Keywords: High Risk, Forestry Weed, Environmental Weed, N-Fixing Shrub, Thicket-forming

Family: ***Fabaceae***

Taxon: ***Cytisus scoparius***

Synonym: *Sarothamnus bourgaei Boiss.*
Sarothamnus oxyphyllus Boiss.
Sarothamnus scoparius (L.) W.D.J.Koch
Sarothamnus vulgaris Wimm.
Spartium scoparium L.

Common Name: Scotch broom
English broom
common broom

Questionaire : current 20090513 **Assessor:** Assessor **Designation:** H(Hawai'i)
Status: Assessor Approved **Data Entry Person:** Assessor **WRA Score 16**

101	**Is the species highly domesticated?**	**y=-3, n=0**	**n**
102	**Has the species become naturalized where grown?**	**y=1, n=-1**	
103	**Does the species have weedy races?**	**y=1, n=-1**	
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)**	**Low**
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)**	**n**
303	**Agricultural/forestry/horticultural weed**	**n=0, y = 2*multiplier (see Appendix 2)**	**y**
304	**Environmental weed**	**n=0, y = 2*multiplier (see Appendix 2)**	**y**
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**	**y=1, n=0**	**n**
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**	**y**
406	**Host for recognized pests and pathogens**	**y=1, n=0**	
407	**Causes allergies or is otherwise toxic to humans**	**y=1, n=0**	
408	**Creates a fire hazard in natural ecosystems**	**y=1, n=0**	**y**
409	**Is a shade tolerant plant at some stage of its life cycle**	**y=1, n=0**	**n**

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**	**n**
503	**Nitrogen fixing woody plant**	**y=1, n=0**	**y**
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**	
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**	**2**
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**	**y**
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**	**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/m2)**	**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**	**y**
805	**Effective natural enemies present locally (e.g. introduced biocontrol agents)**	**y=-1, n=1**	

Designation: H(Hawai'i) **WRA Score** **16**

Supporting Data:

101	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Is the species highly domesticated? No evidence]
102	2013. WRA Specialist. Personal Communication.	NA
103	2013. WRA Specialist. Personal Communication.	NA
201	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Species suited to tropical or subtropical climate(s) 0-Low] "C. scoparius occurs most commonly in cool temperate areas, but can be found down to sea level in areas with a mediterranean climate where winter temperatures drop below zero (Bolos and Vigo, 1984). Its high altitudinal and latitudinal limits are set by persistent low winter temperatures causing dieback of fresh growth and early death (Peterson and Prasad, 1998), but it can still invade areas despite persistent periods of snow cover (Downey and Smith, 2000)."
201	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Species suited to tropical or subtropical climate(s) 0-Low] "Scotch broom is native to the Mediterranean, where its southern distributions are limited by drought and its northern by winter cold ([96], and references therein). Several reviews [29,96,97] indicate that the brooms do not tolerate extreme high or low temperatures. Scotch broom does not do well in areas with very cold winters. Seedlings and young plants are especially sensitive to frost, while mature plants can tolerate fairly severe frosts. Frost appears to have little direct effect on its total height growth as the damaged tips are replaced by growth from lateral buds, but plants may experience considerable dieback after very severe winters [96,97]."
202	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Quality of climate match data 2-High]
203	1998. Peterson, D.J./Prasad, R.. The biology of Canadian weeds. 109. Cytisus scoparius (L.) Link.. Canadian Journal of Plant Science. 78(3): 497-504.	[Broad climate suitability (environmental versatility)? Yes] "The plant occurs at elevations ranging from sea level to approximately 1000 m in temperate regions, and over 1000 m in warmer regions such as Australia (Smith and Hosking 1994). The maximum geographic range has probably not been realized to date."
203	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Broad climate suitability (environmental versatility)? Yes, but climate suitability limited in tropical areas] "Climatic amplitude (estimates) - Mean annual rainfall: 300 - 3000 mm - Rainfall regime: summer; winter; bimodal; uniform - Dry season duration: 0 - 12 months - Mean annual temperature: 5 - 12ºC - Mean maximum temperature of hottest month: 10 - 30ºC - Mean minimum temperature of coldest month: -10 - 5ºC - Absolute minimum temperature: -40 - 0ºC Soil and physiography C. scoparius can be found up to 2000 m altitude, particularly at lower latitudes (Hosking et al., 1998). Its low latitude limits may be associated with a temperate physiology i.e., it ceases growing in the winter months (Hosking et al., 1998). It can occur on vegetation denuded slopes of even a very steep aspect, though plants in such situations are notably less vigorous (Fowler et al., 1996)."
203	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Broad climate suitability (environmental versatility)? Yes, but climate suitability limited in tropical areas] "Typically inhabits mountainous regions and cool coastal areas with dry summers."
203	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Broad climate suitability (environmental versatility)? Yes, but climate suitability limited in tropical areas] "Typically inhabits mountainous regions and cool coastal areas with dry summers."
204	1999. Wagner, W.L./Herbst, D.R./Sohmer, S.H.. Manual of the flowering plants of Hawaii. Revised edition.. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Native or naturalized in regions with tropical or subtropical climates? Yes. Mid-elevation subtropical climate] "Native to central Europe; in Hawaii naturalized in pastures, ca. 610 m, on Hawaii. First collected in 1909 (Rock 3986, BISH)."

205	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Does the species have a history of repeated introductions outside its natural range? Yes] "Scotch broom has been introduced to many parts of the world as an ornamental (e.g. Canada, Chile, India, Iran, Australia, New Zealand, South Africa, and the United States). It is a major weed problem in Australia and New Zealand. In North America, Scotch broom was introduced to Virginia in the early 1800s for use as fodder for domestic sheep. It was considered invasive in this area by 1860 [70]. Scotch broom was introduced to California as an ornamental in the 1850s, was widely used for roadside erosion control in the early 1900s, and was recognized as a problem in California in the 1930s [74]. It was introduced to Vancouver Island in 1850 as an ornamental; and from 3 surviving plants, it spread over most of Vancouver Island over the next century and a half [100]. Deliberate plantings of Scotch broom by the British Columbia Ministry of Highways have accelerated the spread of Scotch broom during the past 50 years."
205	2008. Bonner, F.T./Karrfalt, R.P. (eds.). The Woody Plant Seed Manual. USDA FS Agriculture Handbook 727. Government Printing Office, Washington, D.C.	[Does the species have a history of repeated introductions outside its natural range? Yes] "Scotch broom—C. scoparius (L.) Link—was planted extensively for erosion control during the first half of the century (Gill and Pogge 1974) but is now considered a serious invasive weed throughout the range of its introduction in North America, Australia, and New Zealand (Bossard 1991)."
205	2013. Starr, F./Starr, K.. Plants of Hawaii - Cytisus scoparius. http://www.starrenvironmental.com/images/species/?q=cytisus+scoparius&o=plants [Accessed 04 Oct 2013]	[Does the species have a history of repeated introductions outside its natural range? Maui] " Cytisus scoparius (Scotch broom) flowers and leaves at Upper Kimo Dr Kula, Maui. June 21, 2007. 070621-7511 " … "Cytisus scoparius (Scotch broom) in gulch edge of pasture at Olinda, Maui. November 15, 2009."
301	1999. Wagner, W.L./Herbst, D.R./Sohmer, S.H.. Manual of the flowering plants of Hawaii. Revised edition.. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Naturalized beyond native range? Yes] "Native to central Europe; in Hawaii naturalized in pastures, ca. 610 m, on Hawaii. First collected in 1909 (Rock 3986, BISH)."
301	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Naturalized beyond native range? Yes] "C. scoparius has become a serious weed where introduced, to temperate areas of the eastern and western USA and Canada, Hawaii, central Chile and Argentina, the eastern halves of both islands of New Zealand, south eastern Australia including Tasmania, India, Iran, Japan and the western cape of South Africa (Holm et al., 1979; Parsons and Cuthbertson, 1992; Hosking et al., 1998; Peterson and Prasad, 1998; Isaacson, 2000). This includes, therefore, all habitable continents and several temperate island systems. "
302	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Garden/amenity/disturbance weed? Benefits from disturbance] "Plants establish best after soil or vegetation disturbance caused by e.g. animals, fire or herbicide treatments, but broom can readily invade vegetation without major disturbance (Downey, 2001; Sheppard et al., 2002)."
303	1983. Haselwood, E.L./Motter, G.G./Hirano, R.T. (eds.). Handbook of Hawaiian weeds. University of Hawaii Press, Honolulu	[Agricultural/forestry/horticultural weed? Yes] "At present found on the Island of Hawaii. A weed in pastures and wastelands." …"History: Native to Europe. Introduced to Hawaii as an ornamental; first collected in 1909 between Honokaa and Parker Ranch on the Island of Hawaii." … "Notes: Declared noxious in Regulations 2 and NW 10. A heavy seeder which forms dense stands. Of no forage value."
303	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Agricultural/forestry/horticultural weed? Yes] "Broom occurs as a weed of Eucalyptus plantation forestry in Australia (Barnes and Holz, 2000), India (Rashmi et al., 1987) and Spain (Bolos and Vigo, 1984), and in pine plantations in Japan (Nemoto et al., 1993), UK (Nimmo, 1963), New Zealand (Richardson et al., 1996) and USA (Isaacson, 2000). It is an important weed of the younger stages of all types (softwood or hardwood) of plantation forestry, where short plantation cycles allow broom to persist as seed between disturbances (Peterson and Prasad, 1998; Barnes and Holz, 2000). In such situations it quickly invades forestry tracks, powerline rights-of-way and road verges." … "Broom is a significant weed of forestry, particularly in pine and eucalypt plantations around the world. It either smothers planted saplings or reduces their growth (Peterson and Prasad, 1998; Barnes and Holz, 2000)."

303	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Agricultural/forestry/horticultural weed? Yes] "Scotch broom is a major forestry problem in the U.S., Canada, and New Zealand, particularly in reforestation after logging, as it can quickly overtop commercial crop trees ([59,97] and references therein). Scotch broom establishment after logging interferes with conifer establishment in the Douglas-fir region [30,61,102]. Scotch broom may occupy 90% canopy cover and intercept 65% of the intermittent light in Douglas-fir plantations. In Oregon and Washington, there have been complete stand failures of Douglas fir regeneration because of Scotch broom infestations ([97] and references therein). Studies in Monterey pine (Pinus radiata) plantations in New Zealand suggest that Scotch broom competes with Monterey pine for light and water, reducing growth and biomass of the trees and affecting their resource allocation [151,152]."
303	2008. Bonner, F.T./Karrfalt, R.P. (eds.). The Woody Plant Seed Manual. USDA FS Agriculture Handbook 727. Government Printing Office, Washington, D.C.	[Agricultural/forestry/horticultural weed? Yes] "It increases in response to disturbance of native vegetation and is also a serious weed problem in pine plantations in California and New Zealand."
304	2001. Parsons, W.T./Cuthbertson, E.G.. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Environmental weed? Yes] "Once established, English broom fixes nitrogen in the soil and dominates the vegetation of an area, smothering quite large shrubs and preventing re-establishment of native species, as well as providing harbour for pest animals including feral pigs."
304	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Environmental weed? Yes] "The economic impact of C. scoparius in western North America has been estimated as at least US$ 11 million (Isaacson, 2000). No systematic economic assessment of broom has been carried out in other areas due to the low or unestimated conservation value of infested National Park land. Spraying broom has been estimated to cost ca US$11 per hectare in Australian pasture (Clark, 2000), and containing Australia's largest broom infestation of 10,000 ha cost about US$ 25,000 (Schroder and Howard, 2000). Mulching costs about US$ 500 per hectare (Talbot, 2000). Broom retards the establishment and spread of rare and endemic woody species in the natural ecosystems it has invaded and also smothers the herbaceous layer including the rare species within (Downey and Smith, 2000). Broom can permanently alter the regular nature of tussock and high altitude grassland. Nitrogen fixation is thought to enhance soil fertility sufficiently in some low fertility native ecosystems to allow invasion by other species (Smith, 2000). The presence of broom may alter fire or water cycling regimes that may have dramatic impacts on ecosystem function (Hosking et al., 1998; Downey and Smith, 2000). Broom stands can also encourage other exotic feral animals and birds (Downey and Smith, 2000; Smith, 2000). Broom is a weed that infests areas of natural beauty and National Parks (Hosking et al., 1998) and is therefore likely to have a negative effect on the aesthetic value of certain sites and perhaps their frequency as destinations for tourism. Broom infestations on farms are likely to affect land values and potential returns on the land, thereby affecting the livelihood of resident farmers. Broom is also toxic to some livestock (Peterson and Prasad, 1998). While broom can have general impacts on the habitats it invades, changing nutrient and water cycling, it also has direct impacts on species diversity. Heinrich and Dowling (2000) list 30 species of native flora under threat from broom in Australia, with somewhat similar threats likely in Canada (Peterson and Prasad, 1998) and New Zealand (Fowler and Syrett, 2000). Broom can also out-compete native shrubs (Fogarty and Facelli, 1999)."

304	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Environmental weed? Yes] "Scotch broom threatens endangered ecosystems such as Oregon white oak (Quercus garryana) woodlands in southwestern British Columbia, adjacent Washington, and Oregon by interfering with the establishment and spread of many rare and endemic species found in these endangered ecosystems ([97] and references therein)." … "Scotch broom invasion displaces native plant species including many threatened and endangered species (see Habitat types and Plant Communities). Scotch broom can dominate a plant community, forming a dense monospecific stand (see Growth habit and stand structure). Conditions under broom thickets are shaded and more humid than uninvaded stands and most understory vegetation dies out beneath large, mature broom shrubs ([59] and references therein), which leads to loss of herbaceous plants and tree seedlings on sites where broom is abundant [121]. In a cutover Douglas-fir forest in British Columbia, a 71% reduction in photosynthetically active radiation was measured under Scotch broom stands [102]. In an invaded prairie at Fort Lewis, Washington, a dense stand of mature Scotch broom intercepted 96% of the incident light and all native prairie vegetation was absent under these stands except colonial bentgrass and nonvascular cryptogams [138]. Scotch broom invasion in Australia appears to permanently change the structure, floristic composition and ecology of woodlands at one site [59]." … "Scotch broom invasions may also impact native insects and animals. For example, Wilson and Carey [158] found a negative relationship between Scotch broom and deer mice, suggesting that Scotch broom areas have diminished value as wildlife habitat in the Oregon while oak communities in the Puget Trough, Washington. The small areas of remaining Oregon silverspot and Fender blue butterfly habitat have been invaded by Scotch broom and other nonnative species, changing plant community composition and structure and adversely affecting the quality of habitat for the threatened butterflies [98]. See Habitat Types and Plant Communities for more information on impacted species. Broom invasion may also impact soils in invaded habitats. According to Bossard [17], Scotch broom "tends to acidify the soil," although the source of this assertion is not given. Results present by Haubensak and others [50] suggest that invasion by brooms (Scotch broom or French broom) can increase the total amount of nitrogen and the way in which nitrogen cycles in invaded ecosystems. Scotch broom is capable of fixing nitrogen throughout the year in regions with mild winters [155]. Nitrogen enrichment is unlikely to benefit native plants and may reduce species diversity in ecosystems where nitrogen-fixers are rare, although this has not been tested with regard to invasions by Scotch or Portuguese broom [32,50]."
304	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Environmental weed? Yes] "Seedlings can outcompete conifer seedlings and prevent reforestation. California lists Scotch broom as a C-listed noxious weed, while Idaho, Oregon, and Washington list the species as a class B noxious weed."
304	2011. Richardson, F.J./Richardson, R.G./Shepherd, R.C.H.. Weeds of the South-East: An Identification Guide for Australia. Second Edition. RG and FJ Richardson, Victoria, Australia	[Environmental weed? Yes] "Troublesome and difficult to eradicate, and a severe threat to native bushland."
305	2003. Weber, E.. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	[Congeneric weed? Yes] "Cytisus multiflorus" … "Where invasive, the shrub forms extensive thickets that crowd out native species and prevent natural forest regeneration."
401	1999. Wagner, W.L./Herbst, D.R./Sohmer, S.H.. Manual of the flowering plants of Hawaii. Revised edition.. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Produces spines, thorns or burrs? No] "Many-branched shrubs up to 2(-2.5) m tall; branches green, erect, ascending, or procumbent, 5-angled, sericeous when young, becoming glabrate."
402	2001. Parsons, W.T./Cuthbertson, E.G.. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Allelopathic? No] "…Indian experience is that, where English broom grows wild over large areas of potential forest land, it affords protection of planted seedlings against frost and wind." [Nurse plant]
402	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Allelopathic? No evidence] "Broom is also used as a nurse plant in forestry to protect saplings from frosts and to prevent soil erosion, particularly following controlled burns (Nimmo, 1963; Nemoto et al., 1993; Peterson and Prasad, 1998). In Europe, broom has been sown to restore soil fertility after the last hay crop (Rousseau and Loiseau, 1982)."
403	1999. Wagner, W.L./Herbst, D.R./Sohmer, S.H.. Manual of the flowering plants of Hawaii. Revised edition.. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Parasitic? No] "Many-branched shrubs up to 2(-2.5) m tall; branches green, erect, ascending, or procumbent, 5-angled, sericeous when young, becoming glabrate." [Fabaceae]

404	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Unpalatable to grazing animals? No] "Sheep (not all breeds) and goats (particularly meat goats) are effective at suppressing broom (Rousseau and Loiseau, 1982) even when used strategically on existing stands (Allan et al., 1997), but cannot be used in conservation areas where indiscriminate grazing is undesirable. Large browsing or grazing animals reduce broom biomass, but exert little control (Bossard and Rejmanek, 1994). Large browsing or grazing animals reduce broom biomass, but exert little control (Bossard and Rejmanek, 1994). This can be seen in the frequency and ease with which broom infests cattle-grazed paddocks (Hosking et al., 1998). Rabbits can prevent broom regeneration at high density (Paynter et al., 2000) but do not provide a practical management option."
404	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Unpalatable to grazing animals? No] "Mule deer, elk, and black-tailed jackrabbits were observed browsing on Scotch broom at 2 California sites (mule deer and elk at one site, mule deer and black-tailed jackrabbits at the other) [13,16]. "
404	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Unpalatable to grazing animals? Palatable to goats] "Broom foliage may be mildly toxic, but is generally unpalatable to most livestock, except goats." … "Seedlings are subject to high summer mortality and browsing by wildlife during the first several years." … "Goats confined t a small area can help control stands of young shrubs or young crown sprouts from cut shrubs."
405	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Toxic to animals? Yes] "There have been reports of livestock loss due to ingestion of toxic quinolizidine alkaloids produced by Scotch broom. Human consumption of flowers and seeds of Scotch broom and related species results in nausea and vomiting [82]. Scotch broom is listed as an unsafe herb by the U.S. Federal Drug Administration (1993) [97]."
405	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Toxic to animals? Yes] "Flowers and seeds of brooms contain quinolizidine alkaloids and can be toxic to humans and livestock when ingested. However, toxicity problems de to the brooms are uncommon. Toxicity symptoms include digestive tract disturbance and/or neurological effects, such as trembling or uncoordinated gait."
405	2008. Bonner, F.T./Karrfalt, R.P. (eds.). The Woody Plant Seed Manual. USDA FS Agriculture Handbook 727. Government Printing Office, Washington, D.C.	[Toxic to animals? Yes] "It is largely useless as a browse-plant because of its toxic foliage, a feature that may permit it to increase at the expense of more palatable species (Bossard and Rejmanek 1994; Gill and Pogge 1974)."
406	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Host for recognized pests and pathogens?] "The arthropod natural enemies of C. scoparius are well known and have been extensively studied (Waloff, 1968; Syrett et al., 1999). At least 243 species of insects and mites are associated with broom in Europe, and several other generalist species are now found on broom in its exotic range (Memmott et al., 2000). High numbers of the accidentally introduced psyllid Arytainilla spartiophila, twig-mining moth Leucoptera spartifoliella and seed beetle Bruchus villosus, have been recorded in the USA (Pfeiffer, 1986; Syrett et al., 1999), the latter species causing up to 80% seed loss to adult scotch broom in the eastern states (Redmon et al., 2000). Many other specialised broom-feeding insects have established in North America accidentally (Waloff, 1966), but it is not known how damaging these are. L. spartifoliella, also accidentally introduced in New Zealand, reaches high population density and contributes to the early death of plants. Natural enemies that have caused noticeable damage sufficient to affect the growth and spread of broom are listed. In the native range the natural enemy community can have quite dramatic impacts on broom growth and survival (Waloff and Richards, 1977). Native cerambycid beetles use broom in Australia (Hosking et al., 1998) and pyralid moths of the genus Uresiphita have started using broom since its introduction in both Australia and the USA (Smith, 2000). A range of pathogens have also been recorded from scotch broom, both from the native and exotic range (Guyot and Massenot, 1958; Johnson et al., 1995; Peterson and Prasad, 1998)."
407	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Causes allergies or is otherwise toxic to humans? Possibly, although humans are unlikely to ingest] "Flowers and seeds of brooms contain quinolizidine alkaloids and can be toxic to humans and livestock when ingested. However, toxicity problems de to the brooms are uncommon." … "Scotch and Spanish broom are used medicinally in Europe. However, Scotch broom is considered to be a herb unsafe for human consumption by the United States Food and Drug Administration."
408	2001. Parsons, W.T./Cuthbertson, E.G.. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Creates a fire hazard in natural ecosystems? Yes] "Once established on public land it makes the native vegetation, including large trees, much more susceptible to fire because of its flammability and the intense heat with which it burns."

408	2003. Weber, E.. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	[Creates a fire hazard in natural ecosystems? Yes] "The shrub is flammable and may increase fire intensities in fire-prone areas"
408	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Creates a fire hazard in natural ecosystems? Yes, but not always] :Fire hazard potential: The available literature does not provide a clear picture on the potential fire hazard of broom stands. Several reviews (e.g. [17,34,88,148,160]) indicate that dense broom stands are a fire hazard (also see Fire Ecology). Furthermore, descriptions of the structure and composition of Scotch broom monocultures (see Growth form and stand structure) support the contention that dense, mature stands of broom could be highly flammable. Specifically, as Scotch broom stands age, the ratio of woody to green material also increases, and dead wood accumulates [149]. Scotch broom's frequent location on steep slopes adds to its fire hazard potential [160]."
409	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Is a shade tolerant plant at some stage of its life cycle? No] ""It will not grow in heavily shaded or swampy places, except where waterlogging is temporary." … "Broom can invade all types of woodland and forests where canopy cover is less than about 50% (Waterhouse, 1988)." … "Broom is intolerant of heavy shade; seedlings usually die if germination occurs beneath parental or other relatively dense canopy cover."
409	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Is a shade tolerant plant at some stage of its life cycle? No] "Shade tolerance: Scotch broom's common role as an early seral colonizer [59,157] and its tendency to establish in forest environments following vegetation disturbance that opens the canopy [74,88] imply shade intolerance. Several reviews indicate that Scotch broom survival is best in high-light areas. Scotch broom is generally intolerant of shade and will not grow in heavily shaded places [34,59,97]. Others suggest that it will usually be shaded out once native species are established [17,157] or forest canopy closes [112]. However, Scotch broom can continue to grow and compete for moisture, space, and nutrients under a partial tree canopy on some sites [97]. It can also invade eucalypt dominated vegetation where the tree foliage protective cover is less than about 50% (Waterhouse 1988, cited in [59]). Williams [96] suggests that under low light conditions (10%-30% full sunlight) Scotch broom plants tend to form a single upright shoot and produce sparse foliage and few flowers. In a laboratory study by Vallardes and others [145], seedlings of Scotch broom had greatest survival (~82%) in moderate shade (30% full sunlight), ~30% survival in 100% full sunlight, and ~12% survival in deep shade (3% full sunlight). Rates of net photosynthesis were significantly ($P<0.005$) higher in moderate shade versus full sun, and dark respiration was significantly higher in full sun than in moderate shade. Scotch broom was tentatively classified by the authors as shade intolerant, although further tests are needed for this to be definitive [145]."
410	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)? Yes] "In its native range, broom is usually a calcifuge (Polunin and Smythies, 1973). However, in the exotic range, broom occurs on a broader range of soil types derived from a wide variety of substrates, particularly river sand, schist, granite or basalt and including brunisols, podsols and regosols, but it does not flourish on calcareous soils (Hosking et al., 1998; Peterson and Prasad, 1998). Broom grows and spreads fastest on moist, fertile and alluvium soils high in inorganic phosphorus (Williams, 1981) but can rarely be found on disturbed skeletal sandy soils."
410	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)? Yes] "Literature reviews [17,34,58,59,96,97] indicate that brooms can survive under a wide range of soil conditions and have few constraints to growth on almost any medium. They seem to prefer coarse textured, seasonally dry, well-drained soils and a pH range of 4.5 to 7.5. They do well on sites with low to moderate fertility, but grow only rarely on highly calcareous soils. "
411	1999. Wagner, W.L./Herbst, D.R./Sohmer, S.H.. Manual of the flowering plants of Hawaii. Revised edition.. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Climbing or smothering growth habit? No] "Many-branched shrubs up to 2(-2.5) m tall; branches green, erect, ascending, or procumbent, 5-angled, sericeous when young, becoming glabrate."
412	1983. Haselwood, E.L./Motter, G.G./Hirano, R.T. (eds.). Handbook of Hawaiian weeds. University of Hawaii Press, Honolulu	[Forms dense thickets? Yes] "A heavy seeder which forms dense stands. Of no forage value."
412	1998. Peterson, D.J./Prasad, R.. The biology of Canadian weeds. 109. Cytisus scoparius (L.) Link.. Canadian Journal of Plant Science. 78(3): 497-504.	[Forms dense thickets? Yes] "Scotch broom is capable of forming dense, monospecific stands, and is commonly found on open sites disturbed by fire, logging, or other causes."
412	2003. Weber, E.. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	[Forms dense thickets? Yes] "Establishment depends on disturbance, the plant the forms extensive thickets that crowd out native species and affect wildlife. It smothers large shrubs and prevents establishment of native species."

501	1983. Haselwood, E.L./Motter, G.G./Hirano, R.T. (eds.). Handbook of Hawaiian weeds. University of Hawaii Press, Honolulu	[Aquatic? No] "A weed in pastures and wastelands."
502	1999. Wagner, W.L./Herbst, D.R./Sohmer, S.H.. Manual of the flowering plants of Hawaii. Revised edition.. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Grass? No] Fabaceae
503	2003. Weber, E.. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	[Nitrogen fixing woody plant? Yes] "Where native, this nitrogen-fixing shrub grows commonly on heaths and wasteland." [Fabaceae]
504	1999. Wagner, W.L./Herbst, D.R./Sohmer, S.H.. Manual of the flowering plants of Hawaii. Revised edition.. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)? No] "Many-branched shrubs up to 2(-2.5) m tall; branches green, erect, ascending, or procumbent, 5-angled, sericeous when young, becoming glabrate."
601	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Evidence of substantial reproductive failure in native habitat? No] "C. scoparius is native to Europe, from Ireland to west-central Ukraine and from southern Spain to southern Sweden (Heywood and Ball, 1968). It is very widespread in its native range and reaches densities where it is considered a weed (Maury, 1963; Engel, 1964). Its distribution is less well documented in Eastern Europe and is considered doubtful in Turkey (Greuter et al., 1984)."
602	1983. Haselwood, E.L./Motter, G.G./Hirano, R.T. (eds.). Handbook of Hawaiian weeds. University of Hawaii Press, Honolulu	[Produces viable seed? Yes] "Propagation: By seed."
602	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Produces viable seed? Yes] "Reproduce by seed"
603	1998. Peterson, D.J./Prasad, R.. The biology of Canadian weeds. 109. Cytisus scoparius (L.) Link.. Canadian Journal of Plant Science. 78(3): 497-504.	[Hybridizes naturally? No] "There are no known naturally occurring hybrids of C. scoparius. Bailey (1949) reports a cross between C. scoparius var. andreanus and C. multiflorus, known as C. dallimorei Rolfe, developed at Kew Gardens, England. Cytisus scoparius var. andreanus "Aureus" is a hybrid between C. scoparius and the hybrid C. ´ dallimorei. This is a common garden escapee found in cooler regions of the Australian states of New South Wales, Victoria, and Tasmania (Smith and Hosking 1994). Other species of Cytisus tend to hybridize more readily, e.g. C. multiflorus and C. hirsutus L."
603	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Hybridizes naturally? No] "There are no known naturally occurring hybrids of either Scotch broom or Portuguese broom. There are, however, a number of ornamental hybrids. Some hybrids have escaped cultivation in Australia, although none are thought to be invasive [9,59,97]."
604	2003. Suzuki, N.. Significance of flower exploding pollination on the reproduction of the Scotch broom, Cytisus scoparius (Leguminosae). Ecological Research. 18: 523–532.	[Self-compatible or apomictic? Yes. However, selfing results in very limited seed set] "In the present study, both artificially exploded flowers and artificially selfing flowers produced fruits at a low fruit set (Fig. 1) and similar results were reported for C. scoparius growing in North America (Parker & Haubensak 2002), indicating that the flowers of C. scoparius are self compatible and that facilitated selfing (Schneider & Buchanan 1980; Lloyd & Schoen 1992) may occur when flower visitors trip open a flower without loading any pollen. In the absence of effective pollinators, the explosion of flowers by insects without pollen is better than no flower visits at all."
605	1999. Wagner, W.L./Herbst, D.R./Sohmer, S.H.. Manual of the flowering plants of Hawaii. Revised edition.. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Requires specialist pollinators? No evidence] "Flowers in terminal pseudoracemes, apex vegetatively continuing; calyx ca. 7 mm long, glabrous externally; corolla golden yellow, standard 15-25 mm long"
605	2003. Suzuki, N.. Significance of flower exploding pollination on the reproduction of the Scotch broom, Cytisus scoparius (Leguminosae). Ecological Research. 18: 523–532.	[Requires specialist pollinators? No] "Therefore, at least in Japan, A. mellifera appears to be the most important pollinator for C. scoparius , resulting in a high outcrossing rate with each single flower visit."
605	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Requires specialist pollinators? No. But lack of honeybee pollinators results in limited seed set] "The large yellow flowers of Scotch and Portuguese broom are pollinated by several species of bee [34,97], and possibly other insects [121]. Only a small proportion of flowers develop into fruit (<50%) [34,121]. Parker and others [83,87] demonstrated pollinator limitation in both Scotch broom and French broom, underscoring the potential importance of pollinators to the fecundity and spread of these species. Because nonnative honeybees are often the most common pollinators of broom [86,128], potential negative impacts of beekeeping on broom management have been suggested [86]."

605	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Requires specialist pollinators? No] "Insect-pollinated. Mostly out-crossing."
605	2008. Bonner, F.T./Karrfalt, R.P. (eds.). The Woody Plant Seed Manual. USDA FS Agriculture Handbook 727. Government Printing Office, Washington, D.C.	[Requires specialist pollinators? No] "Each flower must be “tripped” by an appropriate pollinator for fertilization to take place, so the mutualistic relationship with honey bees (Apis mellifera L.) and native bumble bees is essentially obligatory (Parker 1997). Other native North American insects seem to ignore its fragrant blossoms, preferring to work the flowers of indigenous species. The result is that seed production may be severely pollinator-limited (Parker 1997)."
606	2001. Parsons, W.T./Cuthbertson, E.G.. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Reproduction by vegetative fragmentation? No] "…spread solely by seeds, which are ejected noisily from the pods in summer."
606	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Reproduction by vegetative fragmentation? No] "All movement and spread of C. scoparius occurs through the movement of seeds."
606	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Reproduction by vegetative fragmentation? No] "Reproduce by seed"
607	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Minimum generative time (years)? 2+] "Scotch broom becomes reproductive on reaching an age of 2 to 3 years and a height of about 2 to 3 feet (0.6-1 m) [17,59,97], unless damaged or otherwise suppressed [121]. "
607	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Minimum generative time (years)? 2+] "Plants typically grow rapidly during years 3-4, often reaching a height of 2 m. Seed production begins during years 2 or 3, usually when plants reach a height of about 1 m. Shrubs are fully reproductive from years 3-5 through about 9."
701	2001. Parsons, W.T./Cuthbertson, E.G.. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)? Yes] "'English broom is spread solely by seeds, which are ejected noisily from the pods in summer. They are further spread in a number of ways such as on machinery, animals, agricultural produce and in mud. Earthmoving equipment, including road graders, are responsible for much spread."
701	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)? Yes] "Scotch broom distribution patterns along roads and in work sites suggest transport by vehicles and equipment. Additionally, samples taken from recreationist's vehicles (inside and out) and shoes held many Scotch broom seeds [121]. Construction crews can disperse broom seeds long distances by transporting contaminated soil or gravel [34,97]."
701	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)? Yes] "Pods typically burst apart into spiral halves, ejecting seeds a short distance from the parent plant. Seeds disperse to greater distances with water, soil movement, vehicle tires, human activities, and animals."
702	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Propagules dispersed intentionally by people? Yes] "As broom (C. scoparius) is still an important horticultural species, risks remain for significant further spread both through fresh introductions into countries through uninformed horticultural practices and illicit passage of seeds through the post ordered via the internet. Many horticultural varieties of broom have shown no capacity for naturalization and spread. The difficulty of clear identification of the different varieties by the inexperienced will remain a significant risk; however, many official horticultural bodies are aware of the risks and discourage sales of varieties known to be invasive (Atkinson and Sheppard, 2000). Similarly, horticultural use requires assessment of the risks biological control agents pose for the profitability of sales of harmless varieties." … "By far the most widespread use of C. scoparius is in the horticultural industry; it is attractive because of its large, coloured flowers and dark-green foliage (Peterson and Prasad, 1998)."
702	2008. Bonner, F.T./Karrfalt, R.P. (eds.). The Woody Plant Seed Manual. USDA FS Agriculture Handbook 727. Government Printing Office, Washington, D.C.	[Propagules dispersed intentionally by people? Yes] "SHowever, because of its beauty and exceptional summer drought-hardiness, Scotch broom is considered valuable as an ornamental shrub for low maintenance landscapes. The species is very showy in flower and its evergreen stems add interest to winter landscapes. There are over 60 named varieties (Wyman 1986)."
703	2001. Parsons, W.T./Cuthbertson, E.G.. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Propagules likely to disperse as a produce contaminant? Yes] "...further spread in a number of ways such as on machinery, animals, agricultural produce and in mud."
704	2003. Weber, E.. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	[Propagules adapted to wind dispersal? No] "Pods brownish black, linear, 2.5-5(-7) cm long, 0.8-1(-1.3) cm wide, glabrous or ciliate along sutures. Seeds 4-7, reniform, slightly laterally flattened, 4-7 mm long, 2-4 mm wide."

704	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Propagules adapted to wind dispersal? No. Although wind may increase distance of ejected seeds] "Short distance transport of broom seeds is similar to that of many other legume species and involves "ballistic" dispersal. As pods mature and dry, the 2 pod halves split and wrap in alternate directions, audibly snapping apart and catapulting the seeds [17,97,100,121]. Ballistic dispersal of seeds resulted in a mean dispersal distance of 3 feet (96 cm), a median distance of 44 inches (112.8 cm), and a maximum distance of 213 inches (540 cm) at 2 California sites [16]. In Australia, Smith and Harlen [121] found that most Scotch broom seed falls within 3.3 feet (1 m) of parent plants, and rarely beyond 10 to 13 feet (3-4 m) without assistance from wind or insects. Robertson and others [110] found that Scotch broom seed was dispersed as far as 33 feet (10 m) from the edge of thickets, although the means of dispersal was not studied."
705	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Propagules water dispersed? Yes] "Spread of Scotch broom along riverbanks strongly suggests seed dispersal by water [34,96,121]. Williams [96] indicated that the hard seed coat of Scotch broom can survive long distance transport in rivers and streams, and viable seed was recovered from stream sediments up to 160 feet (50 m) downstream from Scotch broom shrubs [121]."
705	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Propagules water dispersed? Yes] "Seeds disperse to greater distances with water, soil movement, vehicle tires, human activities, and animals."
706	2008. Bonner, F.T./Karrfalt, R.P. (eds.). The Woody Plant Seed Manual. USDA FS Agriculture Handbook 727. Government Printing Office, Washington, D.C.	[Propagules bird dispersed? No] "At 2 California study sites, seeds were taken by mice and by ground-feeding birds, but these organisms were strictly seed predators and did not function as dispersers (Bossard 1991)."
707	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Propagules dispersed by other animals (externally)? Yes] "Scotch broom seeds bear elaiosomes that attract ants [94]. After seeds disperse from the pods, ants gather them and typically carry them back to their nest, where they eat the elaiosome. Removal of the elaiosome does not kill the seed nor affect seed germination, and Scotch broom plants may be found in high density around ant nests on some sites. Foraging behavior of ants varies, and not all ants carry seed to their nests [14,16]. Bossard [16] measured mean dispersal distance by ants at 3 feet (96 cm) and maximum dispersal distance at 207 inches (525 cm) at California study sites."
707	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Propagules dispersed by other animals (externally)? Yes] "Several species of ants are attracted to the seed appendages an disperse the seeds while foraging."
707	2008. Bonner, F.T./Karrfalt, R.P. (eds.). The Woody Plant Seed Manual. USDA FS Agriculture Handbook 727. Government Printing Office, Washington, D.C.	[Propagules dispersed by other animals (externally)? Yes] "The legumes open abruptly with a springing motion, vaulting the seeds some distance from the plant (Bossard 1991; Bossard and Rejmanek 1994). The seeds possess a strophiole or elaiosome at the hilar end (figure 1) and are secondarily dispersed by ants (Bossard 1991; Weiss 1909)."
708	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Propagules survive passage through the gut? Yes] "When Scotch broom seeds were fed to domestic goats, 8% of the seeds remained viable following ingestion [57]. Smith and Harlen [121] also suggest evidence that Scotch broom seed may be dispersed in the feces of a variety of animals such as horses."
801	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Prolific seed production (>1000/m2)? Potentially Yes] "Mature Scotch broom shrubs produce anywhere from a few hundred to over 7,000 pods per plant, with a range of zero to 22 seeds per pod (about 5 to 8 on average) [59,97,121,149]. One medium-sized Scotch broom shrub can therefore produce several thousand seeds per year [13,16,59]. Factors that may affect seed production in Scotch broom include predation by insects, site conditions, plant size, climatic conditions (i.e. drought), plant age, and individual plant physiology." … "Scotch broom seed dormancy and longevity contribute to large soil seed banks. Seed bank density under mature broom stands is highly variable [119]. In its native range, soil seed banks below a mature broom canopy vary from 430 to almost 20,000 seeds per m^2 [2,39,59,92]."
801	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Prolific seed production (>1000/m2)? Yes] "Seeds about 5-9 per pod on average, ovoid, compressed, ± 2 mm long, shiny, greenish brown to black, with an appendage that is attractive to certain species of ants." … "A mature shrub can produce about 2000-3500 pods per season. Seed production decreases significantly during drought years." [Potentially produces 10,000 - 31,500 seeds/plant per season]

801	2008. Bonner, F.T./Karrfalt, R.P. (eds.). The Woody Plant Seed Manual. USDA FS Agriculture Handbook 727. Government Printing Office, Washington, D.C.	[Prolific seed production (>1000/m2)? Yes] "The result is that seed production may be severely pollinator-limited (Parker 1997). In spite of this, the plants may produce a prodigious number of seeds; the estimated mean annual production per plant was about 10,000 seeds in 2 California populations (Bossard and Rejmanek 1994)."
802	2003. Weber, E.. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	[Evidence that a persistent propagule bank is formed (>1 yr)? Yes] "It produces large amounts of long-lived seeds and resprouts from the root crown if damaged"
802	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Evidence that a persistent propagule bank is formed (>1 yr)? Yes] "Scotch broom seed dormancy and longevity contribute to large soil seed banks. Seed bank density under mature broom stands is highly variable [119]. In its native range, soil seed banks below a mature broom canopy vary from 430 to almost 20,000 seeds per m² [2,39,59,92]." … "Managers should be alert to the possibility of Scotch broom seed in the soil seed bank, even in areas where broom is no longer present in aboveground vegetation. Loss of seeds from the soil seed bank is mainly through germination and not mortality. At a California foothills site, seed bank germination was substantial 3 years after the removal of mature broom plants. The mean number of seedlings establishing from the seed bank ranged from 120 to 161 seedlings per 0.25 m² at the end of the 2nd germination period, and 15 to 25 seedlings per 0.25 m² at the end of the 3rd germination period. There was no evidence of insect or vertebrate herbivory affecting the density, biomass, relative growth rate, or seedling germination of Scotch broom at this site [16]. Persistent, deeply buried seed banks of Scotch broom were found at 2 study sites in New Zealand, 1 of which lacked Scotch broom in aboveground vegetation. Scotch broom may establish from the seed bank following disturbance, especially fire [89], as improved seed permeability may be brought about by scarifying the seed coat during disturbance [97,121]."
802	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Evidence that a persistent propagule bank is formed (>1 yr)? Yes] "Seeds can survive 30 years or more under field conditions. About 50% of seeds produced in a season remain dormant."
802	2008. Bonner, F.T./Karrfalt, R.P. (eds.). The Woody Plant Seed Manual. USDA FS Agriculture Handbook 727. Government Printing Office, Washington, D.C.	[Evidence that a persistent propagule bank is formed (>1 yr)? Yes] "Seeds of Scotch broom have the capacity to form a persistent seed bank. Bossard (1993) found in seed retrieval experiments that 65% germinated the first year after dispersal, 20% germinated the second year, and 10% germinated the third year. About 5% of the seed population carried over for more than 3 years."
803	2001. Parsons, W.T./Cuthbertson, E.G.. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Well controlled by herbicides? Yes] "Chemical control is also effective. Spraying in the full leaf stage with picloram and triclopyr, either alone or in a commercial mixture, followed by further spraying o any regrowth gives satisfactory control. Glyphosate, fluroxypyr and metsulfuron methyl are promising in recent trials. New Zealand research shows increased effectiveness by the addition of surfactants to several herbicides."
803	2003. Weber, E.. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	[Well controlled by herbicides?] "Chemical control includes applying triclopyr mixed with an oil surfactant to the basal bark just after flowering"
803	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Well controlled by herbicides? Yes. Under certain conditions] "The main chemicals used to control broom are picloram, triclopyr, glyphosate, fluroxypyr and metsulfuron-methyl (Parsons and Cuthbertson, 1992). Specific chemicals are appropriate for specific situations, such as proximity to water courses. The addition of some surfactants to glyphosate and metsulfuron-methyl increases the level of control achieved by these chemicals (Hosking et al., 1998). Herbicide treatment of broom can result in initial broom kill rates of 50 100%. Nevertheless, within a few years broom plants fully regenerate when no future management strategy is applied and, in some cases, spraying recruiting broom may last many years. Chemical control can be applied as a foliar spray, by injecting stem bases (for large isolated individuals) or by painting stumps after cutting mature plants to prevent regeneration (Peterson and Prasad, 1998)."
803	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Well controlled by herbicides? Yes] "The main chemicals used to control broom are picloram, triclopyr, glyphosate, fluroxypyr and metsulfuron-methyl [59,88]. Foliar sprayed glyphosate has been used to kill mature Scotch broom plants [88]. The foliar spray impacts nontarget species, and Scotch broom sprouting may occur after spraying. Triclopyr ester applied to basal bark is also effective at killing Scotch broom (Bossard unpublished data in [17]). Both of thesechemical methods should be used during periods of active growth after flower formation. Chemical removal alone results in standing dead biomass that makes monitoring for and treatment of broom seedlings difficult [17]."

803	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Well controlled by herbicides? Yes] "Herbicide treatments (cut-stem, foliar applications) are effective but costly, as recovering plants often need repeat treatments for several years. In addition, herbicides can damage nontarget native species."
803	2013. DiTomaso, J.M./Kyser, G.B. et al.. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of California, Davis, CA	[Well controlled by herbicides? Yes] "Triclopyr - Rate: Broadcast treatment: 2 to 3 qt Garlon 4 Ultra/acre (1 to 1.5 qt a.e./acre) or 3 to 4 qt Garlon 3A/acre (1.125 to 1.5 qt a.e./acre). Spot treatment: 0.75 to 1.5% v/v solution of Garlon 4 Ultra, or 1 to 1.5% Garlon 3A and water plus 0.25 to 0.5% v/v surfactant to thoroughly wet all leaves. Low volume/thinline treatment: 10% v/v solution of Garlon 4 Ultra plus a 20% v/v ethylated crop oil in water. Basal cut stump treatment: 20% v/v Garlon 4 Ultra in water. Cut stump: Garlon 3A, undiluted or 50% in water. Basal bark treatment: 20% v/v Garlon 4 Ultra in 20% v/v ethylated crop oil and water, or Pathfinder II (ready-to-use formulation). Timing: Postemergence when plants are growing rapidly. Cut stump, basal cut stump, and basal bark treatments can be applied anytime as long as the ground is not frozen. Remarks: Selective herbicide for broadleaf species, will not injure grasses growing nearby. For cut stump treatment, cut stem horizontally at or near ground level and immediately apply herbicide solution. Roots may sucker after cutting, but the treatment should control most resprouts. For basal cut stump treatment, leave a higher stump and treat the cut surface and all the remaining bark. For basal bark treatment, spray the lower trunk, including the root collar, to a height of 12 to 15 inches; the spray should thoroughly wet the lower stem but not to the point of runoff. Plants should not be cut for at least one month after basal bark treatment. Triclopyr is also used in a premix with aminopyralid (Capstone) at 6 to 8 pt product/acre." … "Glyphosate - Rate: Spot treatment: 1.5 to 2% v/v solution of Roundup ProMax (or other trade name with similar concentration of glyphosate) in water to thoroughly wet all leaves. Low volume/thinline treatment: 10% v/v solution of Roundup (or other trade name) in water. Cut stump treatment: 25% v/v Roundup (or other trade name) in water; 50% can reduce resprouting but may exceed label rate if stands are dense. Timing: Foliar treatments should be made in late summer or early fall. For cut stump treatment, apply in late summer, early fall or dormant season; treat immediately after cutting. Remarks: Nonselective systemic herbicide that may kill partially-sprayed plants off target. It gives good control with some resprouts. Plants should not be cut for at least 4 months after foliar treatments. Cut stump applications are made as described for triclopyr." … "Imazapyr - Rate: Spot treatment: 1 to 2% v/v solution of Stalker plus 0.25 to 0.5% surfactant v/v in water to thoroughly wet all leaves. Low volume/thinline treatment: 10% v/v solution of Stalker plus a 20% v/v ethylated crop oil in water. Cut stump treatment: 20% v/v solution of Stalker plus a 20% v/v ethylated crop oil in water or 20% Habitat v/v in 80% water carrier. Basal bark treatment: 20% v/v solution of Stalker plus a 20% v/v ethylated crop oil in water. Timing: Postemergence when plants are growing rapidly. Best when used in late summer to early fall. Remarks: Soil residual herbicide; may result in bare ground around plants for some time after treatment. Cut stump and basal bark applications are as described for triclopyr. Plants should not be cut for at least 4 months after basal bark treatment."
804	2003. Weber, E.. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	[Tolerates, or benefits from, mutilation, cultivation, or fire? Yes] "It produces large amounts of long-lived seeds and resprouts from the root crown if damaged" … "Cutting close to the ground may prevent resprouting. Mature plants can be removed with a weed wrench."
804	2005. Zouhar, K.. Cytisus scoparius, C. striatus. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/ [Accessed 03 Oct 2013]	[Tolerates, or benefits from, mutilation, cultivation, or fire? Yes] "Fire adaptations: Scotch broom sprouts from the stem after top-kill from fire [17,130,137] or mechanical removal [13,58]. "
804	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Tolerates, or benefits from, mutilation, cultivation, or fire? Yes] "Plants tolerate frost, but typically die back after severe cold winter conditions; however, roots or lower stems may survive and generate new growth."
804	2008. Bonner, F.T./Karrfalt, R.P. (eds.). The Woody Plant Seed Manual. USDA FS Agriculture Handbook 727. Government Printing Office, Washington, D.C.	[Tolerates, or benefits from, mutilation, cultivation, or fire? Yes] "It is a drought-deciduous shrub with angled, photosynthetic stems that is able to root-sprout following fire (Bossard and Rejmanek 1994; Gonzales-Andres and Ortiz 1997)."

805	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Effective natural enemies present locally (e.g. introduced biocontrol agents)? Unknown for Hawaii & the Pacific] "Biological control activities targeted at scotch broom started in 1951 in Europe. The twig-mining moth Leucoptera spartifoliella and the weevil Exapion fuscirostre were released in the field in California, USA, in 1960 and 1964, respectively (Andres et al., 1967) and then widely redistributed. The weevil has been recorded destroying between 60 and 90% of seed produced (Syrett et al., 1999) with attack rates of three weevils per pod. L. spartifoliella initially caused severe damage but was found to be already present in Washington State along with its European parasitoid since at least 1941 and soon failed to maintain the high populations reported regularly in New Zealand. L. spartifoliella was introduced to Australia from New Zealand in 1993, where it has established at several release sites and has reached densities that are starting to stunt growth. The seed beetle Bruchus villosus was released in New Zealand in 1987 and in Australia in 1996 (Syrett et al., 1999). The beetle has established in both countries and, in New Zealand, up to 60% seed loss has been recorded at early release sites. B. villosus was shown to have actively moved between eastern North America, where it arrived accidentally, and western North America, where it didn't previously occur, on the basis of the significant damage it caused (Syrett et al., 1999). The psyllid Arytainilla spartiophila was first released in 1993 in New Zealand and in 1995 in Australia and is now established in both countries (Syrett et al., 1999). A bioherbicide is under development for broom in New Zealand (Frohlich and Gianotti, 2000)."
805	2007. DiTomaso, J.. Weeds of California and Other Western States, Volume 1. UCANR Publications, Oakland, CA	[Effective natural enemies present locally (e.g. introduced biocontrol agents)? Unknown in Hawaiian Islands] "Three biocontrol agents are established in California, the Scotch broom seed weevil (Apion fuscirostre), twig miner (Leucoptera spartifoliella), and the accidentally introduced gorse or broom tip moth (Agonopterix nervosa). The seed weevil and the twig miner are specific to Scotch broom. The broom tip moth also attacks gorse"
805	2008. Bonner, F.T./Karrfalt, R.P. (eds.). The Woody Plant Seed Manual. USDA FS Agriculture Handbook 727. Government Printing Office, Washington, D.C.	[Effective natural enemies present locally (e.g. introduced biocontrol agents)? Unknown] "Host-specific pre-dispersal seed predators from Europe (a seed weevil and a bruchid beetle) have been introduced for biocontrol of Scotch broom in the Northwest, but so far these introductions have been largely ineffective, possibly because of asynchrony in the phenology of host and seed predator (Bravo 1980)."

Summary of Risk Traits

High Risk / Undesirable Traits

- Environmentally versatile (elevation range exceeds 1000 m)
- Widely naturalized (including Hawaii Island)
- A weed of forestry plantations
- An environmental weed
- Related Cytisus species have become invasive
- Toxic to cattle
- Increases fire hazard with flammable biomass
- Tolerates many soil types
- Can from dense monocultures that exclude other vegetation
- Limited self-compatibility
- Accidentally & intentionally dispersed by seeds
- Prolific seed production
- Forms a persistent seed bank
- Resprouts after damage from cutting or fire

Low Risk Traits

- May be limited to higher, cooler elevations in tropical island ecosystems
- Unarmed (no spines, thorns or burrs)
- Palatable to goats and sheep
- Intolerant of heavy shade
- Does not spread vegetatively
- Valued as an ornamental in some locations
- Herbicides provide effective control under certain circumstances