Taxon: Cosmos sulphureus

Family: Asteraceae

Common Name(s): orange cosmos
sulphur cosmos
yellow cosmos

Synonym(s): Bidens sulfurea (Cav.) Sch.Bip.
Bidens sulphurea (Cav.) Sch.Bip.
Bidens sulphureus (Cav.) Sch.Bip.
Coreopsis artemisiaefolia Jacq.
Cosmea sulphurea (Cav.) Willd.

Assessor: Assessor **Status:** Assessor Approved **End Date:** 17 Mar 2014

WRA Score: 9.0 **Designation:** H(HPWRA) **Rating:** High Risk

Keywords: Naturalized, Disturbance Weed, Annual Wildflower, Bee-Pollinated, Self-compatible

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	n=0, y = 1*multiplier (see Appendix 2)	y
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	n
304	Environmental weed	n=0, y = 2*multiplier (see Appendix 2)	n
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	y
405	Toxic to animals	y=1, n=0	n
406	Host for recognized pests and pathogens	y=1, n=0	n
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	n

Qsn #	Question	Answer Option	Answer
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		
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	n
705	Propagules water dispersed	y=1, n=-1	n
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	n
801	Prolific seed production (>1000/m2)		
802	Evidence that a persistent propagule bank is formed (>1 yr)		
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire		
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)		

Supporting Data:

Qsn #	Question	Answer
101	**Is the species highly domesticated?**	**n**
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Cosmos comprises about 25 species from tropical America; it belongs to the tribe Heliantheae and is related to the much larger genera Bidens and Coreopsis. Cosmos sulphureus as an ornamental comprises several cultivars." [Certain cultivars may be highly domesticated, but this assessment is for the wild type]

102	**Has the species become naturalized where grown?**	
	Source(s)	**Notes**
	WRA Specialist. 2014. Personal Communication	NA

103	**Does the species have weedy races?**	
	Source(s)	**Notes**
	WRA Specialist. 2014. 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**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Cosmos sulphureus originates from Central America (Mexico) and northern South America, where it is still found in the wild."

202	**Quality of climate match data**	**High**
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	

Qsn #	Question	Answer
203	**Broad climate suitability (environmental versatility)**	**y**
	Source(s)	**Notes**
	Floridata. 2012. Cosmos sulphureus. http://www.floridata.com/ref/c/cosm_sul.cfm. [Accessed 16 Mar 2014]	"Like its cousin, orange cosmos is also a frost tender annual that is rugged and easy to grow." ... "Hardiness:USDA Zones 5 - 10. Orange cosmos will reseed if contact is made with bare soil. " [Frost tender, but able to grow in >5 hardiness zones]
	Gilman, E.F. & Howe, T. 1999. Cosmos sulphureus. FPS-150. University of Florida IFAS Extension. http://edis.ifas.ufl.edu. [Accessed 16 Mar 2014]	"USDA hardiness zones: all zones"
	Missouri Botanical Garden, 2014. Cosmos sulphureus. http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=c248. [Accessed 16 Mar 2014]	"Zone: 2 to 11" [Grows in >5 hardiness zones]

204	**Native or naturalized in regions with tropical or subtropical climates**	**y**
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Cosmos sulphureus originates from Central America (Mexico) and northern South America, where it is still found in the wild."

205	**Does the species have a history of repeated introductions outside its natural range?**	**y**
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"It has been introduced as an ornamental in many countries all over the world, in tropical Africa e.g. in Senegal, Cameroon, Sudan, Tanzania, Malawi, Zambia, Zimbabwe, Mozambique, Réunion and Mauritius."

Qsn #	Question	Answer
301	**Naturalized beyond native range**	**y**
	Source(s)	**Notes**
	Mohlenbrock, R.H. 2002. Vascular flora of Illinois. SIU Press, Carbondale, IL	"adventive in disturbed areas."
	Howell, C. J., & Sawyer, J. W. (2006). New Zealand naturalised vascular plant checklist. New Zealand Plant Conservation Network, Wellington, NZ	"Cosmos sulphureus" ... "Naturalised plant status - Casual"
	Calflora: 2014. Information on California plants for education, research and conservation, with data contributed by public and private institutions and individuals, including the Consortium of Calif. Herbaria. [web application]. Berkeley, California: The Calflora Database [a non-profit organization]. http://www.calflora.org/ . [Accessed 16 Mar 2014]	"Cosmos sulphureus, a dicot, is an annual herb that is not native to California; it was introduced from elsewhere and naturalized in the wild."
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Sometimes it has escaped from cultivation and behaves like a weed, e.g. in Tanzania, Malawi, Zimbabwe, the United States and Canada."

302	**Garden/amenity/disturbance weed**	**y**
	Source(s)	**Notes**
	Floridata. 2012. Cosmos sulphureus. http://www.floridata.com/ref/c/cosm_sul.cfm. [Accessed 16 Mar 2014]	"Before planting orange cosmos check locally to make sure that it is not invasive in your area. In places like Tennessee orange cosmos is naturalizing in "disturbed" areas but so far is not disrupting native plant communities."
	Swaziland's Alien Plants Database. 2014. Cosmos sulphureus. http://www.sntc.org.sz/alienplants/speciesinfo.asp?spid=160. [Accessed 16 Mar 2014]	"Disturbed areas, Minor problem species"
	Oklahoma Invasive Plant Council. 2009. Oklahoma Non-Native Invasive Plant Species. http://ok-invasive-plant-council.org/images/OKinvasivespp.pdf. [Accessed 16 Mar 2014]	"Problems in border states:" [List includes Cosmos sulphureus, but with no description of impacts or problems caused]
	Tennessee Exotic Pest Plant Council. 2004. Invasive Exotic Pest Plants List for 2004. Wildland Weeds 7(4): 13-16	"Watch List A: Exotic plants that naturalize and may become a problem in the future; includes species that are or could become widespread in Tennessee. At this time more information is needed, and there is no consensus about their status." [Includes Cosmos sulphureus
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Where Cosmos sulphureus has been found in the wild in Africa, it is a common roadside weed which does not spread into undisturbed localities. In southern Africa it flowers and fruits in Marc –May."

303	**Agricultural/forestry/horticultural weed**	**n**
	Source(s)	**Notes**
	Randall, R.P. 2012. A Global Compendium of Weeds. 2nd Edition. Department of Agriculture and Food, Western Australia	No evidence

Qsn #	Question	Answer
304	**Environmental weed**	**n**
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Where Cosmos sulphureus has been found in the wild in Africa, it is a common roadside weed which does not spread into undisturbed localities." [No evidence]
	Randall, R.P. 2012. A Global Compendium of Weeds. 2nd Edition. Department of Agriculture and Food, Western Australia	Included in one list of environmental weeds
	WRA Specialist. 2014. Personal Communication	When listed as a weed, most references categorize it as a minor weed of disturbed areas, and not invasive in undisturbed natural areas

305	Congeneric weed	y
	Source(s)	**Notes**
	Nursery and Garden Industry Australia. 2012. Grow Me Instead - A Guide for Gardeners in Queensland Darling Downs. http://www.growmeinstead.com.au/public/GMI-brochure-Qld-Darling-Downs.pdf. [Accessed 14 Mar 2014]	"Cosmos bipinnatus" ... "As this plant is 'free seeding' it only takes a single plant to establish a broad colony on roadsides and other natural areas. The plant can also regenerate from a small piece of stem, so effective disposal of garden waste is important." [This gardening guide discourages the planting of Cosmos bipinnatus as an invasive, and recommends the planting of some native alternatives in Australia]
	Hansen, S. & Drost, D. 2013. Cosmos in the Garden. Utah State University Cooperative Extension. http://extension.usu.edu/htm/publications/file=15108. [Accessed 14 Mar 2014]	"In many texts Cosmos is referred to as a weed due to heavy seed production and self sowing. To avoid this problem, plant in an area where you want it to naturally reseed."
	Cornell University. 2006. Cosmos (C. bipinnatus). http://www.gardening.cornell.edu/homegardening/scene9a85.html. [Accessed 14 Mar 2014]	"May be weedy due to self seeding."
	Randall, R.P. 2012. A Global Compendium of Weeds. 2nd Edition. Department of Agriculture and Food, Western Australia	[Cosmos bipinnatus and Cosmos caudatus included in a number of weed lists]

401	Produces spines, thorns or burrs	n
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Annual herb up to 1.2(–2) m tall, with 4-angled, branched, pubescent to glabrescent stem. Leaves opposite, sessile or with clasping petiole up to 2 cm long; blade ovate in outline, up to 7 cm × 5 cm, very deeply dissected with ultimate segments narrowly oblong, c. 2.5 mm wide, apiculate, glabrous."

402	Allelopathic	
	Source(s)	**Notes**
	WRA Specialist. 2014. Personal Communication	Unknown

403	Parasitic	n

Qsn #	Question	Answer
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Annual herb up to 1.2(–2) m tall, with 4-angled, branched, pubescent to glabrescent stem." [Asteraceae]

404	Unpalatable to grazing animals	y
	Source(s)	**Notes**
	gardenguides.com. 2010. Cosmos Flowers & Deer. Cosmos Flowers & Deer	"A frequent invader of suburban gardens, deer wreak havoc on flowers and plants. Cosmos are annual, colorful flowers that deer usually avoid and can be used in landscapes to repel deer. When used as a border, cosmos prevent deer from entering landscapes where other, more attractive plants grow."
	iVillage Garden Web. 2009. Deer Resistant Annuals. http://forums2.gardenweb.com/forums/load/annuals/msg0919021827035.html?6. [Accessed 16 Mar 2014]	"Cosmos sulphureus (orange only) - a bit of tasting, no significant damage. This surprised me as I expected munching."

405	Toxic to animals	n
	Source(s)	**Notes**
	Wagstaff, D.J. 2008. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	No evidence

406	Host for recognized pests and pathogens	n
	Source(s)	**Notes**
	Missouri Botanical Garden, 2014. Cosmos sulphureus. http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=c248. [Accessed 16 Mar 2014]	"No serious insect or disease problems."
	Gilman, E.F. & Howe, T. 1999. Cosmos sulphureus. FPS-150. University of Florida IFAS Extension. http://edis.ifas.ufl.edu. [Accessed 16 Mar 2014]	"Pest resistance: long-term health usually not affected by pests" ... "Cosmos species may be occasionally bothered by bacterial wilt, canker, powdery mildew, leaf spots, aphids, and Japanese beetles."

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	**Notes**
	Fernald, M.L.& Kinsey, A.C. 1958. Edible Wild Plants of Eastern North America. Harper, New York	"Use: salad or potherb." ... "The young tops and the leaves of this species are eaten, either raw or cooked." ... "Raw it has a slightly unpleasant, oily flavor. This is, perhaps, modified in cooking." [No evidence of toxicity]
	Wagstaff, D.J. 2008. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	No evidence

408	Creates a fire hazard in natural ecosystems	n

Qsn #	Question	Answer
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Annual herb up to 1.2(–2) m tall, with 4-angled, branched, pubescent to glabrescent stem." ... "it is a common roadside weed which does not spread into undisturbed localities." [An annual with no history of increased fire risk]

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	**Notes**
	Gilman, E.F. & Howe, T. 1999. Cosmos sulphureus. FPS-150. University of Florida IFAS Extension. http://edis.ifas.ufl.edu. [Accessed 16 Mar 2014]	"Light requirement: plant grows in full sun"
	Floridata. 2012. Cosmos sulphureus. http://www.floridata.com/ref/c/cosm_sul.cfm. [Accessed 16 Mar 2014]	"Light: Bright sunlight."
	Missouri Botanical Garden, 2014. Cosmos sulphureus. http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=c248. [Accessed 16 Mar 2014]	"Sun: Full sun"

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	**Notes**
	Missouri Botanical Garden, 2014. Cosmos sulphureus. http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=c248. [Accessed 16 Mar 2014]	"Cosmos sulphureus is an annual that is easily grown in average, medium moisture, well-drained soils in full sun. Tolerates dryish soils. Also tolerates poor soils. Avoid rich fertile soils because plants may grow too tall and flop over."
	Gilman, E.F. & Howe, T. 1999. Cosmos sulphureus. FPS-150. University of Florida IFAS Extension. http://edis.ifas.ufl.edu. [Accessed 16 Mar 2014]	"Soil tolerances: sand; acidic; slightly alkaline; loam; clay"
	Floridata. 2012. Cosmos sulphureus. http://www.floridata.com/ref/c/cosm_sul.cfm. [Accessed 16 Mar 2014]	"Well-drained, sandy soils are preferred but yellow cosmos is adaptable. "

411	Climbing or smothering growth habit	n
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Annual herb up to 1.2(–2) m tall, with 4-angled, branched, pubescent to glabrescent stem."

412	Forms dense thickets	n
	Source(s)	**Notes**
	Mohlenbrock, R.H. 2002. Vascular flora of Illinois. SIU Press, Carbondale, IL	"adventive in disturbed areas." [No evidence]

Qsn #	Question	Answer
	Howell, C. J., & Sawyer, J. W. (2006). New Zealand naturalised vascular plant checklist. New Zealand Plant Conservation Network, Wellington, NZ	"Cosmos sulphureus" ... "Naturalised plant status - Casual" [No evidence]
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Where Cosmos sulphureus has been found in the wild in Africa, it is a common roadside weed which does not spread into undisturbed localities." [No evidence]

501	Aquatic	n
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Where Cosmos sulphureus has been found in the wild in Africa, it is a common roadside weed which does not spread into undisturbed localities." [Terrestrial]

502	Grass	n
	Source(s)	**Notes**
	Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. Flora of Panama. Part IX. Family 184. Compositae. Annals of the Missouri Botanical Garden 62(4): 835-1321	"Annual herb to 1 m tall" [Asteraceae]

503	Nitrogen fixing woody plant	n
	Source(s)	**Notes**
	Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. Flora of Panama. Part IX. Family 184. Compositae. Annals of the Missouri Botanical Garden 62(4): 835-1321	"Annual herb to 1 m tall" [Asteraceae]

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Annual herb up to 1.2(–2) m tall, with 4-angled, branched, pubescent to glabrescent stem."

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Cosmos sulphureus is widespread in Central America and elsewhere it may behave as a weed. It does not seem to be in danger of genetic erosion."

602	Produces viable seed	y
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Cosmos sulphureus is propagated by seed."

Qsn #	Question	Answer
	Missouri Botanical Garden, 2014. Cosmos sulphureus. http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=c248. [Accessed 16 Mar 2014]	"Plants will sometimes self-seed, particularly if seed drops on bare ground. Self-seeding may rise to the level of being aggressive in some climates and conditions."

603	Hybridizes naturally	
	Source(s)	**Notes**
	Melchert, T. E. 2010. Chromosome counts of Bidens, Cosmos and Thelesperma species (Asteraceae, Coreopsidinae). Phytologia, 9 (3): 312-333	"Cosmos sulphureus x C. pacificus F1 Hybrids" [Unknown if natural hybrids occur]
	iVillage Garden Web. 2013. Will different Cosmos species cross pollinate? http://forums2.gardenweb.com/forums/load/annuals/msg122343571694.html?7. [Accessed 16 Mar 2014]	"There are a lot of species of Cosmos. At least some of them can cross-pollinate to create F1 hybrids. For example, Cosmos sulphureus can cross with Cosmos pacificus. Both species have 12 chromosomes. Incidentally Cosmos bipinnatus also has 12 chromosomes, so there shouldn't be a chromosome count barrier to making a hybrid with either sulphureus or pacificus. But there can be other barriers. " [Possibly Yes. Unknown if hybrids occur naturally]

604	Self-compatible or apomictic	y
	Source(s)	**Notes**
	Pisareva, L. A. 1970. Self fertility and pseudo-fertility in (Cosmos.). Genetika, 6(2): 57-61	"In a population of Cosmos sulphureus the level of self fertility was not uniform and pre-sowing seed treatment with mutagens or growing the plants under different conditions did not improve it. Self fertility in this and other Cosmos spp. increased toward the end of the growing period, and pseudo-fertility was observed."

605	Requires specialist pollinators	n
	Source(s)	**Notes**
	Kato, M., Itino, I., Hotta, M., Abbas, I., & Okada, H. 1989. Flower visitors of 32 plant species in West Sumatra. Occasional papers of the Kagoshima University Research center for South Pacific, 16: 15-31.	"Of the plants which secrete nectar in a shallow position in a flower, those growing in disturbed and/or open area such as Raphanus sativus, Mimosa pudica, Tibouchina semidecandra, Stachy tarpheta spp., Lantana aculeata, Cosmos sulphureus and Eupatrium odoratum were visited and pollinated by various insects, especially bees."
	Floridata. 2012. Cosmos sulphureus. http://www.floridata.com/ref/c/cosm_sul.cfm. [Accessed 16 Mar 2014]	"Orange cosmos along with common cosmos (C. bipinnatus) are musts for most butterfly gardens."

606	Reproduction by vegetative fragmentation	n
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Cosmos sulphureus is propagated by seed." [No evidence of vegetative spread]

607	Minimum generative time (years)	1

Qsn #	Question	Answer
	Source(s)	**Notes**
	Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. Flora of Panama. Part IX. Family 184. Compositae. Annals of the Missouri Botanical Garden 62(4): 835-1321	"Annual herb to 1 m tall; stems slender, branching, erect, slightly quadrate, glabrate but with a few scattered, large whitish hairs."
	Missouri Botanical Garden, 2014. Cosmos sulphureus. http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=c248. [Accessed 16 Mar 2014]	"Type: Annual" [Able to reach maturity in one growing season]

701	**Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)**	**y**
	Source(s)	**Notes**
	Fosberg, F. R. & Sachet, M-H. 1980. Flora of Micronesia, 4: Caprifoliaceae-Compositae. Smithsonian Contributions to Botany 46: 1-71	"achenes linear-lanceolate; quadrangular, to 2 cm long, with a prominent scabrid beak, pappus of 1-3 stiff, retrorsely barbulate, often deciduous awns." [Likely yes. Barbed awns, and distribution along roads, would facilitate inadvertent dispersal]
	Haines, A. 2011. New England Wild Flower Society's Flora Novae Angliae: A Manual for the Identification of Native and Naturalized Higher Vascular Plants of New England. Yale University Press, Yale, CT	"Fields, roadsides, waste areas." [Distribution along roads suggests an adaptation for disturbance and that seeds may be moved along heavily trafficked corridors]

702	**Propagules dispersed intentionally by people**	**y**
	Source(s)	**Notes**
	Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. Flora of Panama. Part IX. Family 184. Compositae. Annals of the Missouri Botanical Garden 62(4): 835-1321	"A native of Mexico and Guatemala, this species is widely cultivated for ornament and is known from escapes and naturalized populations in many other parts of the world including Panama."
	Fosberg, F. R. & Sachet, M-H. 1980. Flora of Micronesia, 4: Caprifoliaceae-Compositae. Smithsonian Contributions to Botany 46: 1-71	"A pantropical ornamental very commonly planted in gardens in Micronesia, in the Marianas (Agrigan, Tinian, Guam), Carolines (Woleai, Ifaluk, Satawal, Satawan)."
	Floridata. 2012. Cosmos sulphureus. http://www.floridata.com/ref/c/cosm_sul.cfm. [Accessed 16 Mar 2014]	"Try cosmos for quick easy color all summer long. Usage The yellow cosmos is a garden beauty perfect for beds and borders. It is a also a robust grower able to survive harsh conditions in urban gardens and roadway wildflower plantings. Orange cosmos along with common cosmos (C. bipinnatus) are musts for most butterfly gardens."

703	**Propagules likely to disperse as a produce contaminant**	**n**
	Source(s)	**Notes**
	Seedland. 2014. Wildflower Seed Sulphur Cosmos. http://www.wildflowermix.com/info/180+common/cosmos-sulphureus.html. [Accessed 17 Mar 2014]	"Description: half-hardy annual; 30-40 inches tall, flowers range from yellow, orange to reddish." [Seed mixes sold intentionally]
	WRA Specialist. 2014. Personal Communication	This species is deliberately dispersed through intentionally plantings and commercial wildflower seed mixes. To date, there is no evidence that it has become a produce contaminant, although the potential exists if it spreads into the margins of fields, and is moved through hay or livestock fodder.

Qsn #	Question	Answer
704	**Propagules adapted to wind dispersal**	**n**
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Fruit an achene c. 2 cm long, blackish, with a scabrid beak c. 7 mm long; pappus of 2 horizontally spreading awns c. 5 mm long." [Adapted for external attachment and dispersal]
	Torres, C., & Galetto, L. 2011. Flowering phenology of co occurring Asteraceae: a matter of climate, ecological interactions, plant attributes or of evolutionary relationships among species?. Organisms Diversity & Evolution, 11(1): 9-19.	"Table 1 Plant attributes and floral visitors of 43 Asteraceae species growing in the Chaco Serrano forests of La Serranita-Los Aromos; subfamily assignment after Panero and Funk (2008)" [Cosmos sulphureus - Dispersal mechanisms = O other mechanisms (i.e. not wind)]

Qsn #	Question	Answer
705	**Propagules water dispersed**	**n**
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Fruit an achene c. 2 cm long, blackish, with a scabrid beak c. 7 mm long; pappus of 2 horizontally spreading awns c. 5 mm long." ... "Where Cosmos sulphureus has been found in the wild in Africa, it is a common roadside weed which does not spread into undisturbed localities." [Seed morphology and habitat suggest this species is not regularly dispersed by water]

Qsn #	Question	Answer
706	**Propagules bird dispersed**	**n**
	Source(s)	**Notes**
	Jansen, P.C.M.& Cardon, D. 2005. Plant Resources of Tropical Africa. Volume 3. Dyes and Tannins. PROTA, Wageningen, Netherlands	"Fruit an achene c. 2 cm long, blackish, with a scabrid beak c. 7 mm long; pappus of 2 horizontally spreading awns c. 5 mm long." [Adapted for external dispersal]

Qsn #	Question	Answer
707	**Propagules dispersed by other animals (externally)**	**y**
	Source(s)	**Notes**
	Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. Flora of Panama. Part IX. Family 184. Compositae. Annals of the Missouri Botanical Garden 62(4): 835-1321	Genus = "Achenes narrowly cylindrical-fusiform, often apically narrowed into a slender beak, sometimes strigose, mostly with 1-3 stout, barbed awns." Species - "Achenes black, ca. 20 mm long, slender, slightly curved, sharply angled, somewhat compressed, the upper % narrowed into a linear, ascending-strigose beak terminated by 2 porrect, retrorsely strigose bristles 3 mm long."

Qsn #	Question	Answer
708	**Propagules survive passage through the gut**	**n**
	Source(s)	**Notes**
	Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. Flora of Panama. Part IX. Family 184. Compositae. Annals of the Missouri Botanical Garden 62(4): 835-1321	Genus = "Achenes narrowly cylindrical-fusiform, often apically narrowed into a slender beak, sometimes strigose, mostly with 1-3 stout, barbed awns." Species - "Achenes black, ca. 20 mm long, slender, slightly curved, sharply angled, somewhat compressed, the upper % narrowed into a linear, ascending-strigose beak terminated by 2 porrect, retrorsely strigose bristles 3 mm long." [No evidence, and unlikely as seeds are adapted for internal dispersal]

Qsn #	Question	Answer
801	**Prolific seed production (>1000/m2)**	
	Source(s)	**Notes**
	Johnson, A. M. & Whitwell, T. 1996. Species for Wildflower Seed Production. Department of Horticulture, Clemson University, Clemson, SC. http://www.clemson.edu/hort/sctop/pdf_docs/DSec/DSec-01.pdf. [Accessed]	"Species placed in category III had low seed production potential with a seed maturation rating of 5 and/or germination lower than 45% (Table 1). Those species were Achillea millefolium L., Coreopsis lanceolata L., Cosmos bipinnatus Cav., Cosmos sulphureus ... " [Possibly Low Seed Production]

802	**Evidence that a persistent propagule bank is formed (>1 yr)**	
	Source(s)	**Notes**
	Royal Botanic Gardens Kew. 2008. Seed Information Database (SID). Version 7.1. http://data.kew.org/sid/. [Accessed 17 Mar 2014]	"Storage Behaviour: Orthodox Storage Conditions: 100 % viability following drying to mc's in equilibrium with 15 % RH and freezing for 24 years at -20ºC at RBG Kew, WP." [Possibly forms a persistent seed bank. Unknown from field conditions]

803	**Well controlled by herbicides**	**y**
	Source(s)	**Notes**
	Dow AgroSciences. 2003. HERBICIDE ZEAZINE 500 SC. https://www.dowagro.com/webapps/lit/litorder.asp?filepath=/011-10121.pdf&pdf=true. [Accessed]	"ZEAZINE SC controls a broad spectrum of grass and broadleaf weeds in crop rotation situations where sensitive follow up crops are important." ... Weed spp. controlled by ZEAZINE SC:" ... "Broadleaf weeds:" [List of broadleaf weeds controlled includes Cosmos bipinnatus. Would presumably also work on C. sulphureus]

804	**Tolerates, or benefits from, mutilation, cultivation, or fire**	
	Source(s)	**Notes**
	WRA Specialist. 2014. Personal Communication	Unknown

805	**Effective natural enemies present locally (e.g. introduced biocontrol agents)**	
	Source(s)	**Notes**
	WRA Specialist. 2014. Personal Communication	Unknown

Summary of Risk Traits:

High Risk / Undesirable Traits
• Thrives in tropical climates
• Broad climate suitability
• Widely naturalized
• A garden & disturbance weed
• Other Cosmos species have become invasive
• Unpalatable to deer
• Tolerates many soil types
• Seeds freely
• Self-compatible
• Annual – able to reach maturity in one growing season
• Seeds dispersed intentionally by people and externally on animals & possibly machinery or clothing

Low Risk or Desirable Traits
• Unarmed (no spines, thorns or burrs)
• Requires full sun
• Not known to spread vegetatively
• Used as an ornamental & to attract & benefit pollinators