

<b>Taxon:</b> <i>Festuca bromoides</i> L.	<b>Family:</b> Poaceae
<b>Common Name(s):</b> annual fescue brome fescue silver grass six-weeks fescue squirreltail fescue	<b>Synonym(s):</b> Bromus dertonensis All. <i>Festuca dertonensis</i> (All.) Asch. & Graebn. <i>Vulpia bromoides</i> (L.) Gray <i>Vulpia dertonensis</i> (All.) Gola

<b>Assessor:</b> Chuck Chimera	<b>Status:</b> Approved	<b>End Date:</b> 24 May 2024
<b>WRA Score:</b> 18.0	<b>Designation:</b> H(Hawai'i)	<b>Rating:</b> High Risk

**Keywords:** Annual Grass, Crop Weed, Environmental Weed, Dense Cover, Externally Dispersed

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	y = 1*multiplier (see Appendix 2), n = 0	n
303	Agricultural/forestry/horticultural weed	y = 2*multiplier (see Appendix 2), n = 0	y
304	Environmental weed	y = 2*multiplier (see Appendix 2), n = 0	y
305	Congeneric weed	y = 1*multiplier (see Appendix 2), n = 0	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	y = 1, n = -1	n
405	Toxic to animals	y = 1, n = 0	n
406	Host for recognized pests and pathogens	y = 1, n = 0	y
407	Causes allergies or is otherwise toxic to humans	y = 1, n = 0	n
408	Creates a fire hazard in natural ecosystems		

Qsn #	Question	Answer Option	Answer
409	Is a shade tolerant plant at some stage of its life cycle		
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	y
501	Aquatic	y = 5, n = 0	n
502	Grass	y = 1, n = 0	y
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	y = 1, n = -1	y
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	y = 1, n = -1	n
703	Propagules likely to disperse as a produce contaminant	y = 1, n = -1	y
704	Propagules adapted to wind dispersal	y = 1, n = -1	y
705	Propagules water dispersed	y = 1, n = -1	y
706	Propagules bird dispersed	y = 1, n = -1	n
707	Propagules dispersed by other animals (externally)	y = 1, n = -1	y
708	Propagules survive passage through the gut	y = 1, n = -1	y
801	Prolific seed production (>1000/m <sup>2</sup> )	y = 1, n = -1	y
802	Evidence that a persistent propagule bank is formed (>1 yr)	y = 1, n = -1	y
803	Well controlled by herbicides	y = -1, n = 1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire	y = 1, n = -1	n
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
	Flora of North America Editorial Committee. (2007). Flora of North America: North of Mexico, Volume 24. Magnoliophyta: Commelinidae (in part): Poaceae, part 1. Oxford University Press, Oxford, UK	" <i>Vulpia bromoides</i> is a common European species that grows in wet to dry, open habitats. It is adventive and naturalized in North and South America. In North America, it is most common on the west coast, where it grows from British Columbia to northern Baja California; it occurs sparingly in other regions." [No evidence of domestication that reduces weediness]

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. (2024). Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. (2024). 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, Agricultural Research Service, National Plant Germplasm System. (2024). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. <a href="https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch">https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch</a> . [Accessed 24 May 2024]	<p>"Native Africa                      MACARONESIA: Spain [Canarias], Portugal [Azores, Madeira Islands]                      NORTHERN AFRICA: Algeria, Egypt, Libya, Morocco, Tunisia                      NORTHEAST TROPICAL AFRICA: Eritrea, Ethiopia, Sudan                      EAST TROPICAL AFRICA: Kenya, Uganda                      WEST-CENTRAL TROPICAL AFRICA: Cameroon (found only on Mt. Cameroon)                      Asia-Temperate                      WESTERN ASIA: Israel, Jordan, Lebanon, Syria, Turkey                      CAUCASUS: Azerbaijan, Georgia                      Europe                      NORTHERN EUROPE: Denmark, United Kingdom, Ireland, Sweden                      MIDDLE EUROPE: Austria, Belgium, Switzerland, Germany, Hungary, Netherlands, Poland, Slovakia                      EASTERN EUROPE: Russian Federation-European part [European part]                      SOUTHEASTERN EUROPE: Albania, Bulgaria, Greece (incl. Crete), Croatia, Italy (incl. Sardinia, Sicily), Romania, Serbia, Slovenia                      SOUTHWESTERN EUROPE: Spain (incl. Balears), France (incl. Corsica), Portugal"</p>
	Flora of North America Editorial Committee. (2007). Flora of North America: North of Mexico, Volume 24. Magnoliophyta: Commelinidae (in part): Poaceae, part 1. Oxford University Press, Oxford, UK	" <i>Vulpia bromoides</i> is a common European species that grows in wet to dry, open habitats. It is adventive and naturalized in North and South America. In North America, it is most common on the west coast, where it grows from British Columbia to northern Baja California; it occurs sparingly in other regions."

202	Quality of climate match data	High
-----	-------------------------------	------

Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Flora of North America Editorial Committee. (2007). Flora of North America: North of Mexico, Volume 24. Magnoliophyta: Commelinidae (in part): Poaceae, part 1. Oxford University Press, Oxford, UK	" <i>Vulpia bromoides</i> is a common European species that grows in wet to dry, open habitats. It is adventive and naturalized in North and South America. In North America, it is most common on the west coast, where it grows from British Columbia to northern Baja California; it occurs sparingly in other regions."

203	<b>Broad climate suitability (environmental versatility)</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Starr, F. & Starr, K. (2011). New plant records from Midway Atoll, Maui and Kaho'olawe. Bishop Museum Occasional Papers. 110: 23-35	"The following specimens were collected at an elevation of 10,000 ft [3050 m] at the Haleakalā observatories facility on Pu'u Kolekole, on the summit of east Maui. these new high elevation records extend the known altitudinal range of these species in Hawai'i. Previous high elevations are from Wagner et al., 1999." [Includes <i>Vulpia bromoides</i> ]
	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.	[Elevation range exceeds 2000 m, demonstrating environmental versatility] "...in Hawai'i naturalized in dry, disturbed sites such as along roadsides, in pastures, and on rocky slopes, 185-2,590 m,"

204	<b>Native or naturalized in regions with tropical or subtropical climates</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	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 naturalized in dry, disturbed sites such as along roadsides, in pastures, and on rocky slopes, 185-2,590 m, on all of the main islands except Ni'ihau and Kaho'olawe."
	Queensland Government. (2024). Weeds of Australia - <i>Vulpia bromoides</i> . <a href="https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm">https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm</a> . [Accessed 24 May 2024]	"A serious weed of crops, pastures, roadsides, lawns, footpaths, coastal environs, grasslands, open woodlands, disturbed sites and waste areas in temperate, semi-arid and sub-tropical regions."

205	<b>Does the species have a history of repeated introductions outside its natural range?</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	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.	[Widely introduced and naturalized] "Naturalized Africa SOUTHERN AFRICA: Lesotho, South Africa WESTERN INDIAN OCEAN: Mauritius Australasia AUSTRALIA: Australia NEW ZEALAND: New Zealand Northern America REGION: Canada, Mexico, United States Pacific NORTH-CENTRAL PACIFIC: United States [Hawaii] Southern America CARIBBEAN: West Indies CENTRAL AMERICA: Costa Rica, Guatemala, Honduras, El Salvador BRAZIL: Brazil WESTERN SOUTH AMERICA: Colombia, Peru SOUTHERN SOUTH AMERICA: Argentina, Chile, Uruguay"

301	<b>Naturalized beyond native range</b>	<b>y</b>
-----	--	----------

Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	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 Europe, northern Africa, and Asia Minor; in Hawai'i naturalized in dry, disturbed sites such as along roadsides, in pastures, and on rocky slopes, 185-2,590 m, on all of the main islands except Ni'ihau and Kaho'olawe. First collected on Hawai'i in 1905 (Maguire s.n., BISH)."
	Starr, F. & Starr, K. (2011). New plant records from Midway Atoll, Maui and Kaho'olawe. Bishop Museum Occasional Papers. 110: 23-35	"The following specimens were collected at an elevation of 10,000 ft [3050 m] at the Haleakalā observatories facility on Pu'u Kolekole, on the summit of east Maui. these new high elevation records extend the known altitudinal range of these species in Hawai'i. Previous high elevations are from Wagner et al., 1999." [Includes <i>Vulpia bromoides</i> ]
	Flora of North America Editorial Committee. (2007). Flora of North America: North of Mexico, Volume 24. Magnoliophyta: Commelinidae (in part): Poaceae, part 1. Oxford University Press, Oxford, UK	" <i>Vulpia bromoides</i> is a common European species that grows in wet to dry, open habitats. It is adventive and naturalized in North and South America. In North America, it is most common on the west coast, where it grows from British Columbia to northern Baja California; it occurs sparingly in other regions."
	Queensland Government. (2024). Weeds of Australia - <i>Vulpia bromoides</i> . <a href="https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm">https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm</a> . [Accessed 24 May 2024]	"Widely naturalised in southern Australia (i.e. in New South Wales, the ACT, Victoria, Tasmania, many parts of South Australia and large parts of south-western and western Western Australia). Also occasionally naturalised in south-eastern Queensland and on some offshore islands (i.e. Lord Howe Island and Norfolk Island). Widely naturalised in other parts of the world, including in southern Africa, the Mascarenes, New Zealand, Hawaii, North America (the USA and Canada) and the Caribbean."

302	Garden/amenity/disturbance weed	n
	<b>Source(s)</b>	<b>Notes</b>
	Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a> . [Accessed 24 May 2024]	[Agricultural and environmental weed] "Weedy annual grasses like <i>V. bromoides</i> can reduce biodiversity on native grasslands, impede their restoration, and alter ecosystem processes. In pastures, <i>V. bromoides</i> reduces productivity, has low palatability, and its seeds can damage hides and wool of grazing animals. In annual crops like wheat, the species reduces yields (ISSG, 2012)."

303	Agricultural/forestry/horticultural weed	y
	<b>Source(s)</b>	<b>Notes</b>
	Queensland Government. (2024). Weeds of Australia - <i>Vulpia bromoides</i> . <a href="https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm">https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm</a> . [Accessed 24 May 2024]	"A serious weed of crops, pastures, roadsides, lawns, footpaths, coastal environs, grasslands, open woodlands, disturbed sites and waste areas in temperate, semi-arid and sub-tropical regions."

Qsn #	Question	Answer
	<p>Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a>. [Accessed 24 May 2024]</p>	<p>"<i>V. bromoides</i>, along with <i>V. myuros</i> and other annual grasses, has become a major problem in pastures and crops in Australia. Populations of seedlings in Australian pastures can exceed 40,000 per square metre. According to Loo (2005), species of <i>Vulpia</i> have only become of concern to the farming community in Australia since the late 1980s. He suggests that this may be due to climatic changes or, more likely to changes in agronomic practices, like the introduction of direct drilling or minimum tillage. Species of <i>Vulpia</i> produce low quality forage for livestock, and, at high densities, interfere with the yields of crops like wheat. In the Pacific Northwest of the USA, it is worth noting that the closely related <i>V. myuros</i> is becoming increasingly common in wheat based cropping systems as a result of minimum-tillage and direct-seeding becoming a common practice (Ball and Hulting, 2009). Residues of <i>Vulpia</i> can have allelopathic effects on pasture species (subterranean clover - <i>Trifolium subterraneum</i>, lucerne - <i>Medicago sativa</i>, phalaris - <i>Phalaris aquatica</i>) and crops like wheat (<i>Triticum aestivum</i>) (Pratley and Ingrey, 1990). The small, sharp, awned seeds, along with those of <i>Hordeum</i> spp. and <i>Bromus</i> spp. contaminate and devalue sheep's wool in both Australia and New Zealand. The seeds of these species also lodge in the eyes, ears, mouths and skin of livestock, causing them discomfort, which can in turn lead to reduced livestock weight gains."</p>
	<p>Randall, R.P. (2017). <i>A Global Compendium of Weeds</i>. 3rd Edition. Perth, Western Australia. R.P. Randall</p>	<p>"Weed of: Cereals, Pastures"</p>

304	Environmental weed	y
	Source(s)	Notes
	<p>Queensland Government. (2024). Weeds of Australia - <i>Vulpia bromoides</i>. <a href="https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm">https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm</a>. [Accessed 24 May 2024]</p>	<p>"Squirrel-tail fescue (<i>Vulpia bromoides</i>) is regarded as an environmental weed in Victoria and Western Australia."</p>
	<p>Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a>. [Accessed 24 May 2024]</p>	<p>"Weedy annual grasses like <i>V. bromoides</i> can reduce biodiversity on native grasslands, impede their restoration, and alter ecosystem processes. In pastures, <i>V. bromoides</i> reduces productivity, has low palatability, and its seeds can damage hides and wool of grazing animals. In annual crops like wheat, the species reduces yields (ISSG, 2012)."</p>
	<p>Weber, E. (2017). <i>Invasive Plant Species of the World</i>, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK</p>	<p>"Where invasive <i>Vulpia bromoides</i> successfully competes with native grasses and forbs for water, space and nutrients. It forms dense swards crowding out native plants and reducing species richness. It is also a major weed of neglected pastures (Dowling et al., 2004). The small and sharp seeds can cause injury to livestock (Wallace, 1997)."</p>

Qsn #	Question	Answer
305	Congeneric weed	y
	Source(s)	Notes
	CABI. (2024). CABI Compendium Invasive Species. <a href="https://www.cabidigitallibrary.org/product/qi">https://www.cabidigitallibrary.org/product/qi</a> . [Accessed 24 May 2024]	[synonym of <i>Festuca myuros</i> ] " <i>Vulpia myuros</i> is an annual grass, native to much of Europe and parts of Asia, introduced to the USA, Australia and a number of other countries, and reported as invasive in Australia, the western USA and parts of the Pacific. It outcompetes native species in grasslands of the western US and is a significant agricultural weed. It forms dense swards and its shallow roots suppress growth of native grasses and forbs. Establishment of native plants is strongly hindered once it has become dominant; because it is a winter-annual, it grows rapidly in early spring, thus successfully competing with the slower-growing native perennial grasses. It is a problem weed in pastures and in direct-seed cropping systems. Infested hay can cause injury to livestock due to the sharp seeds. Seeds easily attach to animals and cause losses in the wool industry. Residues of degrading <i>Vulpia</i> plants affect growth of other species including crops."

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.	"Glabrous annuals; culms loosely tufted, base decumbent, 1-3(-5.5) dm tall, lower nodes geniculate. Sheaths open, sparsely to evenly pilose or glabrous, margins membranous, overlapping; ligule erose-ciliate, 0.2- 0.6 mm long; blades usually involute, filiform, lower surface pubescent."

402	Allelopathic	n
	Source(s)	Notes
	Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a> . [Accessed 24 May 2024]	"Residues of <i>Vulpia</i> can have allelopathic effects on pasture species (subterranean clover - <i>Trifolium subterraneum</i> , lucerne - <i>Medicago sativa</i> , phalaris - <i>Phalaris aquatica</i> ) and crops like wheat ( <i>Triticum aestivum</i> ) (Pratley and Ingrey, 1990)."

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.	"Glabrous annuals; culms loosely tufted, base decumbent, 1-3(-5.5) dm tall, lower nodes geniculate." [Poaceae. No evidence]

404	Unpalatable to grazing animals	n
	Source(s)	Notes
	Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a> . [Accessed 24 May 2024]	"Hard grazing can be used to limit seed production in species of <i>Vulpia</i> , especially soon after germination in autumn and in spring, when the seedheads are produced (Jones and Whalley, 1992)."

405	Toxic to animals	n
	Source(s)	Notes

Qsn #	Question	Answer
	Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a> . [Accessed 24 May 2024]	[No evidence] "Hard grazing can be used to limit seed production in species of <i>Vulpia</i> , especially soon after germination in autumn and in spring, when the seedheads are produced (Jones and Whalley, 1992)."
	Quattrocchi, U. (2012). CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	No evidence

406	Host for recognized pests and pathogens	y
	Source(s)	Notes
	Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a> . [Accessed 24 May 2024]	The species also acts as host for a range of cereal root diseases including take-all, crown rot, rhizoctonia, bare patch and common root rot. Like other annual grasses, <i>V. bromoides</i> can act as host for the crop pest webworm <i>Hednota</i> spp. It is also a host for the nematode that causes annual ryegrass toxicity (Riley and McKay, 1991).

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	Notes
	Quattrocchi, U. (2012). CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	No evidence
	Wagstaff, D.J. (2008). International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	No evidence

408	Creates a fire hazard in natural ecosystems	
	Source(s)	Notes
	Zouhar, K., Smith, J.K., Sutherland, S. & Brooks, M.L. (2008). Wildland fire in ecosystems: fire and nonnative invasive plants. Gen. Tech. Rep. RMRS-GTR-42-vol. 6. USDA Forest Service, Rocky Mountain Research Station, Ogden, UT	[May increase fire risk] "Although we do not know the degree to which fire promoted invasions in California grasslands, there are a number of nonnatives that consistently have high cover values in burned grassland areas (Klinger and Messer 2001; Parsons and Stohlgren 1989) (table 9-1). These include Eurasian annual grasses such as barbed goatgrass ( <i>Aegilops triuncialis</i> ), slender oat ( <i>Avena barbata</i> ), wild oat ( <i>A. fatua</i> ), ripgut brome ( <i>Bromus diandrus</i> ), soft brome ( <i>B. hordeaceus</i> ), red brome ( <i>B. rubens</i> ), seaside barley ( <i>Hordeum marinum</i> ), mouse barley ( <i>H. murinum</i> ), Italian ryegrass ( <i>Lolium perenne</i> ssp. <i>multiflorum</i> ), medusahead ( <i>Taeniatherum caput-medusae</i> ), brome fescue ( <i>Vulpia bromoides</i> ), and foxtail fescue ( <i>V. myuros</i> )."
	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.	[May increase fuel load & fire risk in fire prone habitats] "...in Hawai'i naturalized in dry, disturbed sites such as along roadsides, in pastures, and on rocky slopes, 185-2,590 m, on all of the main islands except Ni'ihau and Kaho'olawe."

409	Is a shade tolerant plant at some stage of its life cycle	
	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.	[Generally found in open habitats] "in dry, disturbed sites such as along roadsides, in pastures, and on rocky slopes,"



Qsn #	Question	Answer
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	<b>Source(s)</b>	<b>Notes</b>
	Cunningham, G.M., Mulham, W.E., Milthorpe, P.L. & Leigh, J.H. (2011). Plants of Western New South Wales. CSIRO Publishing, Collingwood, Australia	"Recorded from a range of soil types and vegetation communities."
	Benson, D., & McDougall, L. (2005). Ecology of Sydney plant species: part 10, Monocotyledon families Lemnaceae to Zosteraceae. Cunninghamia 9(1): 16-204	"SUBSTRATE: Clay soils on shale, granite, sand."
411	Climbing or smothering growth habit	n
	<b>Source(s)</b>	<b>Notes</b>
	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.	"Glabrous annuals; culms loosely tufted, base decumbent, 1-3(-5.5) dm tall, lower nodes geniculate."
412	Forms dense thickets	y
	<b>Source(s)</b>	<b>Notes</b>
	Weber, E. (2017). Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"It forms dense swards crowding out native plants and reducing species richness."
501	Aquatic	n
	<b>Source(s)</b>	<b>Notes</b>
	Weber, E. (2017). Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	[Terrestrial] "Grassland, heathland, riparian habitats, pastures, disturbed sites."
502	Grass	y
	<b>Source(s)</b>	<b>Notes</b>
	USDA, Agricultural Research Service, National Plant Germplasm System. (2024). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. <a href="https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch">https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch</a> . [Accessed 24 May 2024]	"Genus: Festuca Family: Poaceae (alt. Gramineae) Subfamily: Pooideae Tribe: Poeae Subtribe: Loliinae"
503	Nitrogen fixing woody plant	n
	<b>Source(s)</b>	<b>Notes</b>
	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.	Poaceae
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n

Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	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.	"Glabrous annuals; culms loosely tufted, base decumbent, 1-3(-5.5) dm tall, lower nodes geniculate."
601	<b>Evidence of substantial reproductive failure in native habitat</b>	<b>n</b>
	<b>Source(s)</b>	<b>Notes</b>
	USDA, Agricultural Research Service, National Plant Germplasm System. (2024). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. <a href="https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch">https://npgsweb.ars-grin.gov/gringlobal/taxon/taxonomysearch</a> . [Accessed 24 May 2024]	No evidence. Widespread native & introduced range
602	<b>Produces viable seed</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Queensland Government. (2024). Weeds of Australia - <i>Vulpia bromoides</i> . <a href="https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm">https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm</a> . [Accessed 24 May 2024]	"This species reproduces only by seed, which may be dispersed shorter distances by wind or water. They readily become attached to animals, clothing and vehicles, and are also spread longer distances in contaminated agricultural produce."
603	<b>Hybridizes naturally</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a> . [Accessed 24 May 2024]	"Hubbard (1984) reported that "A rare hybrid with <i>Festuca rubra</i> has been found in Sussex and Suffolk".
	Ainscough, M. M., Barker, C. M., & Stace, C. A. (1986). Natural hybrids between <i>Festuca</i> and species of <i>Vulpia</i> section <i>Vulpia</i> . <i>Watsonia</i> , 16(2), 143-151	"The occurrences and characteristics of the intergeneric hybrids between <i>Festuca rubra</i> L. agg. and <i>Vulpia bromoides</i> (L.) S. F. Gray and <i>V. myuros</i> (L.) C. C. Gmelin (Poaceae) are detailed. The hybrid of <i>V. bromoides</i> has been found on five occasions in three localities in England. involving both <i>F. rubra</i> and <i>F. nigrescens</i> as the other parent. The hybrid of <i>V. myuros</i> has been found on five occasions in four localities in England and Wales. and once in Holland, also involving both <i>F. rubra</i> and <i>F. nigrescens</i> as the other parent. Studies of meiosis in the hybrids show that the chromosomes of <i>F. rubra</i> can exchange genetic material with those of both <i>V. bromoides</i> and <i>V. myuros</i> , although both hybrids are very highly sterile. The significance of these facts to the evolution of <i>F. rubra</i> agg. is discussed."
604	<b>Self-compatible or apomictic</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a> . [Accessed 24 May 2024]	" <i>Vulpia</i> is a high selfing genus but both self-fertilisation and cross-fertilisation seem to occur (Loo, 2005). According to Cotton and Stace (1977), fertile florets are cleistogamous, usually have only one or two stamens and are fully self-fertile."
605	<b>Requires specialist pollinators</b>	<b>n</b>

Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Zomlefer, W.B. (1994). Guide to Flowering Plant Families. The University of North Carolina Press, Chapel Hill & London	Poaceae [anemophilous. Wind-pollinated]
606	<b>Reproduction by vegetative fragmentation</b>	n
	<b>Source(s)</b>	<b>Notes</b>
	Queensland Government. (2024). Weeds of Australia - <i>Vulpia bromoides</i> . <a href="https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm">https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm</a> . [Accessed 24 May 2024]	"This species reproduces only by seed..."
607	<b>Minimum generative time (years)</b>	1
	<b>Source(s)</b>	<b>Notes</b>
	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.	"Glabrous annuals"
701	<b>Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)</b>	y
	<b>Source(s)</b>	<b>Notes</b>
	Benson, D., & McDougall, L. (2005). Ecology of Sydney plant species: part 10, Monocotyledon families Lemnaceae to Zosteraceae. <i>Cunninghamia</i> 9(1): 16-204	"Dispersal, Establishment & Growth: Diaspore adhesive for dispersal (McIntyre et al. 1995), dispersed in mud on cars (Wace 1977)."
	Queensland Government. (2024). Weeds of Australia - <i>Vulpia bromoides</i> . <a href="https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm">https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm</a> . [Accessed 24 May 2024]	"This species reproduces only by seed, which may be dispersed shorter distances by wind or water. They readily become attached to animals, clothing and vehicles, and are also spread longer distances in contaminated agricultural produce."
702	<b>Propagules dispersed intentionally by people</b>	n
	<b>Source(s)</b>	<b>Notes</b>
	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.	"First collected on Hawai'i in 1905" [May have been intentionally introduced in the past]
	Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a> . [Accessed 24 May 2024]	[Introduced intentionally in the past, but no evidence of current intentional introduction] "According to Wallace (1998) the plants most frequently associated with species of <i>Vulpia</i> in Australia are the annual grasses, annual ryegrass ( <i>Lolium rigidum</i> ), barley grasses ( <i>Critesion</i> spp.), and <i>Bromus</i> spp., and introduced, naturalised broadleaved annuals like subterranean clover ( <i>Trifolium subterraneum</i> ), capeweed ( <i>Arctotheca calendula</i> ) and storksbill ( <i>Erodium</i> spp.). Species of <i>Vulpia</i> are usually sub-dominant in the sward but become dominant after removal of the dominant species, for example, after the use of herbicides.
703	<b>Propagules likely to disperse as a produce contaminant</b>	y
	<b>Source(s)</b>	<b>Notes</b>

Qsn #	Question	Answer
	Queensland Government. (2024). Weeds of Australia - <i>Vulpia bromoides</i> . <a href="https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm">https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm</a> . [Accessed 24 May 2024]	"This species reproduces only by seed, which may be dispersed shorter distances by wind or water. They readily become attached to animals, clothing and vehicles, and are also spread longer distances in contaminated agricultural produce."
704	<b>Propagules adapted to wind dispersal</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Queensland Government. (2024). Weeds of Australia - <i>Vulpia bromoides</i> . <a href="https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm">https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm</a> . [Accessed 24 May 2024]	"This species reproduces only by seed, which may be dispersed shorter distances by wind or water."
705	<b>Propagules water dispersed</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Queensland Government. (2024). Weeds of Australia - <i>Vulpia bromoides</i> . <a href="https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm">https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm</a> . [Accessed 24 May 2024]	"This species reproduces only by seed, which may be dispersed shorter distances by wind or water."
706	<b>Propagules bird dispersed</b>	<b>n</b>
	<b>Source(s)</b>	<b>Notes</b>
	Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a> . [Accessed 24 May 2024]	"Seeds are light and readily carried by even light breezes." ... "Accidental Introduction Seeds are easily caught in clothing, particularly knitted items, such as socks. Seeds also readily attach to animal wool, fur or hair and can thus be carried for long distances."
707	<b>Propagules dispersed by other animals (externally)</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Queensland Government. (2024). Weeds of Australia - <i>Vulpia bromoides</i> . <a href="https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm">https://keyserver.lucidcentral.org/weeds/data/media/Html/vulpia_bromoides.htm</a> . [Accessed 24 May 2024]	"This species reproduces only by seed, which may be dispersed shorter distances by wind or water. They readily become attached to animals, clothing and vehicles, and are also spread longer distances in contaminated agricultural produce."
708	<b>Propagules survive passage through the gut</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Malo, J. E., & Suárez, F. (1995). Herbivorous mammals as seed dispersers in a Mediterranean dehesa. <i>Oecologia</i> , 104(2), 246-255	"Appendix 1 Number of seeds germinated from the whole set of 3-g dung samples (n = 104 for rabbit, fallow deer and cattle, ? = 103 for red deer)." [Vulpia bromoides seed germinated from rabbit dung]
801	<b>Prolific seed production (&gt;1000/m2)</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>

Qsn #	Question	Answer
	<p>Figueroa, J. A., Teillier, S., &amp; Jaksic, F. M. (2004). Composition, size and dynamics of the seed bank in a mediterranean shrubland of Chile. <i>Austral Ecology</i>, 29(5), 574-584</p>	<p>"Seed bank density was significantly higher during late spring and summer than during late winter (Table 3). At the end of spring, mean seed density was 20 times higher than at the end of winter (Fig. 2a). The grasses <i>Bromus berterianus</i> and <i>Vulpia bromoides</i> were the two species that contributed most towards the rise in seed density. Together, they made up 29% of the total number of seeds in the bank at the end of winter and 84% at the end of spring. The accumulated density of these two grasses reached 6000 seeds per m2 during late spring, significantly larger than the 369 seeds per m2 reached at the end of winter or the 1780 seeds per m2 in the late summer (Fig. 2b and Table 3). The accumulated density of all remaining species combined, excluding grasses, was significantly greater during late summer (Fig. 2c and Table 3)."</p>

802	Evidence that a persistent propagule bank is formed (>1 yr)	y
	Source(s)	Notes
	<p>Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a>. [Accessed 24 May 2024]</p>	<p>"Seeds germinate readily over the range 11 - 25oC (Loo, 2005). Dillon and Forcella (1984) found that dormant seeds of <i>V. bromoides</i> require an after-ripening period of 2-3 months before they could germinate, and seeds usually germinate in the first year after shedding. McGowan (1970), however, did find that under some conditions seeds could remain dormant for two years, possibly as a result of warm temperatures after rain. Exposure to light enhances germination and also the temperature range over which germination occurs (Dillon and Forcella, 1984)."</p>

Qsn #	Question	Answer
803	Well controlled by herbicides	y
	<b>Source(s)</b>	<b>Notes</b>
	Weber, E. (2017). <i>Invasive Plant Species of the World</i> , 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Chemical control methods include spraying flowering plants with glyphosate to prevent seed set, or treating with simazine, simazine plus paraquat, or dalapon (Wallace, 1997)."
	Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a> . [Accessed 24 May 2024]	"In Australia, control of species of <i>Vulpia</i> is possible with herbicides in legume-based pastures or in grain-legume crops like lupins, but in non-legume crops integrated management is essential to achieve acceptable control. In crops in Australia, Wallace (1998) mentions use of simazine in grain-legume crops, and trifluralin in lupins ( <i>Lupinus</i> spp.), field peas ( <i>Pisum sativum</i> ), canola ( <i>Brassica rapa</i> ), safflower ( <i>Carthamus tinctorius</i> ), linseed ( <i>Linum usitatissimum</i> ), chickpeas ( <i>Cicer arietinum</i> ), and faba beans ( <i>Vicia faba</i> ). Diuron, trisulfuron and cyanazine and metribuzin have also been used in various crops (Wallace, 1998). Leys and Plater (1993) found that tank mixes of simazine plus very low rates of paraquat gave over 90% control of <i>V. bromoides</i> and other grass species in subterranean clover pastures in southern New South Wales. The paraquat destroys any seedlings already emerged and the simazine prevents germination of further seed. Wallace (1998) mentioned the use of propyzamide, carbetamide, 2,2-DPA for control of species of <i>Vulpia</i> in Australian pastures. Both propyzamide and carbetamide also kill other grasses and have residual activity, so could only be used where clover dominance is desired. In New Zealand, where the species is a problem in small seed crops, ethofumesate, terbuthylazine and atrazine have proved useful (Foundation for Arable Research, 2008). The downside of regular repeated application of herbicides is the development of resistance in weed species. Heap (2012) reported that <i>V. bromoides</i> in Victoria first evolved resistance to Group D/22 (bipyridilium - Herbicide Class L in Australia) herbicides in 1990. Research has shown that these particular biotypes are resistant to diquat and paraquat and may be cross resistant to other Group D/22 herbicides."

804	Tolerates, or benefits from, mutilation, cultivation, or fire	n
	<b>Source(s)</b>	<b>Notes</b>
	Benson, D., & McDougall, L. (2005). <i>Ecology of Sydney plant species: part 10, Monocotyledon families Lemnaceae to Zosteraceae</i> . <i>Cunninghamia</i> 9(1): 16-204	"Fire Response: Killed, seedlings recorded less than 1 year after fire (Purdie 1977). Flowering in about 10 months after high intensity fire (1/94 at Lane Cove, P. Kubiak pers. comm.)."
	Weber, E. (2017). <i>Invasive Plant Species of the World</i> , 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Scattered plants can be hand-pulled or dug out. A combination of grazing in spring (to prevent seed set) and grazing in autumn (to reduce seedling establishment) has been shown to reduce the density of the grass."
	Popay, I. (2024). <i>Vulpia bromoides</i> (squirreltail fescue). CABI Compendium. <a href="https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873">https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.117873</a> . [Accessed 24 May 2024]	"[Ploughing and grazing can control <i>Vulpia</i> ] "Seed germination is prevented by ploughing or other cultivation methods that bury the seed deeply in the soil. Individual plants are easily pulled or dug up. Conventional tillage such as ploughing is therefore an effective method of control, but only if it is carried out in March or later in Australia. Hard grazing can be used to limit seed production in species of <i>Vulpia</i> , especially soon after germination in autumn and in spring, when the seedheads are produced (Jones and Whalley, 1992)."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	<b>Source(s)</b>	<b>Notes</b>

Qsn #	Question	Answer
	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.	[Probably no. No evidence of limitations to distribution] "...in Hawai'i naturalized in dry, disturbed sites such as along roadsides, in pastures, and on rocky slopes, 185-2,590 m, on all of the main islands except Ni'ihau and Kaho'olawe."

**Summary of Risk Traits:**

*Festuca bromoides* (brome fescue) is a loosely tufted annual grass native from Africa to temperate Asia and Europe. It has been widely introduced and has naturalized in North and South America, Australasia, Africa, and all the main Hawaiian Islands except Niihau and Kahoolawe. It is a weed of crops, pastures, roadsides, lawns. In addition, it competes with native grasses and forms dense swards that can crowd out native plants and reduce species richness.

**High Risk / Undesirable Traits**

- Elevation range exceeds 2000 m, demonstrating environmental versatility
- Naturalized in regions with tropical climates
- Widely naturalized in the Hawaiian Islands and elsewhere
- A crop and environmental weed
- Other *Vulpia* species have become invasive
- Possibly allelopathic
- Host for a range of cereal root diseases
- Tolerates many soil types
- Forms dense swards crowding out native plants and reducing species richness
- Reproduces by seeds
- Hybridizes with other *Vulpia* and *Festuca* species
- Self-fertile
- Annual (reaches maturity in one growing season)
- Seeds dispersed by attaching to clothing, vehicles, animals, as an agricultural contaminant, & by wind and water
- Prolific seed production
- Seeds may persist in the soil for several years, forming a persistent seed bank

**Low Risk Traits**

- Palatable to animals, although seeds may lodge in the eyes, ears, mouths, and skin of livestock, causing them discomfort
- Non-toxic
- Not reported to spread vegetatively
- Herbicides may provide effective control
- Cultivation & fire may provide effective control



