in Finland (Kulju et al., 2015), Norway, Sweden (Wallentinus, 2002), Lithuania (Tokarska-Guzik, 2005), and Great Britain (Stace, 2010). It is introduced in Canada and North Dakota (Kartesz, 2014). Alternate choices for the uncertainty simulation were both "e."
ES-2 (Is the species highly domesticated)	n - low	0	We found no evidence that *R. confertus* is domesticated.
ES-3 (Weedy congeners)	y - negl	1	*Rumex* is a genus with about 200 species (Mabberley, 2008). Dozens of these species have been identified as weeds by the Global Compendium of Weeds (Randall, 2012). Of these, six species emerge as relatively weedy based on the numerous supporting references for each: *Rumex acetosa*, *R. acetosella*, *R. conglomeratus*, *R. crispus*, *R. obtusifolius*, and *R. pulcher* (Randall, 2012). For example, *R. crispus* is a European plant that has become a troublesome agricultural weed in the United States and Canada (Royer and Dickinson., 1999). *Rumex acetosella* is a common introduced weed throughout the United States and Canada and a listed noxious weed in several states (NRCS, 2014; Weber, 2003).
ES-4 (Shade tolerant at some stage of its life cycle)	n - negl	0	*Rumex confertus* is shade intolerant (Weber, 2003). Seeds require light to germinate, and they germinate in vegetation gaps or disturbed areas (Kołodziejek and Patykowski, 2015).
ES-5 (Plant a vine or scrambling plant, or forms tightly appressed basal rosettes)	n - mod	0	*Rumex confertus* grows from a basal rosette with erect stems that are not tightly appressed (eFloras, 2011; Kulju et al., 2015). However, large plants producing numerous large basal leaves may have a similar shading effect on adjacent vegetation (see photos in Raycheva, 2011).
ES-6 (Forms dense thickets, patches, or populations)	y - high	2	*Rumex confertus* forms clumps of rosettes (Raycheva, 2011). "Forms large stands… rosettes may cover large areas within a short time and shade out native species" (Weber, 2003). We used high uncertainty because most sources we found

Question ID	Answer - Uncertainty	Score	Notes (and references)
			do not mention this, and the ability of *R. confertus* to form dense patches may be highly dependent on location and competition.
ES-7 (Aquatic)	n - negl	0	*Rumex confertus* is not an obligate aquatic plant. It is found in grasslands, forests, rock outcrops, riparian zones, and ruderal areas (eFloras, 2011; Kulju et al., 2015; Raycheva, 2011; Weber, 2003).
ES-8 (Grass)	n - negl	0	*Rumex confertus* is not a grass; it is a member of the Polygonaceae (eFloras, 2011).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	*Rumex confertus* is an herbaceous plant in the Polygonaceae, a family not known to contain nitrogen-fixing species (eFloras, 2011).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	*Rumex confertus* has been well-documented to produce viable seeds naturally and in laboratory settings (Jehlik et al., 2001; Kołodziejek and Patykowski, 2015; Piesik, 2006).
ES-11 (Self-compatible or apomictic)	? - max	0	Unknown.
ES-12 (Requires specialist pollinators)	n - high	0	We found no information about the pollination biology of *R. confertus*; however, many members of *Rumex* are wind pollinated (Ainsworth, 1999; Weber, 2001).
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]	c - high	0	We found no specific information regarding generation time. *Rumex confertus* seed can germinate immediately after dispersal (Kołodziejek and Patykowski, 2015). It exhibits clonal growth, and vegetative reproduction may be its main means of spread (Raycheva, 2011; Stosik, 2006). Alternate choices for the uncertainty simulation were both "b."
ES-14 (Prolific seed producer)	y - negl	1	*Rumex confertus* produces an average of 30,000 seeds per plant in Poland (Piesik, 2006). Germination rates of up to 80% have been observed (Jehlik et al., 2001; Kołodziejek and Patykowski, 2015).
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - mod	1	*Rumex confertus* frequently occurs along roadsides and railway tracks in Europe, and anthropogenic factors are thought to contribute to its spread (Kołodziejek and Patykowski, 2015; Tokarska-Guzik, 2005).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - mod	2	*Rumex confertus* is thought to have been introduced into one area of the Czech Republic via horse fodder (Jehlik et al., 2001), and it is a weed of grass seed crops in Belarus (AGRIS, 2015). Seeds of *Rumex* spp. have been intercepted hundreds of times as contaminants of seed imported for planting and consumption (AQAS, 2016). Thus, we think it is likely that *R. confertus* could be dispersed in trade as a contaminant.
ES-17 (Number of natural dispersal vectors)	3	2	Fruit and seed traits relevant for ES-17a through ES-17e: Seed is an achene, approximately 2.5 x 2.5 mm. The genus *Rumex* forms tepals that are persistent and form membranous wings that assist in fruit dispersal (eFloras, 2011; Zomlefer, 1994).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-17a (Wind dispersal)	y - negl		Seeds are adapted to wind dispersal; they form membranous wings that assist in wind dispersal (eFloras, 2011; Kołodziejek and Patykowski, 2015; Raycheva, 2011; Zomlefer, 1994).
ES-17b (Water dispersal)	y - mod		Seeds are dispersed by water. We found no specific information on seed morphology that contributes to water dispersal, but the species is frequently found along waterways (Kołodziejek and Patykowski, 2015; Tokarska-Guzik, 2005).
ES-17c (Bird dispersal)	n - mod		We found no evidence that *R. confertus* is bird dispersed.
ES-17d (Animal external dispersal)	y - high		Seeds are dispersed externally on animals (Tokarska-Guzik, 2005). We used high uncertainty because we only found one source stating this and no mention of how this might occur.
ES-17e (Animal internal dispersal)	n - low		We found no evidence that *R. confertus* seeds are eaten by animals.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - low	1	*Rumex confertus* seeds are able to germinate immediately in light conditions, and those that are buried in soil undergo secondary dormancy and can form a persistent seed bank “for many years” (Kołodziejek and Patykowski, 2015). One source states that the seeds "exhibit an ability to sprout over a long period of time" (Raycheva, 2011).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	? - max	-1	We found no information regarding *R. confertus*’ tolerance to mutilation, cultivation, or fire.
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - high	0	We found no evidence of herbicide resistance in *R. confertus*. The congener *Rumex dentatus* exhibits resistance to acetolactate synthase (ALS) inhibitors in India (Heap, 2013); however, we answered no with high uncertainty because that is the only member of this well-known genus of weedy species in which herbicide resistance has been observed.
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)	? - max		We found no information regarding allelopathy of *R. confertus*. However, other members of *Rumex* exhibit allelopathy; for example, *R. crispus* appears to be allelopathic, based on natural vegetation patterns and field experiments (Einhellig and Rasmussen, 1973), and decomposing leaves of *R. obtusifolius* are allelopathic against meadow grasses (Carral et al., 1988).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-G2 (Parasitic)	n - negl	0	We found no evidence that *R. confertus* is parasitic. It does not belong to a family known to contain parasitic plants (Heide-Jorgensen, 2008; Nickrent, 2009).
Impacts to Natural Systems			
Imp-N1 (Changes ecosystem processes and parameters that affect other species)	n - low	0	We found no evidence that *R. confertus* changes ecosystem processes.
Imp-N2 (Changes habitat structure)	n - low	0	We found no evidence that *R. confertus* changes habitat structure.
Imp-N3 (Changes species diversity)	y - mod	0.2	*Rumex confertus* has been observed to reduce species diversity in invaded areas in Europe. Its "massive growth has affected the character of phytocoenosis [i.e., plant communities]… the alternation has resulted even in the creation of wasteland" (Misiewicz and Stosik, 2000). It alters plant communities and results in a decrease in biological diversity (Raycheva, 2011).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species?)	y - high	0.1	*Rumex confertus* mainly invades ruderal areas and semi-natural habitats, but it is also known to invade meadows, steppe, and grasslands and may locally impact threatened or endangered prairie species (Kołodziejek and Patykowski, 2015; Raycheva, 2011; Tokarska-Guzik, 2005).
Imp-N5 (Is it likely to affect any globally outstanding ecoregions?)	n - mod	0	It is unlikely that *R. confertus* would be a significant threat to any globally outstanding ecoregions of the United States.
Imp-N6 [What is the taxon's weed status in natural systems? (a) Taxon not a weed; (b) taxon a weed but no evidence of control; (c) taxon a weed and evidence of control efforts]	c - low	0.6	*Rumex confertus* is rapidly increasing its range in meadow-steppes, glades, riverbanks, forests, and floodplains in Europe, and studies have been conducted on the effectiveness of herbicides and biological control agents (Jehlik et al., 2001; Kołodziejek and Patykowski, 2015; Piesik, 2006; Piesik and Wenda-Piesik, 2005). Alternate choices for the uncertainty simulation were both "b."
Impact to Anthropogenic Systems (e.g., cities, suburbs, roadways)			
Imp-A1 (Negatively impacts personal property, human safety, or public infrastructure)	n - low	0	We found no evidence that *R. confertus* has any of these impacts.
Imp-A2 (Changes or limits recreational use of an area)	n - low	0	We found no evidence that *R. confertus* negatively impacts recreational use of any areas. It grows to 50 cm in height and does not appear to impede the use of any areas.
Imp-A3 (Affects desirable and ornamental plants, and vegetation)	n - low	0	We found no evidence that *R. confertus* negatively impacts plants in anthropogenic areas. It is most frequently found in waste places, meadows, riparian areas, and along road and railways (Kołodziejek and Patykowski, 2015; Raycheva, 2011; Tokarska-Guzik, 2005).
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	b - mod	0.1	*Rumex confertus* is a weed of roadsides, railways, and homesites in Europe (Jehlik et al., 2001; Kołodziejek and Patykowski, 2015; Tokarska-Guzik, 2005. However, we found no indication

Question ID	Answer - Uncertainty	Score	Notes (and references)
control; (c) Taxon a weed and evidence of control efforts]			that it is specifically targeted for control in these areas, so we answered "b" and used moderate uncertainty. Alternate choices for the uncertainty simulation were "a" and "c."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	n - mod	0	We found no evidence that *R. confertus* reduces commodity yield.
Imp-P2 (Lowers commodity value)	y - low	0.2	*Rumex confertus* decreases the quality of grazing land and hay (Misiewicz and Stosik, 2000; Raycheva, 2011).
Imp-P3 (Is it likely to impact trade?)	y - high	0	*Rumex confertus* is a weed of pasture lands and hay (Misiewicz and Stosik, 2000; Raycheva, 2011) and is said to be a weed of grass seed crops in Belarus (AGRIS, 2015). However, we found no indication that it does or can impact trade. We answered yes with high uncertainty because all members of *Rumex* are regulated in several states (NRCS, 2014; USDA-AMS, 2014).
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - low	0	We found no evidence that *R. confertus* reduces water quality or availability.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	y - high	0	Members of *Rumex* contain oxalic, acid but many are eaten (Weidema, 2000). We found no evidence that *R. confertus* is toxic, but other members of the genus are known to be. *Rumex crispus* vegetation and seed is toxic to sheep and poultry (Royer and Dickinson., 1999; Stubbendieck et al., 2003). *Rumex acetosella* can cause contact dermatitis in humans and is thought to be toxic to sheep (Stubbendieck et al., 2003).
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]	b - high	0.2	*Rumex confertus* is a weed of pasture lands and hay (Misiewicz and Stosik, 2000; Raycheva, 2011). It is a weed of grass seed crops in Belarus, but the source does not indicate whether *R. confertus* impacts the crop (AGRIS, 2015). We found no evidence that it is being controlled in production systems. We used high uncertainty because two biological and chemical control studies may indicate interest in its control in production areas (Piesik, 2006; Piesik and Wenda-Piesik, 2005). Alternate choices for the uncertainty simulation were "c" and "a."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically referenced points obtained from the Global Biodiversity Information Facility (GBIF, 2015).
Plant hardiness zones			
Geo-Z1 (Zone 1)	n - low	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z2 (Zone 2)	n - mod	N/A	Reported for Xinjiang, China (eFloras, 2011), but this zone only makes up a small percentage of the

Question ID	Answer - Uncertainty	Score	Notes (and references)
			total area in this province. Consequently, we answered no.
Geo-Z3 (Zone 3)	y - high	N/A	One point in Russia. Reported for Alberta and Manitoba, Canada (Kartesz, 2014), and Zone 3 makes up a large portion of these provinces.
Geo-Z4 (Zone 4)	y - low	N/A	Several points in Russia. Four points in Norway. One county in the United States (eastern North Dakota) (Kartesz, 2014).
Geo-Z5 (Zone 5)	y - negl	N/A	Three points in Norway and one point each in Estonia and Russia.
Geo-Z6 (Zone 6)	y - negl	N/A	One point each in Estonia and Poland.
Geo-Z7 (Zone 7)	y - negl	N/A	One to a few points each in Austria, Estonia, Finland, Germany, Norway, and Poland.
Geo-Z8 (Zone 8)	y - high	N/A	One point each in Sweden and the United Kingdom.
Geo-Z9 (Zone 9)	y - high	N/A	A few points in the United Kingdom.
Geo-Z10 (Zone 10)	n - mod	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z11 (Zone 11)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z12 (Zone 12)	n - negl	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 - low	N/A	One county in the United States (North Dakota) (Kartesz, 2014). This species is reported to occur in Kazakhstan and Xinjiang, China (eFloras, 2011), which include this climate class. It occurs in meadow-steppe and forest-steppe in eastern Europe and Asia (Kołodziejek and Patykowski, 2015).
Geo-C4 (Desert)	n - high	N/A	The species is reported to occur in Kazakhstan and Xinjiang, China (eFloras, 2011), which include deserts. However, we answered no because this species does not seem adapted to live in desert environments and is often reported to occur in moist environments (Jehlik et al., 2001; Kołodziejek and Patykowski, 2015; Raycheva, 2011).
Geo-C5 (Mediterranean)	n - mod	N/A	We found no evidence that it occurs in this climate class.
Geo-C6 (Humid subtropical)	y - high	N/A	Reported to occur in northeastern Bulgaria (Raycheva, 2011), which includes this climate class.
Geo-C7 (Marine west coast)	y - high	N/A	A few points in the United Kingdom.
Geo-C8 (Humid cont. warm sum.)	y - high	N/A	Reported to occur in Kazakhstan, Slovakia, and Ukraine, which include this climate class. It also

Question ID	Answer - Uncertainty	Score	Notes (and references)
			occurs in warmer and colder climate classes. Consequently, we answered yes.
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	A few points each in Austria, Estonia, Germany, Poland, and Russia. Reported to occur in the United States in one county in North Dakota that is dominated by this climate class (Kartesz, 2014).
Geo-C10 (Subarctic)	y - low	N/A	Some points in Norway and Russia.
Geo-C11 (Tundra)	y - high	N/A	Reported to occur in Austria, Romania (Bojňanský and Fargašová, 2007), and Slovakia (Bojňanský and Fargašová, 2007), which include this climate class.
Geo-C12 (Icecap)	n - mod	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	Reported to occur in Xinjiang, China (eFloras, 2011), which is dominated by this precipitation band, but it seems unlikely that this species occurs in such dry areas. This province of China includes some mountainous regions where precipitation is higher, and it seems likely that this species occurs only in these areas.
Geo-R2 (10-20 inches; 25-51 cm)	y - high	N/A	One county in North Dakota, United States (Kartesz, 2014). Reported to occur in Kazakhstan, which includes this precipitation band.
Geo-R3 (20-30 inches; 51-76 cm)	y - mod	N/A	Some points in Norway and Russia and a few in Austria.
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	A few points each in Estonia, Russia, and the United Kingdom.
Geo-R5 (40-50 inches; 102-127 cm)	y - high	N/A	We found no georeferenced points for this precipitation band. However, because this species occurs in a broad region of eastern Europe (Bojňanský and Fargašová, 2007; GBIF, 2015) that includes this band, we answered yes.
Geo-R6 (50-60 inches; 127-152 cm)	y - high	N/A	We found no georeferenced points for this precipitation band. However, because this species occurs in a broad region of eastern Europe (Bojňanský and Fargašová, 2007; GBIF, 2015) that includes this band, we answered yes.
Geo-R7 (60-70 inches; 152-178 cm)	n - high	N/A	We found no georeferenced points for this precipitation band. Although this species occurs in a broad region of eastern Europe (Bojňanský and Fargašová, 2007; GBIF, 2015) that includes small isolated pockets of this precipitation band, we answered no because these areas represent a very small portion of eastern Europe.
Geo-R8 (70-80 inches; 178-203 cm)	n - high	N/A	We found no georeferenced points for this precipitation band. Although this species occurs in a broad region of eastern Europe (Bojňanský and Fargašová, 2007; GBIF, 2015) that includes small isolated pockets of this precipitation band, we answered no because these areas represent a very small portion of eastern Europe.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-R9 (80-90 inches; 203-229 cm)	n - high	N/A	One point in Norway. All georeferenced points for this species include 10-40 inch precipitation bands (see evidence above), so it seems odd that we would find this one point so far outside of this range. Without additional evidence, we answered no with high uncertainty.
Geo-R10 (90-100 inches; 229-254 cm)	n - mod	N/A	We found no evidence that this species occurs in this precipitation band.
Geo-R11 (100+ inches; 254+ cm)	n - mod	N/A	We found no evidence that this species occurs in this precipitation band.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - low	1	*Rumex confertus* is known to occur in North Dakota (eFloras, 2011), although its status and behavior there are unknown.
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	-	N/A	
Ent-4b (Contaminant of plant propagative material (except seeds))	-	N/A	
Ent-4c (Contaminant of seeds for planting)	-	N/A	
Ent-4d (Contaminant of ballast water)	-	N/A	
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	
Ent-5 (Likely to enter through natural dispersal)	-	N/A	