Risk Assessment of *Persicaria perfoliata*

Name of Organism:	*Persicaria perfoliata* (L.) H. Gross 1919 – Mile-a-minute Weed
Objective:	Assess the risks associated with this species in Ireland
Version:	Final 15/09/2014
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Expert reviewer	Matthew Jebb - National Botanic Gardens

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About the risk assessment

This risk assessment is based on the **N**on-native species **AP**plication based **R**isk **A**nalysis (NAPRA) tool (version 2.66). NAPRA is a computer based tool for undertaking risk assessment of any non-native species. It was developed by the European and Mediterranean Plant Protection Organisation (EPPO) and adapted for Ireland and Northern Ireland by Invasive Species Ireland. It is based on the Computer Aided Pest Risk Analysis (CAPRA) software package which is a similar tool used by EPPO for risk assessment.

Notes: Confidence is rated as low, medium, high or very high.
Likelihood is rated as very unlikely, unlikely, moderately likely, likely or very likely.
The percentage categories are 0% - 10%, 11% - 33%, 34% - 67%, 68% - 90% or 91% - 100%.
N/A = not applicable.

This is a joint project by Inland Fisheries Ireland and the National Biodiversity Data Centre to inform risk assessments of non-native species for the European Communities (Birds and Natural Habitats) Regulations 2011. It is supported by the National Parks and Wildlife Service.

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Stage 1 - Organism Information *The aim of this section is to gather basic information about the organism.*			
N	**QUESTION**	**RESPONSE**	**COMMENT**
1	What is the reason for performing the risk assessment?		A risk assessment is required as this species is listed as a "Non-native species subject to restrictions under Regulations 49 and 50" in the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011, SI 477/2011.
2	Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	YES	*Persicaria perfoliata* (L.) H. Gross, 1919 – Mile-a-minute weed Taxonomy: Kingdom: Plantae Phylum: Spermatophyta Subphylum: Angiospermae Class: Dicotyledonae Order: Polygonales Family: Polygonaceae Genus: Persicaria Species: perfoliata Synonyms: *Amplelygonum perfoliatum* (L.) Roberty and Vautier, *Chylocalyx perfoliatus* (L.) Hassk, *Echinocaulon perfoliatum* (L.) Hassk, *Echinocaulos perfoliatus* (L.) Meisn, *Fagoparum perfoliatum* (L.) Rafine, *Fagoparum perfoliatum* (L.) Rafine, *Polygonum perfoliatum* L., 1759, *Tracaulon perfoliatum* (L.) Greene, *Truellum perfoliatum* (L.) Sojak (Steward, 1930; Reed, 1979a,b; Park, 1986; Li, 1998; eFloras, 2008). Common name (English): Mile-a-minute weed, Asiatic tearthumb, devil's tearthumb, devil's-tail tearthumb, giant climbing tearthumb, minuteweed, tearthumb (CABI, 2014; GISD, 2011). Similar species include *Polygonum arifolium, Persicaria convolvulus*, *Polygonum sagittatum* and *Polygonum scandens* (CABI, 2014; GISG, 2011; refer to Question 4).
3	If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)	N/A	

Stage 1 - Organism Information *The aim of this section is to gather basic information about the organism.*			
N	**QUESTION**	**RESPONSE**	**COMMENT**
4	Describe the organism.	-	*Persicaria perfoliata* is an annual, herbaceous scrambling vine with prickles and shallow, fibrous roots. It can reach 6 m or more through climbing over shrubs and understory trees. The reddish stems are elongated, branched and furrowed with short recurred prickles along the ridges (GISD, 2011). The leaves are triangular, thin, 3-7 cm long, 2-5 cm wide and glabrous on the upperside with prickles along the mid-rib on the underside (Zheng *et al*., 2005). Distinctive, circular, cup-shaped leafy structures, called ocreas, surround the stem at nodes (Okay, 1999). Flower buds, and later flowers and fruits, emerge from within the ocreas. The inflorescences are capitate or spike-like racemes up to 2 cm long with clusters of 10 to 15 tiny white flowers either terminal or in the axils of upper leaves (Kumar and DiTommaso, 2005). The fruits are attractive, deep blue and arranged in clusters at terminals, each containing a single glossy, black or reddish-black hard seed called an achene (NPS, 2009). *P. perfoliata* is distinguished from its relatives including *Polygonum arifolium, Persicaria convolvulus*, *Polygonum sagittatum* and *Polygonum scandens* by the vine-like stem, triangular leaves, and sharp downward curving spines on stems, petioles, and main leaf veins (Hill *et al*., 1981; Oliver and Coile, 1994). The saucer-shaped ocrea encircling the stem at the nodes is also a key diagnostic characteristic (Kumar and DiTommaso, 2005).
5	Does a relevant earlier risk assessment exist? (give details of any previous risk assessment for Ireland)	YES	In Ireland, a preliminary risk assessment was previously carried out. This was a prioritisation risk assessment as part of the Risk Analysis and Prioritisation for Invasive and Non-native Species in Ireland and Northern Ireland (ISI, 2012). It designated *Persicaria perfoliata* as a “medium risk” invasive species.
6	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?	PARTIAL	Only a preliminary risk assessment was previously conducted in Ireland (refer to Question 5)
7	Where is the organism native?		*P. perfoliata* is native to India, China, Indonesia, Malaysia, Nepal, Korea, Japan, Bangladesh, and the Philippines (Ohwi, 1965; He *et al*., 1984; Li, 1998; eFloras, 2008; Zheng *et al*., 2005).
8	What is the current global distribution of the organism (excluding Ireland)?		Including *P. perfoliata* native range (refer to Question 7) the species has been introduced to the U.S.A. (Connecticut, Delaware, Massachusetts, Maryland, New Jersey, New York, Pennsylvania, Virginia, West Virginia, Washington, DC and Rhode Island) and Turkey (NPS, 2009; NPS-UG, 2009; Guner, 1984). It was also reported in, Auckland, New Zealand where plants were eradicated

Stage 1 - Organism Information *The aim of this section is to gather basic information about the organism.*			
N	**QUESTION**	**RESPONSE**	**COMMENT**
			(NZBI, 2009) and British Columbia, Canada where populations failed to establish (Hill *et al.*, 1981).
9	What is the current distribution of the organism in Ireland?	N/A	It is not currently known to be present in Ireland.
10	Is the organism known to be invasive anywhere in the world?	YES	In the USA, introduced *P. perfoliata* is reported to be invasive in Connecticut, Delaware, Massachusetts, Maryland, New Jersey, New York, Pennsylvania, Virginia, West Virginia, Washington, DC and Rhode Island (NPS, 2009; NPS-UG, 2009). In the USA, *P. perfoliata* has been classified as a 'Class A noxious weed' in the states of Alabama and North Carolina; as a 'invasive banned weed' in the state of Connecticut; as 'prohibited' in Massachusetts; as a 'Prohibited noxious weed' in Ohio; as a 'noxious weed' in Pennsylvania and a 'plant pest' in South Carolina (USDA, NRCS, 2011). Considering the potential invasiveness of *P. perfoliata* the European and Mediterranean Plant Protection Organisation (EPPO) added the species to the EPPO Alert List 2 (pests locally present in the EPPO region). The EPPO subjected *P. perfoliata* to a Pest Risk Assessments (PRAs) and has recommended regulation of the plant within the 500 EPPO countries (EPPO, 2007).

Stage 2 - Detailed assessment: Section A - Entry

This section evaluates the probability of entry of an organism into Ireland. For organisms which are already present, only complete the entry section for currently active pathways of entry and potential future pathways. The entry section need not be completed for pathways which have allowed an organism to enter in the past but are no longer active.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.01	How many active/future pathways are relevant to the potential entry of this organism (n/a, very few, few, moderate number, many or very many)?	FEW	HIGH	The main pathway of introduction of *P. perfoliata* is the contamination of nursery stock plants, primarily container grown plants but also soil and vehicles with the seed of the species (EPPO, 2007). The apparent misidentification or contamination of seed also appears to have been the major source of introduction to the USA (see 1.02). Other pathways which may facilitate the entry of *P. perfoliata* but which are not as significant as contaminate horticulture, include ship ballast and possibly natural dispersal via migratory birds.
1.02	List significant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways.	1. Contaminate horticulture (plants, soil & vehicles)	HIGH	Potential for the species to be introduced as a contaminant of horticultural trade (CABI, 2014; GISD, 2011). Around 1937 *P. perfoliata* was accidentally introduced to Maryland, U.S.A. from China apparently as a contaminant, or in error,for *Meliosma* seed (Moul, 1948). In the 1930s *P. perfoliata* was accidentally introduced to Pennsylvania, U.S.A. either as a contaminant of Rhododendron nursery stock plants, from eastern Asia (Reed 1979 a, b; Riefner, 1982) or as a contaminant of Holly (*Ilex*) seed from Japan (Moul 1948) . In habitats to which it is accidentally introduced it may become naturalised/invasive (CABI, 2014; GISD, 2011).

Pathway 1 – Contaminant of horticulture

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.03	Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (e.g. the organism is a contaminant of imported goods)?	ACCIDENTAL	HIGH	Entry of the species along this pathway is accidental, however, the glossy blue fruits can make it attractive, and the Pennsylvania population established because the nursery owner “was impressed by the beauty of the fruit and reproduced it” (Moul, 1948).
1.04	How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year?	UNLIKELY	MEDIUM	There are no reliable data that exists to allow a reasonable assessment of the number of *P. perfoliata* that may, or may not, be brought inadvertently into Ireland through contaminated horticultural plants. The numbers of *P. perfoliata* likely to travel along this pathway would be considered dependent on the existing supply and demand for plants imported from countries to where *P. perfoliata* is native or introduced (refer to Question

Pathway 1 – Contaminant of horticulture				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
				7) and thus likely hosts for seeds of the species to hitchhike with. There are historical cases reported of seeds arriving with container grown *Rhododendron* (Reed 1979 a, b; Riefner, 1982).*Rhododendron* species have been intentionally introduced into Ireland from the 1760s onwards and planted extensively as ornamentals, rootstock species and for game cover (Dehnen-Schmutz *et al*., 2004; Edwards, 2006; Higgins, 2008). There are, to-date, no known reports of *P. perfoliata* having hitchhiked with *Rhododendron* into Ireland perhaps making it possible to infer that the numbers and likelihood of *P. perfoliata* travelling along this pathway are low. The other historical case was where seed of *P. perfoliata* was a contaminant of, or mistaken for, *Ilex* or *Meliosma* seed (Moul, 1948).
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	VERY LIKELY	HIGH	As a seed contaminate of horticultural material it is very likely that the species could enter Ireland undetected and without the knowledge of the relevant authority. It may be less likely for the species to go undetected as a plant, especially if it is labeled.
1.06	How likely is the organism to survive during passage along the pathway?	LIKELY	HIGH	The species is known to have previously establishment via this pathway (refer to Question 1.02 & 2.14), substantiating that survival during passage is likely.
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	MODERATELY LIKELY	MEDIUM	Establishment would be initially dependent on successful germination. Germination occurs in early to mid-March and continues through April (McCormick and Johnson, 1997; Wu *et al*., 2002). What's more, seeds that may not initially germinate may be viable 3 years after being buried in soil although the germination level is significantly decreased year on year (Van Clef and Stiles, 2001).
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	LIKELY	HIGH	*Persicaria perfoliata* can inhabit a wide range of managed (e.g. cultivated/agricultural land, disturbed areas, forests, plantations and orchards, rail and roadsides, nurseries and urban areas) and semi natural (e.g. natural forests, riverbanks, rocky areas, scrub/shrubland and wetland) terrestrial habitat (Mountain, 1989; Okay, 1997; Wu *et al*., 2002). The species' preferred or principal habitats are disturbed areas, forests, plantations and orchards and riverbanks (CABI, 2014). It thrives where forests are clear-cut (Oliver, 1996). The species is likely to encounter and/or be accidentally introduced to such suitable habitat within the Irish landscape (CORINE, 2006; Fossitt, 2000).

Pathway 1 – Contaminant of horticulture				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	UNLIKELY	LOW	Entry of the species via the contaminant horticulture pathway would be considered dependent on existing supply and demand for plants imported from countries to where the *P. perfoliata* is native and introduced (refer to Question 8) and with such plants acting as likely hosts for seeds of the species to hitchhike with. Rhododendron nursery stock has been regarded as a possible pathway into the USA (Reed 1979 a, b; Riefner, 1982) (refer to Question 1.02). *Rhododendron* species have been intentionally introduced into Ireland from the 1760s onwards and planted extensively as an ornamental plant, rootstock species and for game cover (Dehnen-Schmutz *et al.*, 2004; Edwards, 2006; Higgins, 2008). There are, to-date, no known reports of *P. perfoliata* having hitchhiked with *Rhododendron* or any other ornamental plant, perhaps making it possible to infer that the numbers and likelihood of *P. perfoliata* travelling along this pathway is currently low. The introduction of the species in the form of seed, either as a contaminant of, or as wrongly identified, seed of *Meliosma* and *Ilex*, has been mentioned (refer to Question 1.02).
1.10	Do other pathways need to be considered?	NO	HIGH	

Overall likelihood				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
1.11	Estimate the overall likelihood of entry into Ireland based on all pathways (comment on the key issues that lead to this conclusion).	MODERATELY LIKELY	MEDIUM	Refer to Question 1.09

Stage 2 - Detailed assessment: Section B – Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.01	Is the organism well established in Ireland (if there is any uncertainty answer 'unsure')	NO	MEDIUM	There is no knowledge of the presence of the species in Ireland.
2.02	How likely is it that the organism will be able to establish in Ireland based on the similarity between local climatic conditions and the organism's current global distribution?	LIKELY	HIGH	*P. perfoliata* is commonly found from cold northeastern China to south, tropical Asia, thus is able to tolerate a wide range of temperatures (CABI, 2014). Annual rainfall in its natural habitat in China varies from about 500 to 2000 mm (Zheng *et al.*, 2005). The species preferred climate is temperate/mesothermal (C) or warm temperate, wet all year (cf; CABI, 2014). The species preferred climate and current range encompasses climatic conditions comparable with Ireland; a temperate oceanic climate which is mild, moist and changeable, with abundant rainfall and lack of temperature extremes (Keane and Collins, 2004). The plant has been grown at the National Botanic Gardens in 2004, but failed to set fruit in its first year and died out (Matthew Jebb, pers. comm., 25th July 2014).
2.03	How likely is it that the organism will be able to establish in Ireland based on the similarity between other local abiotic conditions and the organism's current global distribution?	LIKELY	HIGH	Available light and soil moisture are both integral to the successful establishment of this species (GISD, 2011). The plant prefers open habitat and thrives, for example, where forests have been clear-cut (Oliver, 1996). It will tolerate shade for a part of the day but needs a good percentage (63-100%) of the available light (GISD, 2011). The species prefers wet habitat but adapts well to a range of soil moisture conditions (CABI, 2014). It generally grows in areas with an abundance of leaf litter on the soil surface (Okay, 1999). In China, the plant occurs at elevations of 80 – 2300 m (Zheng *et al.*, 2005).
2.04	How likely is the organism to encounter habitats necessary for the survival, development and multiplication of the organism in Ireland?	VERY LIKELY	HIGH	*Persicaria perfoliata* can inhabit a wide range of managed (e.g. cultivated/agricultural land, disturbed areas, forests, plantations and orchards, rail and roadsides, nurseries and urban areas) and semi natural (e.g. natural forests, riverbanks, rocky areas, scrub/shrubland and wetland) terrestrial habitat (Mountain, 1989; Okay, 1997; Wu *et al.*, 2002). The species' preferred or principal habitats are disturbed areas, forests, plantations and orchards and riverbanks (CABI, 2014). It thrives where forests are clear-cut (Oliver, 1996). The species is likely to encounter and/or be accidentally introduced to such suitable habitat within the Irish landscape (CORINE, 2006; Fossitt, 2000).

Stage 2 - Detailed assessment: Section B – Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.05	How likely is it that establishment will occur despite competition from existing species in Ireland?	VERY LIKELY	HIGH	No knowledge of competition as a significant impinging factor in the establishment of the species. Weak growth can occur in low light (16% of ambient) under greenhouse conditions (Van Clef, 2001). Therefore, heavy shade, such as that cast by dense conifer stands, will likely retard growth. However the adaptive nature of the species means that it can reach areas of higher light intensity by attaching to and climbing over other plants with its recurved barbs (GISD, 2011).
2.06	How likely is it that establishment will occur despite predators, parasites or pathogens already present in Ireland?	VERY LIKELY	MEDIUM	A number of potential biological control agents for *P. perfoliata* have been identified. Only on *P. perfoliata*, both in its native and introduced range, the host specialist weevil *Rhinoncomimus latipes* (Coleoptera: Curculionidae) is regarded as the most promising agent (Ding *et al.* 2004). Following intensive host-range testing, *R. latipes* was approved for release in North America in 2004 (Colpetzer *et al.* 2004). It was first released in Delaware and New Jersey, and has subsequently been released in nine other states. The initial indications of the effectiveness of *R. latipes* in controlling mile-a-minute weed are very positive. Weevils have overwintered and established at virtually all sites where they have been released, and *P. perfoliata* populations have declined substantially at many sites. Weevils disperse at a rate of more than 4 km per year after the first year of release. They locate both large and small mile-a-minute weed patches and establish new populations (Shelton, 2014). Fredericks (2001) surveyed for natural enemies of *P. perfoliata* in Delaware and Maryland during 1997–1998 and found the polyphagous Japanese beetle, *Popillia japonica* to be the most damaging insect. *Popillia japonica* was also found to be the most abundant herbivorous species of *P. perfoliata* in Delaware, Maryland, Virginia, and Pennsylvania (Hough-Goldstein *et al.*, 2008a). *Glomerella cingulata* is a likely pathogen of the *P. perfoliata* (Berner *et al.*, 2012). As with *P. perfoliata*, none of these aforementioned potential biocontrol agents are present in Ireland and in the absence of any known predators, parasites or pathogens it is very likely for the species to establish.

Stage 2 - Detailed assessment: Section B – Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.07	How likely is it that establishment will occur despite existing management practices?	N/A	N/A	As *P. perfoliata* is not known to be present in Ireland there are no management practices geared towards control of this species. Best practice management practices for the control of the species in invaded countries are documented and include preventative, physical, chemical and biological measures (CABI, 2014; GISD, 2011). Mechanical control is considered ineffective as seeds are often left behind (Oliver, 1996).
2.08	How likely is it that management practices in Ireland will facilitate the establishment of the organism?	VERY LIKELY	MEDIUM	Management practices which result in ground disturbance and the clearing of ground vegetation and trees is likely to favour the establishment of *P. perfoliata*. Removal of vegetation buffers along streams and forest edges and the clear-cutting of forestry would result in open ground conducive to establishment of the species (GISD, 2011). In the USA, the *P. perfoliata* has a negative effect on Christmas tree farms, forestry operations on pine plantations and reforestation of natural areas (NPS, 2009). The negative impact of the species is likely aided and/or amplified by continual or systematic ground disturbances as a result of managment within these sectors.
2.09	How likely is it that the biological characteristics of the organism would allow it to survive eradication campaigns in Ireland?	LIKELY	MEDIUM	Survival of eradication campaigns is likely given that the species is self pollinating, fast growing, has a viable seed bank (detailed in Question 2.10), and is highly adaptive to different environmental conditions and habitats (CABI, 2014; GISD, 2011).
2.10	How likely is it that the biological characteristics of the organism will facilitate its establishment?	VERY LIKELY	MEDIUM	It is very likely that the biological characteristics of *P. perfoliata* will facilitate its establishment. *P. perfoliata* is primarily a self-pollinated (i.e. fruits and seeds are produced without assistance from pollinators) species with occasional outcrossing (Okay, 1997). During its long growing season, from June until October, *P. perfoliata* can grow up to 6 m (15 cm per day), producing about 50-100 seeds (GISD, 2011). The species may exhibit a bet-hedging strategy by producing a small peak of production in July (which may safeguard production in years of severe drought) and a large peak of production in September (which coincides with major bird migration) (GISD, 2011). Fruits ripen from late June until October in Virginia, but a slightly shorter season occurs in the northeastern USA (Hill *et al.* 1981; Okay 1997). The plant senesces after the first frost in late October or early November in the northeastern USA (Kumar and DiTommaso, 2005). Germination occurs in early to mid-March and continues through April (McCormick and Johnson, 1997; Wu

Stage 2 - Detailed assessment: Section B – Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
				et al., 2002). Seeds may be viable 3 years after being buried in soil (Van Clef and Stiles, 2001). Van Clef and Stiles (2001) found seed germination after 1, 2, and 3 years buried in forest soils was 96%, 25%, and 33%, respectively, which indicates that the species forms a long-term seed bank.
2.11	How likely is it that the organism's capacity to spread will facilitate its establishment?	LIKELY	HIGH	Birds are the primary long-distance dispersal agents of *P. perfoliata* (Okay, 1999). Squirrel, deer and ants are other possible agents of dispersal (Okay, 1999; Van Clef, 2001). Water is another important mode for dispersal with fruits and seed being carried away in stream and river environments (Okay, 1999). Over time parent plants dropping seed result in very localised dominance and spread of this annual species (Van Clef, 2001). Transportation and subsequent cultivation of plant material contaminated with the seed of *P. perfoliata* leads to inadvertent dispersing of the species.
2.12	How likely is it that the organism's adaptability will facilitate its establishment?	VERY LIKELY	HIGH	*P. perfoliata* is a highly adaptive plant. Detailed of the adaptive nature of this species have been highlighted in the answers to Questions 2.02, 2.03, 2.04 and 2.10.
2.13	How likely is it that the organism could establish despite low genetic diversity in the founder population?	VERY LIKELY	HIGH	Given that the species is self pollinating, low genetic diversity in the founder population is unlikely to prevent establishment.
2.14	Based on the history of invasion by this organism elsewhere in the world, how likely is it to establish in Ireland? If possible, specify the instances of invasion elsewhere in the justification box	LIKELY	HIGH	*P. perfoliata* was first introduced to Oregon with ship ballast in the 1890s (Hickman and Hickman, 1977) and then in south central Pennsylvania in the 1930s (Moul, 1948). It did not establish permanent populations in either area (Oliver and Coile, 1994). The first successful established population of *P. perfoliata* was found in late 1930s following its introduction to a nursery site in York County, Pennsylvania and since then it has spread to neighbouring states (Mountain, 1995). From 1930 to the 1980s, *P. perfoliata* was only reported in five counties in Pennsylvania and northern parts of central Maryland (Mountain, 1995; Reed, 1979a,b; Riefner and Windler, 1979). By 2003, *P. perfoliata* was found in Delaware, Maryland, New York, Ohio, Pennsylvania, Virginia, West Virginia, Connecticut and the District of Columbia in the USA (IPANE, 2009; NPS, 2009). With reference to Question 2.16, the establishment of *P. perfoliata* hinges more on the successful entry of the species via the pathway detailed in Section A and less on the species

Stage 2 - Detailed assessment: Section B – Establishment

This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
				potential to grow and develop as an invasive species once present in Ireland.
2.15	If the organism does not establish, then how likely is it that transient populations will continue to occur?	VERY UNLIKELY	MEDIUM	Transient populations would only be considered likely if the environmental conditions necessary for survival, development and multiplication were not met. With particular reference to Question 2.02, 2.03 and 2.04 this is considered very unlikely. It is not known to the author whether the first introduced of *P. perfoliata* to Oregon in the 1890s (Hickman and Hickman, 1977) and then in south central Pennsylvania in the 1930s (Moul, 1948) did not establish permanent populations in either area as a result of unfavourable environmental conditions or eradication campaigns.
2.16	Estimate the overall likelihood of establishment. Mention any key issues in the comments box	VERY LIKELY	HIGH	The climatic and abiotic conditions and habitats necessary for the establishment of *P. perfoliata* exist in Ireland. The species possesses biological traits which are highly conducive to successful establishment. Competition and natural enemies are not likely to significantly prevent growth and development. Existing management practices, particularly within the forestry sector are likely to aid any potential establishment. The establishment of *P. perfoliata* hinges more on the successful entry and less on the species potential to grow and develop as an invasive species in Ireland.

Stage 2 - Detailed assessment: Section C – Spread

This section evaluates the probability of spread of an organism within Ireland. Spread is defined as the expansion of the geographical distribution of an organism within the risk assessment area.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
3.01	What area (given in % or 10km squares) in Ireland could the organism establish (0% - 10%, 11% - 33%, 34% - 67%, 68% - 90% or 91% - 100%)?	34%-67%	MEDIUM	*P. perfoliata* can inhabit a wide range of managed (e.g. cultivated/agricultural land, disturbed areas, forests, plantations and orchards, rail and roadsides, nurseries and urban areas) and semi natural (e.g. natural forests, riverbanks, rocky areas, scrub/shrubland and wetland) terrestrial habitat (Mountain, 1989; Okay, 1997; Wu *et al*., 2002). With references to the CORINE land cover data *P. perfoliata* has the potential to inhabit ~36% of the Irish land surface: road and rail networks – 0.06%, construction sites – 0.03%, green urban areas – 0.04%, non-irrigated arable land – 7.53%, broad leaved forest – 3.23%, mixed forest – 0.42%, coniferous forest – 3.23%, transitional woodland – 5.39%, bare rocks – 0.20%, sparsely vegetated land – 0.29%, inland marshes – 0.23%, peat bogs – 15.37%, salt marshes – 0.07% and stream courses – 0.11% (CORINE, 2006).
3.02	How important is the expected spread of this organism in Ireland by natural means (minimal, minor, moderate, major or massive)?	MAJOR	HIGH	Birds are the primary long-distance dispersal agents of *P. perfoliata* (Okay, 1999). Squirrel, deer and ants are other possible agents of dispersal (Okay, 1999; Van Clef, 2001). Water is another important mode of dispersal with fruits and seed carried away in stream and river environments (Okay, 1999). Over time parent plants dropping seed result in very localised dominance and spread of this annual species (Van Clef, 2001).
3.03	How important is the expected spread of this organism in Ireland by human assistance (minimal, minor, moderate, major or massive)?	MINOR	HIGH	Transportation and subsequent cultivation of plant material contaminated with the seed of *P. perfoliata* leads to inadvertent dispersing of the species.
3.04	Within Ireland, how difficult would it be to contain the organism (minimal, minor, moderate, major or massive)?	MAJOR	HIGH	*P. perfoliata* is known to grow rapidly (GISD, 2011) and in Ireland, the habitats suitable for the establishment and spread of the species are varied and constitute a sizable land cover (refer to Question 3.01) likely making containment of the species difficult. The ability of *P. perfoliata* to culture a viable seed bank of up to 3 years (Van Clef and Stiles, 2001) also makes containment of the species difficult. This is highlight by the fact that of the control measures available, mechanical control is considered ineffective as seeds are often left behind (Oliver, 1996).

Stage 2 - Detailed assessment: Section C – Spread

This section evaluates the probability of spread of an organism within Ireland. Spread is defined as the expansion of the geographical distribution of an organism within the risk assessment area.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
3.05	What proportion (%) of the area in Ireland suitable for establishment, if any, has already been colonised by the organism?	N/A	N/A	To-date, the species is not known to be present in Ireland.
3.06	What proportion of the area in Ireland suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)?	0%-10%	MEDIUM	The species is unlikely to establish more than a few isolated colonies. The proportion of suitable area invaded will be close to 0%
3.07	What other timeframe would be appropriate to estimate any significant further spread of the organism (10, 20, 40, 80 or 160 years)? Please comment on why this timeframe is chosen.	20 - 40	MEDIUM	The only records for the species establishing in the European region is Turkey. Until the plant demonstrates invasiveness in European countries there is probably no need to reassess spread of the species at anything less than 20 year intervals.
3.08	In this timeframe, what proportion of the area (including any currently occupied areas) is likely to have been invaded by this organism?	0-10%	MEDIUM	See answer to 3.06.
3.09	Based on the answers to questions on the potential for establishment and spread in Ireland, define the area endangered by the organism. Be as specific as possible. If available, provide a map showing the area most likely to be endangered.	-	HIGH	The species' preferred or principal habitats of disturbed areas, forests, plantations and orchards and riverbanks (CABI, 2014) are most endangered to invasion.
3.10	Estimate the overall potential for future spread for this organism in (very slowly, slowly, moderately, rapidly or very rapidly). Use the justification box to indicate any key issues.	RAPIDLY	MEDIUM	As highlighted by the common name, mile-a-minute weed, as a fast growing plant, has the potential to spread rapidly (GISD, *2011*). Birds and water are the most important modes of dispersal of the species (Okay, 1999). Humans may also have a hand in the dispersal by the cultivation of plant material contaminated with the seed. The ability of *P. perfoliata* to culture a viable seed bank of up to 3 years (Van Clef and Stiles, 2001) likely makes containment of the species difficult. Within the Irish landscape the species is likely to encounter its favoured habitats of disturbed areas, forests, plantations and orchards and riverbanks (CABI, 2014; CORINE, 2006; Fossit, 2000).

Stage 2 - Detailed assessment: Section D – Impact *This section evaluates the probability of impact of an organism within Ireland.*				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
4.01	How great is the economic loss caused by the organism within its global distribution (excluding Ireland), including the cost of any current management?	MAJOR	MEDIUM	*Persicaria perfoliata* is known to grow rapidly, scrambling over shrubs and other vegetation, blocking the foliage of covered plants from available light and reducing their ability to photosynthesize, which stresses and weakens them (GISD, *2011*). As a result of this competition, which includes monopolising resources, shading, smothering, strangling and rapid growth, *P. perfoliata* has the potential to be a problem to nursery and horticulture crops that are not regularly tilled as a cultivation practice (CABI, 2014; GISD, *2011*). In the USA, the plant has a negative effect on Christmas tree farms, forestry operations on pine plantations and reforestation of natural areas (NPS, 2009).
4.02	How great has the economic cost of the organism been in Ireland from the time of introduction to the present? Exclude any costs associated with managing the organism from your answer.	N/A	N/A	To-date, the species is not known to be present in Ireland.
4.03	How great is the economic cost of the organism likely to be in the future in Ireland? Exclude any costs associated with managing the organism from your answer.	MODERATE	MEDIUM	Economic cost of the species will manifest as losses of profits within the forestry and nursery trade. There is a paucity of information available to fully assess this.
4.04	How great have the economic costs of managing this organism been in Ireland from the time of introduction to the present?	N/A	N/A	To-date, the species is not known to be present in Ireland.
4.05	How great is the economic cost of managing this organism likely to be in the future in Ireland?	MODERATE	MEDIUM	May be difficult and costly to eradicate, presenting an economic burden to landowners and organisations charged with its management

Stage 2 - Detailed assessment: Section D – Impact *This section evaluates the probability of impact of an organism within Ireland.*				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
4.06	How important is environmental harm caused by the organism within its global distribution?	MAJOR	MEDIUM	*P. perfoliata* infestations cause ecological problems in invaded areas. The plant grows rapidly and covers shrubs and other vegetation, dominating its new community (CABI, 2014). Plants and trees covered with *P. perfoliata* are greatly suppressed because of the lack of sunlight. If left unchecked, the shaded plants are killed, and large infestations eventually reduce native plant species in semi-natural areas (GISD, 2011). Mile-a-minute weed's ability to outgrow other species means that it has the potential to reduce reduce naitvie biodiversity, alter or damage ecosystem functioning and services, modify successional patterns and form monocultures (Oliver, 1996).
4.07	How important has the impact of the organism on biodiversity* been in Ireland from the time of introduction to the present? *e.g. decline in native species, changes in community structure, hybridisation	N/A	N/A	To-date, the species is not known to be present in Ireland.
4.08	How important is the impact of the organism on biodiversity likely to be in the future in Ireland?	MAJOR	MEDIUM	Refer to Question 4.06.
4.09	How important has alteration of ecosystem function* caused by the organism been in Ireland from the time of introduction to the present? *e.g. habitat change, nutrient cycling, trophic interactions	N/A	N/A	To-date, the species is not known to be present in Ireland.
4.10	How important is alteration of ecosystem function caused by the organism likely to be in Ireland in the future?	MAJOR	MEDIUM	Refer to Question 4.06.
4.11	How important has decline in conservation status* caused by the organism been in Ireland from the time of introduction to the present? *e.g. sites of nature conservation value, WFD classification, etc.	N/A	N/A	To-date, the species is not known to be present in Ireland.

Stage 2 - Detailed assessment: Section D – Impact
This section evaluates the probability of impact of an organism within Ireland.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.12	How important is decline in conservation status caused by the organism likely to be in the future in Ireland?	MINOR	LOW	Because the species have the potential to establish over such a large area of Ireland (refer to Question 3.01) it is possible that this species will impact on priority species and rarer ground flora found in woodlands of Ireland. Small populations of extremely rare plants may be eliminated entirely (GISD, 2011).
4.13	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within its global distribution?	MINOR	MEDIUM	*P. perfoliata* leaves, petioles, and stems contain prickles, and so the movement of wildlife, and human activities are impacted in infested areas (Okay, 1997). Conversely, there are possibly positive social impacts of the plant due to its value in Chinese medicine (CABI, 2014, GISD, 2011).
4.14	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within Ireland?	N/A	N/A	To-date, the species is not known to be present in Ireland.
4.15	How important is it that genetic traits of the organism could be carried to other organisms / species, modifying their genetic nature and making their economic, environmental or social effects more serious?	MINIMAL	MEDIUM	*Persicaria perfoliata* is a member of sect. *Echinocaulon* of which one other member, *P. sagittata* was once known as an introduction in Ireland, but now considered extinct. It is not considered likely that *P. perfoliata* would hybridise with native *Persicaria* species as these are not close to the section of *Persicaria* in which it is categorised.
4.16	How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	MINIMAL	MEDIUM	There are no records of *Persicaria perfoliata* causing such impacts in North America.
4.17	How important might other impacts not already covered by previous questions be resulting from introduction of the organism? Specify in the justification box.	N/A	MEDIUM	We are not aware of any other impacts the introduction of this species would have.
4.18	How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in Ireland?	MINIMAL	LOW	Refer to Question 2.06

Stage 2 - Detailed assessment: Section D – Impact *This section evaluates the probability of impact of an organism within Ireland.*				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
4.19	Indicate any parts of where economic, environmental and social impacts are particularly likely to occur. Provide as much detail as possible, where possible include a map showing vulnerable areas.	-	MEDIUM	It is an economic problem in commercial forests and nurseries. It is likely to be an environmental problem in semi-natural habitats and areas of conservation interest. Social impacts are likely to be negligible.
4.20	Estimate the overall potential impact of this organism in Ireland. Use the justification box to indicate any key issues.	MAJOR	MEDIUM	Potential establishment and spread of *P. perfoliata* in Ireland is likely to have significant economic and environmental impacts. The species is known to grow rapidly, scrambling over shrubs and other vegetation, blocking the foliage of covered plants from available light and reducing their ability to photosynthesize, which stresses and weakens them (GISD, 2011). As a result of this competition, which includes monopolising resources, shading, smothering, strangling and rapid growth, *P. perfoliata* has the potential to be a problem to nursery and horticulture crops and semi-natural habitats and areas of conservation interest (CABI, 2014; GISD, 2011).

Stage 2 - Detailed assessment: Section E – Conclusion *This section requires the assessor to provide a score for the overall risk posed by an organism, taking into account previous answers to entry, establishment, spread and impact questions.*				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
5.01	Estimate the overall risk of this organism in Ireland. Noting answers given in 1.11, 2.16, 3.10 & 4.20	MAJOR	MEDIUM	Entry of the species via the contaminant horticulture pathway would be considered dependent on existing supply and demand for plants imported from countries to where the *P. perfoliata* is native and/or introduced (refer to Question 8) and with such plants acting as likely hosts for seeds of the species to hitchhike with. Such plants have included *Rhododendron* (refer to Question 1.02). *Rhododendron* species have been intentionally introduced into Ireland from the 1760s onwards and planted extensively as an ornamental plant, rootstock species and for game over (Dehnen-Schmutz *et al.*, 2004; Edwards, 2006; Higgins, 2008). There are, to-date, no known reports of *P. perfoliata* having hitchhiked with *Rhododendron* or any other ornamental plant, perhaps making it possible to infer that the numbers and likelihood of *P. perfoliata* travelling along this pathway is currently low.

				The climatic and abiotic conditions and habitats necessary for the establishment of *P. perfoliata* exist in Ireland. The species possesses biological traits which are highly conducive to successful establishment. Competition and natural enemies are not likely to significantly prevent growth and development. Existing management practices, particularly within the forestry sector are likely to aid any potential establishment. The establishment of *P. perfoliata* hinges more on the successful entry and less on the species potential to grow and develop as an invasive species in Ireland. As highlighted by the common name, mile-a-minute weed, as a fast growing plant, has the potential to spread rapidly (GISD, 2011). Birds and water are the most important modes of dispersal of the species (Okay, 1999). Humans may also have a hand in the dispersal by the cultivation of plant material contaminated with the seed. The ability of *P. perfoliata* to culture a viable seed bank of up to 3 years (Van Clef and Stiles, 2001) likely makes containment of the species difficult. Within the Irish landscape the species is likely to encounter its favoured habitats of disturbed areas, forests, plantations and orchards and riverbanks (CABI, 2014; CORINE, 2006; Fossit, 2000). Potential establishment and spread of *P. perfoliata* in Ireland is likely to have significant economic and environmental impacts. The species is known to grow rapidly, scrambling over shrubs and other vegetation, blocking the foliage of covered plants from available light and reducing their ability to photosynthesize, which stresses and weakens them (GISD, 2011). As a result of this competition, which includes monopolising resources, shading, smothering, strangling and rapid growth, *P. perfoliata* has the potential to be a problem to nursery and horticulture crops and semi-natural habitats and areas of conservation interest (CABI, 2014; GISD, 2011).

Stage 2 - Detailed assessment: Section F – Additional questions

This section is used to gather information about the potential effects of climate change on the risk posed by an organism. It is also an opportunity for the risk assessor to highlight high priority research that could help improve the risk assessment.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
6.01	What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?	-	HIGH	*P. perfoliata* is able to grow in a wide range of climates (refer to Question 2.02) (GISD, 2010). Increases in temperature as a result of climate warming are, therefore, not likely to affect or alter the species' potential entry, establishment, spread or impact in Ireland. Predicted higher rainfall may benefit establishment and spread, given the species' preference for wet habitat.
6.02	What is the likely timeframe for such changes (5, 10, 15, 20, 50 or 100 years)?	20	MEDIUM	Future scenarios on climate alteration suggest increases in mean temperature, higher winter rainfall and more intense storm events. Such changes are more likely to be taking place when selecting longer timeframes although changes are already recognise by the majority of the science community.
6.03	What aspects of the risk assessment are most likely to change as a result of climate change	-	MEDIUM	Wetter climatic conditions as a result of climate change would be expected to favour the spread and establishment of *P. perfoliata*, the implications of which would require re-examination.
6.04	If there is any research that would significantly strengthen confidence in the risk assessment, please note this here. If more than one research area is provided, please list in order of priority.	-	MEDIUM	Modelling of the species potential rate of spread and likely distribution in Ireland would significantly strengthen the confidence in this risk assessment.

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