Taxon: Linum bienne Mill. **Family:** Linaceae

Common Name(s): narrow leaved flax
pale flax
small flowered flax

Synonym(s): L. usitatissimum subsp. angustifolium
Linum angustifolium Huds.
Linum hispanicum Mill.

Assessor: Chuck Chimera **Status:** Assessor Approved **End Date:** 24 May 2019

WRA Score: 8.0 **Designation:** H(HPWRA) **Rating:** High Risk

Keywords: Biennial Herb, Naturalized, Weedy, Self-Compatible, Contaminant

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?		
103	Does the species have weedy races?		
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	(0-low; 1-intermediate; 2-high) (See Appendix 2)	Intermediate
202	Quality of climate match data	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
203	Broad climate suitability (environmental versatility)	y=1, n=0	y
204	Native or naturalized in regions with tropical or subtropical climates	y=1, n=0	y
205	Does the species have a history of repeated introductions outside its natural range?	y=-2, ?=-1, n=0	y
301	Naturalized beyond native range	y = 1*multiplier (see Appendix 2), n= question 205	y
302	Garden/amenity/disturbance weed	n=0, y = 1*multiplier (see Appendix 2)	y
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	n
304	Environmental weed	n=0, y = 2*multiplier (see Appendix 2)	n
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals		
405	Toxic to animals		
406	Host for recognized pests and pathogens		
407	Causes allergies or is otherwise toxic to humans		
408	Creates a fire hazard in natural ecosystems	y=1, n=0	n
409	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0	n

Qsn #	Question	Answer Option	Answer
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y=1, n=0	y
411	Climbing or smothering growth habit	y=1, n=0	n
412	Forms dense thickets	y=1, n=0	n
501	Aquatic	y=5, n=0	n
502	Grass	y=1, n=0	n
503	Nitrogen fixing woody plant	y=1, n=0	n
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0	n
601	Evidence of substantial reproductive failure in native habitat	y=1, n=0	n
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally		
604	Self-compatible or apomictic	y=1, n=-1	y
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	n
607	Minimum generative time (years)	1 year = 1, 2 or 3 years = 0, 4+ years = -1	1
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	y
702	Propagules dispersed intentionally by people		
703	Propagules likely to disperse as a produce contaminant	y=1, n=-1	y
704	Propagules adapted to wind dispersal	y=1, n=-1	n
705	Propagules water dispersed		
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)		
708	Propagules survive passage through the gut	y=1, n=-1	y
801	Prolific seed production (>1000/m2)		
802	Evidence that a persistent propagule bank is formed (>1 yr)		
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire		
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)		

Supporting Data:

Qsn #	Question	Answer
101	**Is the species highly domesticated?**	**n**
	Source(s)	**Notes**
	Adugna, W. (2011). Linum usitatissimum L. [Internet] Record from PROTA4U. Brink, M. & Achigan-Dako, E.G. (Editors). PROTA (Plant Resources of Tropical Africa). Wageningen, Netherlands. http://www.prota4u.org/search.asp. [Accessed 22 May 2019]	"Linum usitatissimum most likely evolved by domestication from wild Linum bienne Mill. ('pale flax'), a short-lived perennial which occurs in western and southern Europe and western Asia." [Linum bienne is the source for a domesticated plant]

102	**Has the species become naturalized where grown?**	
	Source(s)	**Notes**
	WRA Specialist. (2019). Personal Communication	NA

103	**Does the species have weedy races?**	
	Source(s)	**Notes**
	WRA Specialist. (2019). Personal Communication	NA

201	**Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"**	**Intermediate**
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 22 May 2019]	"Native Africa MACARONESIA: Portugal, [Madeira Islands] Spain [Canary Islands] NORTHERN AFRICA: Algeria (n.), Libya (n.), Morocco, Tunisia Asia-Temperate WESTERN ASIA: Cyprus, Iran (n.w.), Iraq (n.), Israel, Lebanon, Syria, Turkey CAUCASUS: Armenia, Azerbaijan, Georgia, Russian Federation-Ciscaucasia [Ciscaucasia] Europe NORTHERN EUROPE: Ireland (s.), United Kingdom (s.) EASTERN EUROPE: Ukraine [Krym] SOUTHEASTERN EUROPE: Albania, Bulgaria, Former Yugoslavia, Greece (incl. Crete), Italy (incl. Sardinia, Sicily) SOUTHWESTERN EUROPE: France (incl. Corsica), Portugal, Spain (incl. Baleares)"
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Preferred Climate/s: Mediterranean"

Qsn #	Question	Answer
202	**Quality of climate match data**	**High**
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 22 May 2019]	

203	Broad climate suitability (environmental versatility)	y
	Source(s)	**Notes**
	Flora of North America. (2019). Linum bienne. http://www.efloras.org. [Accessed 22 May 2019]	"Grasslands, woodlands, disturbed places; 0–1900 m"
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai‘i Press and Bishop Museum Press, Honolulu, HI.	"in Hawai'i apparently sparingly naturalized in meadows, 1,280 m, Wailaulau, Maui."
	Starr, F., Starr, K. & Loope, L.L. 2006. New plant records from the Hawaiian Archipelago. Bishop Museum Occasional Papers 87: 31-43	"Linum bienne (blue flax) is previously only known from a single collection made in 1982 by A. Medeiros from Wailaulau, Maui where it was sparingly naturalized in meadows (Wagner et al., 1999). It was then also reported from Kaua‘i (Oppenheimer, 2004). It is now also known from Hawai‘i, scattered in subalpine pasture and mamane (Sophora chrysophylla) shrubland on the north slope of Mauna Kea in the vicinity of Pu‘u Mali. Material examined. HAWAI‘I: Mauna Kea, Pu‘u Mali, in association with Pennisetum clandestinum and Sophora Chrysophyllum, 6600 ft [2000 m], 23 Jul 2004, Starr, Starr, & Crummer 040723-4."
	Oppenheimer, H. L. 2004. New Hawaiian plant records for 2003. Bishop Museum Occasional Papers. 79: 8-20	"Linum bienne Mill. New island record Known from a single collection made on Maui at Wailaulau in 1982, and sparingly naturalized in meadows at 1280 m (Wagner et al., 1999: 850), L. bienne has been recently observed as a lawn and garden weed in Makawao. The following collection represents a new island record. Material examined: KAUA‘I: Maha‘ulepu, near Pao‘o Pt., 6 m, erect plants with purple flowers naturalized in sandy soil, 26 Apr 2002, Oppenheimer H40213."
	WRA Specialist. (2019). Personal Communication	Collected in the Hawaiian Islands over a broad elevational range (from 6 m to 2000 m), demonstrating environmental versatility

Qsn #	Question	Answer
204	**Native or naturalized in regions with tropical or subtropical climates**	**y**
	Source(s)	**Notes**
	Starr, F., Starr, K. & Loope, L.L. 2006. New plant records from the Hawaiian Archipelago. Bishop Museum Occasional Papers 87: 31-43	"Linum bienne (blue flax) is previously only known from a single collection made in 1982 by A. Medeiros from Wailaulau, Maui where it was sparingly naturalized in meadows (Wagner et al., 1999). It was then also reported from Kaua'i (Oppenheimer, 2004). It is now also known from Hawai'i, scattered in subalpine pasture and mamane (Sophora chrysophylla) shrubland on the north slope of Mauna Kea in the vicinity of Pu'u Mali. Material examined. HAWAI'I: Mauna Kea, Pu'u Mali, in association with Pennisetum clandestinum and Sophora Chrysophyllum, 6600 ft [2000 m], 23 Jul 2004, Starr, Starr, & Crummer 040723-4."

205	**Does the species have a history of repeated introductions outside its natural range?**	**y**
	Source(s)	**Notes**
	Flora of North America. (2019). Linum bienne. http://www.efloras.org. [Accessed 22 May 2019]	"introduced; B.C.; Calif., Oreg., Pa.; Europe, n Africa; introduced also in South America (Argentina, Chile), Pacific Islands (New Zealand)."
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Native to western and southern Europe, widely naturalized"

301	**Naturalized beyond native range**	**y**
	Source(s)	**Notes**
	Oppenheimer, H. L. 2004. New Hawaiian plant records for 2003. Bishop Museum Occasional Papers. 79: 8-20	"Linum bienne Mill. New island record Known from a single collection made on Maui at Wailaulau in 1982, and sparingly naturalized in meadows at 1280 m (Wagner et al., 1999: 850), L. bienne has been recently observed as a lawn and garden weed in Makawao. The following collection represents a new island record. Material examined: KAUA'I: Maha'ulepu, near Pao'o Pt., 6 m, erect plants with purple flowers naturalized in sandy soil, 26 Apr 2002, Oppenheimer H40213."
	Starr, F., Starr, K. & Loope, L.L. 2006. New plant records from the Hawaiian Archipelago. Bishop Museum Occasional Papers 87: 31-43	"Linum bienne Mill. New island record Linum bienne (blue flax) is previously only known from a single collection made in 1982 by A. Medeiros from Wailaulau, Maui where it was sparingly naturalized in meadows (Wagner et al., 1999). It was then also reported from Kaua'i (Oppenheimer, 2004). It is now also known from Hawai'i, scattered in subalpine pasture and mamane (Sophora chrysophylla) shrubland on the north slope of Mauna Kea in the vicinity of Pu'u Mali. Material examined. HAWAI'I: Mauna Kea, Pu'u Mali, in association with Pennisetum clandestinum and Sophora Chrysophyllum, 6600 ft [2000 m], 23 Jul 2004, Starr, Starr, & Crummer 040723-4."
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Native to western and southern Europe, widely naturalized; in Hawai'i apparently sparingly naturalized in meadows, 1,280 m, Wailaulau, Maui. Known from a single collection made in 1982 (Medeiros 239, BISH)."

Qsn #	Question	Answer
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 22 May 2019]	"Naturalized Africa MACARONESIA: Portugal [Azores]"
	Lao, C. 2009. Specimen Details for Linum bienne Mill. ID Number 738701. Bishop Museum, Honolulu, HI. http://nsdb.bishopmuseum.org. [Accessed 22 May 2019]	[Collected on Oahu. Possibly naturalized] "Upright herb, 50-60 cm tall. Single-stemmed, sometimes branched. Leaves linear, 22 mm x 3-4 mm, whorled, pale green. Flowers pale blue, petals striped, centers of flowers containing styles. Flowers fell apart readily when drying. Not fruiting. Possibly purposefully planted ornamental or sprouting of birdseed for pets."

302	Garden/amenity/disturbance weed	y
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"in Hawai'i apparently sparingly naturalized in meadows" [Innocuous naturalized plant in the Hawaiian Islands]
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	Included in a number of publications of weeds and naturalized plants throughout the world. Impacts to agriculture and/or natural areas are unclear. Answering "Yes" to classify this plant as a weed of unspecified impacts.

303	Agricultural/forestry/horticultural weed	n
	Source(s)	**Notes**
	Turland, N., Phitos, D., Kamari, G., & Bareka, P. (2004). Weeds of the traditional agriculture of Crete. Willdenowia, 34: 381-406	[Linum bienne included in a list of agricultural weeds, but there are no descriptions of impacts in this publication] "The goal of this research project was to carry out a thorough floristic survey of weeds in the traditional agriculture of the South Aegean island of Crete, Greece. Fieldwork was carried out by the authors from 2.4.-7.5.2003. Fifty cultivated localities were surveyed, at which 2455 plant records and 483 herbarium gatherings were made. Living material was collected for cytological investigation at UPA. A relational database of the results (localities, taxa observed, herbarium specimens, living material) was created and is placed online as an electronic supplement. The collections and observations were critically evaluated, and a catalogue of the taxa recorded at each locality is provided here. Distributional notes are provided on significant records and selected weed species that are indicators of (obligate to) traditional agriculture."

304	Environmental weed	n
	Source(s)	**Notes**
	DiTomaso, J. 2007. Weeds of California and Other Western States. 2 Volumes. UCANR Publications, Oakland, CA	"Appendix: Non-native Naturalized Plants Rarely Naturalized in California" ... "Linum bienne ... Comments/Other Distribution - Perennial; grasslands, woodlands" [Included among rarely naturalized plants, with no evidence of negative impacts reported]
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"in Hawai'i apparently sparingly naturalized in meadows" [No evidence of negative impacts]

Qsn #	Question	Answer
	Starr, F., Starr, K. & Loope, L.L. 2006. New plant records from the Hawaiian Archipelago. Bishop Museum Occasional Papers 87: 31-43	[No evidence] "Linum bienne (blue flax) is previously only known from a single collection made in 1982 by A. Medeiros from Wailaulau, Maui where it was sparingly naturalized in meadows (Wagner et al., 1999). It was then also reported from Kauaʻi (Oppenheimer, 2004). It is now also known from Hawaiʻi, scattered in subalpine pasture and mamane (Sophora chrysophylla) shrubland on the north slope of Mauna Kea in the vicinity of Puʻu Mali. Material examined. HAWAIʻI: Mauna Kea, Puʻu Mali, in association with Pennisetum clandestinum and Sophora Chrysophyllum, 6600 ft [2000 m], 23 Jul 2004, Starr, Starr, & Crummer 040723-4."

Qsn #	Question	Answer
305	**Congeneric weed**	**y**
	Source(s)	**Notes**
	Queensland Government. (2019). Weeds of Australia. Cichorium intybus. http://keyserver.lucidcentral.org. [Accessed 24 May 2019]	"French flax (Linum trigynum) is regarded as an environmental weed in Tasmania, Victoria and Western Australia. This garden escape has become widely naturalised in open areas in Australia, particularly in grasslands and open woodlands. It is seen as a potential threat to one or more vegetation formations in Victoria and appears on some local and regional environmental weeds lists in this state (e.g. in Knox city and the Goulburn Broken Catchment). French flax (Linum trigynum) has also been recorded in Phillip Island Nature Park in Victoria and numerous conservation areas in South Australia (i.e. Marino Conservation Park, Angove Conservation Park, Para Wirra Recreation Park, Morialta Conservation Park, Watts Gully Native Forest Reserve, Kyeema Conservation Park, Sturt Gorge Recreation Park, Belair National Park and Little Mount Crawford Native Forest Reserve). In Tasmania, French flax (Linum trigynum) is widespread in grasslands and grassy woodlands and in south-western Western Australia it grows mainly in damp sites. In New South Wales it is chiefly found south from the Bulahdelah district, and is a weed of woodlands, grasslands and roadsides at Mount Annan Botanic Gardens south-west of Sydney."
	Canadian Food Inspection Agency.2019. The Biology of Linum usitatissimum L. (Flax). Biology Document BIO1994-10. Plant Biosafety Office, Ottawa, Canada. http://www.inspection.gc.ca/. [Accessed 24 May 2019]	"Volunteer flax is a common weed in fields where flax crop is grown in western Canada and it had been ranked as the 26th most abundant weed (Leeson et al. 2005). Volunteer flax emerges over an extended period of time during the growing season with 50% emergence occurring after the in-crop herbicide application (Dexter et al. 2010a). The population densities of volunteer flax ranged from 31 to 4,597 plants m-2 in 20 commercial fields surveyed in the Canadian Prairies. Naked seeds and flax seed bolls can be lost before or after harvest and are the primary contributor to the seed bank and the reason for volunteer persistence over time. In a study conducted in 10 commercial fields in Alberta, Dexter et al. (2011) reported higher seed losses associated with direct harvesting methods when compared to the windrow harvest methods. The maximum yield loss was found to be 44 kg ha-1 or 2.3% of the estimated crop yield. With respect to seed persistence in the soil, it varied with years and the burial depth (longer seed persistence at 10 cm). In a survey of 20 Western Canadian fields following flax production, volunteers continued to emerge in some fields for three growing seasons at low densities (Dexter et al. 2010a). Cultural, mechanical, chemical, and integrated strategies can be used to control volunteer flax." [Can be a weed with poor management practices, but otherwise apparently a weed of minor significance]

401	**Produces spines, thorns or burrs**	**n**
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[No evidence] "Biennial, short-lived perennial, or rarely annual herbs; stems ascending or occasionally erect, slender, 6-60 cm long, glabrous. Leaves linear to linear-lanceolate, 6-12 mm long, 0.5-1.6 mm wide, 1-3-nerved, glabrous, margins entire, apex acuminate."

Qsn #	Question	Answer
402	**Allelopathic**	
	Source(s)	**Notes**
	WRA Specialist. (2019). Personal Communication	Unknown

403	**Parasitic**	**n**
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Biennial, short-lived perennial, or rarely annual herbs; stems ascending or occasionally erect, slender, 6-60 cm long, glabrous. Leaves linear to linear-lanceolate, 6-12 mm long, 0.5-1.6 mm wide, 1 -3-nerved, glabrous, margins entire, apex acuminate." [No evidence]

Qsn #	Question	Answer
404	**Unpalatable to grazing animals**	
	Source(s)	**Notes**
	Fernández-Lugo, S., De Nascimento, L., Mellado, M., Bermejo, L. A., & Arévalo, J. R. (2009). Vegetation change and chemical soil composition after 4 years of goat grazing exclusion in a Canary Islands pasture. Agriculture, Ecosystems & Environment, 132(3-4), 276-282	[Linum bienne persisted in control pots, in spite of goat grazing, suggesting they may be unpalatable] "Extensive goat production systems have played an important role in the structure and specific composition of Tenerife's pastures. Due to the steady decline of grazing goats in the Island, the study of the impact of removal of goat grazing on plant communities is of primary importance, in order to delineate a proper conservation strategy for these ecosystems. We analysed changes in floristic composition, species richness, diversity and soil chemical properties of this plant community during 4 years of removal of goat grazing. No changes in species richness or diversity were detected during the study period, but a species turnover was noted in response to absence of goat grazing, related to soil magnesium content. Although this study showed little changes in Tenerife's pastures after 4 years of removal of goat grazing, changes on this community are expected due to soil chemical properties modification in response to absence of goat grazing. It is suggested that a longer period of exclusion will be necessary to detect changes in plant species composition, and additional studies are necessary to develop a suitable pasture management strategy in order to maintain the stability of these ecosystems." … "Moreover, five out of the twelve exotic species (F. parviflora, C. endivia, Rumex acetosella, Oxalis pescaprae and Conyza bonariensis) appeared only in the exclosure plots, while one appeared exclusively in control plots (Linum bienne)."
	Dash, J., Naik, B. S. and Mohapatra, U. B. (2017). Linseed: A Valuable Crop Plant. International Journal of Advanced Research 5(3), 1428-1442	[Linum usitatissimum, cake is palatable. Flax is derived from L. bienne] "After the extraction of oil from the linseed seed, the residue left behind is called cake, which is brown in colour. Prior to defatting (to remove all or almost all), this cake contains 21.78% of non nitrogenous extract, 29.37% lipids and 27.78% protein, 7.02% fibre, 3.40% ash and 10.65% total humidity (Gutierrez et al., 2010). So it is a protein rich palatable feed for livestock. It is fed to the cattle to improve their health condition and to develop the gloss of their coat, although linseed meal is used as an additive in baking products (Coskuner and Karababa, 2007). However, linseed contain phytic acid, cyanogenic glucoside and goiterogen which limit the linseed cake as animal feed as these are anti nutritional factors. So meal or seeds should be properly processed to remove the toxic constituents."

405	**Toxic to animals**	
	Source(s)	**Notes**
	Adugna, W. (2011). Linum usitatissimum L. [Internet] Record from PROTA4U. Brink, M. & Achigan-Dako, E.G. (Editors). PROTA (Plant Resources of Tropical Africa). Wageningen, Netherlands. http://www.prota4u.org/search.asp. [Accessed 24 May 2019]	"The seed contains the cyanogenic glucoside linamarin, which in the presence of the endogenous enzyme linase (released after seed crushing) hydrolyses to form the poisonous hydrogen cyanide. Prior heating of the presscake avoids cyanide intoxication."

Qsn #	Question	Answer
	Plants for a Future. (2019). Linum usitatissimum. https://pfaf.org/user/Plant.aspx?LatinName=Linum+usitatissimum. [Accessed 24 May 2019]	[The domesticated derivative of L. bienne may be toxic to livestock] "The seed of some strains contain cyanogenic glycosides in the seed though the toxicity is low, especially if the seed is eaten slowly. It becomes more toxic if water is drunk at the same tim [76, 222]. The cyanogenic glycosides are also present in other parts of the plant and have caused poisoning to livestock[240]. Contraindicated with a stricture of the oesophagus in no bowel movement conditions and acute gut inflammatory diseases. Contraindicated in pregnancy. Some suggestion it should be avoided with prostate gland diseases [301]."

406	Host for recognized pests and pathogens	
	Source(s)	**Notes**
	Duke, J. A. (1983). Linum usitatissimum. Handbook of Energy Crops. https://hort.purdue.edu. [Accessed 24 May 2019]	"Many fungi have been found on flax, but the most serious diseases are flax wilt, several rusts, seedling blights, and Pasmo. Causative agents are: Alternaria brassiceae, A. lini, A. linicola, A. solani, A. tenuis; Ascochyta linicola, Botrytis cinerea, Colletotrichum lini, C. linicola, Corticium solani, Diplodia lini, Erysiphe cichoracearum, E. polygoni, E. polyphaga, Fusarium acuminatum, F. avenaceum, F. lini, Kabatiella lini, Leveillula linacearum, Melampsora lini, Mycosphaerella linorum, M. tulasnei, Oidiopsis lini, Oidium lini, Phoma lini, P. linicola, Polyspora lini, Pythium spp., Rhizoctonia solani, Sclerotinia fuckeliana, S. libertiana, S. minor, S. sclerotiorum, Sclerotium rolfsii, Septoria linicola, Sphaerella linorum, Thielaviopsis basicola and Trichothecium roseum. Important viruses causing disease in flax are: Aster yellows (Chlorogenus callistephi), Beet curly top and Yellows. Flax may be parasitized by Cuscuta epilinum, C. epithymum, C. indecora, C. pentagona and Striga lutea. The bacteria Agrobacterium tumefaciens and Pseudomonas atrofaciens also cause diseases. Insects are not a serious problem in flax production. Nematodes isolated from flax include the following species: Ditylenchus dipsaci, Helicotylenchus erythrinae, H. spp., Heterodera schachtii, Meloidogyne arenaria, M. hapla, M. incognita., M. incognita acrita, M. thamesi, M. javanica, Paratylenchus sp., Pratylenchus coffeae, P. penetrans, Tylenochorhynchus spp., and Xiphinema spp. " [Linum usitatissimum most likely evolved by domestication from wild Linum bienne. May share similar pathogens]
	Springer, Y. P. (2009). Do extreme environments provide a refuge from pathogens? A phylogenetic test using serpentine flax. American Journal of Botany, 96(11), 2010-2021	"Melampsora lini Persoon (Uredinales) is an autoecious, macrocyclic, rust fungus that attacks stem and leaf tissue of plants in the family Linaceae (Flor, 1954 ; Lawrence et al., 2007). It is an obligate pathogen, causing localized, nonsystemic lesions on plant stems and leaves that reduce host plant vigor via destruction of photosynthetic tissue (Littlefi eld, 1981)." … "Additionally, within the study area, plant species other than Hesperolinon spp. that could potentially be infected by M. lini (e.g., Linum bienne) are extremely uncommon."

407	Causes allergies or is otherwise toxic to humans	
	Source(s)	**Notes**

Qsn #	Question	Answer
	NC State Extension. (2019). Linum usitatissimum. https://plants.ces.ncsu.edu/plants/all/linum-usitatissimum/. [Accessed 24 May 2019]	"Poison Part: All parts Poison Delivery Mode: Ingestion, dermatitis Symptoms: Linseed oil may cause skin irritation upon contact. Ingestion causes difficulty of breathing, paralysis, and convulsions Toxic Principle: Cyanogenic glycoside (linomarin) Severity: TOXIC ONLY IF LARGE QUANTITIES EATEN. SKIN IRRITATION MINOR, OR LASTING ONLY FOR A FEW MINUTES" [Linum usitatissimum most likely evolved by domestication from wild Linum bienne]

408	Creates a fire hazard in natural ecosystems	n
	Source(s)	**Notes**
	Starr, F., Starr, K. & Loope, L.L. 2006. New plant records from the Hawaiian Archipelago. Bishop Museum Occasional Papers 87: 31-43	"Linum bienne (blue flax) is previously only known from a single collection made in 1982 by A. Medeiros from Wailaulau, Maui where it was sparingly naturalized in meadows (Wagner et al., 1999). It was then also reported from Kaua'i (Oppenheimer, 2004). It is now also known from Hawai'i, scattered in subalpine pasture and mamane (Sophora chrysophylla) shrubland on the north slope of Mauna Kea in the vicinity of Pu'u Mali." [Scattered plants unlikely to contribute much to fuel loads or to fire risk, even if growing in fire prone habitats]
	Weiss, E., & Zohary, D. (2011). The Neolithic Southwest Asian founder crops: their biology and archaeobotany. Current Anthropology, 52(S4), S237-S254	"Linum bienne grows mainly in wet places such as moist grassy areas, springs, seepage areas on rocky slopes, moist clay soils, and marshy lands."

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	**Notes**
	Plants for a Future. (2019). Linum bienne. https://pfaf.org/user/Plant.aspx?LatinName=Linum+bienne. [Accessed 24 May 2019]	" It cannot grow in the shade. It prefers moist soil." … "Prefers a light well-drained moderately fertile humus-rich soil in a sunny sheltered position"
	T.E.R:R.A.I.N. (2019). Linum bienne (Pale flax). http://www.terrain.net.nz/. [Accessed 24 May 2019]	"Widespread throughout New Zealand on roadsides, open waste places and riverbeds." [Occurs in high light environments]

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	**Notes**
	Plants for a Future. (2019). Linum bienne. https://pfaf.org/user/Plant.aspx?LatinName=Linum+bienne. [Accessed 24 May 2019]	"Suitable for: light (sandy) and medium (loamy) soils and prefers well-drained soil. Suitable pH: acid, neutral and basic (alkaline) soils. It cannot grow in the shade. It prefers moist soil."
	Wildflowers of Ireland. (2019). Information on Pale Flax. http://www.wildflowersofireland.net. [Accessed 24 May 2019]	"This plant, which is pollinated by bees and wasps, grows in dry grassland and on neutral or calcareous soil."

Qsn #	Question	Answer
	Practical Plants. (2019). Linum bienne - Pale Flax. https://practicalplants.org/wiki/Linum_bienne. [Accessed 24 May 2019]	Has soil ph preference Acid +, Neutral + and Alkaline + Has soil texture preference Sandy + and Loamy + Has soil water retention preference Well drained +

411	Climbing or smothering growth habit	n
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Biennial, short-lived perennial, or rarely annual herbs; stems ascending or occasionally erect, slender, 6-60 cm long, glabrous. Leaves linear to linear-lanceolate, 6-12 mm long, 0.5-1.6 mm wide, 1 -3-nerved, glabrous, margins entire, apex acuminate."

412	Forms dense thickets	n
	Source(s)	**Notes**
	Flora of North America. (2019). Linum bienne. http://www.efloras.org. [Accessed 24 May 2019]	"Grasslands, woodlands, disturbed places; 0–1900 m" [No evidence]
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"in Hawai'i apparently sparingly naturalized in meadows"
	Starr, F., Starr, K. & Loope, L.L. 2006. New plant records from the Hawaiian Archipelago. Bishop Museum Occasional Papers 87: 31-43	"now also known from Hawai'i, scattered in subalpine pasture and mamane (Sophora chrysophylla) shrubland on the north slope of Mauna Kea in the vicinity of Pu'u Mali."
	T.E.R:R.A.I.N. (2019). Linum bienne (Pale flax). http://www.terrain.net.nz/. [Accessed 24 May 2019]	[No evidence] "Widespread throughout New Zealand on roadsides, open waste places and riverbeds."

501	Aquatic	n
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Terrestrial] "Biennial, short-lived perennial, or rarely annual herbs… in Hawai'i apparently sparingly naturalized in meadows"

502	Grass	n
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 22 May 2019]	Family: Linaceae Subfamily: Linoideae

503	Nitrogen fixing woody plant	n
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 22 May 2019]	Family: Linaceae Subfamily: Linoideae

Qsn #	Question	Answer
504	**Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)**	**n**
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Biennial, short-lived perennial, or rarely annual herbs; stems ascending or occasionally erect, slender, 6-60 cm long, glabrous."

601	**Evidence of substantial reproductive failure in native habitat**	**n**
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Native to western and southern Europe, widely naturalized"

602	**Produces viable seed**	**y**
	Source(s)	**Notes**
	Plants for a Future. (2019). Linum bienne. https://pfaf.org/user/Plant.aspx?LatinName=Linum+bienne. [Accessed 23 May 2019]	"Propagation: Seed - sow early spring in situ[1]."

Qsn #	Question	Answer
603	**Hybridizes naturally**	
	Source(s)	**Notes**
	Muir, A. D., & Westcott, N. D. (Eds.). (2003). Flax: the genus Linum. Taylor & Francis, New York, NY	"Cross-hybridization between cultivated flax and wild species has been tried since the beginning of scientifically based plant breeding in flax. Interspecific hybridization between cultivated flax and L. angustifolium has been successfully conducted (Tammes, 1923). In addition, Gill and Yermanos (1967) report successful hybridization with L. africanum, L. corymbiferum and L. decumbens. Using embryo-rescue techniques, hybrids with L. monogynum have been produced (Nickel, 1993). None of these interspecific crosses has had any practical use in flax breeding. So far, only L. grandiflorum has been used in breeding for cultivated flax. By pollinating L. usitatissimum with L. grandiflorum, the induction of dihaploid embryo growth in cultivated flax is possible."
	Jhala, A. J., Hall, L. M., & Hall, J. C. (2008). Potential hybridization of flax with weedy and wild relatives: an avenue for movement of engineered genes?. Crop Science, 48(3), 825-840	[Possibly yes. Flax is believed to be the domesticate form of L. bienne] "Linum contains approximately 230 species which are distributed in many parts of the world and may grow in sympatry with cultivated flax. Interspecific hybridization and cytogenetic studies between flax and congeneric species demonstrated that cultivated flax has the ability to hybridize and form viable F1 plants with at least nine species of Linum (L. africanum, L. angustifolium, L. corymbiferum, L. decumbens, L. floccosum, L. hirsutum, L nervosum, L. pallescens, and L. tenue). Hybridization of flax with many other wild relatives has either not been studied or reported. However, based on the evidence of reported hybridization with wild or weedy relatives, gene flow from flax to wild or weedy relatives is possible in several species native to North America, depending on species distribution, sympatry, concurrent flowering, ploidy level, and sexual compatibility."

604	Self-compatible or apomictic	y
	Source(s)	**Notes**
	Desmond, E. (2018). Exploring Candidate Genes for theS-locus': The Control of Heterostyly Across Wild and Cultivated Species in the Genus Linum. MSc Thesis. Durham University, Durham, UK	"Not all species exhibit heterostyly: wild flax, L. bienne and its cultivated relative L. usitatissimum, are both self-compatible and homostylous, despite other closely-related members of the genus such as L. grandiflorum and L. narbonense showing heterostyly; the majority lie somewhere in between."
	Weiss, E., & Zohary, D. (2011). The Neolithic Southwest Asian founder crops: their biology and archaeobotany. Current Anthropology, 52(S4), S237-S254	"Some wild forms are annual, and others are biennial or perennial; all are predominantly self-pollinated."

Qsn #	Question	Answer
605	**Requires specialist pollinators**	**n**
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Flowers homostylous; sepals subequal, narrowly ovate, 4-5.5 mm long, midvein raised, margins of inner sepals scarious and somewhat ciliate, margins of outer sepals entire, apex acuminate; petals blue, obovate, 8-14 mm long; stigmas linear."
	T.E.R:R.A.I.N. (2019). Linum bienne (Pale flax). http://www.terrain.net.nz/. [Accessed 23 May 2019]	"The flowers are hermaphrodite and are pollinated by bees and wasps."

606	Reproduction by vegetative fragmentation	n
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Biennial, short-lived perennial, or rarely annual herbs; stems ascending or occasionally erect, slender, 6-60 cm long, glabrous." [No evidence]
	Plants for a Future. (2019). Linum bienne. https://pfaf.org/user/Plant.aspx?LatinName=Linum+bienne. [Accessed 24 May 2019]	"Propagation - Seed - sow early spring in situ"

607	Minimum generative time (years)	1
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Biennial, short-lived perennial"
	Flora of North America. (2019). Linum bienne. http://www.efloras.org. [Accessed 24 May 2019]	"Herbs, biennial or short-lived perennial (flowering 1st year)"
	Weiss, E., & Zohary, D. (2011). The Neolithic Southwest Asian founder crops: their biology and archaeobotany. Current Anthropology, 52(S4), S237-S254	"Some wild forms are annual, and others are biennial or perennial; all are predominantly self-pollinated."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y
	Source(s)	**Notes**
	Esler, A. E. (1988). The naturalisation of plants in urban Auckland, New Zealand 4. The nature of the naturalised species. New Zealand Journal of Botany, 26(3), 345-385	"Seeds of some plants (Capsella bursa-pastoris, Juncus spp., Luzula spp., Plantago spp., Linum spp.) become mucilaginous when wet and can be carried long distances adhering to moving objects. Seeds may become quite firmly fixed as the mucilage dries."
	T.E.R:R.A.I.N. (2019). Linum bienne (Pale flax). http://www.terrain.net.nz/. [Accessed 24 May 2019]	"Widespread throughout New Zealand on roadsides, open waste places and riverbeds." [Occurs in heavily trafficked areas]

Qsn #	Question	Answer
702	**Propagules dispersed intentionally by people**	
	Source(s)	**Notes**
	WRA Specialist. (2019). Personal Communication	Unclear. Possibly an accidental introduction, or intentionally cultivated, but generally not grown as much as the domesticated Linum usitatissimum

703	Propagules likely to disperse as a produce contaminant	y
	Source(s)	**Notes**
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Major Pathway/s: Contaminant, Herbal, Ornamental Dispersed by: Humans, Horse, Livestock"
	Lao, C. 2009. Specimen Details for Linum bienne Mill. ID Number 738701. Bishop Museum, Honolulu, HI. http://nsdb.bishopmuseum.org. [Accessed 22 May 2019]	"Possibly purposefully planted ornamental or sprouting of birdseed for pets."

704	Propagules adapted to wind dispersal	n
	Source(s)	**Notes**
	Flora of North America. (2019). Linum bienne. http://www.efloras.org. [Accessed 24 May 2019]	"Capsules broadly ovate to subglobose, 4–6 × 4–6 mm, apex very sharp-pointed, segments ± persistent on plant, margins ciliate. Seeds 2.5–3 × 1.5–2 mm." [Seeds small, but lack adaptations for wind dispersal]

705	Propagules water dispersed	
	Source(s)	**Notes**
	Esler, A. E. (1988). The naturalisation of plants in urban Auckland, New Zealand 4. The nature of the naturalised species. New Zealand Journal of Botany, 26(3), 345-385	"Seeds of some plants (Capsella bursa-pastoris, Juncus spp., Luzula spp., Plantago spp., Linum spp.) become mucilaginous when wet and can be carried long distances adhering to moving objects. Seeds may become quite firmly fixed as the mucilage dries."
	T.E.R:R.A.I.N. (2019). Linum bienne (Pale flax). http://www.terrain.net.nz/. [Accessed 24 May 2019]	"Widespread throughout New Zealand on roadsides, open waste places and riverbeds." [Occurrence in riverbeds suggests water dispersal]

706	Propagules bird dispersed	n
	Source(s)	**Notes**
	Esler, A. E. (1988). The naturalisation of plants in urban Auckland, New Zealand 4. The nature of the naturalised species. New Zealand Journal of Botany, 26(3), 345-385	"Seeds of some plants (Capsella bursa-pastoris, Juncus spp., Luzula spp., Plantago spp., Linum spp.) become mucilaginous when wet and can be carried long distances adhering to moving objects. Seeds may become quite firmly fixed as the mucilage dries." [Could possibly adhere to birds, but not adapted for internal bird dispersal]

Qsn #	Question	Answer
707	**Propagules dispersed by other animals (externally)**	
	Source(s)	**Notes**
	Esler, A. E. (1988). The naturalisation of plants in urban Auckland, New Zealand 4. The nature of the naturalised species. New Zealand Journal of Botany, 26(3), 345-385	"Seeds of some plants (Capsella bursa-pastoris, Juncus spp., Luzula spp., Plantago spp., Linum spp.) become mucilaginous when wet and can be carried long distances adhering to moving objects. Seeds may become quite firmly fixed as the mucilage dries."

708	Propagules survive passage through the gut	y
	Source(s)	**Notes**
	Quinn, L. D. et al. (2008). Germination of invasive plant seeds after digestion by horses in California. Natural Areas Journal, 28(4), 356-363	"Table 1: Scientific and common names for species germinating in both trials. The trial in which each species germinated is indicated by a '1' or a '2' in the last column. For species which were native or unknown, a lowercase "u" indicates unknown status, while lowercase "n" indicates the species is native to the United States. The 32 species are listed by category of invasiveness according to Cal IPC (2006) and USDA, NRCS (2007). None of these species were categorized as noxious weeds by CDFA." [Both Linum bienne and Linum usitatissimum seeds germinated from horse feces]

801	Prolific seed production (>1000/m2)	
	Source(s)	**Notes**
	Flora of North America. (2019). Linum bienne. http://www.efloras.org. [Accessed 24 May 2019]	"Capsules broadly ovate to subglobose, 4–6 × 4–6 mm, apex very sharp-pointed, segments ± persistent on plant, margins ciliate. Seeds 2.5–3 × 1.5–2 mm."
	Reiné, R., Chocarro, C., & Fillat, F. (2004). Soil seed bank and management regimes of semi-natural mountain meadow communities. Agriculture, Ecosystems & Environment, 104(3), 567-575	"Table 1 Mean number of seed per square meter area in four meadows of the Spanish Pyrenees" [Linum bienne - Extensive uncut = 20.79 ± 14.63 Seedsm−2 ± S.E.]

802	Evidence that a persistent propagule bank is formed (>1 yr)	
	Source(s)	**Notes**
	Royal Botanic Gardens Kew. (2019) Seed Information Database (SID). Version 7.1. Available from: http://data.kew.org/sid/. [Accessed 24 May 2019]	"Storage Behaviour: Orthodox Storage Conditions: Long-term storage under IPGRI preferred conditions at RBG Kew, WP. Oldest collection18 years; average germination change 94 to 87.5%, mean storage period 14 years, 2 collections"

803	Well controlled by herbicides	y
	Source(s)	**Notes**

Qsn #	Question	Answer
	Canadian Food Inspection Agency.2019. The Biology of Linum usitatissimum L. (Flax). Biology Document BIO1994-10. Plant Biosafety Office, Ottawa, Canada. http://www.inspection.gc.ca/. [Accessed 24 May 2019]	[Herbicides that control flax would likely be effective] "Because flax is a broadleaf species, control of volunteer flax in field crops is particularly difficult to achieve. However, the Saskatchewan Flax Development Commission (2018) recommends the use of quinclorac herbicide which provides excellent control of volunteer flax in wheat. Products or mixtures that contain dichlorprop will provide some suppression of volunteer flax in cereal crops. Use the maximum recommended rates. Products that include 2,4-D LV ester will have slightly more effect on the flax than 2,4-D amine or MCPA."

804	**Tolerates, or benefits from, mutilation, cultivation, or fire**	
	Source(s)	**Notes**
	Duke, J. A. (1983). Linum usitatissimum. Handbook of Energy Crops. https://hort.purdue.edu. [Accessed 24 May 2019]	[Unknown for L. bienne] "Reported from the Central Asian, Near Eastern and Mediterranean Centers of Diversity, flax or cvs thereof is reported to tolerate disease, drought, fungi, grazing, herbicides, hydrogen fluoride, high pH, pesticides, rust, virus, and weeds (Duke, 1978)."

805	**Effective natural enemies present locally (e.g. introduced biocontrol agents)**	
	Source(s)	**Notes**
	WRA Specialist. (2019). Personal Communication	Unknown. Naturalized on three Hawaiian Islands, but no information on natural enemies found

Summary of Risk Traits:

High Risk / Undesirable Traits
• Elevation range exceeds 1000 m, demonstrating environmental versatility
• Naturalized in regions with tropical climates
• Naturalized on Kauai, Maui and Hawaii (Hawaiian Islands); widely naturalized elsewhere
• A weed of lawns, disturbed areas, pastures, and potentially of agriculture
• Other Linum species are weeds
• Seeds may contain toxic compounds
• Tolerates many soil types
• Reproduces by seeds
• Self-compatible
• Reaches maturity in one year
• Seeds dispersed as a contaminant, possibly by water, and possibly attached to animals, equipment and vehicles
• Viable seeds survive gut passage after consumption by horses

Low Risk Traits
• Despite widespread naturalization and reports of weediness, impacts appear to be minimal, or are generally innocuous
• Unarmed (no spines, thorns or burrs)
• Shade-intolerant
• Not reported to spread vegetatively
• Herbicides may provide effective control