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Weed Risk Assessment for *Diplotaxis viminea* (L.) DC. (Brassicaceae) – Vineyard wall rocket

Top left: Drawing of *Diplotaxis viminea* (source: Sturm, 1796). Top right: Small, dense patch (source: Rignanese, 2016). Bottom left: Plant habit (source: Rignanese, 2016). Bottom right: Herbarium specimen at the Missouri Botanical Garden, image licensed under CC BY-NC-SA 3.0 (MBG, 2016).

Agency Contact:

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

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

Introduction Plant Protection and Quarantine (PPQ) regulates noxious weeds under the authority of the Plant Protection Act (7 U.S.C. § 7701-7786, 2000) and the Federal Seed Act (7 U.S.C. § 1581-1610, 1939). A noxious weed is 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.

Diplotaxis viminea **(L.) DC. – Vineyard wall rocket**

Species Information

Family: Brassicaceae

Synonyms: *Sisymbrium vimineum* L. (NGRP, 2016), *Brassica brevicaulis* (Wibel) Bubani, *B. prolongi* (Boiss.) Boiss., *B. viminea* (L.) Boiss., *Crucifera viminea* E.H.L. Krause, and *Eruca viminea* (L.) Mill. (The Plant List, 2016). Additional synonyms are available at The Plant List (2016).

Common names: Vineyard wall rocket (NGRP, 2016).

Botanical description: *Diplotaxis viminea* is a slender annual plant that grows to 10-30 cm high. It forms a basal rosette of leaves and flowering stems with or without leaves (Bojňanský and Fargašová, 2007). It blooms June through October in western Europe (Hanf, 1983), but may have an extended flowering period of up to eight months elsewhere in its range (Picó et al., 2002).

Initiation: PPQ received a market access request for wheat seed for planting from the government of Italy (MPAAF, 2010). A commodity import risk analysis determined that *D. viminea* could be associated with this commodity as a seed contaminant. In this assessment, the PERAL Weed Team evaluated the 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: *Diplotaxis viminea* is native to northern Africa (Algeria, Egypt, Morocco, and Tunisia), Western Asia (Cyprus, Israel, Jordan, Lebanon, Syria, Turkey), and Europe (Bulgaria, Crete, Croatia, France, Greece, Italy, Portugal, Romania, Sardinia, Sicily, Slovenia, Spain, Ukraine, and the region formerly known as Yugoslavia) (Bojňanský and Fargašová, 2007; NGRP, 2016; Ugrinović and Škof, 2011; Warwick, 1995; Yaniv, 1995). However, for Ukraine and Romania, this species may actually be a naturalized exotic that was introduced before 1500 A.D. (i.e., an archaeophyte; DAISIE, 2016). *Diplotaxis viminea* is exotic in Austria, Germany, the Netherlands, and the Azores (Euro+Med, 2006+; Warwick, 1995). It has been reported as naturalized in New Zealand (Allan, 1935; Garnock-Jones, 1979), but we could not verify these older records with the New Zealand Plants database (Landcare Research, 2016). It was once included in the adventive flora of Belgium, but closer examination of plant material revealed that it was confused with *D. muralis* (L.) DC. (Verloove and Lambinon, 2008). Plants that were possibly *D. viminea* were collected from Point Lonsdale, Victoria, Australia, in 1949, but have not been seen since (Messina, 2015). *Diplotaxis viminea* was reported as a casual in the United Kingdom at one point (Mott et al., 1886), but is currently not known to be part of the flora (Stace, 2010).

U.S. distribution and status: We found no evidence that this species is naturalized (e.g., EDDMapS, 2016; Kartesz, 2016; NGRP, 2016; NRCS, 2016) or cultivated in the United States (e.g., Bailey and Bailey, 1976; Brenzel, 1995; Dave's Garden, 2016; Page and Olds, 2001; Univ. of Minn., 2016). One researcher reports that it is present in the United States, but taxonomists with the Flora of North America examined that material and determined it to be the species *D. muralis*, which is an allopolyploid hybrid of *D. viminea* and *D. tenuifolia* (Martínez-Laborde, NoDate).

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

1. *Diplotaxis viminea* analysis

Establishment/Spread Potential *Diplotaxis viminea* is an herbaceous annual that is self-fertile (Takahata et al., 2008), reproduces through seed production (Pignone and Martínez-Laborde, 2011), and is dispersed by gravity (Alday et al., 2011). As an agricultural weed, it may also be dispersed as a contaminant of trade and through other human activity, but we found no evidence of this. We did not find any strong evidence that *D. viminea* is naturalized outside of Eurasia, although it may be naturalized in some portions of Europe. Overall, we had very high uncertainty for this risk element (see discussion).
Risk score = 1 Uncertainty index = 0.37

Impact Potential *Diplotaxis viminea* is classified as an agricultural and ruderal weed by several workers in Europe (Abbate et al., 2013; Brullo et al., 2007; Hanf, 1983; Warwick, 1995). However, we found no specific evidence of impacts, suggesting that it is probably only a minor weed. We had very high uncertainty for this risk element.
Risk score = 1.3 Uncertainty index = 0.33

Geographic Potential Based on three climatic variables, we estimate that about 61 percent of the United States is suitable for the establishment of *D. viminea* (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 *D. viminea* represents the joint distribution of Plant Hardiness Zones 6-11, areas with 0-70 inches of annual precipitation, and the following Köppen-Geiger climate classes: steppe, desert, Mediterranean, humid subtropical, marine west coast, humid continental warm summers, humid continental cool summers, and subarctic. Our analysis of this species' potential U.S. distribution required several assumptions about the suitability of several of these climate variables based on the species' general distribution through the Balkan peninsula in Europe (see the Geo Potential risk element in Appendix A).

[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).

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. *Diplotaxis viminea* occurs in a variety of open and disturbed habitats such as plains, hills, rubble piles, roadsides, waste places, fields, crops, gardens, and vineyards, and prefers sandy, chalky, often damp, nutrient-rich soils (Hand, 2004; Hanf, 1983; Warwick, 1995; Yaniv, 1995).

Entry Potential Our analysis suggests this species has a low likelihood of entering the United States. On a scale of 0 to 1, where 1 indicates a maximum likelihood of entry, *D. viminea* obtained an entry risk score of 0.09. The most likely pathway for entry is intentionally for propagation. Although this species is not known to be cultivated as an ornamental or a minor crop, because it is closely related to arugula and because other species of *Diplotaxis* are cultivated and harvested from the wild as leafy vegetables, *D. viminea* may eventually be imported for propagation or for breeding with closely related species (see the Entry Potential risk element in Appendix A). It may also be able to enter as a contaminant of birdseed or wool, as *D. muralis* has done (Clement and Foster, 1994; Hanson and Mason, 1985). *Diplotaxis viminea* is easily confused with *D. muralis* (Verloove and Lambinon, 2008), and it is possible that *D. viminea* may be mistakenly imported into the United States.
Risk score = 0.09 Uncertainty index = 0.31

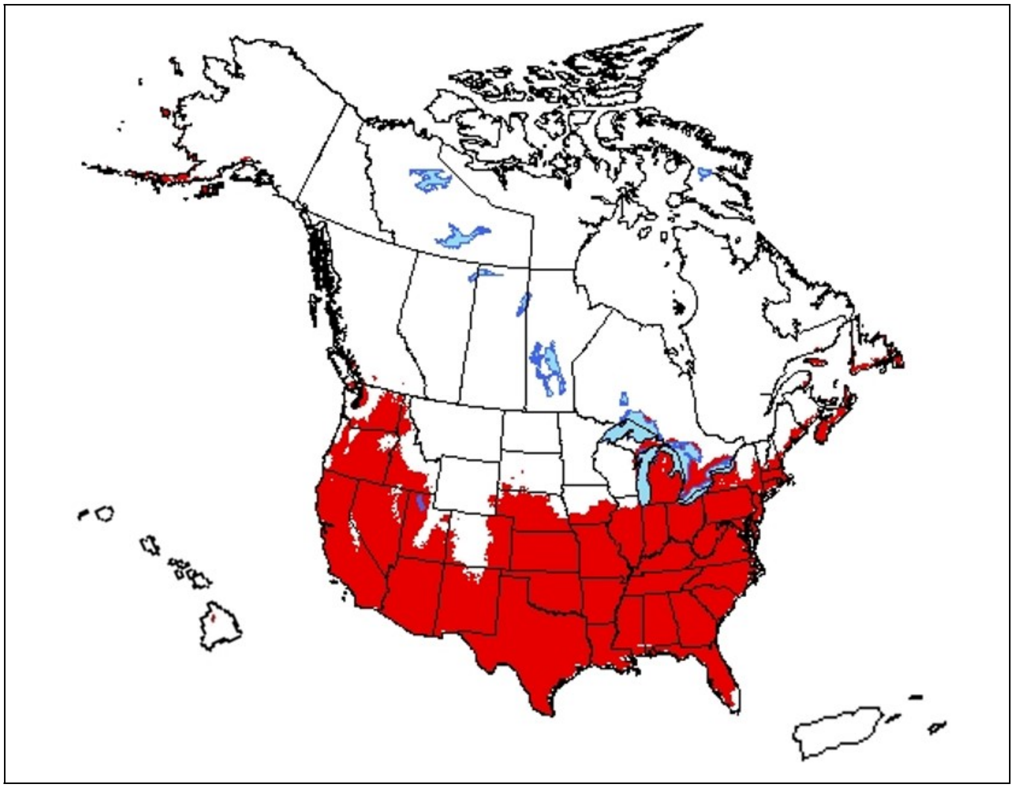

Figure 1. Potential geographic distribution of *Diplotaxis viminea* in the United States and Canada. Map insets for Hawaii and Puerto Rico are not to scale.

2. Results

Model Probabilities: P(Major Invader) = 4.2%
P(Minor Invader) = 55.2%
P(Non-Invader) = 40.6%

Risk Result = Evaluate Further
Secondary Screening = Evaluate Further

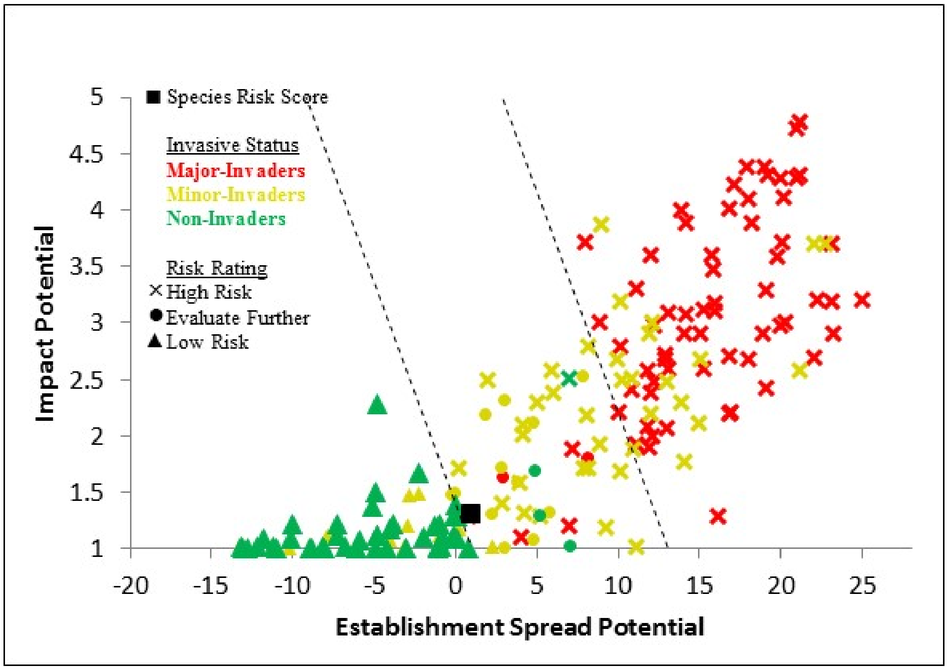

Figure 2. *Diplotaxis viminea* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

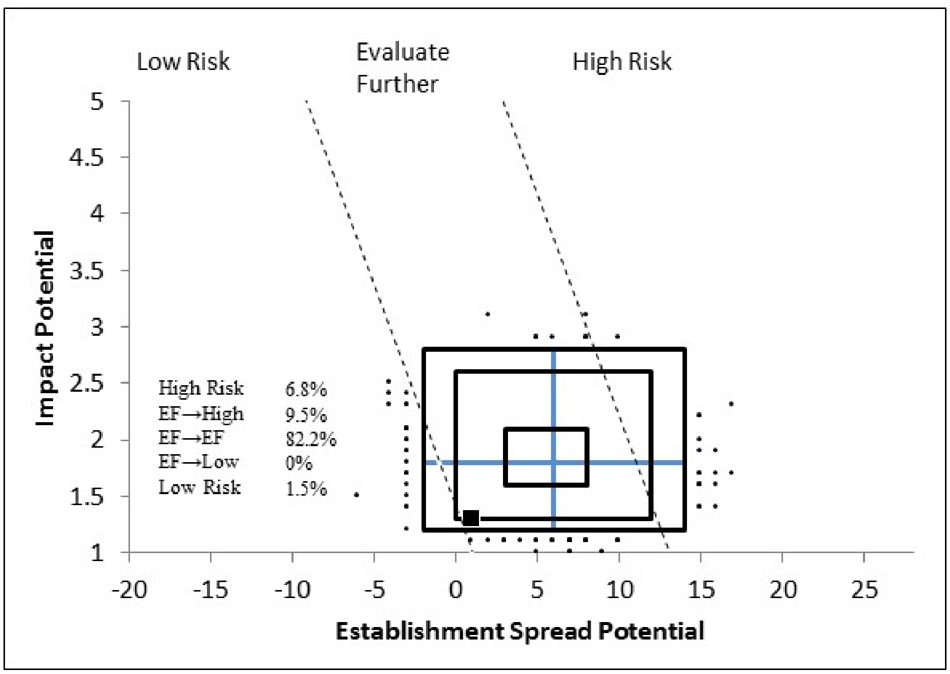

Figure 3. Model simulation results (N=5,000) for uncertainty around the risk score for *D. viminea*. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The result of the weed risk assessment for *Diplotaxis viminea* is Evaluate Further, indicating it had an overall moderate risk score (Fig. 2). While the observed risk score is located near the threshold that separates the low risk and evaluate further (i.e., moderate risk) regions, our uncertainty analysis indicates that additional evidence may move the risk score away from this threshold (Fig. 3). Overall, we had a very high level of uncertainty with this assessment because there is very little biological information about this species' ability to establish, reproduce, spread, and cause harm. Like many other minor weeds, we found evidence it is considered a weed, but little additional information.

Diplotaxis muralis (2n=42) is an allopolyploid hybrid between *D. viminea* (2n=20) and *D. tenuifolia* (2n=22) (Eschmann-Grupe et al., 2003; Pradhan et al., 1992), with *D. viminea* as the female parent (Eschmann-Grupe et al., 2003; Warwick et al., 1992). *Diplotaxis muralis* and *D. tenuifolia* are naturalized in the United States, with widely scattered populations (Kartesz, 2016). *Diplotaxis muralis* is more abundant than *D. tenuifolia* and is present in about half of the states (Kartesz, 2016). Relative to *D. viminea*, both species are more invasive and are continuing to spread and expand their range (Hurka et al., 2003). "In fact, it is not difficult to observe fields in which … *D. tenuifolia*, or *D. muralis* are the most, or among the most, abundant species" (Pignone and Martínez-Laborde, 2011). It is unclear how *D. viminea* may behave if introduced to the United States, where there may be few herbivores and others forms of biotic control. However, it seems unlikely that it would be more invasive than either *D. muralis* or *D. tenuifolia*, and thus far, neither of these species have been regulated as noxious weeds by a state agency (e.g., NPB, 2016; USDA-AMS, 2016).

4. Literature Cited

7 U.S.C. § 1581-1610. 1939. The Federal Seed Act, Title 7 United States Code § 1581-1610.

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

Abbate, G., E. Cicinelli, D. Iamonico, and M. Iberite. 2013. Floristic analysis of the weed communities in wheat and corn crops: A case study in western-Central Italy. Annali Di Botanica (Roma) 3:97-105.

Alday, J. G., Y. Pallavicini, R. H. Marrs, and C. Martínez-Ruiz. 2011. Functional groups and dispersal strategies as guides for predicting vegetation dynamics on reclaimed mines. Plant Ecology 212(11):1759-1775.

Allan, H. H. 1935. Additions to the alien flora of New Zealand. Transactions and Proceedings of the Royal Society of New Zealand 65:1-8.

Anonymous. 2016. Herbario Virtual del Mediterraneo Occidental, Comunidad Valenciana. Departament de Biologia, Universitat de Les Illes Balears. http://herbarivirtual.uib.es/cas-uv/index.html. (Archived at PERAL).

APHIS. 2016. Phytosanitary Certificate Issuance & Tracking System (PCIT). United States Department of Agriculture, Animal and Plant Health

Inspection Service (APHIS). https://pcit.aphis.usda.gov/pcit/. (Archived at PERAL).

AQAS. 2016. Agriculture Quarantine Activity Systems (AQAS) Database. United States Department of Agriculture - Plant Protection and Quarantine. https://mokcs14.aphis.usda.gov/aqas/login.jsp. (Archived at PERAL).

Auld, B. A., and R. W. Medd. 1987. Weeds: An Illustrated Botanical Guide to the Weeds of Australia. Inkata Press, Melbourne, Australia. 255 pp.

Bailey, L. H., and E. Z. Bailey. 1976. Hortus Third: A Concise Dictionary of Plants Cultivated in The United States and Canada (revised and expanded by The Staff of the Liberty Hyde Bailey Hortorium). Macmillan, New York, U.S.A. 1290 pp.

Bojňanský, V., and A. Fargašová. 2007. Atlas of Seeds and Fruits of Central and East-European Flora: The Carpathian Mountains Region. Springer, Dordrecht, The Netherlands. 1046 pp.

Brenzel, K. N. (ed.). 1995. Sunset Western Garden Book. Sunset Publishing Corporation, Menlo Park, California. 624 pp.

Brullo, S., G. Giusso del Galdo, R. Guarino, P. Minissale, and G. Spampinato. 2007. A survey of the weedy communities of Sicily. Annali Di Botanica (nuova serie) 7:127-161.

Bruneton, J. 1999. Toxic Plants Dangerous to Humans and Animals. Lavoisier Publishing, Paris, France. 545 pp.

Burrows, G. E., and R. J. Tyrl. 2013. Toxic Plants of North America, 2nd ed. Wiley-Blackwell, Ames, IA. 1383 pp.

Clement, E. J., and M. C. Foster (eds.). 1994. Alien Plants of the British Isles: A Provisional Catalogue of Vascular Plants (excluding grasses). Botanical Society of the British Isles, London, U.K. 590 pp.

D'Antuono, L. F., S. Elementi, and R. Neri. 2008. Glucosinolates in *Diplotaxis* and *Eruca* leaves: Diversity, taxonomic relations and applied aspects. Phytochemistry 69(1):187-199.

DAISIE. 2016. Delivering Alien Invasive Species Inventories for Europe (DAISIE, Online Database). http://www.europe-aliens.org/index.jsp. (Archived at PERAL).

Danin, A. 2016. Flora of Israel [Online Database]. The Hebrew University of Jerusalem. http://flora.org.il/en/plants/. (Archived at PERAL).

Dave's Garden. 2016. Plant files database. Dave's Garden. http://davesgarden.com/guides/pf/go/1764/. (Archived at PERAL).

DPI. 2016. Victorian resources online statewide: Diplotaxis (*Diplotaxis viminea*). Department of Primary Industries (DPI). Last accessed July 29, 2016, http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/weeds_diplotaxis.

Earlywine, D. T., R. J. Smeda, T. C. Teuton, C. E. Sams, and X. Xiong. 2010. Evaluation of oriental mustard (*Brassica juncea*) seed meal for weed suppression in turf. Weed Technology 24(4):440-445.

EDDMapS. 2016. Early Detection & Distribution Mapping System (EDDMapS) [Online Database]. The University of Georgia - Center for Invasive Species and Ecosystem Health. http://www.eddmaps.org/. (Archived at PERAL).

Eschmann-Grupe, G., H. Hurka, and B. Neuffer. 2003. Species relationships within *Diplotaxis* (Brassicaceae) and the phylogenetic origin of *D. muralis*. Plant Systematics and Evolution 243(1/2):13-29.

Euro+Med. 2006+. Euro+Med PlantBase - The information resource for Euro-Mediterranean plant diversity [Online Database]. Botanic Garden and Botanical Museum Berlin-Dahlem. http://ww2.bgbm.org/EuroPlusMed/. (Archived at PERAL).

Garnock-Jones, P. J. 1979. Checklist of dicotyledons naturalised in New Zealand 4. Rhoeadales. New Zealand Journal of Botany 17(3):303-310. DOI: 310.1080/0028825X.0021979.10426905.

GBIF. 2016. GBIF, Online Database. Global Biodiversity Information Facility (GBIF). http://www.gbif.org/. (Archived at PERAL).

Gulden, R. H., S. I. Warwick, and A. G. Thomas. 2008. The Biology of Canadian Weeds. 137. *Brassica napus* L. and *B. rapa* L. Canadian Journal of Plant Science 88(5):951-996.

Hand, R. 2004. Supplementary notes to the Flora of Cyprus IV. Willdenowia 34(2):427-456.

Hanf, M. 1983. The Arable Weeds of Europe: With their Seedlings and Seeds. BASF, Ipswich, U.K. 494 pp.

Hanson, C. G., and J. L. Mason. 1985. Bird seed aliens in Britain. Watsonia 15:237-252.

Heap, I. 2016. The international survey of herbicide resistant weeds. Weed Science Society of America. http://weedscience.org/. (Archived at PERAL).

Heide-Jorgensen, H. S. 2008. Parasitic Flowering Plants. Brill, Leiden, The Netherlands. 438 pp.

Hurka, H., W. Bleeker, and B. Neuffer. 2003. Evolutionary processes associated with biological invasions in the Brassicaceae. Biological Invasions 5(4):281-292.

IPPC. 2012. International Standards for Phytosanitary Measures No. 5: Glossary of Phytosanitary Terms. Food and Agriculture Organization of the United Nations, Secretariat of the International Plant Protection Convention (IPPC), Rome, Italy. 38 pp.

IPPC. 2015. International Standards for Phytosanitary Measures No. 2: Framework for Pest Risk Analysis. Food and Agriculture Organization of the United Nations, Secretariat of the International Plant Protection Convention (IPPC), Rome, Italy. 18 pp.

Kartesz, J. 2016. The Biota of North America Program (BONAP). North American Plant Atlas. http://bonap.net/tdc. (Archived at PERAL).

Kleemann, S. G. L., B. S. Chauhan, and G. S. Gill. 2007. Factors affecting seed germination of perennial wall rocket (*Diplotaxis tenuifolia*) in Southern Australia. Weed Science 55(5):481-485.

Koop, A., L. Fowler, L. Newton, and B. Caton. 2012. Development and validation of a weed screening tool for the United States. Biological Invasions 14(2):273-294.

Landcare Research. 2016. Ngā Tipu o Aotearoa - New Zealand Plants. Landcare Research. http://nzflora.landcareresearch.co.nz/. (Archived at PERAL).

Mabberley, D. J. 2008. Mabberley's Plant-Book: A Portable Dictionary of Plants, Their Classification and Uses (3rd edition). Cambridge University Press, New York. 1021 pp.

Martin, P. G., and J. M. Dowd. 1990. A protein sequence study of the dicotyledons and its relevance to the evolution of the legumes and nitrogen fixation. Australian Systematic Botany 3:91-100.

Martínez-Laborde, J. B. NoDate. Flora of North America: *Diplotaxis* de Candolle. efloras.org. Last accessed August 2, 2016, http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=110479.

MBG. 2016. Tropicos Database. Missouri Botanical Garden (MBG). http://www.tropicos.org/Home.aspx. (Archived at PERAL).

Messina, A. 2015. VicFlora: *Diplotaxis viminea* (L.) DC. Royal Botanic Gardens Victoria. http://data.rbg.vic.gov.au/vicflora/flora/taxon/422c4736-2b98-446b-bae0-11af1ea031b4. (Archived at PERAL).

Mifsud, S. 2007. *Diplotaxis viminea*. MaltaWildPlants.com. Last accessed July 29, 2016, http://www.maltawildplants.com/CRUC/Diplotaxis_viminea.php.

Mott, F. T., T. Carter, E. F. Cooper, J. E. M. Finch, and C. W. Cooper (eds.). 1886. The Flora of Leicestershire Including the Cryptogams, with Maps of the County. Williams and Norgate, Edinburgh. 372 pp.

MPAAF. 2010. § 319.5 Requirements for submitting requests to change the regulations in 7 CFR part 319. Ministero delle Politiche Agricole, Alimentari e Forestali (MPAAF), Rome. 29 pp.

NGRP. 2016. Germplasm Resources Information Network (GRIN). United States Department of Agriculture, Agricultural Research Service, National Genetic Resources Program (NGRP). https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch.aspx?language=en. (Archived at PERAL).

Nickrent, D. 2009. Parasitic plant classification. Southern Illinois University Carbondale, Carbondale, IL. Last accessed June 12, 2009, http://www.parasiticplants.siu.edu/ListParasites.html.

NPB. 2016. State Regulated Noxious Weeds [Online Database]. The National Plant Board (NPB). Last accessed April 11, 2016, http://nationalplantboard.org/laws-and-regulations/state-regulated-noxious-weeds/.

NRCS. 2016. The PLANTS Database. United States Department of Agriculture, Natural Resources Conservation Service (NRCS), The National Plant Data Center. http://plants.usda.gov/cgi_bin/. (Archived at PERAL).

Orchard, H. E. 1955. Sand rocket or Lincoln weed (*Diplotaxis tenuifolia*, (L) DC). Journal of the Department of Agriculture of South Australia 59(4):138-139.

Page, S., and M. Olds (eds.). 2001. The Plant Book: The World of Plants in a Single Volume. Mynah, Hong Kong. 1020 pp.

Parsons, W. T., and E. G. Cuthbertson. 2001. Noxious weeds of Australia (2nd edition). CSIRO Publishing, Collingwood, Victoria, Australia. 698 pp.

Picó, F. X., H. de Kroon, and J. Retana. 2002. An extended flowering and fruiting season has few demographic effects in a Mediterranean perennial herb. Ecology 83(7):1991-2004.

Pignone, D., and J. B. Martínez-Laborde. 2011. *Diplotaxis*. Pages 137-147 *in* C. Kole (ed.). Wild Crop Relatives: Genomic and Breeding Resources: Oilseeds. Springer Berlin Heidelberg, Berlin, Heidelberg.

PPQ. 2015. Guidelines for the USDA-APHIS-PPQ Weed Risk Assessment Process. United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ). 125 pp.

Pradhan, A. K., S. Prakash, A. Mukhopadhyay, and D. Pental. 1992. Phylogeny of *Brassica* and allied genera based on variation in chloroplast and mitochondrial DNA patterns: Molecular and taxonomic classifications are incongruous. Theoretical and Applied Genetics 85(2-3):331-340.

Preston, C. 2006. Resistance to acetolactate synthase-inhibiting herbicides in *Diplotaxis tenuifolia* (L.) DC., Pages 526-529 *in* C. Preston, J. H. Watts, and N. D. Crossman (eds.). 15th Australian Weeds Conference, Papers and Proceedings, Adelaide, South Australia, 24-28 September 2006: Managing weeds in a changing climate. Weed Management Society of South Australia, Victoria; Australia.

Randall, R. P. 2012. A Global Compendium of Weeds, 2nd edition. Department of Agriculture and Food, Western Australia, Perth, Australia. 1107 pp.

Rignanese, L. 2016. Can I use a photograph of yours of *Diplotaxis viminea*? Personal communication to A. L. Koop on July 30, 2016, from Luigi Rignanese, photographer.

Salisbury, E. 1961. Weeds and Aliens. Collins, London. 384 pp.

Santi, C., D. Bogusz, and C. Franche. 2013. Biological nitrogen fixation in non-legume plants. Annals of Botany 111(5):743-767.

Stace, C. 2010. New Flora of the British Isles (3rd ed.). Cambridge University Press, Cambridge, UK. 1130 pp.

Sturm, J. G., (Painter). 1796. Ruthen-Rauke, *Crucifera viminea*. Orginally published in *Deutschlands Flora in Abbildungen* but obtained from https://commons.wikimedia.org/wiki/File:Diplotaxis_viminea_Sturm34.jpg. Last accessed August 2, 2016.

Takahata, Y., N. Konno, and K. Hinata. 2008. Genotypic variation for floral characters in *Brassica* and allied genera with special reference to breeding system. Breeding Science 58(4):385-392.

The Plant List. 2016. The Plant List, Version 1 [Online Database]. Kew Botanic Gardens and the Missouri Botanical Garden. http://www.theplantlist.org/. (Archived at PERAL).

Ugrinović, K., and M. Škof. 2011. Collecting, characterisation and conservation of autochthonous germplasm of *Diplotaxis* sp. in Slovenia. Pages 581-584 *in* M. Pospišil (ed.). Proceedings. 46th Croatian and 6th International Symposium on Agriculture. Opatija. Croatia. University of Zagreb, Faculty of Agriculture, Zagreb, Croatia.

Univ. of Minn. 2016. Plant Information Online Database. University of Minnesota. https://plantinfo.umn.edu/default.asp. (Archived at PERAL).

USDA-AMS. 2016. State noxious-weed seed requirements recognized in the administration of the Federal Seed Act. United States Department of

Agriculture (USDA), Agricultural Marketing Service (AMS), Washington D.C. 121 pp.

van Treuren, R., P. Coquin, and U. Lohwasser. 2012. Genetic resources collections of leafy vegetables (lettuce, spinach, chicory, artichoke, asparagus, lamb's lettuce, rhubarb and rocket salad): composition and gaps. Genetic Resources and Crop Evolution 59(6):981-997.

Verloove, F., and J. Lambinon. 2008. Neophytes in Belgium: Corrections and adjustments. Systematics and Geography of Plants 78(1):63-79.

Warwick, S. 1995. New taxonomic views within *Eruca* and *Diplotaxis* genera in the light of hybridization and molecular findings. Pages 22-34 *in* S. Padulosi (ed.). Rocket Genetic Resources Network. Report of the First Meeting, 13-15 November 1994, Lisbon, Portugal. International Plant Genetic Resources Institute, Rome, Italy.

Warwick, S. I., I. Aguinagalde, and L. D. Black. 1992. Molecular systematics of *Brassica* and allied genera (Subtribe Brassicinae, Brassiceae) -- Chloroplast DNA variation in the genus *Diplotaxis*. Theoretical and Applied Genetics 83(6/7):839-850.

Yaniv, Z. 1995. Preliminary report on major activities initiated within the framework of Network activities activities conducted in Israel. Pages 2-6 *in* S. Padulosi (ed.). Rocket Genetic Resources Network. Report of the First Meeting, 13-15 November 1994, Lisbon, Portugal. International Plant Genetic Resources Institute, Rome, Italy.

Appendix A. Weed risk assessment for *Diplotaxis viminea* (L.) DC. (Brassicaceae). 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]	d - high	0	*Diplotaxis viminea* is native to northern Africa (Algeria, Egypt, Morocco, and Tunisia), Western Asia (Cyprus, Israel, Jordan, Lebanon, Syria, Turkey), and Europe (Bulgaria, Crete, Croatia, France, Greece, Italy, Portugal, Romania, Sardinia, Sicily, Slovenia, Spain, Ukraine, and the region formerly known as Yugoslavia) (Bojňanský and Fargašová, 2007; NGRP, 2016; Ugrinović and Škof, 2011; Warwick, 1995; Yaniv, 1995). However, for Ukraine and Romania, this species may actually be a naturalized exotic that was introduced before 1500 A.D. (i.e., an archaeophyte; DAISIE, 2016). *Diplotaxis viminea* is exotic in Austria, Germany, the Netherlands, and the Azores (Euro+Med, 2006+; Warwick, 1995). It has been reported as naturalized in New Zealand (Allan, 1935; Garnock-Jones, 1979), but we could not verify these older records with the New Zealand Plants database (Landcare Research, 2016). It was considered adventive in the flora of Belgium, but closer examination of plant material revealed that it was confused with *D. muralis* (L.) DC. (Verloove and Lambinon, 2008). Plants that were possibly *D. viminea* were collected from Victoria, Australia, in 1949, but have not been seen since (Messina, 2015). *Diplotaxis viminea* was reported as a casual in the United Kingdom at one point (Mott et al., 1886), but currently it is not known to be part of the flora (Stace, 2010). Overall, the weight of the evidence indicates that this species escapes, but does not persist for very long. For the few countries where it is reported as naturalized, we did not find any additional information about its status in those areas. Consequently, we answered "d" for casual, and chose "e" for both alternate answers in our uncertainty analysis.
ES-2 (Is the species highly domesticated)	n - low	0	We found no evidence that *D. viminea* is cultivated, much less highly domesticated. There are three accessions of *D. viminea* in the International Minor Leaf Vegetables Database (van Treuren et al., 2012), so there may be some interest in cultivating it (see evidence under Ent-3).
ES-3 (Weedy congeners)	y - negl	1	There are approximately 27 species in the genus *Diplotaxis* (Mabberley, 2008), and 12 of them have been reported as weeds to a lesser or greater extent, including *D. viminea* (Randall, 2012). Of the weedy species, *D. muralis* and *D. tenuifolia* appear to be significant weeds as each of them have been reported 80 or more times as weeds (Randall, 2012). These species have become invasive and are continuing to spread (Hurka et al., 2003). "In fact, it is not difficult to observe fields in which *D. erucoides*, or *D. tenuifolia*, or *D. muralis* are the most, or among the most,

Question ID	Answer - Uncertainty	Score	Notes (and references)
			abundant species" (Pignone and Martínez-Laborde, 2011). Diplotaxis viminea reduces yield in crops and pastures if not controlled (Orchard, 1955). It also competes with crops for water during the summer, discolors grains, and increases the moisture content of harvested seed (Kleemann et al., 2007; Preston, 2006). It is also regulated as a noxious weed in South Australia and Victoria, Australia (Parsons and Cuthbertson, 2001).
ES-4 (Shade tolerant at some stage of its life cycle)	n - low	0	*Diplotaxis viminea* occurs in a variety of open and disturbed habitats such plains, hills, roadsides, waste places, fields, crops, gardens, and vineyards (Hand, 2004; Hanf, 1983; Warwick, 1995; Yaniv, 1995). This species is characteristic of heliophilous (sun-loving) vegetation in Sicily (Brullo et al., 2007). Because we found no evidence indicating that it occurs in shady habitats or is shade tolerant, we answered no.
ES-5 (Plant a vine or scrambling plant, or forms tightly appressed basal rosettes)	n - negl	0	This species produces a basal rosette of leaves (Bojňanský and Fargašová, 2007). However, based on photographs, individual plants do not appear to form a tightly appressed basal rosette (Anonymous, 2016; Mifsud, 2007).
ES-6 (Forms dense thickets, patches, or populations)	? - max	0	We found no reports that this species forms dense populations; however, a photograph suggests that it may be able to form dense patches (see top right image on the cover page of this document).
ES-7 (Aquatic)	n - negl	0	This species is a terrestrial plant (Bojňanský and Fargašová, 2007) and is not reported to occur in aquatic habitats (e.g., Hand, 2004; Hanf, 1983; Warwick, 1995; Yaniv, 1995).
ES-8 (Grass)	n - negl	0	This species is not a grass; it is a plant in the mustard family (Brassicaceae; NGRP, 2016).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	We found no evidence that this species fixes nitrogen. Furthermore, it is an herbaceous annual and not a woody species (Bojňanský and Fargašová, 2007), and not a member of a plant family known to contain nitrogen-fixing species (Martin and Dowd, 1990; Santi et al., 2013).
ES-10 (Does it produce viable seeds or spores)	y - low	1	*Diplotaxis viminea* produces seeds (Pignone and Martínez-Laborde, 2011). Although we found no evidence about seed viability or germination rates, because it is an annual plant (Bojňanský and Fargašová, 2007; Hanf, 1983), and because we found no evidence that it reproduces vegetatively, it must produce viable seeds.
ES-11 (Self-compatible or apomictic)	y - negl	1	Flowers can be pollinated by their own pollen (i.e., autogamous; Takahata et al., 2008). Of a large set of Brassicaceae species sampled, including 13 *Diplotaxis*, some researchers found that *D. viminea* had the lowest pollen count per flower and the lowest pollen to ovule ratio, which is consistent with autogamy in general (Takahata et al., 2008). "*D*[*iplotaxis*] *viminea* is a clearly autogamous species, as indicated by its much smaller flowers, apparently sterile lateral anthers, and high degree of ovule fertilization and seed formation..." (Pignone and Martínez-Laborde, 2011).
ES-12 (Requires specialist pollinators)	n - low	0	We found no information about the pollination biology of this species. However, because it is autogamous and has a

Question ID	**Answer - Uncertainty**	**Score**	**Notes (and references)**
			relatively low pollen to ovule ratio, it seems unlikely that it requires pollinators, much less specialist ones.
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 - low	1	Annual (Bojňanský and Fargašová, 2007; Hanf, 1983). The flowering season for *D. viminea* extends to 8 or more months in the Mediterranean (Picó et al., 2002), and from April through November in Spain (Anonymous, 2016). As an annual plant, this species, by definition, has a minimum generation time of at most a year. Because it has an extended flowering season, it may be possible that two or more generations occur in a single year. Consequently, we answered "b" and chose "a" for both of our alternate answers.
ES-14 (Prolific seed producer)	? - max	0	Unknown. We found no information about seed production rates, number of seeds per fruit, number of flowers per plant or unit area, or seed viability. Based on photographs of small patches of individuals (e.g., the top right image on cover page), we suspect that it may be able to produce more than 5000 seeds per square meter based on the number of plants per unit area. Its congener *D. muralis*, which is a hybrid offspring of *D. viminea*, can produce up to 79,000 seeds per plant (Salisbury, 1961). *Diplotaxis tenuifolia* can produce up to 500,000 seeds per plant (Salisbury, 1961).
ES-15 (Propagules likely to be dispersed unintentionally by people)	? - max	0	We found no evidence that this species is or is not dispersed unintentionally by human activity. However, because it produces relatively small seeds (0.9-1.1 x 0.6-0.8 mm in size; Bojňanský and Fargašová, 2007) and is present in agricultural and ruderal sites where there is a lot of human activity (Hand, 2004; Hanf, 1983; Warwick, 1995; Yaniv, 1995), we believe it is likely to be dispersed unintentionally. Because so little is known about the biology of this species, we answered unknown.
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - mod	-1	*Diplotaxis viminea* is believed to have been introduced to Britain in foreign seed (Mott et al., 1886), but this species is currently not known to be present in the flora of Britain (Stace, 2010) Mott et al. may have confused *D. viminea* with *D. muralis* (Clement and Foster, 1994). The congener *D. muralis* was introduced to England in ballast and was formerly a wool casual (Clement and Foster, 1994). *Diplotaxis muralis* has also been documented as a contaminant of birdseed (Hanson and Mason, 1985). We found no evidence that any *Diplotaxis* species has been introduced as a contaminant to the United States since 1985 (AQAS, 2016). Because the one piece of evidence for *D. viminea* is based on a very old report, and because we did not find much evidence of dispersal as a contaminant for other *Diplotaxis* species, we answered no with moderate uncertainty.
ES-17 (Number of natural dispersal vectors)	0	-4	Fruit and seed traits for questions ES-17a through ES-17e: Fruit is a silique (Hanf, 1983; Pignone and Martínez-Laborde, 2011), which is a pod that dehisces along two sides. Seeds are ovate, somewhat compressed, and 0.9-1.1 x 0.6-0.8 mm in size (Bojňanský and Fargašová, 2007). Seeds are dispersed by gravity (Alday et al., 2011).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-17a (Wind dispersal)	n - negl		We found no evidence that this species is dispersed by wind, nor does it have any traits typically associated with wind-dispersal such as winged or plumose seeds. Because it is dispersed by gravity (Alday et al., 2011), we answered no with negligible uncertainty.
ES-17b (Water dispersal)	n - mod		We found no evidence suggesting it is dispersed by water. Because it is not restricted to aquatic habitats, we answered no with moderate uncertainty.
ES-17c (Bird dispersal)	n - high		We found no evidence.
ES-17d (Animal external dispersal)	? - max		We found no evidence for this species. However, because the congener *D. muralis* was associated with wool imports in the United Kingdom, we answered unknown.
ES-17e (Animal internal dispersal)	n - high		We found no evidence.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	? - max	0	A weed risk assessment prepared by the Victoria Department of Primary Industries stated that greater than 25 percent of the seeds survive five years (DPI, 2016); however, we could not verify this statement. The current online version of the source the DPI document cited does not include any information about seed longevity (Danin, 2016). It would be surprising for an annual not to have long-term dormancy; however, without additional information we answered this question as unknown.
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	We found no evidence that this species is resistant to herbicides. In Australia, *D. tenuifolia* is resistant to acetolactate synthase (ALS)-inhibiting herbicides in cereals (Heap, 2016), and in Israel, *D. erucoides* is resistant to some ALS-inhibiting herbicides as well, but in wheat (Heap, 2016). Because *D. viminea* is reported to be autogamous (Takahata et al., 2008), it seems unlikely it could acquire resistance through hybridization with these other two species.
ES-21 (Number of cold hardiness zones suitable for its survival)	6	0	
ES-22 (Number of climate types suitable for its survival)	8	2	
ES-23 (Number of precipitation bands suitable for its survival)	7	0	
IMPACT POTENTIAL			Because we found relatively little information on the biology of *Diplotaxis viminea*, and because we do not have any information about the behavior of this species outside of Eurasia where coevolved herbivores and pathogens are likely impacting plant populations, we used high uncertainty for most of the questions in this risk element.
General Impacts			
Imp-G1 (Allelopathic)	n - low	0	The genus *Diplotaxis*, like other Brassicaceae species, is a major producer of glucosinolates, which are a type of allelopathic compound (Pignone and Martínez-Laborde, 2011). Glucosinolates have detrimental effects on crop yield and seed germination of crops and other weeds (reviewed in Earlywine et al., 2010; Gulden et al., 2008). However,

Question ID	Answer - Uncertainty	Score	Notes (and references)
			relative to other *Diplotaxis* and *Eruca* (Brassicaceae) species, *D. viminea* is part of a species group with relatively low concentrations of glucosinolates (D'Antuono et al., 2008). Because we found no evidence that D. viminea is allelopathic and because it has been shown to produce low concentrations of glucosinolates, we used low uncertainty.
Imp-G2 (Parasitic)	n - negl	0	We found no evidence that this species is parasitic. Furthermore, it is not a member of a plant family known to contain parasitic plant species (Heide-Jorgensen, 2008; Nickrent, 2009).
Impacts to Natural Systems			
Imp-N1 (Changes ecosystem processes and parameters that affect other species)	n - high	0	We found no evidence of this impact.
Imp-N2 (Changes habitat structure)	n - high	0	We found no evidence of this impact.
Imp-N3 (Changes species diversity)	n - high	0	We found no evidence of this impact.
Imp-N4 (Is it likely to affect federal Threatened and Endangered species?)	n - mod	0	Because we found no evidence that this species invades or is problematic in natural areas, we answered no.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions?)	n - mod	0	Because we found no evidence that this species invades or is problematic in natural areas, we answered no.
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]	a - mod	0	We found no evidence that this species invades natural areas or is considered a weed of natural areas. Consequently we answered "a" and chose "b" for both alternate answers for the uncertainty simulation.
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 this species negatively impacts human property and infrastructure. Because it seems unlikely that a small herbaceous annual would have this impact, we answered no with low uncertainty.
Imp-A2 (Changes or limits recreational use of an area)	n - low	0	We found no evidence of this impact. Because it seems unlikely that a small herbaceous annual would limit recreational use of an area, we answered no with low uncertainty.
Imp-A3 (Affects desirable and ornamental plants, and vegetation)	n - high	0	We found no evidence of this 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]	b - high	0.1	This species grows in gardens and waste places (Bojňanský and Fargašová, 2007), such as reclaimed mines (Alday et al., 2011). It occurs on roadsides (Hand, 2004) and is a weed of ruderal sites (Hanf, 1983). It is weedy in roadsides and waste places (Warwick, 1995). Because we found no evidence that it is controlled in these types of environments, we answered "b" and chose "a" and "c" as our alternate answers for the uncertainty analysis.
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	n - high	0	We found no evidence that this species reduces commodity yield.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-P2 (Lowers commodity value)	n - high	0	We found no evidence that this species lowers commodity value. *Diplotaxis tenuifolia* and *D. muralis* are "reputed to taint animal products," but are grazed infrequently (Auld and Medd, 1987).
Imp-P3 (Is it likely to impact trade?)	n - high	0	We found no evidence that this species is regulated by another country (e.g., APHIS, 2016) or that it is likely to follow a pathway as a contaminant (see ES-16). However, we note that *D. tenuifolia* is regulated in Chile, Colombia, Peru, and the Republic of Korea (APHIS, 2016), and that *D. muralis* has been documented as a contaminant of birdseed (Hanson and Mason, 1985) and wool (Clement and Foster, 1994).
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - low	0	We found no evidence. Because this species is not an aquatic and does not appear to grow densely along irrigation and drainage channels, we used low uncertainty.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - mod	0	We found no evidence that this taxon 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]	b - mod	0.2	This species grows in fields and vineyards (Bojňanský and Fargašová, 2007). It is a weed of vegetable crops (Hanf, 1983). It is weedy in fields, crops, vineyards, and gardens (Warwick, 1995). It is a weed of wheat in central Italy, but only found in 1.6 percent of the studied fields (Abbate et al., 2013). It is weedy in vineyards, olive, carob, and almond groves (Brullo et al., 2007). This species is well documented as an agricultural weed, but we did not find an evidence of control. Consequently, we answered "b" and selected "c" for both alternate answers for our uncertainty analysis.
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically referenced points obtained from the Global Biodiversity Information Facility (GBIF, 2016).
Plant hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence that this species occurs in this hardiness zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence that this species occurs in this hardiness zone.
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence that this species occurs in this hardiness zone.
Geo-Z4 (Zone 4)	n - negl	N/A	We found no evidence that this species occurs in this hardiness zone.
Geo-Z5 (Zone 5)	n - low	N/A	This species is reported to occur in the region represented by Bulgaria, Croatia, Montenegro, Romania, Serbia, Slovenia, Ukraine, and Bosnia and Herzegovina (Bojňanský and Fargašová, 2007; GBIF, 2016; Warwick, 1995). However, only about five percent of this area is represented by this hardiness zone, and this corresponds to mountainous regions. Because this species is rarely found at altitudes higher than 500 meters (Ugrinović and Škof, 2011), we used low uncertainty.
Geo-Z6 (Zone 6)	y - high	N/A	This species is reported to occur in the region represented by Bulgaria, Croatia, Montenegro, Romania, Serbia, Slovenia, Ukraine, and Bosnia and Herzegovina (Bojňanský and

Question ID	Answer - Uncertainty	Score	Notes (and references)
			Fargašová, 2007; GBIF, 2016; Warwick, 1995). Because 50 percent of the area of this region is represented by this hardiness zone, we answered yes with high uncertainty.
Geo-Z7 (Zone 7)	y - negl	N/A	Spain. Some points in France and two points in Germany.
Geo-Z8 (Zone 8)	y - negl	N/A	Many points in France.
Geo-Z9 (Zone 9)	y - negl	N/A	France, Spain, and the United Kingdom.
Geo-Z10 (Zone 10)	y - negl	N/A	France, Israel, and Spain. Cyprus (Hand, 2004).
Geo-Z11 (Zone 11)	y - mod	N/A	Israel. A couple of points in Spain.
Geo-Z12 (Zone 12)	n - high	N/A	A couple of points along coastal Israel. However, because of potential mapping errors at such minor spatial scales, we answered no with high uncertainty.
Geo-Z13 (Zone 13)	n - negl	N/A	We found no evidence that this species occurs in this hardiness zone.
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - negl	N/A	We found no evidence that this species occurs in this climate class.
Geo-C2 (Tropical savanna)	n - negl	N/A	We found no evidence that this species occurs in this climate class.
Geo-C3 (Steppe)	y - negl	N/A	Spain. One point in Israel (GBIF, 2016). Occurs in semi-steppe shrublands in Israel (Danin, 2016).
Geo-C4 (Desert)	y - high	N/A	One point in Israel (GBIF, 2016). Occurs in desert areas in Israel (Danin, 2016).
Geo-C5 (Mediterranean)	y - negl	N/A	France, Israel, and Spain (GBIF, 2016). Occurs in Mediterranean habitats in Israel (Danin, 2016).
Geo-C6 (Humid subtropical)	y - high	N/A	This species is reported to occur in the region represented by Bulgaria, Croatia, Montenegro, Romania, Serbia, Slovenia, Ukraine, and Bosnia and Herzegovina (Bojňanský and Fargašová, 2007; GBIF, 2016; Warwick, 1995). Because this region includes some areas represented by this climate class, we answered yes.
Geo-C7 (Marine west coast)	y - negl	N/A	Many points in France.
Geo-C8 (Humid cont. warm sum.)	y - high	N/A	This species is reported to occur in the region represented by Bulgaria, Croatia, Montenegro, Romania, Serbia, Slovenia, Ukraine, and Bosnia and Herzegovina (Bojňanský and Fargašová, 2007; GBIF, 2016; Warwick, 1995), which includes some areas with this climate class.
Geo-C9 (Humid cont. cool sum.)	y - mod	N/A	This species is reported to occur in the region represented by Bulgaria, Croatia, Montenegro, Romania, Serbia, Slovenia, Ukraine, and Bosnia and Herzegovina (Bojňanský and Fargašová, 2007; GBIF, 2016; Warwick, 1995). Because this region is dominated by this climate class, we answered yes.
Geo-C10 (Subarctic)	y - high	N/A	A few points in France.
Geo-C11 (Tundra)	n - high	N/A	This species is reported to occur in the region represented by Bulgaria, Croatia, Montenegro, Romania, Serbia, Slovenia, Ukraine, and Bosnia and Herzegovina (Bojňanský and Fargašová, 2007; GBIF, 2016; Warwick, 1995). This region includes some minor areas in this climate class, but because they are minor and because we found no evidence this species occurs in tundra habitats, we answered no with high uncertainty.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence that this species occurs in this climate class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	y - high	N/A	Three points in Israel (GBIF, 2016). Ordinarily, we would not have answered yes based on such limited evidence; however, a separate source states this species occurs in desert areas in Israel (Danin, 2016).
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	Some points in France, Israel, and Spain.
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	Many points in France, and some in Israel and Spain.
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	France and Spain.
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	France and Spain.
Geo-R6 (50-60 inches; 127-152 cm)	y - low	N/A	Some points in France.
Geo-R7 (60-70 inches; 152-178 cm)	y - low	N/A	A few points in Spain. This species is reported to occur in the region represented by Bulgaria, Croatia, Montenegro, Romania, Serbia, Slovenia, Ukraine, and Bosnia and Herzegovina (Bojňanský and Fargašová, 2007; GBIF, 2016; Warwick, 1995), which includes this precipitation band.
Geo-R8 (70-80 inches; 178-203 cm)	n - high	N/A	This species is reported to occur in the region represented by Bulgaria, Croatia, Montenegro, Romania, Serbia, Slovenia, Ukraine, and Bosnia and Herzegovina (Bojňanský and Fargašová, 2007; GBIF, 2016; Warwick, 1995). Although this region includes this precipitation band, we answered no because it represents only a very minor portion of the region.
Geo-R9 (80-90 inches; 203-229 cm)	n - high	N/A	This species is reported to occur in the region represented by Bulgaria, Croatia, Montenegro, Romania, Serbia, Slovenia, Ukraine, and Bosnia and Herzegovina (Bojňanský and Fargašová, 2007; GBIF, 2016; Warwick, 1995). Although this region includes this precipitation band, we answered no because it represents only a very minor portion of the region.
Geo-R10 (90-100 inches; 229-254 cm)	n - low	N/A	We found no evidence that this species occurs in this precipitation band.
Geo-R11 (100+ inches; 254+ cm)	n - negl	N/A	We found no evidence that this species occurs in this precipitation band.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	n - low	0	We found no evidence that this species is present in the United States (e.g., Dave's Garden, 2016; EDDMapS, 2016; Kartesz, 2016; NRCS, 2016; Univ. of Minn., 2016).
Ent-2 (Plant proposed for entry, or entry is imminent)	n - low	0	We found no evidence that its entry is imminent.
Ent-3 (Human value & cultivation/trade status)	b - high	0.05	We found no evidence that *D. viminea* is cultivated. *Diplotaxis acris* and *D. erucoides* are cultivated (Bailey and Bailey, 1976). *Diplotaxis tenuifolia* and *D. muralis* are leafy vegetables that are both cultivated and harvested from the wild (van Treuren et al., 2012). During the 1990s, some wild *Diplotaxis* populations were becoming endangered in Europe through over-collecting due to increased demand for arugula (Pignone and Martínez-Laborde, 2011), *Eruca sativa*, which is a close relative of *Diplotaxis*. There are

Question ID	Answer - Uncertainty	Score	Notes (and references)
			three accessions of *D. viminea* in the International Minor Leaf Vegetables Database (van Treuren et al., 2012). Researchers have used the genus *Diplotaxis* in breeding studies with the agronomically important genus *Brassica* as a source for potentially beneficial traits to *Brassica* (Pignone and Martínez-Laborde, 2011). *Diplotaxis viminea* is easily confused with *D. muralis* (Verloove and Lambinon, 2008). Based on the general interest and use of these plant genera, we answered "b" with high uncertainty because it is possible that *D. viminea* may be intentionally imported. Since 1985, U.S. officials have twice intercepted *D. tenuifolia* and *D. muralis* from airline passengers attempting to propagate these species (AQAS, 2016).
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	n - low		We did not find any evidence that *D. viminea* is present in these countries. It is present in Europe, western Asia, and northern Africa (Bojňanský and Fargašová, 2007; NGRP, 2016; Ugrinović and Škof, 2011; Warwick, 1995; Yaniv, 1995), and possibly Australia (Messina, 2015) and New Zealand (Allan, 1935; Garnock-Jones, 1979).
Ent-4b (Contaminant of plant propagative material (except seeds))	n - mod	0	We found no evidence that *D. viminea* contaminates this pathway.
Ent-4c (Contaminant of seeds for planting)	n - mod	0	*Diplotaxis viminea* is believed to have been introduced to Britain in foreign seed (Mott et al., 1886), but this species is currently not known to be present in the flora (Stace, 2010) and was possibly confused with *D. muralis* (Clement and Foster, 1994). Because the one piece of evidence for *D. viminea* is based on a very old report, and because we did not find much evidence for other *Diplotaxis* species, we answered no with moderate uncertainty.
Ent-4d (Contaminant of ballast water)	n - mod	0	We found no evidence for *D. viminea*, but the congener *D. muralis* was introduced to England in ballast (Clement and Foster, 1994).
Ent-4e (Contaminant of aquarium plants or other aquarium products)	n - low	0	We found no evidence, and believe this pathway is unlikely since *D. viminea* is not an aquatic plant nor is it associated with aquatic and wetland species.
Ent-4f (Contaminant of landscape products)	n - mod	0	We found no evidence that *D. viminea* contaminates this pathway.
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	n - mod	0	We found no evidence that *D. viminea* contaminates this pathway.
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	n - mod	0	We found no evidence that *D. viminea* contaminates this pathway.
Ent-4i (Contaminant of some other pathway)	e - high	0.04	We found no evidence for *D. viminea*. However, because *D. muralis*, a very close relative, has been documented as a contaminant of bird seed (Hanson and Mason, 1985) and as a wool alien (Clement and Foster, 1994), we answered "e" with high uncertainty. We chose the maximum score represented by "e" because birds are very messy and seeds

Question ID	Answer - Uncertainty	Score	Notes (and references)
			would be discarded in environments where they could easily germinate.
Ent-5 (Likely to enter through natural dispersal)	n - negl	0	This pathway is very unlikely as the species is not present in a neighboring region. Furthermore, it does not have any adaptations for long-distance dispersal (see evidence under ES-17).