Taxon: Calothamnus quadrifidus R. Br. **Family:** Myrtaceae

Common Name(s): common net bush
one-sided bottlebrush

Synonym(s): Calothamnus quadrifidus f. obtusus

Assessor: Chuck Chimera **Status:** Assessor Approved **End Date:** 8 Jan 2018

WRA Score: 6.0 **Designation:** EVALUATE **Rating:** Evaluate

Keywords: Weedy Shrub, Unpalatable, Bird-Pollinated, Self-Compatible, Serotinous

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?		
103	Does the species have weedy races?		
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	(0-low; 1-intermediate; 2-high) (See Appendix 2)	Intermediate
202	Quality of climate match data	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
203	Broad climate suitability (environmental versatility)	y=1, n=0	y
204	Native or naturalized in regions with tropical or subtropical climates	y=1, n=0	n
205	Does the species have a history of repeated introductions outside its natural range?	y=-2, ?=-1, n=0	?
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		
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		
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	n
408	Creates a fire hazard in natural ecosystems		
409	Is a shade tolerant plant at some stage of its life cycle		

Qsn #	Question	Answer Option	Answer
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	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)		
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	n
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		
705	Propagules water dispersed		
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)	y=1, n=-1	n
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)	y=1, n=-1	y
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire	y=1, n=-1	y
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)		

Supporting Data:

Qsn #	Question	Answer
101	**Is the species highly domesticated?**	**n**
	Source(s)	**Notes**
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 4 Jan 2018]	"C. quadrifidus has a number of subspecies and cultivars include yellow-flowered, dwarf, and grey-green foliaged forms." [No evidence of domestication]
	George, A. S., & Gibson, N. (2010). A revision of Calothamnus quadrifidus (Myrtaceae). Nuytsia, 20, 57-77	[No evidence] "George, A.S. & Gibson, N. A revision of Calothamnus quadrifidus (Myrtaceae). Nuytsia 20: 57–77 (2010). The highly variable species Calothamnus quadrifidus R.Br. is discussed and an infraspecific classification with eight subspecies is proposed. The following new taxa are described: Calothamnus quadrifidus subsp. petraeus A.S.George & N.Gibson, C. quadrifidus subsp. seminudus A.S.George & N.Gibson and C. quadrifidus subsp. teretifolius A.S.George & N.Gibson. New combinations are C. quadrifidus subsp. angustifolius (Ewart) A.S.George & N.Gibson, C. quadrifidus subsp. asper (Turcz.) A.S.George & N.Gibson and C. quadrifidus subsp. homalophyllus (F.Muell.) A.S.George & N.Gibson, and a new status is given for C. quadrifidus subsp. obtusus (Benth.) A.S.George & N.Gibson."

102	**Has the species become naturalized where grown?**	
	Source(s)	**Notes**
	WRA Specialist. 2018. Personal Communication	NA

103	**Does the species have weedy races?**	
	Source(s)	**Notes**
	WRA Specialist. 2018. Personal Communication	NA

201	**Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"**	**Intermediate**
	Source(s)	**Notes**
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Calothamnus quadrifidus ... Preferred Climate/s: Mediterranean"
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 4 Jan 2018]	'Native: Australasia Australia: Australia - Western Australia"

Qsn #	Question	Answer
202	**Quality of climate match data**	**High**
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 4 Jan 2018]	

203	Broad climate suitability (environmental versatility)	y
	Source(s)	**Notes**
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 4 Jan 2018]	"C. quadrifidus is very adaptable to a range of environmental and growing conditions and is considered moderately hardy, tolerating windy and coastal situations. It grows naturally in a dry summer climate but will also grow in somewhat more humid conditions."
	Dave's Garden. 2018. Calothamnus Species, Australian Net Bush, One-sided Bottlebrush - Calothamnus quadrifidus. https://davesgarden.com/guides/pf/go/74823/. [Accessed 8 Jan 2018]	"Hardiness: USDA Zone 9b: to -3.8 °C (25 °F) USDA Zone 10a: to -1.1 °C (30 °F) USDA Zone 10b: to 1.7 °C (35 °F) USDA Zone 11: above 4.5 °C (40 °F)"
	Mazza, G. 2018. Calothamnus quadrifidus. http://www.photomazza.com/?Calothamnus-quadrifidus. [Accessed 8 Jan 2018]	"It is cultivable in full sun or slight shade in the zones with tropical, subtropical climate and in warm temperate ones, where it can resist to temperatures to about -4 °C, or little less, when adult and for a very short time."

204	Native or naturalized in regions with tropical or subtropical climates	n
	Source(s)	**Notes**
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Calothamnus quadrifidus ... Preferred Climate/s: Mediterranean"

205	Does the species have a history of repeated introductions outside its natural range?	?
	Source(s)	**Notes**
	Sheat, B. & Schofield, G. 1995. Complete Gardening in Southern Africa. Struik Publishers, Cape Town, South Africa	"A relatively hardy evergreen with slender upright stems." [Cultivated as an ornamental in South Africa]
	Barrett, R. & Tay, E. P. 2016. Perth Plants: A Field Guide to the Bushland and Coastal Flora of Kings Park and Bold Park. CSIRO Publishing, Clayton, Australia	"Several Calothamnus species have been planted in the bushland of Kings Park"
	Dave's Garden. 2018. Calothamnus Species, Australian Net Bush, One-sided Bottlebrush - Calothamnus quadrifidus. https://davesgarden.com/guides/pf/go/74823/. [Accessed 8 Jan 2018]	"This plant has been said to grow in the following regions: Kempner, Texas"

301	Naturalized beyond native range	y

Qsn #	Question	Answer
	Source(s)	**Notes**
	Keighery, G. (2013). Weedy native plants in Western Australia: an annotated checklist. Conservation Science Western Australia, 8, 259-273	"Calothamnus quadrifidus R. Br. subsp. quadrifidus ... Friends of Koondoola Bushland in the City of Wanneroo have removed over 5000 seedlings of this species, originating from amenity plantings, from banksia woodland in Koondoola (Keighery & Keighery 2007). The species also has self-perpetuating populations in Kings Park and from roadside plantings." ... "Calothamnus quadrifidus subsp. homalophyllus ... Plantings of this subspecies have resulted in dense monocultures in Kings Park after seeding into tuart/banksia woodland. Hybrids have been formed between this species and C. validus (G Keighery 16917) in Kings Park (Keighery & Keighery 2007)." ... "Calothamnus quadrifidus subsp. teretifolius ... Plantings of this subspecies have occurred along main road verges (e.g. Sues Road), next to experimental arboreta and in gravel pits in many parts of the Blackwood Plateau. This gives an apparently much wider range and ecological amplitude to what is an extremely restricted ironstone endemic of the base and slopes of the Whicher Range."
	Keighery, G. (2002). The enemy within: native environmental weeds of Western Australia. In 13th Australian Weeds Conference–Papers and Proceedings (pp. 93-95). Plant Protection Society, Perth	"Summary In Western Australia thirty five species of Western Australian plants have become naturalised, largely outside their ranges, from plantings. Fifty four eastern Australian species are also naturalized." ... "Acacia myrtifolia (Sm.) Willd., Calothamnus graniticus Hawkeswood, Calothamnus validus S.Moore and Calothamnus quadrifidus R.Br. have been widely used recently as road side plantings and for revegetation purposes and are already localised escapes. Some of these species have proved highly invasive in very short time periods, for example, Friends of Koondoola Bushland have removed over 5000 seedlings of Calothamnus quadrifidus from Banksia woodland in Koondoola Regional Park from amenity plantings less than 15 years old. The species has also self seeded into Warwick Open Space and Kings Park from roadside plantings."

Qsn #	Question	Answer
302	**Garden/amenity/disturbance weed**	**y**
	Source(s)	**Notes**
	Keighery, G. (2013). Weedy native plants in Western Australia: an annotated checklist. Conservation Science Western Australia, 8, 259-273	[Weed in botanical garden . Potential environmental weed] "Calothamnus quadrifidus R. Br. subsp. quadrifidus ... Friends of Koondoola Bushland in the City of Wanneroo have removed over 5000 seedlings of this species, originating from amenity plantings, from banksia woodland in Koondoola (Keighery & Keighery 2007). The species also has self-perpetuating populations in Kings Park and from roadside plantings." ... "Calothamnus quadrifidus subsp. homalophyllus ... Plantings of this subspecies have resulted in dense monocultures in Kings Park after seeding into tuart/banksia woodland. Hybrids have been formed between this species and C. validus (G Keighery 16917) in Kings Park (Keighery & Keighery 2007)." ... "Calothamnus quadrifidus subsp. teretifolius ... Plantings of this subspecies have occurred along main road verges (e.g. Sues Road), next to experimental arboreta and in gravel pits in many parts of the Blackwood Plateau. This gives an apparently much wider range and ecological amplitude to what is an extremely restricted ironstone endemic of the base and slopes of the Whicher Range."

303	**Agricultural/forestry/horticultural weed**	**n**
	Source(s)	**Notes**
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	[No evidence to date] "Calothamnus quadrifidus ... References: Australia-E-358, Australia-N- 945, Australia-E-380, Australia-N-7, Australia-N-354, Australia-N-1902, Chile- I-1872, Australia-W-1977, Chile-W-1977."

304	**Environmental weed**	
	Source(s)	**Notes**
	Australian Native Plant Society. 2015. Australian Weeds in Australia. http://anpsa.org.au/weeds6.html. [Accessed 8 Jan 2018]	[Calothamnus quadrifidus included in weedy list. Impacts in natural environment not specified] "Western Australian plants causing problems in.....Western Australia. The following are all Western Australian native plants which have become weedy somewhere in Western Australia. Many are popular in cultivation and this reinforces the need for care in plant selection."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	[Cited as an environmental weed. Impacts unspecified] "Calothamnus quadrifidus ... References: Australia-E-358, Australia-N- 945, Australia-E-380, Australia-N-7, Australia-N-354, Australia-N-1902, Chile- I-1872, Australia-W-1977, Chile-W-1977."

Qsn #	Question	Answer
	Keighery, G. (2013). Weedy native plants in Western Australia: an annotated checklist. Conservation Science Western Australia, 8, 259-273	[Weed in botanical garden . Potential environmental weed] "Calothamnus quadrifidus R. Br. subsp. quadrifidus ... Friends of Koondoola Bushland in the City of Wanneroo have removed over 5000 seedlings of this species, originating from amenity plantings, from banksia woodland in Koondoola (Keighery & Keighery 2007). The species also has self-perpetuating populations in Kings Park and from roadside plantings." ... "Calothamnus quadrifidus subsp. homalophyllus ... Plantings of this subspecies have resulted in dense monocultures in Kings Park after seeding into tuart/banksia woodland. Hybrids have been formed between this species and C. validus (G Keighery 16917) in Kings Park (Keighery & Keighery 2007)." ... "Calothamnus quadrifidus subsp. teretifolius ... Plantings of this subspecies have occurred along main road verges (e.g. Sues Road), next to experimental arboreta and in gravel pits in many parts of the Blackwood Plateau. This gives an apparently much wider range and ecological amplitude to what is an extremely restricted ironstone endemic of the base and slopes of the Whicher Range."

305	Congeneric weed	y
	Source(s)	**Notes**
	Keighery, G. (2013). Weedy native plants in Western Australia: an annotated checklist. Conservation Science Western Australia, 8, 259-273	"Although many of the species discussed below will likely remain only minor weeds of remnant bushland, there are a series of species (Agonis flexuosa, Allocasuarina huegeliana, Calothamnus spp., Ceratopteris thalictroides, Chamelaucium uncinatum, Eucalyptus megacornuta, Hakea costata and Melaleuca lanceolata) that have the capacity to completely alter the structure of communities that they invade. These are as damaging to the conservation of the remnant bushland invaded as are many exotic invasive species." ... "Calothamnus graniticus Hawkeswood subsp. graniticus ... Seeding and established along roadsides north of Dwellingup and in Kings Park. Possibility of hybridization exists between scarp (subsp. leptophyllus Hawkeswood) and Cape Naturaliste (subsp. graniticus) subspecies." ... "Calothamnus rupestris ... Naturalized from plantings along road verges and forming a dense monoculture, subsequently spreading downslope into adjacent bushland." ... "Calothamnus validus ... Naturalized from plantings and forming dense monocultures in Kings Park."

401	Produces spines, thorns or burrs	n
	Source(s)	**Notes**
	Barrett, R. & Tay, E. P. 2016. Perth Plants: A Field Guide to the Bushland and Coastal Flora of Kings Park and Bold Park. CSIRO Publishing, Clayton, Australia	"Erect, compact or spreading shrub; 0.9-2 m high." [No evidence]

402	Allelopathic	
	Source(s)	**Notes**
	WRA Specialist. 2018. Personal Communication	Unknown. No evidence found

Qsn #	Question	Answer
403	**Parasitic**	**n**
	Source(s)	**Notes**
	Barrett, R. & Tay, E. P. 2016. Perth Plants: A Field Guide to the Bushland and Coastal Flora of Kings Park and Bold Park. CSIRO Publishing, Clayton, Australia	"Erect, compact or spreading shrub; 0.9-2 m high." [No evidence]

404	Unpalatable to grazing animals	y
	Source(s)	**Notes**
	Rafferty, C., & Lamont, B. B. (2007). Selective herbivory by mammals on 19 species planted at two densities. Acta Oecologica, 32(1), 1-13	"The biomass of five species was unaffected by herbivory. C. calophylla, C. quadrifidus and C. sanguineus contained essential oils and supports our earlier findings on their palatabilityreducing effect (Jones et al., 2003)."
	Jones, A. S., Lamont, B. B., Fairbanks, M. M., & Rafferty, C. M. (2003). Kangaroos avoid eating seedlings with or near others with volatile essential oils. Journal of Chemical Ecology, 29(12), 2621-2635	[Calothamnus quadrifidus was one of the species tested & not browsed by western grey kangaroos] "Abstract—Preliminary studies indicate that western grey kangaroos browse seedlings of non Myrtaceae species rather than Myrtaceae. Seven morphologically-matched species pairs of Myrtaceae/non-Myrtaceae placed at three field sites showed that kangaroos avoided the essential-oil-containing Myrtaceae, but readily consumed the matched essential-oil-lacking non Myrtaceae. The one exception (Pittosporaceae) had limited herbivory and was later found to possess two essential oils in its leaves." ... "The pilot study showed that Myrtaceae seedlings were not browsed in contrast to seedlings from four other families."

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
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	No evidence in genus

406	Host for recognized pests and pathogens	
	Source(s)	**Notes**
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 4 Jan 2018]	"C. quadrifidus is not prone to disease or attack from many pests. Scale insects can be managed by good horticultural practice such as regular pruning and adequate nutrition to keep growth vigorous, and positioning plants with good airflow. It is always best to regularly inspect plants and prune out any affected branches before populations of scale are allowed to build up."

Qsn #	Question	Answer
	Morin, L., Aveyard, R., & Lidbetter, J. (2011). Myrtle rust: host testing under controlled conditions. NSW Department of Primary Industries, West Pennant Hills, NSW, Australia	[Potential host of myrtle rust] "Myrtle rust (Uredo rangelii) was first detected in Australia in April 2010. This exotic plant pathogen belongs to the guava/eucalyptus rust complex (Puccinia psidii sensu lato), which is native to South and Central America and known to have a very wide host range within the Myrtaceae family." ... "Fully-developed uredinia were observed on all replicates across both experiments of 27 taxa from 8 tribes belonging to the following 17 genera: Agonis, Austromyrtus, Beaufortia, Callistemon, Calothamnus, Chamelaucium, Darwinia, Eucalyptus, Gossia, Kunzea, Leptospermum, Melaleuca, Metrosideros, Syzygium, Thryptomene, Tristania, Verticordia." ... "It is important to reiterate that the disease scores recorded for individual plants of each taxon in our experiments are not a measure of the overall severity of myrtle rust on plants, but rather a qualitative assessment of the type of symptoms that developed. For example, while all replicates of Calothamnus quadrifidus were given a disease score of 4 or 5 because fully-developed uredinia were observed (Table 3), only a few leaves in each plant were actually infected by the rust (Appendix C)."

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

408	Creates a fire hazard in natural ecosystems	
	Source(s)	**Notes**
	Kim, J. H., Walck, J. L., Hidayati, S. N., Merritt, D. J., & Dixon, K. W. (2009). Germinability of seeds stored in capsules on plants of two myrtaceous shrubs: differences among age cohorts and between species. Australian Journal of Botany, 57(6), 495-501	" ... Calothamnus quadrifidus R.Br. These species are common and widespread in the temperate region of south-west Australia and are representative of some of the most conspicuously deeply serotinous woody shrubs (Department of Environment and Conservation 2008)." [Adapted to release seeds following fire]
	Keighery, G. (2013). Weedy native plants in Western Australia: an annotated checklist. Conservation Science Western Australia, 8, 259-273	"Calothamnus quadrifidus subsp. homalophyllus ... Plantings of this subspecies have resulted in dense monocultures in Kings Park after seeding into tuart/banksia woodland." [Formation of dense stands could increase fire risk]

409	Is a shade tolerant plant at some stage of its life cycle	
	Source(s)	**Notes**
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 4 Jan 2018]	"C. quadrifidus grows well in either full sun or part shade, though it favours a warm, open and sunny position, and while not being a heavy feeder, it will perform best if provided with regular additions of compost and/or the occasional application of a 'complete' or balanced fertiliser."

Qsn #	Question	Answer
	Dave's Garden. 2018. Calothamnus Species, Australian Net Bush, One-sided Bottlebrush - Calothamnus quadrifidus. https://davesgarden.com/guides/pf/go/74823/. [Accessed 8 Jan 2018]	"Sun Exposure: Full Sun"

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	**Notes**
	Western Australian Herbarium (1998–2018). FloraBase—the Western Australian Flora. Department of Parks and Wildlife. https://florabase.dpaw.wa.gov.au/. [Accessed 8 Jan 2018]	"Calothamnus quadrifidus ... Wide variety of soils & habitats."
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 3 Jan 2018]	"It commonly grows naturally among granite outcrops, in sand or sandy-gravel, however it adapts well to other soil types such as loam, and even clay. A neutral to mildly alkaline soil is probably best, though it is known to grow also in mildly acidic soil. Whatever the soil type, better drainage will improve results."
	Kim, J. H., Walck, J. L., Hidayati, S. N., Merritt, D. J., & Dixon, K. W. (2009). Germinability of seeds stored in capsules on plants of two myrtaceous shrubs: differences among age cohorts and between species. Australian Journal of Botany, 57(6), 495-501	"While Callistemon occurs in swampy flats, Calothamnus is found growing in a wide variety of soils and upland habitats."

411	Climbing or smothering growth habit	n
	Source(s)	**Notes**
	Corrick, M.G. & Fuhrer, B. (2009). Wildflowers of Southern Western Australia. Third Edition. Rosenberg Publishing, Kenthurst, Australia	"Shrub, spreading or upright, 2-4 m high; leaves to 3 cm long, terete or flattened, hairy or glabrous"

412	Forms dense thickets	y
	Source(s)	**Notes**
	Keighery, G. (2013). Weedy native plants in Western Australia: an annotated checklist. Conservation Science Western Australia, 8, 259-273	"Calothamnus quadrifidus subsp. homalophyllus ... Plantings of this subspecies have resulted in dense monocultures in Kings Park after seeding into tuart/banksia woodland."

501	Aquatic	n
	Source(s)	**Notes**
	Barrett, R. & Tay, E. P. 2016. Perth Plants: A Field Guide to the Bushland and Coastal Flora of Kings Park and Bold Park. CSIRO Publishing, Clayton, Australia	[Terrestrial] "Erect, compact or spreading shrub" ... "Wide variety of soils and habitats."

502	Grass	n
	Source(s)	**Notes**

Qsn #	Question	Answer
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 3 Jan 2018]	Family: Myrtaceae Subfamily: Myrtoideae Tribe: Melaleuceae

503	Nitrogen fixing woody plant	n
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 4 Jan 2018]	Family: Myrtaceae Subfamily: Myrtoideae Tribe: Melaleuceae

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	**Notes**
	Barrett, R. & Tay, E. P. 2016. Perth Plants: A Field Guide to the Bushland and Coastal Flora of Kings Park and Bold Park. CSIRO Publishing, Clayton, Australia	"Erect, compact or spreading shrub"

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	**Notes**
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 4 Jan 2018]	"Calothamnus quadrifidus naturally occurs in the south-west region of Western Australia where it is widely distributed." [No evidence]
	George, A. S., & Gibson, N. (2010). A revision of Calothamnus quadrifidus (Myrtaceae). Nuytsia, 20, 57-77	"Widespread and locally common throughout south-western Western Australia from Shark Bay to Busselton, east to Israelite Bay and inland to the Southern Cross area, except a triangle between Margaret River, Denmark and Collie"

602	Produces viable seed	y
	Source(s)	**Notes**
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 4 Jan 2018]	"C. quadrifidus reproduces readily by seed and 'ripe' fruits can be collected in paper bags and placed in warm conditions (~30°C) to release the seed, for later sowing in autumn or early spring. Softwood or tip cuttings taken in late summer are recommended if you want to propagate a particular form."

Qsn #	Question	Answer
603	**Hybridizes naturally**	**y**
	Source(s)	**Notes**
	Keighery, G. (2013). Weedy native plants in Western Australia: an annotated checklist. Conservation Science Western Australia, 8, 259-273	"Calothamnus quadrifidus subsp. homalophyllus ... Hybrids have been formed between this species and C. validus (G Keighery 16917) in Kings Park (Keighery & Keighery 2007)."

604	**Self-compatible or apomictic**	**y**
	Source(s)	**Notes**
	Coates, D. J., Sampson, J. F., & Yates, C. J. (2007). Plant mating systems and assessing population persistence in fragmented landscapes. Australian Journal of Botany, 55 (3), 239-249	"All species are self-compatible, have large showy flowers or inflorescences, are pollinated by animals and geitonogamous pollination is likely to be common. L. orbifolia, C. quadrifidus and E. rameliana are largely bird-pollinated, although C. quadrifidus is also likely to be mammal pollinated." ... "Table 1. Summary of study-species characteristics ... Calothamnus quadrifidus ... Breeding system - Self-compatible protandrous"
	Yates, C. J., Elliott, C., Byrne, M., Coates, D. J., & Fairman, R. (2007). Seed production, germinability and seedling growth for a bird-pollinated shrub in fragments of kwongan in south-west Australia. Biological Conservation, 136(2), 306-314	"we can be confident that self-incompatibility is not a factor in the mating system of C. quadrifidus since paternity analysis with exclusion probability has unambiguously identified self-pollination in progeny arrays (Byrne et al., 2007)."
	Byrne, M., Elliott, C. P., Yates, C., & Coates, D. J. (2007). Extensive pollen dispersal in a bird-pollinated shrub, Calothamnus quadrifidus, in a fragmented landscape. Molecular Ecology, 16(6), 1303-1314	[Capable of selfing] "Geitonogamous pollination is possible because shrubs can have a large number of flowers "Comparison of two populations of similar size but different density showed greater internal pollination and less selfing in the denser population, suggesting an influence of density on pollinator behaviour." ... occurring simultaneously at various developmental stages, and pollinator observations show birds visiting multiple flowers per plant (Yates et al . 2006)." [Geitonogamy - Transfer of pollen from an anther of one flower to a stigma of another flower on the same plant.]

605	**Requires specialist pollinators**	**n**
	Source(s)	**Notes**

Qsn #	Question	Answer
	Collins, B.G., Newland, C., & Briffa, P. (1984) Nectar utilization and pollination by Australian honeyeaters and insects visiting Calothamnus quadrifidus (Myrtaceae). Australian Journal of Ecology, 9, 353–365	"Nectar availability in Calothamnus quadrifidus flowers was studied at Wongamine Nature Reserve in late spring (November). Despite some overnight depletion by moths and other invertebrates, more nectar was present in flowers at dawn than at the preceding dusk. Significant nectar depletion occurred within a few hours after dawn, mainly due to foraging by two honeyeater species. Lichmera indistincta and Phylidonyris nigra. Thereafter, nectar availability was maintained at relatively low levels, principally because of foraging by honeyeaters and honey bees. Apis mellifera, that became active during the warmer part of the day. Although individual honeyeaters consumed more nectar than A. mellifera, honey bees were so abundant that their total impact was greater than that of either honeyeater species for much of the day. Transfer of C. quadrifidus pollen between flowers is necessary in order to achieve a high level of seed set, as the flowers appear to be protandrous. Honeyeaters appeared to be considerably more significant pollen vectors than A. mellifera."
	Byrne, M., Elliott, C. P., Yates, C., & Coates, D. J. (2007). Extensive pollen dispersal in a bird-pollinated shrub, Calothamnus quadrifidus, in a fragmented landscape. Molecular Ecology, 16(6), 1303-1314	"The flowers are protandrous and transfer of pollen between flowers by birds, honey possums or introduced European honeybees is necessary for seed set (Collins et al . 1984)."

606	Reproduction by vegetative fragmentation	n
	Source(s)	**Notes**
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 4 Jan 2018]	"C. quadrifidus reproduces readily by seed and 'ripe' fruits can be collected in paper bags and placed in warm conditions (~30°C) to release the seed, for later sowing in autumn or early spring. Softwood or tip cuttings taken in late summer are recommended if you want to propagate a particular form."

607	Minimum generative time (years)	
	Source(s)	**Notes**
	Mazza, G. 2018. Calothamnus quadrifidus. http://www.photomazza.com/?Calothamnus-quadrifidus. [Accessed 8 Jan 2018]	"It is a fast growing species appreciated, in addition to its abundant and long lasting flowering and the delicate foliage, also for the facility of cultivation and adaptability to different typologies and conditions of soil." [Time to maturity unspecified]

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	n
	Source(s)	**Notes**
	Groom, P. K., & Lamont, B. (2015). Plant life of southwestern Australia: adaptations for survival. De Gruyter Open Ltd, Warsaw/Berlin	"Plant species that have no specialised means of dispersal have seeds that simply fall out of the open fruit, possibly dislodged by wind or swaying of fruits. Example genera are Eucalyptus, Melaleuca, Calothamnus, Corymbia (all Myrtaceae) and Xanthorrhoea (Xanthorrhoeaceae)"

Qsn #	Question	Answer
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 4 Jan 2018]	"The fruits produced are woody capsules that remain on the plant throughout its life and can contain seeds for many years."

702	Propagules dispersed intentionally by people	y
	Source(s)	**Notes**
	Sheat, B. & Schofield, G. 1995. Complete Gardening in Southern Africa. Struik Publishers, Cape Town, South Africa	"A relatively hardy evergreen with slender upright stems." [Cultivated as an ornamental in South Africa]
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 4 Jan 2018]	"Also known as Common Net Bush or One-sided Bottlebrush it is an excellent plant to grow in Australian gardens. The beautiful flowers produced over a long period are noticeably bird attracting and the lovely texture of the foliage provides a pleasing contrast in the garden. Calothamnus quadrifidus can be grown to create an effective screen and/or windbreak."
	Australian Native Plants Society. 2017. Calothamnus quadrifidus. http://www.anpsa.org.au/c-qua.html. [Accessed 4 Jan 2018]	"It is the most widely cultivated member of the genus and, despite its natural habitat in a dry summer climate, it has proven adaptable to more humid areas "

703	Propagules likely to disperse as a produce contaminant	n
	Source(s)	**Notes**
	Australian Native Plants Society. 2017. Calothamnus quadrifidus. http://www.anpsa.org.au/c-qua.html. [Accessed 8 Jan 2018]	"The fruits produced are woody capsules that remain on the plant throughout its life and can contain seeds for many years." [No evidence. Unlikely, unless seeds are released and potentially contaminate soil in potted plants]

704	Propagules adapted to wind dispersal	
	Source(s)	**Notes**
	George, A. S., & Gibson, N. (2010). A revision of Calothamnus quadrifidus (Myrtaceae). Nuytsia, 20, 57-77	"Fruit barrel-shaped, 6–14 mm long, smooth or warted; 2 sepals enlarged, incurved. Seeds 1.4–2 mm long, smooth." [Seeds small. May be dislodged and moved by wind]
	Groom, P. K., & Lamont, B. (2015). Plant life of southwestern Australia: adaptations for survival. De Gruyter Open Ltd, Warsaw/Berlin	"Plant species that have no specialised means of dispersal have seeds that simply fall out of the open fruit, possibly dislodged by wind or swaying of fruits. Example genera are Eucalyptus, Melaleuca, Calothamnus, Corymbia (all Myrtaceae) and Xanthorrhoea (Xanthorrhoeaceae)"

Qsn #	Question	Answer
705	**Propagules water dispersed**	
	Source(s)	**Notes**
	Groom, P. K., & Lamont, B. (2015). Plant life of southwestern Australia: adaptations for survival. De Gruyter Open Ltd, Warsaw/Berlin	[Buoyancy of seeds unknown] "Plant species that have no specialised means of dispersal have seeds that simply fall out of the open fruit, possibly dislodged by wind or swaying of fruits. Example genera are Eucalyptus, Melaleuca, Calothamnus, Corymbia (all Myrtaceae) and Xanthorrhoea (Xanthorrhoeaceae)"

706	**Propagules bird dispersed**	**n**
	Source(s)	**Notes**
	Groom, P. K., & Lamont, B. (2015). Plant life of southwestern Australia: adaptations for survival. De Gruyter Open Ltd, Warsaw/Berlin	"Plant species that have no specialised means of dispersal have seeds that simply fall out of the open fruit, possibly dislodged by wind or swaying of fruits. Example genera are Eucalyptus, Melaleuca, Calothamnus, Corymbia (all Myrtaceae) and Xanthorrhoea (Xanthorrhoeaceae)"
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 4 Jan 2018]	"The fruits produced are woody capsules that remain on the plant throughout its life and can contain seeds for many years."

707	**Propagules dispersed by other animals (externally)**	**n**
	Source(s)	**Notes**
	George, A. S., & Gibson, N. (2010). A revision of Calothamnus quadrifidus (Myrtaceae). Nuytsia, 20, 57-77	"Fruit barrel-shaped, 6–14 mm long, smooth or warted; 2 sepals enlarged, incurved. Seeds 1.4–2 mm long, smooth." [No evidence. No means of external attachment, although small size may allow for some adherence to animals]
	Groom, P. K., & Lamont, B. (2015). Plant life of southwestern Australia: adaptations for survival. De Gruyter Open Ltd, Warsaw/Berlin	"Plant species that have no specialised means of dispersal have seeds that simply fall out of the open fruit, possibly dislodged by wind or swaying of fruits. Example genera are Eucalyptus, Melaleuca, Calothamnus, Corymbia (all Myrtaceae) and Xanthorrhoea (Xanthorrhoeaceae)" [No evidence. No means of external attachment]

Qsn #	Question	Answer
708	**Propagules survive passage through the gut**	**n**
	Source(s)	**Notes**
	Gordon, D. R., Mitterdorfer, B., Pheloung, P. C., Ansari, S., Buddenhagen, C., Chimera, C., ... & Williams, P. A. 2010). Guidance for addressing the Australian Weed Risk Assessment questions. Plant Protection Quarterly, 25(2): 56-74	"Answer 'no' where the taxon is unlikely to be eaten by animals or if seeds are not viable following passage through the gut."
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 8 Jan 2018]	"The fruits produced are woody capsules that remain on the plant throughout its life and can contain seeds for many years." [No evidence that seeds are consumed]

801	**Prolific seed production (>1000/m2)**	
	Source(s)	**Notes**
	Yates, C. J., Elliott, C., Byrne, M., Coates, D. J., & Fairman, R. (2007). Seed production, germinability and seedling growth for a bird-pollinated shrub in fragments of kwongan in south-west Australia. Biological Conservation, 136(2), 306-314	"Mean seed set (±SE) among populations varied between 3.10 ± 1.58 and 19.23 ± 1.53 seeds per fruit (Fig. 2)." [Number of seeds per plant unspecified]

802	**Evidence that a persistent propagule bank is formed (>1 yr)**	**y**
	Source(s)	**Notes**
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 4 Jan 2018]	"The fruits produced are woody capsules that remain on the plant throughout its life and can contain seeds for many years." [Forms a persistent "canopy bank". Persistence in soil unknown]

Qsn #	Question	Answer
	Kim, J. H., Walck, J. L., Hidayati, S. N., Merritt, D. J., & Dixon, K. W. (2009). Germinability of seeds stored in capsules on plants of two myrtaceous shrubs: differences among age cohorts and between species. Australian Journal of Botany, 57(6), 495-501	[Forms a persistent canopy seed bank, but persistence in soil unknown] "Canopy-stored seed banks are a common trait among members of several plant families in sclerophyllous woodlands of Australia and South Africa, with their fruits usually opening in response to damage or fire. Unknown is whether the degree of dormancy and of germination differs among age cohorts in seeds stored on the mother plant. We examined the extent and speed of germination from two intensely serotinous myrtaceous species, Callistemon glaucus and Calothamnus quadrifidus, for seed held in capsules for up to 9 years. Germination of both species differed significantly among age cohorts ($P < 0.0001$). However, no consistent increase in germination over a range of temperatures with storage was found, suggesting that no after-ripening occurred and that seeds were non-dormant at maturity." ... "Although both species of Myrtaceae in the present study form an aerial (canopy) seed bank, seeds of Callistemon would have a higher capacity to remain in a soil seed bank once dispersed than those of Calothamnus (assuming that the seed can retain longevity under the high soil moisture conditions in the soil seed bank). The relatively small seeds of Callistemon germinated to higher percentages in light than in darkness, but the large seeds of Calothamnus germinated equally well in both light conditions"

803	Well controlled by herbicides	y
	Source(s)	**Notes**
	Moore, J. 2006. The tolerance of direct seeded native species to herbicides. www.herbiguide.com.au	"Table 3: The tolerance of various native plant species to post emergent herbicides" ... "X = Don't use - less than 50% growth and/or survival." [Calothamnus quadrifidus not tolerant, and presumably effectively controlled, by a number of herbicides]

804	Tolerates, or benefits from, mutilation, cultivation, or fire	y
	Source(s)	**Notes**
	Fisher, J. L., Loneragan, W. A., Dixon, K., & Veneklaas, E. J. (2009). Soil seed bank compositional change constrains biodiversity in an invaded species-rich woodland. Biological Conservation, 142(2): 256-269	"Appendix A ... Calothamnus quadrifidus - FS = Fire response: R = resprouter"
	Dave's Garden. 2018. Calothamnus Species, Australian Net Bush, One-sided Bottlebrush - Calothamnus quadrifidus. https://davesgarden.com/guides/pf/go/74823/. [Accessed 8 Jan 2018]	"On Aug 31, 2009, Stake from Barmera, Australia wrote: Very attractive plant if kept trimmed, will tolerate hard pruning and can be hedged. "
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2016. Growing Native Plants. Calothamnus quadrifidus. https://www.anbg.gov.au/gnp/interns-2011/calothamnus-quadrifidus.html. [Accessed 4 Jan 2018]	"Regular pruning (in conjunction with adequate nutrition) will keep this plant dense and growing vigorously. With age it can become rather woody and "leggy" if left unattended. C. quadrifidus will happily tolerate removal of up to one third of the foliage, which is best done just after flowering. Hard pruning into old wood may affect the next season's flowering, as the flowers are borne on stems of the previous season's growth."

Qsn #	Question	Answer
805	**Effective natural enemies present locally (e.g. introduced biocontrol agents)**	
	Source(s)	**Notes**
	WRA Specialist. 2018. Personal Communication	Unknown

Summary of Risk Traits:

High Risk / Undesirable Traits
• Adaptable to a range of environmental conditions (possesses environmental versatility)
• Native to Mediterranean climate, but able to grow in tropical climates
• Naturalized outside native range in Australia
• Regarded as a weed in Australia, with potential negative environmental impacts
• Other species have become invasive
• Unpalatable to browsing animals (due to essential oils)
• Potential host of myrtle rust
• Tolerates many soil types
• Forms dense stands in native range
• Reproduces by seeds
• Hybridizes with other Calothamnus species
• Self-compatible
• Seeds dispersed by people (and possibly wind)
• Serotinous - seeds persist on plants for years prior to release
• Able to resprout after cutting, hard pruning & fire

Low Risk Traits
• Unarmed (no spines, thorns, or burrs)
• Ornamental
• Not reported to spread vegetatively
• Seeds remain on plant until fire triggers release (may limit ability to spread in absence of fire)

Second Screening Results for Tree/tree-like shrubs

(A) Shade tolerant or known to form dense stands?> Yes. Forms dense stands in Australia. Tolerates partial shade
(B) Bird or clearly wind-dispersed?> Unknown. Possibly wind-dispersed
(C) Life cycle <4 years? Unknown
Outcome = Evaluate Further