Taxon: Verbesina encelioides **Family:** Asteraceae

Common Name(s): American dogweed
butter daisy
golden crown-beard
South African daisy

Synonym(s): Ximenesia encelioides Cav.

Assessor: Chuck Chimera **Status:** Assessor Approved **End Date:** 25 Feb 2015

WRA Score: 21.0 **Designation:** H(Hawai'i) **Rating:** High Risk

Keywords: Agricultural Weed, Environmental Weed, Toxic, Annual, Wind-Dispersed

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?		
103	Does the species have weedy races?		
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	(0-low; 1-intermediate; 2-high) (See Appendix 2)	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	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		
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		
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals		
405	Toxic to animals	y=1, n=0	y
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

Qsn #	Question	Answer Option	Answer
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	n
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0	n
601	Evidence of substantial reproductive failure in native habitat	y=1, n=0	n
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally		
604	Self-compatible or apomictic	y=1, n=-1	y
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	n
607	Minimum generative time (years)	1 year = 1, 2 or 3 years = 0, 4+ years = -1	1
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	y
702	Propagules dispersed intentionally by people		
703	Propagules likely to disperse as a produce contaminant	y=1, n=-1	y
704	Propagules adapted to wind dispersal	y=1, n=-1	y
705	Propagules water dispersed	y=1, n=-1	n
706	Propagules bird dispersed		
707	Propagules dispersed by other animals (externally)	y=1, n=-1	y
708	Propagules survive passage through the gut		
801	Prolific seed production (>1000/m2)		
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	y
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire	y=1, n=-1	n
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	y=-1, n=1	n

Supporting Data:

Qsn #	Question	Answer
101	**Is the species highly domesticated?**	**n**
	Source(s)	**Notes**
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	[No evidence] "Verbesina encelioides (Cav.) Benth. & Hook. f. ex A. Gray, golden crownbeard, is a sunflower-like herbaceous annual plant ranging in height from 0.3 to 1.7 m with showy yellow flowers. It is native to the southwestern United States, the Mexican Plateau, and other parts of tropical America."

102	**Has the species become naturalized where grown?**	
	Source(s)	**Notes**
	WRA Specialist. 2015. Personal Communication	NA

103	**Does the species have weedy races?**	
	Source(s)	**Notes**
	WRA Specialist. 2015. Personal Communication	NA

201	**Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"**	**High**
	Source(s)	**Notes**
	USDA, ARS, National Genetic Resources Program. 2015. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: http://www.ars-grin.gov/. [Accessed 23 Feb 2015]	"Native: NORTHERN AMERICA (Check conservation status in U.S. & Canada in NatureServe Explorer database) North-Central U.S.A.: United States - Illinois, Iowa, Kansas, Missouri, Nebraska, Oklahoma Northwestern U.S.A.: United States - Colorado, Wyoming Southeastern U.S.A.: United States - Arkansas, Florida, Georgia, Louisiana, North Carolina, South Carolina South-Central U.S.A.: United States - New Mexico, Texas Southwestern U.S.A.: United States - Arizona, California, Utah Northern Mexico: Mexico - Chihuahua, Coahuila, Durango, Nuevo Leon, San Luis Potosi, Sonora, Tamaulipas, Zacatecas Southern Mexico: Mexico - Hidalgo, Jalisco, Oaxaca"

202	**Quality of climate match data**	**High**
	Source(s)	**Notes**
	USDA, ARS, National Genetic Resources Program. 2015. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: http://www.ars-grin.gov/. [Accessed 23 Feb 2015]	

203	**Broad climate suitability (environmental versatility)**	**y**

Qsn #	Question	Answer
	Source(s)	**Notes**
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"Verbesina encelioides is found in a wide variety of habitats with differing temperatures, climates, and elevations. In its native range in North and South America, particularly in Mexico and the states of Texas, Arizona, and North Dakota, it is found at elevations of up to 2,750 m (Walther 2004)."
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Elevation range exceeds 1000 m, demonstrating environmental versatility] "in Hawai'i naturalized and relatively common in dry, disturbed sites, 0-2,805 m"

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	**Notes**
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"Native to southeastern North America and parts of Central and South America (Walther 2004, Strother 2006), V. encelioides is currently found on a number of major Pacific islands. In Hawai'i it is found on all of the main islands except Ni'ihau (Wagner et al. 2005): Kure, Midway Atoll, Pearl and Hermes Reef, Kaui, O'ahu, Moloka'i, La¯na'i, Maui, Kaho' olawe, and Hawai'i are its recorded locations (Wagner et al. 2005)."

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"V. encelioides has been introduced to the southwestern Arabian Peninsula, Argentina, the Pacific islands and Australia."
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"Verbesina encelioides has now successfully established on all major continents with the exception of Antarctica. It has successfully naturalized in many warm regions of the world: the southern U.S. states, parts of South America, the Bahamas, Cuba, Dominican Republic, Puerto Rico, Saudi Arabia, India, Ethiopia, Morocco, Botswana, Namibia, Israel, and Australia (Coleman 1966, Al- Farraj 1990, Keeler et al. 1992, Lopez et al. 1996, Arellano 1997, Walther 2004, European and Mediterranean Plant Protection Organization 2006, Solomon et al. 2006, USDA National Resources Conservation Service 2006)."

301	Naturalized beyond native range	y
	Source(s)	**Notes**

Qsn #	Question	Answer
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"In Hawai'i it is found on all of the main islands except Ni'ihau (Wagner et al. 2005): Kure, Midway Atoll, Pearl and Hermes Reef, Kaui'i, O'ahu, Moloka'i, Lana'i, Maui, Kaho' olawe, and Hawai'i are its recorded locations (Wagner et al. 2005). In particular, it is found in great abundance on the Northwestern Hawaiian Islands of Kure and Midway Atoll. However, it is not documented to occur on any other Pacific islands." ... "Verbesina encelioides has now successfully established on all major continents with the exception of Antarctica. It has successfully naturalized in many warm regions of the world: the southern U.S. states, parts of South America, the Bahamas, Cuba, Dominican Republic, Puerto Rico, Saudi Arabia, India, Ethiopia, Morocco, Botswana, Namibia, Israel, and Australia (Coleman 1966, Al- Farraj 1990, Keeler et al. 1992, Lopez et al. 1996, Arellano 1997, Walther 2004, European and Mediterranean Plant Protection Organization 2006, Solomon et al. 2006, USDA National Resources Conservation Service 2006)."
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"in Hawai'i naturalized and relatively common in dry, disturbed sites, 0-2,805 m, on Kure Atoll, Midway Atoll, and all of the main islands except Niihau. Naturalized prior to 1871 9Hillebrand, 1888), perhaps first on Maui."

302	Garden/amenity/disturbance weed	
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"In Australia, it occurs as a weed of sandy loams along roadsides, stock routes, field headlands and in some woodland communities."
	Kaul, M. L. H., & Mangal, P. D. (1987). Phenology and germination of crownbeard (Verbesina encelioides). Weed science 35(4): 513 518	[Disturbance adapted weed of agriculture and the environment. See 3.03 & 3.04] "In North India, it is a prominent postmonsoon and winter weed infesting maize, pearl millet, wheat, rice, peanut, gram, rape, and mustard fields. In addition, it is abundant along roadsides and railway tracts and on the wastelands, occurring mostly in sandy and sandy-loam soils"

303	Agricultural/forestry/horticultural weed	y
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"common weed in maize and sorghum in Argentina and peanuts in the United States. It is recorded and completely overwhelming the crop in at least one locality in the south west of the Arabian Peninsula."
	Kaul, M. L. H., & Mangal, P. D. (1987). Phenology and germination of crownbeard (Verbesina encelioides). Weed science 35(4): 513 518	"In North India, it is a prominent postmonsoon and winter weed infesting maize, pearl millet, wheat, rice, peanut, gram, rape, and mustard fields."

Qsn #	Question	Answer
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"It is a pest of various crops in the southern United States and India and is poisonous to sheep and cattle." ... "It is known to infest many crops including Raphanus sativus L. (radish), Zea mays L. (maize), Pennisetum glaucum (L.) R. Br. (pearl millet), Triticum sp. (wheat), Oryza sp. (rice), Lens culinaris M. (gram), Brassica napus L. (rapeseed), Brassicaceae sp. (mustard), Cucumus melo L. (honeydew melon), and Arachis hypogaea L. (peanut) (Kaul and Mangal 1987, Grichar and Sestak 1998, Inderjit et al. 1999, Brandenberger et al. 2005). In particular, V. encelioides is problematic for peanut farmers in southern states of the United States such as Oklahoma or Texas..."
	CABI. 2015. Verbesina encelioides in: Invasive Species Compendium. www.cabi.org/isc	"V. encelioides can directly impact agriculture, through competition with crops like peanuts in the USA, as well as poisoning livestock, including cattle and sheep in both the USA but more so in Argentina. Competitive experiments have shown that 3.2 V. encelioides weeds per metre row can decrease peanut harvest by 50% (Farris and Murray, 2006). One mechanism facilitating this interference success may be allelopathy (Inderjit et al., 1999). Toxicity in livestock has been linked to galegine, a chemical which causes dullness and anorexia at low doses and death at high doses when ingested in a single meal (Oelrichs and Vallely, 1981; Keeler et al., 1986; Keeler et al., 1992; Lopez et al., 1996; Jain et al., 2008)."

304	Environmental weed	y
	Source(s)	**Notes**
	Herbst, D.R. & Wagner, W.L. 1992. Alien Plants on the Northwestern Hawaiian Islands. Pp. 189-224 in Stone et al. (eds.) Alien Plant Invasions in Native Ecosystems of Hawai`i: Management & Research. Coop. Nat. Park Res. Studies Unit, U Hawaii, Honolulu, HI	"Golden crown-beard (Verbesina encelioides) has become a management problem. It was first reported on Kure Atoll by H.F. Clay in October 1959, growing near the radar reflector on Green Island. Bermuda grass (Cynodon dactylon), ironwood, and sourbush (Pluchea symphytifolia) were growing with it. Clay surmised that seeds of these plants were brought on equipment from Midway Atoll in 1955 when the reflector was built (Clay 1961). Golden crown-beard and sweet alyssum (Lobularia maritima) have become widespread on Green Island and are undergoing population explosions (Corn et al. 1981). Golden crown-beard forms a thicket that limits the space for ground-nesting seabirds, and it has become necessary to mow the central plain of Green Island to restore nesting areas for the birds."

Qsn #	Question	Answer
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"In Hawai'i, V. encelioides has caused substantial habitat degradation on Midway and Kure Atoll (K. Niethammer [U.S. Fish and Wildlife Service] and D. Smith [Hawai'i Department of Land and Natural Resources] as cited in Shluker 2002)." ... "It tends to reduce habitat quality by creating a physical barrier to nesting birds, lowering nest density, and shading out native plants (Klavitter, USFWS, pers. comm., 2007). Its aggressive growth abilities inhibit the growth of native plants such as Scaevola taccada taccada (naupaka) and Ipomea pes-caprae (beach morning glory) (Shluker 2002, Walther 2004; pers. obs.). These native plants are important for the long-term habitat of nesting seabirds (Shluker 2002). On Midway Atoll, V. encelioides outcompetes all 20 of the extant native plant species (John Klavitter, U.S. Fish and Wildlife Service, pers. comm., 2007)." ... "Thick infestations of the plant contain few nests of any seabird species, whereas areas that have been cleared of V. encelioides have numerous nests of Phoebastria immutabilis (Laysan albatross), Phoebastria nigripes (black-footed albatross), Puffinus nativitatis (Christmas shearwater), and Puffinus pacificus (wedge-tailed shearwater) (VanderWerf and Rohrer 1997 as cited in Shluker 2002; John Klavitter, U.S. Fish and Wildlife Service, pers. comm., 2007)."
	CABI. 2015. Verbesina encelioides in: Invasive Species Compendium. www.cabi.org/isc	"V. encelioides has proven most problematic to natural systems when invading oceanic islands (e.g. the Hawaiian islands). V. encelioides is invasive and problematic on the northwestern Hawaiian islands where it can form monotypic stands on sandy, coastal soils. By displacing native vegetation and disrupting the nesting behaviour of marine birds, this weed has transformed certain islands, like Midway Atoll and Kure Atoll, to the disadvantage of native wildlife (Shluker, 1999). Scaveola sericea (naupaka) and Ipomea pescaprae (beach morning glory) have been suggested as impacted native plant species." ... "V. encelioides has impacted the nesting activities of some marine birds (laysan albatross Phoebastria immutabilis, blackfoot albatross Phoebastria nigripes, Christmas shearwater Puffinus nativitatis and wedge-tailed shearwaters Puffinus pacificus) by trapping hatchling and young birds in its intertwining branches in the northwest Hawaiian islands."

305	Congeneric weed	
	Source(s)	**Notes**
	National Institute for Environmental Studies. 2015. Invasive Species of Japan - Verbesina alternifolia. http://www.nies.go.jp/biodiversity/invasive/DB/detail/80650e.html. [Accessed 24 Feb 2015]	"Introduced to Japan in 1961. Established since ca. 1980" ... "Impact: Potentially: Competition with native species. Affected organism: Native grasses. "
	Holm, L. G., Pancho, J.V., Herberger, J.P. & Plucknett, D.L. 1979. A Geographical Atlas of World Weeds. John Wiley and Sons, New York, NY	Verbesina alternifolia is considered to be a weed and is naturalized in Japan.

401	Produces spines, thorns or burrs	n
	Source(s)	**Notes**

Qsn #	Question	Answer
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[No evidence] "Taprooted annual herbs; stems 2-10 dm long, many-branched. Leaves opposite, upper ones alternate, ovate or deltate, 4-15 cm long, 2-10 cm wide, both surfaces canescent-strigoese, sometimes less so on upper surface4, margins coarsely and often irregularly serrate, petioles dilated at base to form a pair of stipule-like auricles. Heads solitary at the ends of long peduncles or in clusters of 2-3, radiate; involucral bracts ca. 15, green, subequal, linear, 7-15 mm long; ray florets 10-15 per head, pistillate, rays bright yellow, 10-25 mm long; disk florets numerous, corollas yellow, ca. 8 mm long. Achenes winged"

402	Allelopathic	
	Source(s)	**Notes**
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	[Possibly] "In addition to competition for resources, it is speculated that V. encelioides possesses allelopathic properties that may be detrimental to plant growth, apparently involving phenolic compounds (Goel 1987, Inderjit et al. 1999). Verbesina encelioides forms dominant monotypic stands on wastelands and roadsides and is found to be gregarious among grasses in semiarid locations (Goel 1987). As a result, researchers have speculated that the plant may be allelopathic. Currently, only two published studies have been conducted to understand the interference mechanism of this weed."

403	Parasitic	n
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Taprooted annual herbs" [Asteraceae. No evidence]

404	Unpalatable to grazing animals	
	Source(s)	**Notes**
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	[Ingestion is typically accidental or occurs during times of stress or drought] "Although livestock do not readily consume the plant, animals such as sheep, cattle, and pigs may be forced to under conditions of drought (when other food options are depleted), overstocking, or pasture dominance by V. encelioides (Lopez et al. 1996). Livestock are also known to consume the plant when it is mixed in with hay or other feed (Lopez et al. 1996, Keeler et al. 1986)."
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Somewhat palatable but toxic] "It is extremely toxic but not readily eaten by stock except when animals are stressed and other feed is limited; sheep are more affected than cattle and pigs less so. Most deaths occur either in stock travelling during periods of drought or when plants have matured."

405	Toxic to animals	y

Qsn #	Question	Answer
	Source(s)	**Notes**
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"In Argentina, V. encelioides grows in important Ovis sp. (sheep), Bos sp. (cattle), and Sus sp. (pig) production areas (Lopez et al. 1996). It has caused livestock deaths as a result of the toxic compound galegine (3- methyl-2-butenylguanine/isoamylene guanidine) present in a concentration of 0.08% (Keeler et al. 1992). This compound compromises respiration, causes hemorrhaging of the heart, and ultimately results in death (Keeler et al. 1992). It is possible that the relative toxicity of the plant is dependent on its geographical area and/or growing conditions. In Australia, heavy losses of sheep have been reported as a result of V. encelioides toxicosis. Although livestock do not readily consume the plant, animals such as sheep, cattle, and pigs may be forced to under conditions of drought (when other food options are depleted), overstocking, or pasture dominance by V. encelioides (Lopez et al. 1996)."
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"It is extremely toxic but not readily eaten by stock except when animals are stressed and other feed is limited; sheep are more affected than cattle and pigs less so. Most deaths occur either in stock travelling during periods of drought or when plants have matured."

406	Host for recognized pests and pathogens	y
	Source(s)	**Notes**
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"If winter conditions are mild, V. encelioides causes further damage to crops due to yearround persistence and suitability as a host for other crop pests (Grichar and Sestak 1998). Verbesina encelioides is a highly favored host for thrips species that act as vectors of the tomato spotted wilt virus (TSWV) (Grichar and Sestak 1998). Because the plants are often found in clusters, the visibility of the flowers makes the plants very attractive to thrips (Mitchell and Smith 1996), and Yudin et al. (1988) recommended managing V. encelioides to help prevent the spread of the virus. In Hawai'i, the plant is a reservoir host for both the TSWV and the Impatiens necrotic spot virus (Cho et al. 1986). The TSWV virus is vectored by a minimum of nine species of thrips; two of these, Franklinella fusca Hinds and F. occidentalis Pergande, are the primary species coupled with southern Texas peanut crops (Mitchell et al. 1990). These species grow from first instar to adult on the leaves of V. encelioides (Mitchell and Smith 1996). Verbesina encelioides subsp. encelioides is also host to Phenacoccus solani Ferris, the solanum mealybug, which infests potato tubers (Scale- Net 2006)."
	CABI. 2015. Verbesina encelioides in: Invasive Species Compendium. www.cabi.org/isc	"V. encelioides is a known host to thrips (Frankliniella spp.), which are potential vectors of tomato spotted wilt virus. However, there are no studies linking V. encelioides to increases in tomato spotted wilt virus in cultivated crops (Mitchell and Smith, 1996)."

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

Qsn #	Question	Answer
	CABI. 2015. Verbesina encelioides in: Invasive Species Compendium. www.cabi.org/isc	[No evidence] "Its economic and social benefits are limited, but V. encelioides is a horticultural species and has been used as a medicinal plant among certain native American peoples, and is being scrutinized for potential commercial medicinal value."

408	Creates a fire hazard in natural ecosystems	n
	Source(s)	**Notes**
	CABI. 2015. Verbesina encelioides in: Invasive Species Compendium. www.cabi.org/isc	[No evidence] "V. encelioides is an annual herb."

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	**Notes**
	CABI. 2015. Verbesina encelioides in: Invasive Species Compendium. www.cabi.org/isc	"It is not tolerant to salinity or to shade and requires exposure to light to establish."

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	**Notes**
	Kaul, M. L. H., & Mangal, P. D. (1987). Phenology and germination of crownbeard (Verbesina encelioides). Weed science 35(4): 513 518	"Based on the seed parameters, the favorable habitats of crownbeard were open and sand dune areas even though in nature it grows in a variety of soil types of diverse composition and texture (Table 2)."
	Dave's Garden. 2015. PlantFiles: Cowpen Daisy, Golden Crownbeard - Verbesina encelioides. http://davesgarden.com/guides/pf/go/59964/. [Accessed 24 Feb 2015]	"Soil pH requirements: 7.9 to 8.5 (alkaline) 8.6 to 9.0 (strongly alkaline) over 9.1 (very alkaline)"

411	Climbing or smothering growth habit	n
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Taprooted annual herbs; stems 2-10 dm long, many-branched."

412	Forms dense thickets	y
	Source(s)	**Notes**
	Kaul, M. L. H., & Mangal, P. D. (1987). Phenology and germination of crownbeard (Verbesina encelioides). Weed science 35(4): 513 518	"Germination after the first cyclonic rains is quick, when numerous pure stands of this weed appear in a variety of habitats in northern and central India."
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"In addition, V. encelioides has the ability to form dense monotypic stands particularly along roadsides and among grasses in semiarid locations (Goel 1987) and can grow at elevations from sea level to 2,750 m (Walther 2004)."

501	Aquatic	n

Qsn #	Question	Answer
	Source(s)	**Notes**
	CABI. 2015. Verbesina encelioides in: Invasive Species Compendium. www.cabi.org/isc	[Terrestrial] "V. encelioies can be found in a variety of habitats, from riparian to coastal to upland to island. The preferred habitat is tropical to subtropical, with disturbed porous sandy soils and an open canopy (McCoy, 1987). The plant is also found along roads. The species does well on alkaline soils. Habitats with high shade or with very fine soil texture are not optimal sites for this species (Kaul and Mangal, 1987). It may become more invasive on fertile soils; it has been observed to have robust growth when associated with nesting marine birds, and poor growth when on islands with poor soils (Shluker, 1999)."

502	Grass	n
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	Asteraceae

503	Nitrogen fixing woody plant	n
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	Asteraceae

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Taprooted annual herbs; stems 2-10 dm long, many-branched."

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	**Notes**
	CABI. 2015. Verbesina encelioides in: Invasive Species Compendium. www.cabi.org/isc	No evidence

602	Produces viable seed	y
	Source(s)	**Notes**
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"Its invasive characteristics include high seed production (as many as 300–350 seeds per flower and multiple flowers per plant), seed dormancy, ability to tolerate dry conditions, and possible allelopathic effects."

603	Hybridizes naturally	

Qsn #	Question	Answer
	Source(s)	**Notes**
	Vassilevska-Ivanova, R. D., Kraptchev, B. V., Stancheva, I., & Geneva, M. (2013). A compact sunflower line produced after cross Helianthus annuus x Verbesina encelioides. Central European Journal of Biology, 8(5): 492-498	[Unknown. Artificial hybrids possible] "Intergeneric cross was made between the cultivated sunflower inbred line HA89 and an accession of wild Verbesina encelioides tolerant to drought and high temperature. The line was a BC2F5 progeny. The most remarkable feature of the plants was their compact architecture due to short petiole length and also, rather specific bright-yellow inflorescences. Similar plant architecture did not exist in either the wild or the cultivated parent. For sunflower, it is considered as a favourable and potentially useful adaptive trait. The line was multi-branched of medium type branching and possessed good agronomic characteristics. The overall characteristics of HA-VERBENC line make it a useful plant material for research on wide hybridization."

604	Self-compatible or apomictic	y
	Source(s)	**Notes**
	Kaul, M. L. H., & Mangal, P. D. (1987). Phenology and germination of crownbeard (Verbesina encelioides). Weed science 35(4): 513 518	"In addition to high and rapid seed germination, efficient seedling survival, and quick vegetative and reproductive growth found in these experiments, the weed exhibits extensive seed production, efficient self- and cross-pollination, and broad ecological amplitude (8). All these features have contributed to the biological success of this species both in space and time in North India."
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"Verbesina encelioides exhibits a high potential for reproduction. The plant exhibits efficient self- and cross-pollination."

605	Requires specialist pollinators	n
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Heads solitary at the ends of long peduncles or in clusters of 2-3, radiate; involucral bracts ca. 15, green, subequal, linear, 7-15 mm long; ray florets 10-15 per head, pistillate, rays bright yellow, 10 25 mm long; disk florets numerous, corollas yellow, ca. 8 mm long. "
	The Pollinator Partnership & NAACP. 2009. Selecting Plants for Pollinators. A Regional Guide for Farmers, Land Managers, and Gardeners In the and NAPPC Prairie Parkland (Subtropical) Province. The Pollinator Partnership™/North American Pollinator Protection Campaign, San Francisco, CA	"The following chart lists plants that attract pollinators." [Verbesina encelioides - Visitation by Pollinator = bees, beetles, flies, butterflies]
	Bryant, V. M., & Jones, G. D. (2006). Forensic palynology: Current status of a rarely used technique in the United States of America. Forensic Science International, 163(3): 183-197	[insect-pollinated] "The remaining 2% of pollen also came mostly from insect-pollinated types such as golden crownbeard (Verbesina encelioides) and red false mallow (Sphaeralcea coccinea)."

606	Reproduction by vegetative fragmentation	n
	Source(s)	**Notes**

Qsn #	Question	Answer
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	[No evidence] "Verbesina encelioides exhibits a high potential for reproduction. The plant exhibits efficient self- and cross-pollination. It reproduces solely by winged seeds that are dispersed by light winds (Kaul and Mangal 1987)."

607	Minimum generative time (years)	1
	Source(s)	**Notes**
	Kaul, M. L. H., & Mangal, P. D. (1987). Phenology and germination of crownbeard (Verbesina encelioides). Weed science 35(4): 513 518	"Flowering was initiated between 102 to 118 days after sowing and was followed by fruit set after 10 to 12 days. In North India, a majority of the seeds germinated in February. Vegetative growth continued until June, flowering began in March, and fruit setting started in May and continued until December when the plant dried up."
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Seeds germinate in autumn or early winter forming a rosette. Seedlings grow slowly during winter until flower stalks are produced in spring. Flowering commences in October or November and continues throughout summer while there is sufficient moisture. Plants die in Autumn."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"...seeds anchored by the bristles in wool, fur, clothing, bags and other fibrous materials may travel long distances. Some seed may also be spread as an impurity in pasture hay and even cereal grains and some during road grading."

702	Propagules dispersed intentionally by people	
	Source(s)	**Notes**
	CABI. 2015. Verbesina encelioides in: Invasive Species Compendium. www.cabi.org/isc	[Possibly in the past. Unlikely now] " Intentional Introduction: None reported, but it V. encelioides has been used in horticulture and for medicinal purposes. There is potential for accidental or purposeful introductions occurring from horticultural or medicinal activities."

703	Propagules likely to disperse as a produce contaminant	y
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Some seed may also be spread as an impurity in pasture hay and even cereal grains and some during road grading."

Qsn #	Question	Answer
704	**Propagules adapted to wind dispersal**	**y**
	Source(s)	**Notes**
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"It reproduces solely by winged seeds that are dispersed by light winds (Kaul and Mangal 1987)."

705	**Propagules water dispersed**	**n**
	Source(s)	**Notes**
	CABI. 2015. Verbesina encelioides in: Invasive Species Compendium. www.cabi.org/isc	"V. encelioides spreads by seed, which are dispersed by the wind."

706	**Propagules bird dispersed**	
	Source(s)	**Notes**
	CABI. 2015. Verbesina encelioides in: Invasive Species Compendium. www.cabi.org/isc	"V. encelioides may potentially be dispersed by birds."

707	**Propagules dispersed by other animals (externally)**	**y**
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Crown beard spreads only by seed, some of which are equipped with wings and fine bristles, making them particularly suited to dispersal by wind and animals." ... "...seeds anchored by the bristles in wool, fur, clothing, bags and other fibrous materials may travel long distances."

708	**Propagules survive passage through the gut**	
	Source(s)	**Notes**
	CABI. 2015. Verbesina encelioides in: Invasive Species Compendium. www.cabi.org/isc	[Unknown, but unlikely] "Natural Dispersal (Non-Biotic): V. encelioides spreads by seed, which are dispersed by the wind. Vector Transmission (Biotic): V. encelioides may potentially be dispersed by birds. Accidental Introduction: Transport of this species is most likely accidental, via contaminated soils on vehicle tyres, bulldozer treads or shoes."

801	**Prolific seed production (>1000/m2)**	
	Source(s)	**Notes**
	CABI. 2015. Verbesina encelioides in: Invasive Species Compendium. www.cabi.org/isc	"Its invasive characteristics include high seed production (as many as 300–350 seeds per flower and multiple flowers per plant), seed dormancy, ability to tolerate dry conditions, and possible allelopathic effects."

802	**Evidence that a persistent propagule bank is formed (>1 yr)**	**y**

Qsn #	Question	Answer
	Source(s)	**Notes**
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"Its invasive characteristics include high seed production (as many as 300–350 seeds per flower and multiple flowers per plant), seed dormancy, ability to tolerate dry conditions, and possible allelopathic effects." ... "Seeds can lie dormant when soils are desiccated to below 5% moisture content and when temperatures are between 38 and 46□C (Kaul and Mangal 1987)." ... "In areas receiving little rain, with soil moisture below 5%, seeds will lie dormant until the first heavy rains (Kaul and Mangal 1987)."
	Kaul, M. L. H., & Mangal, P. D. (1987). Phenology and germination of crownbeard (Verbesina encelioides). Weed science 35(4): 513 518	"Its seeds exhibit remarkable endurance to climatic extremes and survive under extremely high temperatures (38 to 46 C) and soil droughts of Haryana and Punjab during which they lie dormant in soils desiccated to below 5% moisture content. Germination after the first cyclonic rains is quick, when numerous pure stands of this weed appear in a variety of habitats in northern and central India."
	Royal Botanic Gardens Kew. 2008. Seed Information Database (SID). Version 7.1. http://data.kew.org/sid/. [Accessed 25 Feb 2015]	"Storage Behaviour: Orthodox Storage Conditions: Long-term storage under IPGRI preferred conditions at RBG Kew, WP. Oldest collection10 years; germination change 88 to 99%, 8 years, 1 collection"

803	Well controlled by herbicides	y
	Source(s)	**Notes**
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"Chemical control is aided by an initial mechanical weeding of the plants to allow smaller plants to receive sufficient amounts of the chemical (K. Niethammer, USFWS, as cited in Shluker 2002). Rodeo (Dow AgroSciences, Indianapolis, Indiana) (active ingredient: glyphosphate) is used to control populations of V. encelioides on Midway Atoll in a concentration of 1.17–2.0 ml per liter of water (K. Niethammer, USFWS, as cited in Shluker 2002). Herbicides only need to be applied twice, and then the area requires monitoring only once. On Kure Atoll, a 2% solution of Roundup (Monsanto, St. Louis, Missouri) (active ingredient: glyphosphate) controlled populations of V. encelioides grow-ing in the midst of native plant species (Smith and Woodside, unpubl. data, cited in Shluker 2002). For monospecific stands of V. encelioides, a combination of Roundup and Garlon 3A (Dow AgroSciences, Indianapolis, Indiana) was found to be effective (D. Smith, Hawai'i Department of Land and Natural Resources, as cited in Shluker 2002). More recently John Klavitter (USFWS, pers. comm., 2006) also reported success on Midway Atoll using Garlon 4 (active ingredient: triclopyr), Aquamaster (Monsanto, St. Louis, Missouri) (active ingredient: glyphosate), or SpeedZone (PBI/Gordon, Kansas City, Missouri) (active ingredients: carfentrazone; 2,4- D; mecoprop; dicamba)."

804	Tolerates, or benefits from, mutilation, cultivation, or fire	n
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Grub and burn single plants or small groups."

Qsn #	Question	Answer
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"Other alternatives for controlling V. encelioides include controlled burns or the use of salt water (seawater)."

805	**Effective natural enemies present locally (e.g. introduced biocontrol agents)**	**n**
	Source(s)	**Notes**
	Feenstra, K. R., & Clements, D. R. (2008). Biology and Impacts of Pacific Island Invasive Species. 4. Verbesina encelioides, Golden Crownbeard (Magnoliopsida: Asteraceae). Pacific Science, 62(2), 161-176	"No biological control agents are currently available for V. encelioides. At least 14 fungal pathogens have been recorded in association with V. encelioides (Table 1) that could potentially be tested for efficacy and host specificity."

Summary of Risk Traits:

High Risk / Undesirable Traits
• Broad climate suitability. Elevation range exceeds 1000 m, demonstrating environmental versatility
• Thrives in tropical climates
• Widely naturalized
• Disturbance-adapted
• Agricultural weed
• Environmental weed
• Other Verbesina species have become invasive
• Toxic to livestock
• Host of crop pathogens
• Tolerates many soil types
• Forms dense stands that can exclude other vegetation
• Reproduces by seed
• Self-compatible
• Able to reach maturity in <1 year (annual)
• Seeds dispersed by wind, & by attachment to animals, clothing & as a soil or seed contaminant
• Seed bank may persist beyond 1 year

Low Risk Traits
• Unarmed (no spines, thorns or burrs)
• Grows in full sun (shade-intolerant)
• Not reported to spread vegetatively
• Herbicides may provide effective control
• Burning & mechanical control may also be effective