

Key Words: High Risk, Naturalized, Commercial Crop, Hybridizes, Self-compatible

**Family:** *Malvaceae*

**Taxon:** *Gossypium hirsutum*

**Synonym:** *Gossypium jamaicense* Macfad.  
*Gossypium lanceolatum* Tod.  
*Gossypium mexicanum* Tod.  
*Gossypium morrillii* O. F. Cook & J. Hubb.  
*Gossypium palmeri* G. Watt  
*Gossypium punctatum* Schumach.  
*Gossypium purpurascens* Poir.  
*Gossypium religiosum* L.  
*Gossypium schottii* G. Watt  
*Gossypium taitense* Parl.  
*Gossypium tridens* O. F. Cook & J. Hubb.

**Common Name:** Upland cotton  
 American cotton  
 Bourbon cotton

Questionnaire :	current 20090513	Assessor:	Chuck Chimera	Designation:	H(HPWRA)
Status:	Assessor Approved	Data Entry Person:	Chuck Chimera	WRA Score	9
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)		High
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		
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)		
303	Agricultural/forestry/horticultural weed		n=0, y = 2*multiplier (see Appendix 2)		n
304	Environmental weed		n=0, y = 2*multiplier (see Appendix 2)		n
305	Congeneric weed		n=0, y = 1*multiplier (see Appendix 2)		
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		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	y=1, n=0	n
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	n
501	Aquatic	y=5, n=0	n
502	Grass	y=1, n=0	n
503	Nitrogen fixing woody plant	y=1, n=0	n
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0	n
601	Evidence of substantial reproductive failure in native habitat	y=1, n=0	n
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally	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	y
703	Propagules likely to disperse as a produce contaminant	y=1, n=-1	n
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	y
707	Propagules dispersed by other animals (externally)	y=1, n=-1	n
708	Propagules survive passage through the gut	y=1, n=-1	y
801	Prolific seed production (>1000/m2)	y=1, n=-1	n
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire	y=1, n=-1	
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	y=-1, n=1	

## Supporting Data:

101	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Is the species highly domesticated? No. This assessment deals with the wild type of <i>G. hirsutum</i> , although cultivars may be bred that have a reduced potential to naturalize] "Modern cotton cultivars do not possess any of the attributes commonly associated with problematic weeds, such as seed dormancy, persistence in soil seed banks, germination under adverse environmental conditions, rapid vegetative growth, a short life cycle, very high seed output, high seed dispersal and long-distance dispersal of seeds (Keeler 1985; Keeler 1989)."
102	2012. WRA Specialist. Personal Communication.	NA
103	2012. WRA Specialist. Personal Communication.	NA
201	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.	[Species suited to tropical or subtropical climate(s) 2-High] "Native to the tropical and subtropical Americas, the Caribbean, and questionably some Pacific Islands, but widespread in cultivation;"
201	2004. Francis, J.K. (ed.). Wildland Shrubs of the United States & its Territories: Thamnisc Descriptions volume 1. Gen. Tech. Rep. IITF-GTR-26. USDA Forest Service International Institute of Tropical Forestry, San Juan, PR	[Species suited to tropical or subtropical climate(s) 2-High] "Range.—The native range of wild cotton includes Tropical Florida, the West Indies, Northern South America, Mexico, and Central America (Howard 1989, Liogier 1994, Long and Lakela 1976) and apparently several Pacific Islands including Samoa (Kohel and Lewis 1984)."
202	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.	[Quality of climate match data 2-High]
203	1983. Duke, J.A.. Handbook of Energy Crops - <i>Gossypium hirsutum</i> . <a href="http://www.hort.purdue.edu/newcrop/duke_energy/gossypium_hirsutum.html">http://www.hort.purdue.edu/newcrop/duke_energy/gossypium_hirsutum.html</a>	[Broad climate suitability (environmental versatility)? Possibly Yes] "Ranging from the Cool Temperate Moist to Wet through Tropical Very Dry to Moist Forest Life Zones, Upland Cotton is reported to tolerate annual precipitation of 2.9 (irrigated) to 27.8 dm (mean of 36 cases = 11.3), annual temperature of 7.0 to 27.8°C (mean of 36 cases = 20.7), and pH of 4.5 to 8.4 (mean of 31 cases = 66). In the Northern Hemisphere, cotton production extends to 37°N in the United States, 47°N in Soviet Union, and 42°N in Manchuria. In the Southern Hemisphere, the limits are 32°S in South America and Australia, and to about 30°S in Africa. Sensitive in any stage to frost, cotton limits are set by the early and late frosts. Cotton is crop of warm plains, grown commercially from sea level to 1,200 m, with some perennial forms found at 1,800 m."
203	2004. Francis, J.K. (ed.). Wildland Shrubs of the United States & its Territories: Thamnisc Descriptions volume 1. Gen. Tech. Rep. IITF-GTR-26. USDA Forest Service International Institute of Tropical Forestry, San Juan, PR	[Broad climate suitability (environmental versatility)? Possibly No] "Wild cotton is mainly a plant of the coastal strand and lower coastal plains. The species has a particular affinity for small islands. It also grows in disturbed places, particularly along roads and on river overflow areas, well inland."
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] "Native to the tropical and subtropical Americas, the Caribbean, and questionably some Pacific Islands, but widespread in cultivation;"
205	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.	[Does the species have a history of repeated introductions outside its natural range? Yes] "...widespread in cultivation;"
205	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Does the species have a history of repeated introductions outside its natural range? Yes] "G. hirsutum is the most widely planted species in Australia but a small amount of <i>G. barbadense</i> is also cultivated. Two other species, <i>G. arboreum</i> and <i>G. herbaceum</i> , are cultivated in Asia, but are not grown commercially in Australia."
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] "in Hawaii at least sparingly naturalized at Hale'iwa, Oahu, and perhaps elsewhere. Although cultivated in Hawaii at least during this century, the first naturalized collection was made in 1956 (Degener 24074, BISH)."

301	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Naturalized beyond native range? Yes] "Small naturalised populations of both <i>G. hirsutum</i> and <i>G. barbadense</i> occur in parts of northern Australia, particularly in areas associated with a prolonged supply of fresh water (Hnatiuk 1990)(data from Australian State herbaria), but these 'feral' populations do not appear to be derived from modern cotton cultivars (see Section 1.7)." ... "Although the Queensland herbarium also has specimens of <i>G. hirsutum</i> collected from plants that naturalised in Queensland, the majority of feral <i>G. hirsutum</i> populations occur in the Northern Territory and northern Western Australia."
301	2002. Starr, F./Martz, K./Loope, L.L.. New plant records from the Hawaiian archipelago. Bishop Museum Occasional Papers. 69: 16-27.	[Naturalized beyond native range? Yes] " <i>Gossypium hirsutum</i> (upland cotton) was previously known from Hale'iwa, O'ahu where it was collected by Degener in 1956 (Wagner et al., 1999: 876). More recently, it was collected at La Pérouse Bay in leeward East Maui. This collection represents a new island record for Maui. Material examined. MAUI: E. Maui, La Pérouse, stands growing in and near kiawe forest, 10 ft [3 m], 15 Apr 2000, Starr & Martz 000415-1."
301	2007. Addison, S.J./Farrell, T./Roberts, G.N./Rogers, D.J.. Roadside surveys support predictions of negligible naturalisation potential for cotton ( <i>Gossypium hirsutum</i> ) in north-east Australia. <i>Weed Research</i> . 47: 192-201.	[Naturalized beyond native range? Yes] "Additional Climex modelling was conducted using irrigation scenarios because some sites, especially inland creek crossings, were similar to locations where naturalised populations of <i>G. hirsutum</i> are known to occur in the Northern Territory on river banks, floodplain margins and beach strands (Eastick, 2002)."
302	2007. Hussey, B.M.J./Keighery, G. J./Dodd, J./Lloyd, S.G./Cousens, R.D.. <i>Western Weeds. A Guide to the Weeds of Western Australia</i> . The Weed Society of Western Australia, Victoria Park, WA	[Garden/amenity/disturbance weed? Potentially] "Originally from central America and grown worldwide as a source of cotton fibre, it has escaped from cultivation and is now found occasionally in wasteland, creeks and pindan in the Kimberley, and at Port Hedland." [Colonizes disturbed areas, but no information on impacts has been described]
303	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Agricultural/forestry/horticultural weed? No] " <i>G. hirsutum</i> and <i>G. barbadense</i> may occur as escapes from agriculture and/or as small populations of naturalised exotic species (see above) (Lazarides et al. 1997) (Sindel 1997). Where such populations have established, however, they are not considered to threaten agricultural productivity or native biodiversity."
304	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Environmental weed? No] "Cotton has been grown for centuries throughout the world without any reports that it is a serious weed pest. No <i>Gossypium</i> species are recognised as problematic weeds in Australia, either agriculturally or environmentally (Tothill et al. 1982; Lazarides et al. 1997). Cotton has no relatives that are problematic weeds (Keeler et al. 1996), although locally <i>G. sturtianum</i> can be weedy (Lazarides et al. 1997)."
305	2007. Randall, R.P.. <i>Global Compendium of Weeds - Index</i> . <a href="http://www.hear.org/gcw/">http://www.hear.org/gcw/</a>	[Congeneric weed? Potentially] Several <i>Gossypium</i> species are reported as weeds, but evidence of detrimental impacts is difficult to determine. Most species appear to be naturalized, without specification of negative impacts.
401	1999. Wagner, W.L./Herbst, D.R./Sohmer, S.H.. <i>Manual of the flowering plants of Hawaii</i> . Revised edition.. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Produces spines, thorns or burrs? No] "Shrubs or annual subshrubs 1-2 m tall, usually stellate pubescent. Leaf blades usually wider than long, 8-15 cm wide, cut angulately to about the middle into 3 or 5 lobes, the lobes broadly triangular to ovate, acute to acuminate, midvein on lower surface with a basal gland, stipules 0.5-2 cm long."
402	2001. Kohli, R. K./Singh, D.P./Batish, D.R.. <i>Allelopathy in agroecosystems</i> . Food Products Press, Binghamton, NY	[Allelopathic? No] No evidence. Allelopathic effects of other plants on <i>Gossypium hirsutum</i> cultivation are reported.
403	1999. Wagner, W.L./Herbst, D.R./Sohmer, S.H.. <i>Manual of the flowering plants of Hawaii</i> . Revised edition.. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Parasitic? No] Malvaceae
404	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Unpalatable to grazing animals? No] "As discussed in Section 1.4, cotton volunteers occur in all Australian cotton growing areas and are relatively common where cotton seed is used as livestock feed. There is no indication, however, that these volunteers sponsor self-perpetuating feral populations. Typically, however, such volunteers are killed by roadside management practices and/or grazed by livestock, thereby limiting their potential to reproduce and become weedy."
405	1974. Freeland, W.J./Janzen, D.H.. <i>Strategies in Herbivory by Mammals: The Role of Plant Secondary Compounds</i> . <i>The American Naturalist</i> . 108(961): 269-289.	[Toxic to animals? Consumption of large numbers of seeds could result in poisoning, although this is unlikely to occur naturally] " <i>Gossypium hirsutum</i> seeds contain 2%o 5%o gossypol, a toxic phenolic compound (Levin 1971). Diets containing 0.1% gossypol are lethal to large herbivorous mammals (Levin 1971). A 4%o tannic acid diet causes weight loss and growth retardation in weanling rats, and an 8%o tannic acid diet kills them (Glick and Joslyn 1970a). Oak leaves contain up to 5%o tannin (Feeny 1968b), and concentrations are much higher in tree species harvested as a commercial source of tannin."

405	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Toxic to animals? No. Although seeds possess toxic properties] "Cotton is not a pathogen and not capable of causing disease in humans, animals or plants. Cotton pollen is not allergenic. Because it is relatively large and heavy, and is not easily dispersed by wind, the potential for cotton pollen to act as an air born allergen is particularly low. However, inhalation of cotton dust by mill workers can cause byssinosis, an asthma-like condition, in sensitive individuals. Preventative measures such as the use of facemasks have been successful in lowering the incidence of this condition." ... "Cotton tissue, particularly the seeds, can be toxic if ingested in excessive quantities because of the presence of anti-nutritional and toxic factors including gossypol and cyclopropenoid fatty acids (including dihydrosterculic, sterculic and malvalic acids). Cotton seed is processed into four major products: oil, meal, hulls and linters. After extensive processing to remove toxicants, especially gossypol and its derivatives, the oil and linters are used as premium vegetable oils and as cellulose dietary additives for human consumption, respectively."
406	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Host for recognized pests and pathogens? Yes] "More than 1326 species of insects have been reported in commercial cotton fields worldwide but only a small proportion are pests (Matthews & Tunstall 1994). Of the 30 pests of cultivated <i>G. hirsutum</i> , the most important are the caterpillars of <i>Helicoverpa armigera</i> and <i>Helicoverpa punctigera</i> , and the spider mite <i>Tetranychus urticae</i> (Shaw 2000; Pyke & Brown 2000)." ... "Diseases in cotton may affect the quality of the fibre and seed, as well as the yield and cost of production of the cotton crop (Bell 1999; Cotton Australia 2002a). The main diseases affecting cotton in Australia include: Seedling diseases; Fungal wilt diseases ( <i>Fusarium</i> wilt or verticillium wilt); and Leaf spots."
407	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Causes allergies or is otherwise toxic to humans? No] "Cotton is not a pathogen and not capable of causing disease in humans, animals or plants. Cotton pollen is not allergenic. Because it is relatively large and heavy, and is not easily dispersed by wind, the potential for cotton pollen to act as an air born allergen is particularly low. However, inhalation of cotton dust by mill workers can cause byssinosis, an asthma-like condition, in sensitive individuals. Preventative measures such as the use of facemasks have been successful in lowering the incidence of this condition."
408	2008. Anonymous. The Biology of <i>Gossypium hirsutum</i> L. and <i>Gossypium barbadense</i> L. (cotton). Version 2. Office of the Gene Technology Regulator, Canberra	[Creates a fire hazard in natural ecosystems? No] "Weed competition and fire were also identified to further reduce the probability of permanent cotton populations establishing in the identified areas (Rogers et al. 2007)." [Fire eliminates cotton plants from an area. Not a fire adapted plant]
409	2004. Francis, J.K. (ed.). Wildland Shrubs of the United States & its Territories: Thamnisc Descriptions volume 1. Gen. Tech. Rep. IITF-GTR-26. USDA Forest Service International Institute of Tropical Forestry, San Juan, PR	[Is a shade tolerant plant at some stage of its life cycle? No] "Wild cotton competes well with weeds and grasses but does not tolerate shade and cannot grow under tree cover."
410	2004. Francis, J.K. (ed.). Wildland Shrubs of the United States & its Territories: Thamnisc Descriptions volume 1. Gen. Tech. Rep. IITF-GTR-26. USDA Forest Service International Institute of Tropical Forestry, San Juan, PR	[Tolerates a wide range of soil conditions? Yes] "Wild cotton can grow in almost all types of well drained soils. Optimum pH's are said to be from 5.2 to 7.0 (Center for New Crops and Plants Products 2002). Soil disturbance is usually necessary for its establishment. It tolerates moderate amounts of salts in the soil and salt spray."
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] "Shrubs or annual subshrubs 1-2 m tall..."
412	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.	[Forms dense thickets? No evidence]
412	2007. Hussey, B.M.J./Keighery, G. J./Dodd, J./Lloyd, S.G./Cousens, R.D.. Western Weeds. A Guide to the Weeds of Western Australia. The Weed Society of Western Australia, Victoria Park, WA	[Forms dense thickets? No evidence]
412	2008. Anonymous. The Biology of <i>Gossypium hirsutum</i> L. and <i>Gossypium barbadense</i> L. (cotton). Version 2. Office of the Gene Technology Regulator, Canberra	[Forms dense thickets? No evidence]

501	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.	[Aquatic? No] Terrestrial
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] Malvaceae
503	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.	[Nitrogen fixing woody plant? No] Malvaceae
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] "Shrubs or annual subshrubs 1-2 m tall, usually stellate pubescent."
504	2004. Francis, J.K. (ed.). Wildland Shrubs of the United States & its Territories: Thamnic Descriptions volume 1. Gen. Tech. Rep. IITF-GTR-26. USDA Forest Service International Institute of Tropical Forestry, San Juan, PR	[Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)? No] "Wild cotton, also known as upland cotton, in wild populations is a shrub or occasionally a small tree to 5 m in height and 15 cm in stem diameter. The plant is deeply rooted with a taproot and laterals."
601	2012. WRA Specialist. Personal Communication.	[Evidence of substantial reproductive failure in native habitat? No] No evidence
602	2008. Anonymous. The Biology of <i>Gossypium hirsutum</i> L. and <i>Gossypium barbadense</i> L. (cotton). Version 2. Office of the Gene Technology Regulator, Canberra	[Produces viable seed? Yes] "Cotton is generally propagated by seed."
603	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Hybridizes naturally? Yes, but may be limited] "Fertile progeny are also produced when <i>G. hirsutum</i> is cross-pollinated with <i>G. barbadense</i> (Brubaker et al. 1999a), thereby potentially providing another ready means by which <i>G. hirsutum</i> genes may be spread in the environment. The geographic isolation of naturalised <i>G. barbadense</i> from cultivated <i>G. hirsutum</i> poses a significant barrier to gene flow between these species in Australia."
603	2010. Pleasants, J.M./Wendel, J.F.. Reproductive and Pollination Biology of the Endemic Hawaiian Cotton, <i>Gossypium tomentosum</i> (Malvaceae). <i>Pacific Science</i> . 64(1): 45-55.	[Hybridizes naturally? Potentially with <i>G. tomentosum</i> ] "Abstract: <i>Gossypium tomentosum</i> is a cotton species endemic to the Hawaiian Islands. We studied several aspects of its reproductive biology, including potential pollinators, floral biology, and diurnal and seasonal flowering phenology. Flower visitors were observed in <i>G. tomentosum</i> populations on O'ahu, Kaho'olawe, and Maui. Primary visitors were introduced species, honeybees and carpenter bees, both of which were pollinating the flowers. No native bee species were seen visiting flowers. In examining floral biology we found that in some cases 10% of flowers had styles that were as short as the anthers or were recurved toward the anthers. In the greenhouse, in the absence of pollinators, these flowers were the only ones that set fruit. Flowering of <i>G. tomentosum</i> commences in January and February, following the rainy season, peaks in May, and may continue into August and September. In one year, after higher than average precipitation during the rainy season, there was a greater abundance of flowering, and flowering persisted later into the year. Transgenic varieties of commercial cotton, <i>G. hirsutum</i> , are grown in Hawai'i and are interfertile with <i>G. tomentosum</i> . Honeybees and carpenter bees are also known pollinators of commercial cotton. Because these pollinators are long distance foragers, we estimate that transgenic cotton fields would have to be greater than 10 km from a <i>G. tomentosum</i> population to prevent gene flow."
604	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Self-compatible or apomictic? Yes] "Cotton is a facultative self-pollinator, and an opportunistic out-croser when insect pollinators are present (Oosterhuis & Jernstedt 1999)."

605	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Requires specialist pollinators? No] "Cotton is a facultative self-pollinator, and an opportunistic out-crosser when insect pollinators are present (Oosterhuis & Jernstedt 1999)." ... "The level of out crossing observed in Australia is in the order of 1 to 2% between plants in adjacent rows (Thomson 1966a; Mungomery & Glassop 1969a; Llewellyn & Fitt 1996). This is relatively low compared to that seen in some other countries. Differences in pollinator species may be responsible for the lower rate, in particular the absence of bumble bees, which are known to be very effective pollinators (Llewellyn & Fitt 1996). Honeybees were implicated as the chief pollinating agent in a Queensland study (Mungomery & Glassop 1969a). Since honeybees were not present for a similar study in the Ord River valley (Thomson 1966a) it was suggested that native bees might be responsible for the cross-pollination in this region. In cotton out-crossing experiments conducted near Narrabri in New South Wales, no bees were detected, and although small numbers of wasps and flies were recorded, it was suggested that hibiscus beetles were likely to be the major cross-pollinators in these trials (Llewellyn & Fitt 1996)."
606	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Reproduction by vegetative fragmentation? No] "As cotton does not generally reproduce vegetatively (Serdy et al. 1995), spread within the environment occurs by seed dispersal."
607	1983. Duke, J.A.. Handbook of Energy Crops - <i>Gossypium hirsutum</i> . <a href="http://www.hort.purdue.edu/newcrop/duke_energy/gossypium_hirsutum.html">http://www.hort.purdue.edu/newcrop/duke_energy/gossypium_hirsutum.html</a>	[Minimum generative time (years)? <1 in cultivation] "Fl. variable as to locality, approx. 3 months after planting. "
607	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Minimum generative time (years)? Potentially <1 year in cultivation] "Reproductive maturity is reached about 4 5 weeks after planting, with the formation of floral buds ('squares'). Typically, about 25 days elapse between the initial appearance of a square and anthesis (flower opening) (Oosterhuis & Jernstedt 1999). Under normal crop conditions, about 60% of squares and immature fruit are abscised prematurely. Mature flowers are not usually shed before pollination (Oosterhuis & Jernstedt 1999)."
607	2004. Francis, J.K. (ed.). Wildland Shrubs of the United States & its Territories: Thamnisc Descriptions volume 1. Gen. Tech. Rep. IITF-GTR-26. USDA Forest Service International Institute of Tropical Forestry, San Juan, PR	[Minimum generative time (years)? Mostly >1] "Growth and Management.—Although wild cotton in its cultivated form is managed as an annual, it is a true perennial, and if allowed to do so under favorable conditions, will live for several years (Kohel and Lewes 1984) and become tall and woody. Wild cotton in Puerto Rico grows 1 to 1.5 m in its first year. The wild variety requires 15 or more nodes to be formed along the main axis before it can flower. Consequently, the plant is rarely able to bloom during its first year (Kohel and Lewis 1984)."
701	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)? Yes] "Observations of dispersed seeds and the occurrence of volunteer plants in the northern Australian trials (Monsanto, unpublished data) indicate that delinted black seed has the lowest risk of unintentional spread within the environment. When dispersal of black seed occurs, it is associated with spillage at sowing in cotton production areas."
701	2007. Addison, S.J./Farrell, T./Roberts, G.N./Rogers, D.J.. Roadside surveys support predictions of negligible naturalisation potential for cotton ( <i>Gossypium hirsutum</i> ) in north-east Australia. Weed Research. 47: 192-201.	[Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)? Yes, but limited in north east Australia] "Over 3 years, 22 cotton plants were found at eight sites. Within the cotton production region, volunteers averaged 2.28 plants km <sup>1</sup> of road; their most likely source was seed cotton spilt during the previous harvest. Further north, three plants were found over 3 years, at an average density of 0.089 plants km <sup>1</sup> of road" ... "The surveys indicate that roadsides in north east Australia are a hostile environment for the establishment of cotton plants, with no evidence of naturalisation or secondary spread. Current transport practices utilizing fully covered loads present negligible risk of producing naturalised populations of cotton (either transgenic or non-transgenic) on roadsides in north-east Australia."
702	2004. Francis, J.K. (ed.). Wildland Shrubs of the United States & its Territories: Thamnisc Descriptions volume 1. Gen. Tech. Rep. IITF-GTR-26. USDA Forest Service International Institute of Tropical Forestry, San Juan, PR	[Propagules dispersed intentionally by people? Yes] " <i>Gossypium hirsutum</i> is the principal cultivated cotton throughout the world (Vijayakumar 2002). It has naturalized in many locations, especially in island habitats, including Hawaii (Neal 1965)."
703	2002. Eastick, R.. The Potential Weediness of Transgenic Cotton in Northern Australia. Technical Bulletin NO. 305. N.T. Department of Business, Industry and Resource Development, Darwin	[Propagules likely to disperse as a produce contaminant? No. Intentional dispersal via cattle feed] "Fuzzy seed (ginned) had the greatest potential for intentional spread as cattle feed introduced into non-cropping habitats, but had a low risk of unintentional escape as feed lots were physically restricted, although viable cottonseed can pass through the digestive tract of cattle."

704	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Propagules adapted to wind dispersal? Mostly gravity dispersed] "Soon after anthesis, the anthers of cotton flowers dehisce, discharging their pollen. Cotton pollen is relatively large and heavy, and not easily dispersed by wind (Jenkins 1992)."
704	2004. Francis, J.K. (ed.). Wildland Shrubs of the United States & its Territories: Thamnisc Descriptions volume 1. Gen. Tech. Rep. IITF-GTR-26. USDA Forest Service International Institute of Tropical Forestry, San Juan, PR	[Propagules adapted to wind dispersal? Yes. Short distances] "The wind disburse the seeds over short distances by blowing the lint until it catches on vegetation."
705	1966. Stephens, S.G.. The Potentiality for Long Range Oceanic Dispersal of Cotton Seeds. The American Naturalist. 100(912): 199-210.	[Propagules water dispersed? Yes] "Seeds of the Wake Island form of <i>hirsutum</i> have salt water tolerance comparable to that of <i>sandvicense</i> , but it seems doubtful that this would be sufficient to maintain them for the necessary period of time (19 months)."
705	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Propagules water dispersed? Yes] "Unprocessed 'seed cotton', that retains all of the fibres attached to the seedcoat, also has a high potential for dispersal within the environment. Monsanto's data suggest that volunteers from dispersed seed cotton were relatively common in irrigation channels and drains, and along roadsides. Roadside volunteers most likely established following seed cotton spillage during transport of cotton modules from the paddock to the gin."
706	2004. Francis, J.K. (ed.). Wildland Shrubs of the United States & its Territories: Thamnisc Descriptions volume 1. Gen. Tech. Rep. IITF-GTR-26. USDA Forest Service International Institute of Tropical Forestry, San Juan, PR	[Propagules bird dispersed? Yes] "Birds also move seeds when they use cotton lint for nest building materials."
707	2008. Anonymous. The Biology of <i>Gossypium hirsutum</i> L. and <i>Gossypium barbadense</i> L. (cotton). Version 2. Office of the Gene Technology Regulator, Canberra	[Propagules dispersed by other animals (externally)? No evidence] "There are no reports of mammals, including rodents, feeding on mature cotton bolls or carrying seed cotton any great distance from the cotton fields."
708	2002. Eastick, R.. The Potential Weediness of Transgenic Cotton in Northern Australia. Technical Bulletin NO. 305. N.T. Department of Business, Industry and Resource Development, Darwin	[Propagules survive passage through the gut? Yes] "...viable cottonseed can pass through the digestive tract of cattle." ... "Dispersal: Seed cotton and black seed have a very low risk of contaminating natural habitats. Fuzzy seed provides the greatest risk through intentional feeding to cattle."
801	2008. Anonymous. The Biology of <i>Gossypium hirsutum</i> L. and <i>Gossypium barbadense</i> L. (cotton). Version 2. Office of the Gene Technology Regulator, Canberra	[Prolific seed production (>1000/m <sup>2</sup> )? No] "Under Australian conditions a <i>G. hirsutum</i> plant produces approximately 29-40 seeds per boll (Eastick 2002; Yasuor et al. 2007) with 10-12 bolls per plant (Eastick 2002; Roche & Bange 2006)." [Maximum of ca. 480 seeds per plant. Unlikely to reach such high seed densities, even under cultivation]
802	2002. Anonymous. The biology and ecology of cotton ( <i>Gossypium hirsutum</i> ) in Australia. Office of the Gene Technology Regulator, Canberra	[Evidence that a persistent propagule bank is formed (>1 yr)? Potentially] "Agronomically, hard seeds are undesirable and the trait has been largely eliminated from modern commercial cultivars through breeding and selection (Mauncy 1986; Hopper & McDaniel 1999). The existence of a soil seed bank does not appear to have been investigated specifically, although it seems unlikely because dispersed seeds that do not germinate are rapidly weathered, leading to significant decreases in their viability (Hallowin 1975; Woodstock et al. 1985). In addition to induced dormancy, cotton seeds collected immediately following fruit maturation can display 'innate dormancy' (Taylor & Lankford 1972a) – an inherent condition of the mature seed/embryo that prevents the seed from germinating, even when exposed to appropriate environmental conditions. The duration of innate dormancy varies from no dormancy in certain varieties (Hsi & Reeder 1953) to several months in others (Christidis 1955). Taylor and Lankford (Taylor & Lankford 1972b) demonstrated that the germinability of 1-year old cotton seeds kept under storage was about 8 – 24 % lower than seeds from the same seed lot in subsequent years. They also observed that the positive effect of seed age on germinability could reduce the negative impact of factors that may induce dormancy, such as cold temperature." ... "Post-dispersal, seeds that do not germinate are likely to be removed by seed predators or rot, rather than become incorporated into a persistent soil seed bank, which is in any case unlikely for reasons outlined above."
802	2008. Royal Botanic Gardens Kew. Seed Information Database (SID). Version 7.1. <a href="http://data.kew.org/sid/">http://data.kew.org/sid/</a>	[Evidence that a persistent propagule bank is formed (>1 yr)? Potentially Yes] "Storage Conditions: 6% germination following 25 years storage at room temperature (Harrington, 1972); no problem for long-term storage under IBPGR preferred conditions (SSLR); long-term storage under IPGRI preferred conditions at RBG Kew, WP. Oldest collection 15 years"

803	2002. Eastick, R.. The Potential Weediness of Transgenic Cotton in Northern Australia. Technical Bulletin NO. 305. N.T. Department of Business, Industry and Resource Development, Darwin	[Well controlled by herbicides? Yes] "Cultivated fields were not included since control of cotton volunteers in production areas is successfully managed through cultivation and herbicide application."
804	2004. Francis, J.K. (ed.). Wildland Shrubs of the United States & its Territories: Thamnnic Descriptions volume 1. Gen. Tech. Rep. IITF-GTR-26. USDA Forest Service International Institute of Tropical Forestry, San Juan, PR	[Tolerates, or benefits from, mutilation, cultivation, or fire? Possibly] "Wild cotton usually has a single trunk, unless disturbed, but may have branches arising just above the ground."
804	2008. Anonymous. The Biology of <i>Gossypium hirsutum</i> L. and <i>Gossypium barbadense</i> L. (cotton). Version 2. Office of the Gene Technology Regulator, Canberra	[Tolerates, or benefits from, mutilation, cultivation, or fire? Intolerant of Fire] "Weed competition and fire were also identified to further reduce the probability of permanent cotton populations establishing in the identified areas (Rogers et al. 2007)." [Fire eliminates cotton plants from an area]
805	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.	[Effective natural enemies present locally (e.g. introduced biocontrol agents)? Unknown] "in Hawaii at least sparingly naturalized at Hale`iwa, Oahu, and perhaps elsewhere. Although cultivated in Hawaii at least during this century, the first naturalized collection was made in 1956 (Degener 24074, BISH)." [Established in Hawaiian Islands, but unknown if any natural pests or pathogens are limiting its spread]

## **Summary of Risk Traits**

### **High Risk / Undesirable Traits**

- Naturalized on Oahu, and East Maui, Hawaiian Islands
- Naturalized in Australia
- Thrives in tropical climates
- Tolerates many soil conditions (and potentially able to exploit many different habitat types)
- Host of pests and pathogens
- Capable of hybridization with other *Gossypium* species
- A facultative self-pollinator
- May reach reproductive maturity in less than 1 year
- Seeds dispersed accidentally along roads, by wind, water, birds and by passage through cattle, among other vectors
- Seeds may persist in soil

### **Low Risk / Desirable Traits**

- Despite ability to spread, evidence of negative impacts are generally not reported or unspecified
- Fodder tree
- Non-toxic foliage (although seeds may be toxic)
- Shade intolerant
- Important commercial crop