

Taxon: *Impatiens glandulifera* Royle

Family: Balsaminaceae

Common Name(s): Himalayan balsam
Indian balsam
ornamental jewelweed
policeman's-helmet

Synonym(s): *Impatiens roylei* Walp.

Assessor: Chuck Chimera

Status: Assessor Approved

End Date: 21 Nov 2017

WRA Score: 12.0

Designation: H(HPWRA)

Rating: High Risk

Keywords: Annual Herb, Environmental Weed, Dense Stands, Ballistic Dispersal, Water-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	n=0, y = 1*multiplier (see Appendix 2)	n
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)	y
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	n
405	Toxic to animals	y=1, n=0	n
406	Host for recognized pests and pathogens		
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		
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	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant		
704	Propagules adapted to wind dispersal	y=1, n=-1	n
705	Propagules water dispersed	y=1, n=-1	y
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)		
708	Propagules survive passage through the gut	y=1, n=-1	n
801	Prolific seed production (>1000/m ²)	y=1, n=-1	y
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	y=1, n=-1	n
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
	CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	[No evidence of domestication] "I. glandulifera is native to the foothills of the Himalayas from north-west Pakistan to northern India. The native range in the western Himalayas is relatively small compared to its invasive range. According to Beerling and Perrins (1993), I. glandulifera is native from Kashmir to Garhwal between 2000 and 2500 masl, and Polunin and Stainton (1984) report the plant can grow up to 4000 masl in its native range. The plant is also recorded as native in Nepal (USDA-ARS, 2008), and possibly in Bhutan."

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. 2017. Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. 2017. 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, Germplasm Resources Information Network. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 21 Nov 2017]	"Native: Asia-Tropical Indian Subcontinent: India - Himachal Pradesh, - Jammu and Kashmir, - Mizoram, - Uttar Pradesh; Nepal; Pakistan"

202	Quality of climate match data	High
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 21 Nov 2017]	

203	Broad climate suitability (environmental versatility)	y
	Source(s)	Notes
	Cockel, C. P., & Tanner, R. A. (2012). <i>Impatiens glandulifera</i> Royle (Himalayan balsam). Pp. 67-77 in R. A. Francis (ed.). A Handbook of Global Freshwater Invasive Species. Earthscan, New York, NY	"It is also tolerant of a range of climates (Chittka and Schürkens, 2001) and soil pH values from relatively acidic to neutral (pH 5.0 to 8.0) (Grime et al, 1988) as well as a high to low nutrient level soil (Beerling and Perrins,1993)."

Qsn #	Question	Answer
	CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	[Elevation range exceeds 2000 m, demonstrating environmental versatility] "In the native range the plant occurs at high altitudes between 1600 and 4300 m, but in Europe it is found at lower elevations. In the UK it has not been found above 210 m and in the eastern Alps in Austria it occurs at up to 1200 m (Drescher and Prots, 2000)."

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 21 Nov 2017]	"Native: Asia-Tropical Indian Subcontinent: India - Himachal Pradesh, - Jammu and Kashmir, - Mizoram, - Uttar Pradesh; Nepal; Pakistan Naturalized: Asia-Temperate Eastern Asia: Japan Siberia: Russian Federation - Altay, - Gorno-Altay, - Irkutsk, - Krasnoyarsk, - Novosibirsk Australasia New Zealand: New Zealand Europe Eastern Europe: Estonia; Latvia; Lithuania; Russian Federation-European part - European part; Ukraine Middle Europe: Austria; Belgium; Czech Republic; Germany; Hungary; Netherlands; Poland; Slovakia; Switzerland Northern Europe: Denmark; Finland; Ireland; Norway; Sweden; United Kingdom Southeastern Europe: Croatia; Italy; Romania; Slovenia Southwestern Europe: France Northern America : Canada; United States Southern Mexico: Mexico - Morelos"

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes
	CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	" <i>I. glandulifera</i> is introduced and invasive in much of Europe, and parts of Canada, the USA and New Zealand."

301	Naturalized beyond native range	y
	Source(s)	Notes

Qsn #	Question	Answer
	<p>USDA, ARS, Germplasm Resources Information Network. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 21 Nov 2017]</p>	<p>"Naturalized: Asia-Temperate Eastern Asia: Japan Siberia: Russian Federation - Altay, - Gorno-Altay, - Irkutsk, - Krasnoyarsk, - Novosibirsk Australasia New Zealand: New Zealand Europe Eastern Europe: Estonia; Latvia; Lithuania; Russian Federation-European part - European part; Ukraine Middle Europe: Austria; Belgium; Czech Republic; Germany; Hungary; Netherlands; Poland; Slovakia; Switzerland Northern Europe: Denmark; Finland; Ireland; Norway; Sweden; United Kingdom Southeastern Europe: Croatia; Italy; Romania; Slovenia Southwestern Europe: France Northern America : Canada; United States Southern Mexico: Mexico - Morelos"</p>

302	Garden/amenity/disturbance weed	n
	Source(s)	Notes
	<p>CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc</p>	<p>[A disturbance-adapted weed with negative ecological impacts. See 3.04] "As an annual, the species is dependent on open sites for germination each spring; it is consequently favoured by disturbance."</p>

303	Agricultural/forestry/horticultural weed	n
	Source(s)	Notes
	<p>CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc</p>	<p>"<i>I. glandulifera</i> is not a weed of agricultural fields. However, native herbaceous plants and tree regeneration can be out-competed by the dense growth of the species (Larson and Martinson, 1998; Maule et al., 2000)."</p>

304	Environmental weed	y
	Source(s)	Notes

Qsn #	Question	Answer
	CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	" <i>I. glandulifera</i> is a highly invasive annual species which has spread rapidly in many parts of Europe and North America after its introduction as an ornamental. The spread is likely to continue to more northerly or high montane areas as a result of global climatic change. Due to its ability to form dense stands and its conspicuous appearance it has been blamed for negative biodiversity effects. Even though these effects are less severe than often thought, further spread is undesirable and should not be facilitated by further use, in particular in natural areas. Control is advisable in certain situations, e.g. nature reserves and conservation sensitive areas, but eradication from larger parts of its invasive range is not feasible due to the need to control the plant on a catchment scale, which is often impossible due to the sheer scale of occurrence and division of land ownership."
	Hulme, P. E., & Bremner, E. T. (2006). Assessing the impact of <i>Impatiens glandulifera</i> on riparian habitats: partitioning diversity components following species removal. <i>Journal of Applied Ecology</i> , 43(1), 43-50	[Reduces diversity of common native ruderal species] "Removal experiments appear particularly well suited to assess the impacts of herbaceous non-native plants on ruderal communities. By partitioning diversity components, impacts were consistently assessed at local and community scales and, when combined with analysis of species accumulation curves, provided a comprehensive assessment of impact on the plant community. The approach adopted in this study highlights that although <i>Impatiens</i> reduces native species diversity in open and frequently disturbed riparian vegetation, many of the species negatively influenced by <i>Impatiens</i> are widespread ruderal species. Furthermore, management may lead to a compensatory increase in the abundance of other non-native species and thus fail to achieve desired conservation goals."

305	Congeneric weed	y
	Source(s)	Notes
	Adamowski, W. 2008. Balsams on the offensive: the role of planting in the invasion of <i>Impatiens</i> species. Pp 57-70 in Tokarska-Guzik et al. (eds.) <i>Plant Invasions: Human Perception, Ecological Impacts and Management</i> . Backhuys Publishers, Leiden	"The genus <i>Impatiens</i> includes a number of species with very attractive flowers. Some of them were introduced for cultivation already in the 19th century. At least two taxa have become popular decorative plants. The introductions of balsams have resulted in a few spectacular biological invasions. Because of the recent interest in the genus as a source of potential decorative plants and the cultivation of many new taxa, a study was undertaken to analyse the threat of invasive balsam species. In the temperate climatic zone, the taxa originating from mountainous areas of China seem to pose the greatest risk of spreading. These regions are characterized by well-marked climatic seasons. Over 80% of the balsam species growing in these areas are annuals wintering as seeds. The balsams coming from tropical Africa are mostly perennials, adapted to a more even climatic pattern. They can be expected to expand in tropical zones characterized by abundant precipitation."

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

Qsn #	Question	Answer
	Tropicos.org. 2017. Missouri Botanical Garden. http://www.tropicos.org/ . [Accessed 21 Nov 2017]	[No evidence] " <i>Impatiens glandulifera</i> ... Robust succulent plants, usually more than 100 cm tall, glabrous. Leaves opposite-verticillate, 60-150 x 18-65 mm, elliptic-ovate, serrate, base glandular stipitate; petiole 30-35 mm long. Inflorescence short, compact. Peduncles up to 90 mm long. Bracts elliptic-ovate or lanceolate-ovate, 7-8(-10) mm long. Flowers pink-red or red-purple, c. 30 mm long. Lateral sepals oblique cordate, 7-9 mm long. Lower sepal saccate, abruptly ending in a spur 5-6 mm long; spur incurved. Anterior petal orbicular-depressed, 7-8 x 12 mm; dorsally crested, apex bilobed. Lateral united petals 26 mm long, unequal; lower one larger (15 mm), upper with a thin incurved appendage. Capsule broadly clavate, 14-18(-25) mm long, nodding. Seeds sub globose, 3 mm broad, rugose. "

402	Allelopathic	
	Source(s)	Notes
	Weber, E. 2017. <i>Invasive Plant Species of the World</i> , 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"The plant contains allelopathic compounds that can inhibit germination and growth of seedlings (Vrchotova et al., 2011); their ecological role has not yet been studied."

403	Parasitic	n
	Source(s)	Notes
	Tropicos.org. 2017. Missouri Botanical Garden. http://www.tropicos.org/ . [Accessed 21 Nov 2017]	"Robust succulent plants, usually more than 100 cm tall, glabrous." [Balsaminaceae. No evidence]

404	Unpalatable to grazing animals	n
	Source(s)	Notes
	CABI, 2017. <i>Invasive Species Compendium</i> . Wallingford , UK: CAB International. www.cabi.org/isc	"Cattle are known to feed on the whole plant (Beerling and Perrins, 1993) but the browse value is not known."
	Cockel, C. P., & Tanner, R. A. (2012). <i>Impatiens glandulifera</i> Royle (Himalayan balsam). Pp. 67-77 in R. A. Francis (ed.). <i>A Handbook of Global Freshwater Invasive Species</i> . Earthscan, New York, NY	"Sheep and cattle are known to feed on the leaves, stems and flowers of <i>I. glandulifera</i> (Beerling and Perrins, 1993; Navchoo and Kachroo, 1995), and although there is no evidence of widespread grazing in the UK, horses by the River Thames at Richmond upon Thames, Surrey, have been observed to feed on <i>I. glandulifera</i> plants (Cockel, C., pers. obs., 2005). As a management regime though, grazing at the water's edge may inevitably result in further disturbance and if permitted at the time of seed dispersal may lead to seed being transported to other uninvaded sites."

405	Toxic to animals	n
	Source(s)	Notes
	Cockel, C. P., & Tanner, R. A. (2012). <i>Impatiens glandulifera</i> Royle (Himalayan balsam). Pp. 67-77 in R. A. Francis (ed.). <i>A Handbook of Global Freshwater Invasive Species</i> . Earthscan, New York, NY	[No evidence] "Sheep and cattle are known to feed on the leaves, stems and flowers of <i>I. glandulifera</i> (Beerling and Perrins, 1993; Navchoo and Kachroo, 1995), and although there is no evidence of widespread grazing in the UK, horses by the River Thames at Richmond upon Thames, Surrey, have been observed to feed on <i>I. glandulifera</i> plants (Cockel, C., pers. obs., 2005)."

Qsn #	Question	Answer
	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

406	Host for recognized pests and pathogens	
	Source(s)	Notes
	Cockel, C. P., & Tanner, R. A. (2012). <i>Impatiens glandulifera</i> Royle (Himalayan balsam). Pp. 67-77 in R. A. Francis (ed.). A Handbook of Global Freshwater Invasive Species. Earthscan, New York, NY	"Throughout the Himalayas <i>I. glandulifera</i> is a host to both specialist and generalist arthropod species, including the generalist flea beetle, <i>Altica hemensis</i> , which is capable of causing complete skeletonization of the leaves when in high abundance, and the more specialist stem-boring beetles, <i>Metialma suturella</i> and <i>Languriophasma cyanea</i> . <i>Impatiens glandulifera</i> is also the host to a number of plant pathogens including both <i>Phoma</i> and <i>Septoria</i> leaf spots and an autoecious rust pathogen <i>Puccinia cf. komarovii</i> , which infects the stem and the leaves of the plant."

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	Notes
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	" <i>Impatiens glandulifera</i> ... Root juice used in hematuria; seeds diuretic." [No evidence]

408	Creates a fire hazard in natural ecosystems	n
	Source(s)	Notes
	Tropicos.org. 2017. Missouri Botanical Garden. http://www.tropicos.org/ . [Accessed 21 Nov 2017]	"Robust succulent plants, usually more than 100 cm tall, glabrous." [Unlikely based on growth form]
	CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	[No evidence. Dense stands could contribute to fuel load, but does not occur in fire prone habitats] "In Europe, <i>I. glandulifera</i> is predominantly a weed of riparian systems where it can form dense monocultures along river banks (Pysek, 1995; Kowarik, 2003). <i>I. glandulifera</i> is also found in damp natural woodland, where it can attain its maximum known height (up to 3m), in addition the plant is found in forest plantations, forest clearings, railway embankments, waste ground, urban areas, roadside ditches and wet meadows. In the native range, <i>I. glandulifera</i> is predominately a plant of high altitudes, moist, fertile valleys where it grows in clusters of 30-60 plants mixed in with surrounding native vegetation (Tanner et al., 2008)."

409	Is a shade tolerant plant at some stage of its life cycle	
	Source(s)	Notes
	CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	" <i>I. glandulifera</i> has a preference for high atmospheric humidity. It grows in half-shade but also in full sunlight."

Qsn #	Question	Answer
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	Notes
	Cockel, C. P., & Tanner, R. A. (2012). <i>Impatiens glandulifera</i> Royle (Himalayan balsam). Pp. 67-77 in R. A. Francis (ed.). <i>A Handbook of Global Freshwater Invasive Species</i> . Earthscan, New York, NY	" <i>Impatiens glandulifera</i> is tolerant of a wide variety of soil textures and structures, and can be found on fine and coarse alluvium (Beerling and Perrins, 1993). It is also tolerant of a range of climates (Chittka and Schürkens, 2001) and soil pH values from relatively acidic to neutral (pH 5.0 to 8.0) (Grime et al, 1988) as well as a high to low nutrient level soil (Beerling and Perrins, 1993)."
	CABI, 2017. <i>Invasive Species Compendium</i> . Wallingford, UK: CAB International. www.cabi.org/isc	"It occurs on a wide spectrum of soils from nutrient-poor to nutrient-rich and grows on mineral soils as well as on peat (Kowarik, 2003)."

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Weber, E. 2017. <i>Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds</i> . CABI Publishing, Wallingford, UK	"Stems scout, purplish, hollow, 50-250 cm tall, branched above. Leaves opposite or in whorls of three, lanceolate to elliptical, 51- 8 cm long and 2 . 57- cm wide, margins finely toothed. Inflorescences arc racemes with 21- 4 flowers."

412	Forms dense thickets	y
	Source(s)	Notes
	Cockel, C. P., & Tanner, R. A. (2012). <i>Impatiens glandulifera</i> Royle (Himalayan balsam). Pp. 67-77 in R. A. Francis (ed.). <i>A Handbook of Global Freshwater Invasive Species</i> . Earthscan, New York, NY	"Predominately a weed of riparian habitats, <i>I. glandulifera</i> has invaded riverbanks and lakesides where it forms dense monospecific stands (Shaw and Tanner, 2008) (Figure 6.2) enabling the plant to outcompete native species (Hulme and Bremner, 2006; Maskell et al, 2006)."
	Weber, E. 2017. <i>Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds</i> . CABI Publishing, Wallingford, UK	"The extremely shallow root system and the annual life form of the plant promote soil erosion along watercourses. When dense patches die off in the autumn, the soil becomes exposed and is then susceptible to erosion from high water (Clements el al., 2008)." ... "Once established the plant can dominate the vegetation and can choke out all other herbaceous plant species."

501	Aquatic	n
	Source(s)	Notes
	Weber, E. 2017. <i>Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds</i> . CABI Publishing, Wallingford, UK	"Forests and forest edges, woodland, riparian habitats." [Terrestrial, but water dispersed and invades riparian habitats]

Qsn #	Question	Answer
502	Grass	n
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 21 Nov 2017]	Family: Balsaminaceae

503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	Tropicos.org. 2017. Missouri Botanical Garden. http://www.tropicos.org/ . [Accessed 21 Nov 2017]	"Robust succulent plants, usually more than 100 cm tall, glabrous." [Balsaminaceae. No evidence]

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes
	CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	" <i>I. glandulifera</i> is a tall glabrous annual reaching 50 to 250 cm in height. It is now Europe's tallest annual species. Its stems can be 0.5 to 5 cm in diameter and are sometimes branched in the upper part. Roots are up to 15 cm deep, the plants often forming numerous adventitious roots from the lower nodes."

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	[No evidence. Widespread native & introduced range] " <i>I. glandulifera</i> is native to the foothills of the Himalayas from north-west Pakistan to northern India. The native range in the western Himalayas is relatively small compared to its invasive range. According to Beerling and Perrins (1993), <i>I. glandulifera</i> is native from Kashmir to Garhwal between 2000 and 2500 masl, and Polunin and Stainton (1984) report the plant can grow up to 4000 masl in its native range. The plant is also recorded as native in Nepal (USDA ARS, 2008), and possibly in Bhutan. <i>I. glandulifera</i> is introduced and invasive in much of Europe, and parts of Canada, the USA and New Zealand."

602	Produces viable seed	y
	Source(s)	Notes
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"As an annual, the plant reproduces solely by seeds. Seed rain can reach 5000-6000 seeds/m ² but the plant does not develop a persistent seed bank."

603	Hybridizes naturally	
	Source(s)	Notes

Qsn #	Question	Answer
	Staples, G.W. & Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	"Generally, only plant breeders are likely to cross-pollinate <i>impatiens</i> deliberately."
	Grey-Wilson, C. 1980. <i>Impatiens</i> of Africa. A.A. Balkema, Rotterdam, Netherlands	[Unknown for <i>Impatiens glandulifera</i>] "Hybrids between different species occurs in African <i>Impatiens</i> , although the frequency of such hybridisation is not known. However, it is true to say that hybrids nearly always occur in areas where the habitat has been disturbed in some way." ... "The chances of crossing are likely providing suitable pollinating agents are available. This does not of course imply that hybrids will occur, it merely increases the chances."

604	Self-compatible or apomictic	y
	Source(s)	Notes
	CABI, 2017. Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	"The self-compatible flowers of <i>I. glandulifera</i> have the highest sugar nectar production per flower than any native European plant species (Chittka and Schürkens, 2001). This enables the plant to attract numerous insect pollinators, especially bees (<i>Apis mellifera</i>), bumble-bees (<i>Bombus</i> spp.) and syrphids."
	Cockel, C. P., & Tanner, R. A. (2012). <i>Impatiens glandulifera</i> Royle (Himalayan balsam). Pp. 67-77 in R. A. Francis (ed.). A Handbook of Global Freshwater Invasive Species. Earthscan, New York, NY	"While there is a lack of evidence of self-pollination among the genus <i>Impatiens</i> (Grey-Wilson, 1980), as demonstrated with cultivated plants that require hand pollination in order to produce seeds, the self-pollinating abilities of <i>I. glandulifera</i> specifically have received little attention. However, Valentine (1978) observes that <i>I. glandulifera</i> , although self-compatible (via geitonogamy), is not able to automatically self-pollinate due to protandry."

605	Requires specialist pollinators	n
	Source(s)	Notes
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"The plant attracts numerous pollinators - mostly bumblebees. It has been shown that large stands of Himalayan balsam may reduce flower visitation rates of nearby native plants, providing therefore a potential competition for pollinators, although other factors such as land use type play a role as well"
	CABI, 2017. Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	"The self-compatible flowers of <i>I. glandulifera</i> have the highest sugar nectar production per flower than any native European plant species (Chittka and Schürkens, 2001). This enables the plant to attract numerous insect pollinators, especially bees (<i>Apis mellifera</i>), bumble-bees (<i>Bombus</i> spp.) and syrphids."

606	Reproduction by vegetative fragmentation	n
	Source(s)	Notes
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"As an annual, the plant reproduces solely by seeds. Seed rain can reach 5000-6000 seeds/m ² but the plant does not develop a persistent seed bank."

607	Minimum generative time (years)	1
-----	---------------------------------	---

Qsn #	Question	Answer
	Source(s)	Notes
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"As an annual, the plant reproduces solely by seeds."
	CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"The time from germination to the onset of flowering is 13 weeks in Germany, with flowering continuing for a further 12 weeks (Sebald et al., 1998)."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y
	Source(s)	Notes
	Cockel, C. P., & Tanner, R. A. (2012). <i>Impatiens glandulifera</i> Royle (Himalayan balsam). Pp. 67-77 in R. A. Francis (ed.). A Handbook of Global Freshwater Invasive Species. Earthscan, New York, NY	"There is also evidence that <i>I. glandulifera</i> is capable of invading disturbed deciduous woodland and ungrazed tall herb/ruderal/grassland habitats (e.g. Maskell et al, 2006; Andrews et al, 2009) as a result of human-assisted transportation of seed material in soil, by beekeepers and accidental release in garden waste and on vehicles (Kowarik, 2003)."
	CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Transport with topsoil is probable (Beerling and Perrins, 1993) but it is not clear, however, to what extent this has occurred in the introduction or spread to new areas. The transport of seed with river gravel in trains was reported in Germany (Hartmann et al., 1995), as well as contamination of building rubbish transported to waste disposal sites."

702	Propagules dispersed intentionally by people	y
	Source(s)	Notes
	CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"International transport may be motivated by the ongoing use and promotion of the species as a garden plant." ... " <i>I. glandulifera</i> was imported as an ornamental species for its showy and scented flowers. It is being used as a garden plant in many European countries and is still sold by seed companies (Beerling and Perrins, 1993). The general public have aided the transport of this species throughout the UK, deliberately planting seeds in hedgerows and grassland (Rotherham, 2000). The flowers are very rich in pollen, and bee-keepers have dispersed seeds in order to enhance forage for honey bees (Hegi, 1912; Hartmann et al., 1995)."

Qsn #	Question	Answer
703	Propagules likely to disperse as a produce contaminant	
	Source(s)	Notes
	CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	[Cultivation with other ornamentals & ballistic seed dispersal could result in contamination of other potted plants in nursery or landscape settings] "Seeds are expelled from the plant by explosive dehiscence of the capsule and can lead to dispersal distances of 7 m." ... "Transport with topsoil is probable (Beerling and Perrins, 1993) but it is not clear, however, to what extent this has occurred in the introduction or spread to new areas." ... " <i>I. glandulifera</i> was imported as an ornamental species for its showy and scented flowers. It is being used as a garden plant in many European countries and is still sold by seed companies"

704	Propagules adapted to wind dispersal	n
	Source(s)	Notes
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Seeds are dispersed a few metres from the explosive dehiscence of the capsule and may be carried further by water."
	Cockel, C. P., & Tanner, R. A. (2012). <i>Impatiens glandulifera</i> Royle (Himalayan balsam). Pp. 67-77 in R. A. Francis (ed.). A Handbook of Global Freshwater Invasive Species. Earthscan, New York, NY	[Ballistic dispersal] "Stamp and Lucas (1983) describe the explosive action of the seed capsules as ballistic, and Bond (1998) describes how the seed capsules of the genus explode in a fusillade at a mere touch lending the genus <i>Impatiens</i> (meaning impatient) its name. Stamp and Lucas (1983) conclude that seeds with ballistic properties are smooth and hence aerodynamic, as well as necessarily heavy to generate sufficient momentum in flight to cover some distance."

705	Propagules water dispersed	y
	Source(s)	Notes
	Cockel, C. P., & Tanner, R. A. (2012). <i>Impatiens glandulifera</i> Royle (Himalayan balsam). Pp. 67-77 in R. A. Francis (ed.). A Handbook of Global Freshwater Invasive Species. Earthscan, New York, NY	" <i>I. glandulifera</i> has found its ideal conditions predominantly along the rivers of Europe and elsewhere, aided by the explosive release of its seeds coupled with hydrochorous dispersal."
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Seeds are dispersed a few metres from the explosive dehiscence of the capsule and may be carried further by water." ... "The plant has achieved a large range in Europe by spreading along rivers and is now a serious invader of river-accompanying vegetation and moist slopes within forests. It also spreads in northern America and invades riparian habitats that are important for rearing salmon (Clements et al., 2008)."

706	Propagules bird dispersed	n
	Source(s)	Notes
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Fruits are capsules, 15-35 mm long, opening explosively when ripe, coiling. Seeds up to 16 per fruit, black, 4-7 mm long and 2-4 mm wide" ... "Seeds are dispersed a few metres from the explosive dehiscence of the capsule and may be carried further by water."

Qsn #	Question	Answer
	Kleyheeg, E., Van Leeuwen, C. H., Morison, M. A., Nolet, B. A., & Soons, M. B. (2015). Bird-mediated seed dispersal: reduced digestive efficiency in active birds modulates the dispersal capacity of plant seeds. <i>Oikos</i> , 124(7), 899-907	[No intact seeds were retrieved from mallards] "Seeds of all species except AGR and IMP were retrieved intact from the faeces of mallards (Table 1)," ... "Table 1. Studied wetland plant seeds with their mean length, number of seeds fed to each mallard per treatment and overall mean intact retrieval." [Impatiens glandulifera - Mean retrieval (%) = 0]

707	Propagules dispersed by other animals (externally)	
	Source(s)	Notes
	CABI, 2017. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	[Possibly carried] "Isolated observations of seeds dispersed up to 10 m from the mother plant may indicate the possibility of seed transport by small rodents (Beerling and Perrins, 1993)."

708	Propagules survive passage through the gut	n
	Source(s)	Notes
	Boedeltje, G., Jongejans, E., Spanings, T., & Verberk, W. C. (2016). Effect of gut passage in fish on the germination speed of aquatic and riparian plants. <i>Aquatic Botany</i> , 132, 12-16	"First of all, it should be noted that carp had a strong negative effect on seed survival of several species (Boedeltje et al., 2015).For example, for <i>I. glandulifera</i> , no viable seeds were available for germination after gut passage ..."
	Kleyheeg, E., Van Leeuwen, C. H., Morison, M. A., Nolet, B. A., & Soons, M. B. (2015). Bird-mediated seed dispersal: reduced digestive efficiency in active birds modulates the dispersal capacity of plant seeds. <i>Oikos</i> , 124(7), 899-907	[No intact seeds were retrieved from mallards] "Seeds of all species except AGR and IMP were retrieved intact from the faeces of mallards (Table 1)," ... "Table 1. Studied wetland plant seeds with their mean length, number of seeds fed to each mallard per treatment and overall mean intact retrieval." [Impatiens glandulifera - Mean retrieval (%) = 0]

801	Prolific seed production (>1000/m2)	y
	Source(s)	Notes
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"As an annual, the plant reproduces solely by seeds. Seed rain can reach 5000-6000 seeds/m2 but the plant does not develop a persistent seed bank."
	Cockel, C. P., & Tanner, R. A. (2012). <i>Impatiens glandulifera</i> Royle (Himalayan balsam). Pp. 67-77 in R. A. Francis (ed.). A Handbook of Global Freshwater Invasive Species. Earthscan, New York, NY	"When the plant grows in dense monocultures, the population can produce a seed rain of up to 30,000 seeds per square metre (Cronk and Fuller, 2001), that are dispersed widely by autochory, up to 7m from the parent plant. The propagule pressure applied by the production and explosive dispersal of such a large number of seeds increases the probability that seed will find suitable habitats and environmental conditions for successful germination (Williamson, 1996)."

802	Evidence that a persistent propagule bank is formed (>1 yr)	
	Source(s)	Notes
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"As an annual, the plant reproduces solely by seeds. Seed rain can reach 5000-6000 seeds/m2 but the plant does not develop a persistent seed bank."

Qsn #	Question	Answer
	Cockel, C. P., & Tanner, R. A. (2012). <i>Impatiens glandulifera</i> Royle (Himalayan balsam). Pp. 67-77 in R. A. Francis (ed.). <i>A Handbook of Global Freshwater Invasive Species</i> . Earthscan, New York, NY	"Though Cronk and Fuller (2001) and Grime et al (1988) note that <i>I. glandulifera</i> produces no persistent seed bank, year on year, seeds can remain viable for up to 18 months (Beerling and Perrins, 1993). If imbibed at 20°C, seeds can remain viable for up to three years (Mumford, 1988)."
	CABI, 2017. <i>Invasive Species Compendium</i> . Wallingford, UK: CAB International. www.cabi.org/isc	[Possibly Yes] "Although the species is reported as not having a persistent seed bank (Grime et al., 1988), there are indications that at least some seed can persist for 18 months (Beerling and Perrins, 1993)."

803	Well controlled by herbicides	y
	Source(s)	Notes
	CABI, 2017. <i>Invasive Species Compendium</i> . Wallingford, UK: CAB International. www.cabi.org/isc	"Both selective herbicides such as 2,4-D and triclopyr, and non-selective herbicides such as glyphosate were found suitable in controlling <i>I. glandulifera</i> . According to the locally applicable law, a permit may be required to use herbicides, in particular near water."

804	Tolerates, or benefits from, mutilation, cultivation, or fire	n
	Source(s)	Notes
	CABI, 2017. <i>Invasive Species Compendium</i> . Wallingford, UK: CAB International. www.cabi.org/isc	" <i>I. glandulifera</i> is not resistant to grazing or cutting. Maintaining traditional forms of land-use in grassland will prevent invasion into such vegetation. Mowing and grazing can also be successful in eliminating existing infestations though this would need repeating annually and on a catchment scale. Mechanical Control As an annual, and in discrete areas, <i>I. glandulifera</i> can be more easily controlled than perennial invasive plants. Any control must aim at preventing the plants from setting seed. Best results are achieved by applying mechanical control late in the season, i.e. when the plants are in flower or beginning to flower. Early cutting of the plants below the first node can control populations though this is labour intensive. In Germany, several mechanical methods have been tested (Hartmann et al., 1995), and mowing with or without removal of the plant material, mulching or soil cultivation have all been successful. In larger stands and where soil conditions permit, agricultural machinery may be used. Where the soil is wet and soft, heavy machinery will damage the soil and provide open spaces ideal for re-establishment. In smaller stands, hand-held brush cutters can be used and hand-pulling of the plants is also feasible. In such cases, care has to be taken that pulled plants find no chance to re-grow where they are deposited. For lasting success, the area should be monitored for re-growth."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	Notes

Qsn #	Question	Answer
	<p>CABI, 2017. Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc</p>	<p>[Unknown in Hawaiian Islands] "Since 2006, research has been conducted on the biological control of <i>I. glandulifera</i>, where numerous surveys for natural enemies have been conducted throughout the plants native range (India and Pakistan). Due to the high level damage observed in the field, the rust fungus <i>Puccinia komarovii</i> was prioritised for further study. Cross inoculation studies revealed a high level of specificity of this rust towards <i>I. glandulifera</i> and as such, the rust was renamed as a variety, <i>P. komarovii</i> var. <i>glanduliferae</i> (Tanner et al., 2014). Experiments were conducted to determine the lifecycle of the rust and revealed that it is macrocyclic (has all five spore stages) and is autoecious (completes its lifecycle on <i>I. glandulifera</i> only) (Tanner et al., 2015). Host specificity testing assessed 75 non-target plant species including several varieties of selected species and proved that the rust is a true specialist to its natural host <i>I. glandulifera</i> (Tanner et al., 2015). A Pest Risk Assessment (PRA), which fully detailed the research conducted on the host-range, lifecycle and ecology of the rust was submitted to FERA in 2014; this was followed by a public consultation. The PRA underwent further evaluation by the European Commission's Standing Committee on Plant Health and following their feedback Defra Ministers approved the release of an isolate from India in July 2014. Since then, the rust has been released at selected sites in England and Wales. Further details of rust releases in the UK can be found in Varia et al. (2016). Biotyping inoculation experiments undertaken at CABI have shown that the susceptibility of <i>I. glandulifera</i> to the rust can vary dramatically between individual populations of <i>I. glandulifera</i> even when grown under the same environmental conditions. For example, susceptible populations (supporting successful sporulation of the rust) and populations that are completely resistant (no symptoms of infection) to the rust have been identified (Varia et al., 2016). A molecular study by Nagy and Korpelainen (2015) concluded that there have been multiple introductions of <i>I. glandulifera</i> from both Pakistan and India into the UK. As rust fungi are highly host specific, it is believed that different strains of the rust exist which have evolved with distinct biotypes of the plant. As such, a strain from Pakistan is currently being assessed against UK populations of <i>I. glandulifera</i> and results show that it infects a different range of UK populations to the strain from India (Varia et al., 2016). Permission to release this strain from quarantine was approved by Defra in January 2017 and this strain will be trialed in the field at selected sites during 2017."</p>
	<p>Cockel, C. P., & Tanner, R. A. (2012). <i>Impatiens glandulifera</i> Royle (Himalayan balsam). Pp. 67-77 in R. A. Francis (ed.). <i>A Handbook of Global Freshwater Invasive Species</i>. Earthscan, New York, NY</p>	<p>[Unknown in Hawaiian Islands] "The lack of specialist natural enemies in the introduced range affords <i>I. glandulifera</i> a competitive advantage over native species enabling the plant to invest more into growth and fecundity and less in the secondary chemicals used to deter natural enemy attack."</p>

Summary of Risk Traits:

High Risk / Undesirable Traits

- Elevation range exceeds 2000 m, demonstrating environmental versatility
- Grows in temperate & tropical climates
- Widely naturalized (although no evidence in Hawaiian Islands to date)
- Environmental weed (reduces native diversity)
- Other *Impatiens* species are invasive
- Tolerates many soil types
- Forms dense stands that exclude other vegetation
- Reproduces by seeds
- Self-compatible
- Annual life cycle (rapidly reaches maturity)
- Seeds dispersed ballistically, by water, and both intentionally and accidentally by people
- Prolific seed production (>5000 seeds/m²)

Low Risk Traits

- Unarmed (no spines, thorns, or burrs)
- Palatable to browsing/grazing animals
- Non-toxic
- Ornamental
- Not reported to spread vegetatively
- Seeds rapidly lose viability (although some reports suggest viability of 18 months)
- Herbicides may provide effective control
- Not resistant to cutting, grazing, or mowing (mechanical control methods may be effective)