Risk Assessment of *Rhododendron ponticum*

Name of Organism:	*Rhododendron ponticum* L. – Rhododendron
Objective:	Assess the risks associated with this species in Ireland
Version:	Final 15/09/2014
Author(s)	Erin O'Rourke, Liam Lysaght
Expert reviewer	Therese Higgins

Stage 1 - Organism Information

Stage 2 - Detailed Assessment
Section A - Entry
Section B - Establishment
Section C - Spread
Section D - Impact
Section E - Conclusion
Section F - Additional Questions

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.

DOCUMENT CONTROL SHEET

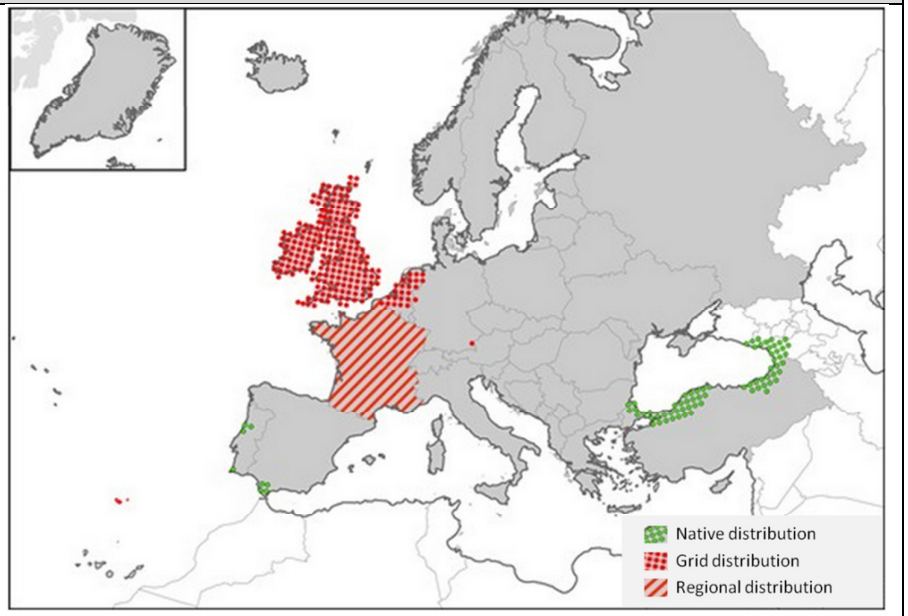
Name of Document:	Risk Assessment of *Rhododendron ponticum*				
Author (s):	Dr Erin O'Rourke and Dr Liam Lysaght				
Authorised Officer:	Dr Liam Lysaght				
Description of Content:	Non-native species risk assessment				
Approved by:	Dr Liam Lysaght				
Date of Approval:	15/09/2014				
Assigned review period:	n/a				
Date of next review:	n/a				
Document Code	n/a				
This documents comprises	TOC	Text	List of tables	List of Figures	No. Appendices
	n/a	YES	n/a	n/a	n/a

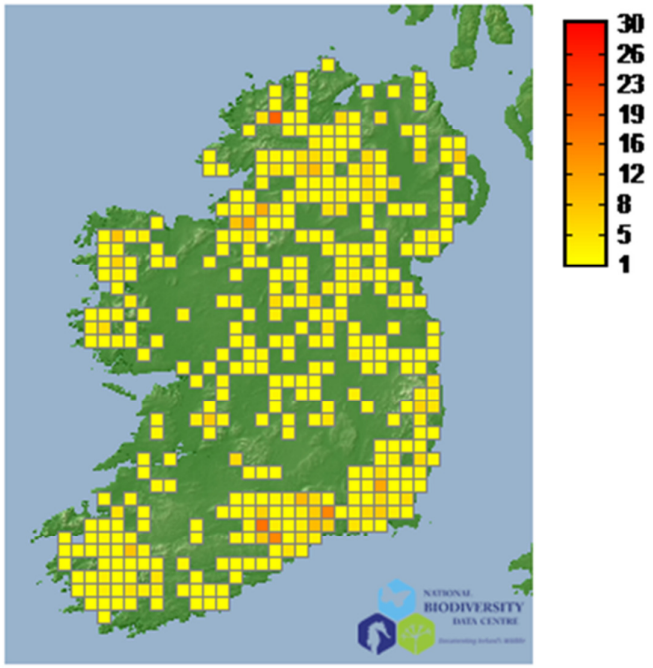
Version Control Table

Version No.	Status	Authors(s)	Reviewed by	Approved by	Date of issue
Draft 1	Complete	Dr Erin O'Rourke	Ms Colette O'Flynn		13/02/2014
Expert review	Complete	Dr Erin O'Rourke	Dr Therese Higgins	Dr Liam Lysaght	26/02/2014
Public consultation	Complete	Dr Erin O'Rourke		Dr Liam Lysaght	09/05/2014
Public consultation 2	Complete	Dr Erin O'Rourke		Dr Liam Lysaght	14/08/2014
Final	Complete	Dr Erin O'Rourke		Dr Liam Lysaght	15/09/2014

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	*Rhododendron ponticum* L. - Rhododendron Taxonomy: Kingdom: Plantae Phylum: Spermatophyta Subphylum: Angiospermae Class: Dicotyledonae Order: Ericales Family: Ericaceae Genus: Rhododendron Species: ponticum Synonyms: *Rhododendron lancifolium* Moench, *Rhododendron speciosum* (Wild.) Sweet. Common name (English): Rhododendron, common Rhododendron, pontic Rhododendron, purple-flowered Rhododendron The population of *R. ponticum* in Britain and Ireland derives almost entirely from Spain and Portugal (Milne & Abbott 2000, Erfmeier & Bruelheide 2004, 2005; Preston *et al*., 2002). The Black Sea population of *R. ponticum* is reported to have little involvement in the genetic makeup of the population (Milne & Abbott 2000). Recently, the name *Rhododendron × superponticum* Cullen has been suggested for the invasive populations in Britain and Ireland (Cullen 2011).
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	
4	Describe the organism.	-	Densely branched, spreading to upright shrub to 5m; leaves 6-20cm, evergreen, ± flat, elliptic to oblong or narrowly so, entire, glabrous; flowers mauvish-purple, c.4-6cm across; stamens 10; ovary glabrous but glandular (Stace, 1997). Sparsely hairy or 'bristly' ovaries are reported from some British invasive Rhododendron stands (Cullen, 2011). These may be the result of introgression with other *Rhododendron* species (namely *R. catawbiense* for which there is also molecular evidence of introgression with

Stage 1 - Organism Information *The aim of this section is to gather basic information about the organism.*			
N	**QUESTION**	**RESPONSE**	**COMMENT**
			some British *R. ponticum* populations (Milne & Abbott, (2000). However, it may also be an inherent characteristic of 'pure' *R. ponticum*, as Cullen (2011) reports similar observation from native Iberian stands. Similar conclusions may thus be drawn for Irish material as this has been shown to be of Iberian origin, possibly via Britain (Milne & Abbott, 2000).
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 *Rhododendron ponticum* as a "high 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?		The species is a native of the area to the south of the Black Sea (i.e. the Caucasus, northern Turkey and the southeast corner of Bulgaria) and, disjunctly, Lebanon and three small areas in the Iberian Peninsula, i.e. in southwest Spain, and southern and central Portugal (Figure 1; Cross 1975; Higgins, 2008; Hulme, 2006, 2009).

Stage 1 - Organism Information *The aim of this section is to gather basic information about the organism.*			
N	**QUESTION**	**RESPONSE**	**COMMENT**
			 **Figure 1.** Native and non-native distribution of *Rhododendron ponticum* L. – Rhododendron (Modified from Hulme, 2006).
8	What is the current global distribution of the organism (excluding Ireland)?		Including *R. ponticum's* native range (refer to Question 7) the species has been introduced to United Kingdom, Ireland, Belgium, France and Netherlands, and is present in Austria (Figure 1; Hulme, 2006).
9	What is the current distribution of the organism in Ireland?	-	*Rhododendron ponticum* is widespread in Ireland, particularly in the north west, south west and south east of the country (Preston *et al.*, 2002, Reynolds, 2002). The National Biodiversity Data Centre hold 1425 verified records of the species (Figure 2; NBDC, 2014).

Stage 1 - Organism Information *The aim of this section is to gather basic information about the organism.*			
N	**QUESTION**	**RESPONSE**	**COMMENT**
			 **Figure 2.** Map showing most of the verified records for *Rhododendron ponticum* per 10km^2 in Ireland. Colour scale bar slows density of records per 10km (National Biodiversity Data Centre, 2014).
10	Is the organism known to be invasive anywhere in the world?	YES	*Rhododendron ponticum* has a reputation as an aggressive invader in temperate Atlantic areas (Mejias *et al.*, 2002). In Ireland, in areas with sufficiently acid soils, and particularly where the mild climate allows, Rhododendron has invaded woodland, plantation forestry and to a lesser extent, heath and bog (Higgins, 2008). In many places it has replaced the native shrub layer and grows in dense thickets excluding native vegetation below and limiting natural tree regeneration (Higgins, 2008). There is increasing invasion of the species in continental Europe (Hulme, 2006).

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)?	VERY FEW	HIGH	The main pathway of introduction of *R. ponticum* is the horticultural trade.
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. Horticultural trade	HIGH	Potential for the species to be sourced through the horticultural trade, particularly via mail order seed companies and via the Internet (CABI, 2014). From habitats to which it is introduced it may become naturalised/invasive, under suitable mild and moist climatic conditions, available seed bed for germination and sufficiently acidic soils to allow flowering and seed production.

Pathway 1 – Horticultural trade

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)?	INTENTIONAL	HIGH	*Rhododendron ponticum* was intentionally introduced into Ireland from the 1760s onwards (Higgins, 2008). It has been widely disturbed as an ornamental plant of gardens and parks (Dehnen-Schmutz *et al*., 2004). It was introduced as a rootstock species for less hardy *Rhododendron* species and cultivars (Edwards, 2006; Higgins, 2008). It was planted as game (deer and fowl) cover in woodland habitats (Dehnen-Schmutz, *et al*., 2004). It has also been planted for shelter to exposed homesteads (Higgins, 2008).
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 exist to allow a reasonable assessment to be made of the number of animals that may, or may not, be brought into Ireland e.g. no figures available on the number of plants sold and subsequently planted. There are a number of other species of Rhododendron, closely related to *R. ponticum*, which are likely to cater for any existing supply and demand for such a plant, as reflected in online gardening centres (see, for example, http://www.gardens4you.ie/index.php?/shrubs-and-bushes/Rhododendron&gclid=CJusrcLHwbwCFcNl2wod628AAQ)

Pathway 1 – Horticultural trade				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	MODERATELY LIKELY	MEDIUM	It is unlikely that the species could enter Ireland undetected and without the knowledge of the relevant authority as a labeled plant. However, it is likely that the species could enter Ireland undetected and without the knowledge of the relevant authority as seed *via* the Internet and/or mail order trade.
1.06	How likely is the organism to survive during passage along the pathway?	LIKELY	MEDIUM	Likely for the species health requirements (i.e. nutrient and housing) to be catered for by the horticultural trader and subsequently by the garden centre and/or gardener.
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	LIKELY	MEDIUM	The growth of *R. ponticum* can occur throughout the growing season with defined periods of growth occurring between May and June, July-August and a third period of growth in September (CABI, 2014). Horticultural traders and gardeners are likely to stock and buy *R. ponticum* at the time of year most appropriate to planting; usually sold growing in pots, with most sales probably taking place in the spring or autumn planting seasons (Dehnen-Schmutz, 2013).
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	LIKELY	MEDIUM	Stace (1997) noted that suitable habitat for the establishment of *R. ponticum* can be found throughout the British Isles. In the wild the species inhabits mixed deciduous forest, temperate heaths, and raised and blanket bogs (Hulme, 2006). The species is likely to encounter such suitable habitat within the Irish landscape (CORINE, 2006; Fossitt, 2000). Nowadays any plants that do enter the country are most likely planted domestically in private gardens.
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	MODERATELY LIKELY	MEDIUM	Horticultural trade has been the main pathway for *R. ponticum* into the country, planted for ornamental purposes, used as a rootstock, for game cover and dwelling shelter (refer to Question 1.03). The entry of *R. ponticum*, followed by the subsequent establishment and spread has resulted in the presence of the species in 461 of the ~1018 10 km squares which constitute Ireland (Preston *et al.*, 2002). Under the European communities (Bird and Natural Habitats) Regulations 2011, it is an offence to plant, disperse, allow or cause the dispersal, spread or growth of *R. ponticum.* We can only assume the future entry of the species via horticultural trade is as a result of trade and consumer ignorance to the invasiveness of this species and the associated Regulations and/or the ease at which the plant can be sourced via the internet.
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')	YES	HIGH	*Rhododendron ponticum* is widespread in Ireland, particularly in the north west, south west and south east of the country (Preston *et al*., 2002, Reynolds, 2002). It is present in 461 of the ~1018 10 km squares which constitute the country (Preston *et al*., 2002). Rhododendron is well established across the Irish territory, but as the climate changes (milder and moister) and also as land management patterns change (increased abandonment of less productive farming areas) there is new potential for invasion sites to be created, and the overall invasion potential of the species may increase. For example, if the south east of the country becomes less dry, susceptible soils there may better facilitate flowering and seedling establishment of the species.
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?	VERY LIKELY	HIGH	*Rhododendron ponticum* is tolerant to a wide range of temperatures and to shade, but is intolerant to drought; it grows best in uniformly damp climates (Higgins, 2008; Hulme, 2006). It has a reputation as an aggressive invader in temperate Atlantic areas (Mejias *et al*., 2002). It is widespread in Ireland (Figure 2); a country with a temperate oceanic climate which is mild, moist and changeable, with abundant rainfall and lack of temperature extremes (Keane and Collins, 2004). In the south west of Ireland where *R. ponticum* has proven to be most invasive, mean daily temperatures range from 5-7°C (January) to 14.5-15.5°C (July) and year-round rainfall exceeds 1200 mm (Collins and Cummins, 1996).
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?	VERY LIKELY	HIGH	It thrives on well drained, acid soils, in mild, damp climates, and has naturalised in such situations across Ireland (Higgins, 2008). It is less vigorous on wetter substrates and on more neutral and base rich soils (Higgins, 2008). Seedlings have difficulty becoming established in areas where there is continuous leaf litter and among dense herbaceous vegetation (Higgins, 2008; Hulme, 2006). Establishment is best in disturbed areas where the native vegetation has been in some way disrupted, providing an opening in the plant cover (Hulme, 2006).
2.04	How likely is the organism to encounter habitats necessary for the survival, development and multiplication of the organism in Ireland?	VERY LIKELY	MEDIUM	*Rhododendron ponticum* has the capacity to colonise a range of habitats from managed and ancient woodlands to moorland and urban areas, also invading peatlands, scrub woods, heathlands and woodlands, and has spread from gardens to invade woodland and national parks (Higgins, 2008; Hulme, 2008; Thomson *et al*., 1993). When the species was

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
				planted intentionally into habitats it was offered the most suitable conditions for survival (Dehnen-Schmutz and Williamson, 2006).
2.05	How likely is it that establishment will occur despite competition from existing species in Ireland?	VERY LIKELY	HIGH	Very heavy shade, such as that cast by dense conifer stands, will retard growth, but it can grow vigorously below deciduous trees such as oak, birch and mountain ash (Higgins, 2008). Competition is not likely to be an impinging factor in the establishment of the species.
2.06	How likely is it that establishment will occur despite predators, parasites or pathogens already present in Ireland?	LIKELY	HIGH	Potentially toxic chemicals, particularly 'free' phenols, and diterpenes, occur in significant quantities in the tissues of Rhododendron, such that foliage is unpalatable to vertebrates (grazers such as sheep, deer and cattle) and few predatory insects feed on the plant (Higgins, 2008; Hulme, 2006). Refer to Question 4.16.
2.07	How likely is it that establishment will occur despite existing management practices?	LIKELY	HIGH	Management of Rhododendron is not straightforward. Throughout Britain and Ireland various agencies have spent time and resources in attempting to control this plant and have found that it is an ongoing battle (Higgins, 2008). Some of the most seriously affected areas are remote and over difficult terrain (Higgins, 2008). Rhododendron is a prolific seed producer and regrows vigorously when cut (Barron, 2007), and is very resilient to herbicide treatments so that effective herbicidal control requires very specific conditions (Higgins, 2008). Many different approaches to the problem have been used, with varying success at different sites (Higgins, 2008). Management of *R. ponticum* itself favours reestablishment; where the control of dense stands, producing abundant seed, results in cleared areas perfect as seed beds for re-invasion (Dehnen-Schmutz, 2013).
2.08	How likely is it that management practices in Ireland will facilitate the establishment of the organism?	LIKELY	MEDIUM	Through intentional planting *R. ponticum* establishment has historically benefited from management practices (refer to Question 1.03) and without this planting it might perhaps still exist in the British Isles today as specimens in botanical and horticultural collections like thousands of other introduced plants (Dehnen-Schmutz & Williamson 2006). Ground disturbance resulting from trampling, burning and forestry operations (particularly scrub clearance and felling which leaves moss covered tree stumps and bare ground) and intensive grazing are conducive to the germination of Rhododendron seed (Barron, 2007; Higgins, 2008; Stephenson *et al*. 2006).

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
2.09	How likely is it that the biological characteristics of the organism would allow it to survive eradication campaigns in Ireland?	VERY LIKELY	HIGH	*Rhododendron ponticum* is so widespread and difficult to manage in Ireland that complete eradication would be impossible. However, in order to meet the nature conservation objectives at projected sites, some management of the plant is required so that the status of native habitats may be improved (Higgins, 2008) Biological properties of the species that could prevent successful eradication at localised sites are: the plants ability to produce a large amount of seeds, and seeds in the soil can also remain viable for several years (Hulme, 2006); vigorous regrowth when cut back from stumps that have not been controlled adequately with herbicide applications (Dehnen-Schmutz, 2013; Higgins, 2008); and the thick waxy leaves of the plant do not absorb herbicides easily, with older leaves harder to treat (Higgins, 2008).
2.10	How likely is it that the biological characteristics of the organism will facilitate its establishment?	VERY LIKELY	HIGH	Reproduction is mainly by seed. Plants begin to flower at c. 10-12 years of age, with flowers produced every year thereafter in optimal conditions (Higgins, 2008). Flowering and seed set is more abundant in the open and in broken canopy than under closed canopy (Higgins, 2008). Flowering occurs for a two week period sometime in May and June (Higgins, 2008). The plant produces a large amount of pollen and nectar and attracts a range of insect visitors, including bumble-bees which are thought to be the main pollinators (unable to self-pollinate) (Higgins, 2008, Stout, 2007). Over a period of six months, successfully fertilised flowers mature into capsules (Higgins, 2008). Capsules dry out and seeds, which are small (c 1.5mm long and 0.5mm wide) and light, can be found from December onwards (Cross, 1981; Higgins, 2008). Seed production is very large, with a single bush in Killarney found to produce more than 1 million seeds (Cross, 1975).
2.11	How likely is it that the organism's capacity to spread will facilitate its establishment?	VERY LIKELY	HIGH	Dispersal of seed is by wind, water and, to a much lesser extent, on animal fur and human clothing (Higgins, 2008). Seed may be dispersed by wind for distances up to about 1km but the majority of the seed is likely to be dropped much closer to the parent plant, probably within 100m, especially in enclosed situations (Higgins, 2008).

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
2.12	How likely is it that the organism's adaptability will facilitate its establishment?	LIKELY	MEDIUM	*Rhododendron ponticum*, adaptable to Irish climate and soil, is very shade tolerant and has become widely established in several habitats, notably heathlands and woodlands from adjacent gardens (Higgins, 2008; Maguire *et al*., 2008). The species is, however, intolerant to drought (Hulme, 2006). Although Rhododendron is best adapted to more acid soils, it has naturalised on soils with a pH range of 3.3 – 6.4 (Higgins, 2008). Evidence from Britain has found widespread introgression of *R. ponticum* with other cultivated *Rhododendron* spp (namely *R. catawbiense* and/or *R. maximum*) (Milne & Abbott, 2000). Hybrids with the more cold-tolerant *R. catawbiense* appear to have a higher frequency in colder parts of the UK (Eastern Scotland) suggesting that introgression with that species may confer better cold tolerance on invasive populations. Further examination of the genetic composition of Irish populations is required in order to discover whether this scenario also applies here.
2.13	How likely is it that the organism could establish despite low genetic diversity in the founder population?	VERY LIKELY	HIGH	Molecular studies on 29 accessions from two Irish sites (Killarney and Connemara) indicated that like British material, established *R.ponticum* in Ireland was of Iberian origin (Milne & Abbott, 2000). In addition, although it was not a central research question of this study, the authors also suggested that the relatively high abundance of a particular haplotype in the Irish material was indicative of a genetic 'bottleneck', and further that this may be the result of the original Irish introduction being from a sub-set of the plants introduced into Britain. That said, we have observed the successful establishment of this species across a range of climatic conditions from north (Donegal) to south (West Cork) and from East (Dublin, Wicklow, Wexford) to west (Cork, Kerry, Connemara).
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	VERY LIKELY	HIGH	*Rhododendron ponticum* is already established is several European countries, including Ireland (refer to Question 8), with increasing invasion of the species in continental Europe (Hulme, 2006).
2.15	If the organism does not establish, then how likely is it that transient populations will continue to occur?	VERY UNLIKELY	HIGH	The species is established and there are no reports of short-lived *R. ponticum* individuals or populations.

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
2.16	Estimate the overall likelihood of establishment. Mention any key issues in the comments box	VERY LIKELY	HIGH	*Rhododendron ponticum* is widespread in Ireland (Preston *et al*., 2002, Reynolds, 2002). It thrives on well drained, acid soils, in mild, damp climates, and has naturalised in such situations across the country (Higgins, 2008). Establishment is best in disturbed areas where the native vegetation has been in some way disrupted, providing an opening in the plant cover (Hulme, 2006). It has the capacity to colonise a range of habitats from managed and ancient woodlands to moorland and urban areas, also invading peatlands, scrub woods, heathlands and woodlands, and has spread from gardens to invade woodland and national parks (Higgins, 2008; Hulme, 2008; Thomson *et al*., 1993).

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%)?	11%-33%	MEDIUM	About ~26% of Ireland is covered with habitat suitable for the establishment and spread of *R. ponticum*; coniferous woodland (3.23%), deciduous woodland (0.41%), mixed woodland (0.42%), transitional woodland (5.89%), moors and heaths (0.78%), peat bogs (15.37%) and green urban areas (0.04%) (CORINE, 2006). It is of note that CORINE land cover data does not account for gardens, which represent important terrestrial habitat for the species, however it is suspected that even if gardens where accounted for, the area in Ireland that the species has the potential to establish would still amount to 11%-33%.
3.02	How important is the expected spread of this organism in Ireland by natural means (minimal, minor, moderate, major or massive)?	MAJOR	HIGH	A single mature *Rhododendron ponticum* is capable of producing a million tiny seeds per year (Cross. 1975). Dispersal of the seed is by wind and water, and to a much lesser extent on animal fur and human clothing (Higgins, 2008; Hulme, 2006). Seed may be dispersed by wind for distances up to about 1km but the majority of the seed is likely to be dropped much closer to the parent plant, probably within 100m, especially in enclosed situations (Higgins, 2008; Stephenson *et al.*, 2007). *Rhododendron ponticum* is also able to propagate itself through vegetative means, both by suckering from roots and by layering when branches touch sufficiently moist ground (Maguire *et al.*, 2008).
3.03	How important is the expected spread of this organism in Ireland by human assistance (minimal, minor, moderate, major or massive)?	MODERATE	MEDIUM	*Rhododendron ponticum* was intentionally introduced to Ireland (refer to Question 1.03), at which time human assistance played a central role in the spread of the species. Today, in light of Regulations and the increased awareness of the plants invasiveness (refer to Question 10) intentional planting is only moderately likely. Accidental human assisted spread may occur via the disposal of *R. ponticum* pot-plants or plant parts in landfill sites or rubbish collection sites (CABI, 2014).
3.04	Within Ireland, how difficult would it be to contain the organism (minimal, minor, moderate, major or massive)?	MAJOR	HIGH	Major difficulties are encountered in the containment of R. *ponticum*. This is because the species is a prolific seed producer, with seeds easily dispersed over some distance by wind and water, it regrows vigorously when cut, and is very resilient to herbicide treatments (Barron, 2007; Higgins, 2008). The difficulty and cost of its management mean that reservoirs for reinfestation of cleared areas, and for initial infestation of new areas are likely to persist. In addition, where Rhododendron populations are present adjacent to forestry, management processes (harvesting) are likely to increase the suitability of the site for expansion of the population.

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?	0%-10%	MEDIUM	Although *R. ponticum* has the potential to spread to 11%-33% of the Irish land cover (refer to Question 3.01), at present it is most likely that 0%-10% of land area has been colonised by the species.
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	For further spread a period longer than 5 years is likely to be required. This is because vegetative spread is slow. Seed production is prolific and can be dispersed over long distance, however seedlings are dependent on 'safe sites' (Cross, 1975) for successful germination, and maturation of the species from seed to mature, flowering plant can take c.10-12 years in ideal climatic conditions (mild winters and wet summers) and longer (up to 20 years) where the growing season is shorter (northerly areas such as Donegal and Scotland) and where summer drought might limit growth (south east Ireland) (Higgins, 2008).
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	LOW	As land management changes in response to economic and policy shifts, there is potential for new areas to become 'invadable' by *R. ponticum*. Rhododendron is commonly used as hedging/shelter in upland areas of where acid grassland exists on sufficiently well-drained soils. Its rate of establishment in these situations is normally low because of the dense grass swards maintained by sheep grazing (or mowing) and the low bite height of sheep that clip off very small (1-2 year old) seedlings of Rhododendron. Should these areas become less intensively grazed (e.g. in a switch from sheep to extensive cattle), then establishment from seed is more likely to occur.
3.08	In this timeframe, what proportion of the area (including any currently occupied areas) is likely to have been invaded by this organism?	11%-33%	LOW	Refer to Question 3.07.
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.	-	MEDIUM	Over its global invasive range the species endangers mixed deciduous forest, temperate heaths, and raised and blanket bogs (Hulme, 2006). In Ireland, *R. ponticum* has invaded three habitats of international importance under the EC Habitats Directive: upland oak woods, bogs and heath (Table 1; Maguire *et al.*, 2008). The species threatens the conservation value of Glenveagh National Park, Union Wood, Connemara National Park, Killarney National Park, Glengarriff Nature Reserve, Tomnafinnogue, Wicklow Mountains National Park, and Borris Wood (Table 1). All of which are Special Areas of Conservation (SAC).

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
3.10	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.	MODERATELY	MEDIUM	*Rhododendron ponticum* has the potential to spread at a moderate rate due to the species prolific seed production and the relative easy at which the seed can be dispersed. Spread, however, dependent on seedling germination success at 'safe sites' i.e suitable seed bed such as rotting stumps and fallen logs. Within the Irish landscape the species is likely to encounter its favoured wild habitats of mixed deciduous forest, temperate heaths, and raised and blanket bogs (CORINE, 2006; Fossit, 2000; Hulme, 2006).

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	HIGH	*R. ponticum* is causing major economic losses within its existing geographic range particularly in the Britain and Ireland. It is an economic problem in commercial forests, moorlands managed for gamebirds and conservation sites (Hulme, 2006). Losses are due to control costs of the species, losses of biodiversity, impacts on landscape aesthetics, loss of grazing land, impacts on forestry, and the species' role as a reservoir for the tree pathogen *Phytophthora ramoroum* (Dehnen-Schmutz, 2013). As of yet only the economic management costs have a momentary value. A survey among nature conservation organisations, forestry and private landowners provided information on 52,000 ha of land affected by *R. ponticum* in 2001 (Dehnen-Schmutz *et al*. 2004). Costs reported for the control of 1275 ha of *R. ponticum* in that year totalled more than £670,000. Negative impacts on tourism because of overgrown footpaths and riding tracks are reported from the Snowdonia National Park (Jackson 2008). In its native range in Turkey, *R. ponticum* ssp *ponticum* is causing considerable problems for forestry (Esen & Zedaker 2004).
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	HIGH	As of yet only economic management costs have a momentary value.
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.	N/A	HIGH	As of yet there are only projected economic management costs.
4.04	How great have the economic costs of managing this organism been in Ireland from the time of introduction to the present?	MODERATE	LOW	Data provided by the Irish Heritage Council to Kelly *et al*. (2013) report on the economic cost of invasive and non-native species in Ireland and Northern Ireland detail the following *R. ponticum* control costs: clearance at Poulgorm Wood, Glengarriff in 2007 – €34,468.00; removal of invasive species including *R. ponticum* at Ballyseedy Wood in 2007 - €32,000.00; and removal Upper Heathland in 2008 - €15,000.00. No other information could be sourced on the cost of Rhododendron management to-date.
4.05	How great is the economic cost of managing this organism likely to be in the future in Ireland?	MASSIVE	HIGH	The projected annual costs of *R. ponticum* to Irish Forestry based on estimates from Britain (Williams *et al*., 2010) are €869,173 for Ireland and €341,387 for Northern Ireland (Kelly *et al*., 2013)

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	HIGH	The main direct environmental harm caused by *R. ponticum* is the change of species composition and reduced biodiversity in invaded habitats (refer to Question 4.07; Rotherham 2001, Cross 1982). There are also environmental impacts due to the loss of areas invaded by *R. ponticum* previously used for low intensity grazing (Jackson 2008). The plant is also poisonous for animals (except for the seedlings) and mortalities have been reported in spring when sheep return from wintering (Jackson 2008).
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	MAJOR	HIGH	*Rhododendren ponticum* has a dramatic effect on habitat structure and native biodiversity in the areas where it has been introduced. Few native plants survive once *R. ponticum* invades an area, only those trees which manage to grow above the level of the Rhododendron canopy will persist. When such trees die, they cannot be replaced because seedlings cannot become established under the lightless canopy, at which point, the Rhododendron completely dominates (Hulme, 2006).
4.08	How important is the impact of the organism on biodiversity likely to be in the future in Ireland?	MAJOR	HIGH	*R. ponticum* is already impacting upon biodiversity and it is not expected that this negative impacts will change in the future if current management campaigns are not increased. If the species spreads further the threat to biodiversity is likely to increase.
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	MAJOR	HIGH	As detailed in 4.07, *R. ponticum* alters ecosystem functioning by replacing the native shrub layer, resulting in the growth of dense thickets which exclude native vegetation below and limit natural tree regeneration (Higgins, 2008). *R. ponticum* growing along streams has been found to disrupt food webs by degrading community structures with reduced invertebrate abundance and suppressed algal production (Hladyz *et al*. 2011). The species is also likely to alter ecosystem services, for example the water retention or carbon sequestration ability of habitats (Dehnen-Schmutz, 2013).
4.10	How important is alteration of ecosystem function caused by the organism likely to be in Ireland in the future?	MAJOR	HIGH	*R. ponticum* is already altering ecosystem functioning and it is not expected that this negative impact will change in the future if current management campaigns are not increased.
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.	MAJOR	HIGH	*Rhododendron ponticum* is a serious problem in several National Parks and Nature Reserves, especially where these are located on or near to sites of former demesne lands (Table 1; Higgins, 2008). In Ireland, Rhododendron has invaded three habitats of international importance under the EU Habitats Directive: upland oak woods, bogs and heath (Table 1; Maguire *et al*., 2008). For example, it is now an invasive species in Glenveagh National Park, Union Wood, Connemara National Park, Killarney National Park, Glengarriff Nature Reserve, Tomnafinnogue, Wicklow Mountains National Park, and Borris Wood (Table 1). In the National Survey of Native

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

<table>
<tr><th>N</th><th>QUESTION</th><th>RESPONSE</th><th>CONFIDENCE</th><th>JUSTIFICATION</th></tr>
<tr><td></td><td></td><td></td><td></td><td>Woodlands (Perrin et al,. 2008), Rhododendron was found to be present at 23% of the 1,217 woodlands surveyed, with infestation classified as ‘severe’ in more than half of these sites.

Table 1. Habitats affected by Rhododendron in NPWS sites (Taken from Higgins, 2008)
<table>
<tr><td>Habitats affected by Rhododendron in NPWS sites</td><td>Site Area</td><td>Main habitats affected</td><td>Rhododendron Extent</td></tr>
<tr><td>1. Glenveagh National Park</td><td>16,958 ha</td><td>Oak woodland, heath & bog</td><td>Extensive in Glen– c.150ha distributed throughout larger area.</td></tr>
<tr><td>2. Union Wood</td><td>62 ha</td><td>Oak woodland, mixed woodland</td><td>Significant stands in c. 9ha.</td></tr>
<tr><td>3. Connemara National Park</td><td>2,957 ha</td><td>Heath & bog</td><td>c. 25 ha of significant stands and scattered plants in additional area.</td></tr>
<tr><td>4. Killarney National Park</td><td>10,000 ha</td><td>Oak woodland, wet woodland, heath, bog, conifer woods</td><td>Extensive stands in > 500 ha and scattered stands in greater area</td></tr>
<tr><td>5. Glengarriff Nature Reserve</td><td>312 ha</td><td>Oak woodland, conifer clear fell</td><td>Significant stands formerly extended over most of site c. 300ha</td></tr>
<tr><td>6. Tomnafinnogue</td><td>65 ha</td><td>Oak woodland, small patches of wet woodland</td><td>Significant stands over c. 10ha and scattered plants also.</td></tr>
<tr><td>7. Wicklow Mountains National Park</td><td>18,000 ha</td><td>Woodland edge, grassland, conifer clear fell</td><td>Formerly several clumps totalling < 10ha in total. Currently < 1ha.</td></tr>
<tr><td>8. Borris Wood (Privately owned)</td><td>110 ha</td><td>Oak woodland</td><td>In thickets with laurel over c.10-20ha</td></tr>
<tr><td>9. Castlehackett</td><td>65 ha</td><td>Oak/Beech woodland</td><td>Small amount (< 1 ha) among greater laurel infestation</td></tr>
</table></td></tr>
<tr><td>4.12</td><td>How important is decline in conservation status caused by the</td><td>MAJOR</td><td>HIGH</td><td>R. ponticum is already impacting upon the conservation status of protected and/or important sites and it is not expected that these negative impacts will change in the</td></tr>
</table>

Stage 2 - Detailed assessment: Section D - Impact *This section evaluates the probability of impact of an organism within Ireland.*				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
	organism likely to be in the future in Ireland?			future if current management campaigns are not increased. Additionally, sites that are currently moderately infested are likely to become severely infested without management, further impacting the conservation status of those habitats.
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?	MODERATE	MEDIUM	Negative impacts on tourism because of overgrown footpaths and riding tracks are reported from the Snowdonia National Park (Jackson 2008). Anecdotal information suggests that honey from Rhododendron is toxic to humans; known as 'Honey intoxication' and results in relatively short-lived intestinal and cardiac problems but is rarely fatal (Hulme, 2006; Maguire *et al.*, 2008).
4.14	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within Ireland?	MODERATE	MEDIUM	In mid June 2014, hillwalkers had to be rescued after becoming trapped in a forest of Rhododendron plants in the Knockmealdown Mountains. Rescuers described reaching the trapped hillwalkers, through the virtually impenetrable plants on the Tipperary/Waterford border, as “one of their most difficult-ever tasks” http://www.rte.ie/news/2014/0617/624367-rhododendron-rescue/. Refer also to Question 4.13.
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?	MINOR	MEDIUM	*R. ponticum* has introgressed with other *Rhododendron* species (Milne and Abbott, 2000). For example, wild populations in eastern Scotland and northern England have been found to have hybridised with a North American species (*R. catawbiense*) which is a popular plant in Rhododendron collections (Higgins, 2008). The genetic traits of *R. ponticum* could not be carried to native species, as there are no species of Rhododendron native to Ireland.
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)?	MAJOR	MEDIUM	*Rhododendron ponticum* hosts a serious plant health pathogen called *Phytophthora ramorum.* This is a fungus that has the potential to attack a wide variety of native woody plants and is the causative agent of ‘Sudden Oak Death’ (Barron, 2007; Maguire *et al*., 2008). The first indication of the disease on *R. ponticum* is wilting of shoots. These develop a brown/black colour that spreads along the twig and can move onto the leaves, where the leaf bases and tips blacken (Maguire, 2008). It does not generally kill R. Ponticum, however when the infection in this carrier host achieves a certain level, the blight may pass on to susceptible adjacent tress in which it can potentially cause lethal bleeding cankers of the trunk (Higgins, 2008). To date, nationally, Rhododendron has now been found to be infected at 22 different forest locations and the non-compliant cutting and unauthorised removal of Rhododendron for foliage production remains an ongoing serious disease management problem at several of the P. ramorum infected forest sites (FDP, 2014).

Stage 2 - Detailed assessment: Section D - Impact

This section evaluates the probability of impact of an organism within Ireland.

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.17	How important might other impacts not already covered by previous questions be resulting from introduction of the organism? Specify in the justification box.	MODERATE	MEDIUM	Personal observation (Higgins) suggests that *R.ponticum* has a significant drying effect on soils where severe levels of infestation occur. Where infestation occurs along the edges of bogs and along existing drains on bogs, there is some risk that establishment of large clumps may exacerbate drying of the peat surfaces and subsequent peatland degradation.
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?	MAJOR	HIGH	Potentially toxic chemicals, particularly 'free' phenols, and diterpenes, occur in significant quantities in the tissues of Rhododendron, such that foliage is unpalatable to vertebrates (grazers such as sheep, deer and cattle) and few insects feed on the plant (Higgins, 2008; Hulme, 2006).
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, environmental and social problem in commercial forests, moorlands managed for gamebirds, recreational areas and conservation sites (Hulme, 2006).
4.20	Estimate the overall potential impact of this organism in Ireland. Use the justification box to indicate any key issues.	MAJOR	HIGH	*Rhododendron ponticum* is the most expensive alien plant conservation problem in Britain and Ireland (Dehnen-Schmutz and Williamson, 2006). It is an economic problem in commercial forests, moorlands managed for gamebirds and conservation sites (Hulme, 2006). As of yet only economic management costs have a momentary value. There are massive projected annual costs of *R. ponticum* to Irish Forestry based on estimates from Britain (Williams *et al*., 2010; Kelly *et al*., 2013). The main direct environmental harm caused by *R. ponticum* is the change of species composition and reduced biodiversity in invaded habitats. *Rhododendron ponticum* hosts a serious plant health pathogen called *Phytophthora ramorum.* This is a fungus that has the potential to attack a wide variety of native woody plants and is the causative agent of 'Sudden Oak Death' (Barron, 2007; Maguire *et al*., 2008). As an aggressive invasive species and also as a host of *P. ramorum*, *R. ponticum* is one of the biggest conservation issues facing Irish woodlands today.

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-MASSIVE	HIGH	Horticultural trade has been the main pathway for *R. ponticum* into the country, planted for ornamental purposes, used as a rootstock, for game cover and dwelling shelter (refer to Question 1.03). The entry of *R. ponticum*, followed by the subsequent establishment and spread has resulted in the presence of the species in 461 of the ~1018 10 km squares which constitute Ireland (Preston *et al*., 2002). Under the European communities (Bird and Natural Habitats) Regulations 2011, it is an offence to plant, disperse, allow or cause the dispersal, spread or growth of *R. ponticum.* We can only assume the future entry of the species via horticultural trade is as a result of trade and consumer ignorance to the invasiveness of this species and the associated Regulations and/or the ease at which the plant can be sourced via the internet. *Rhododendron ponticum* is widespread in Ireland (Preston *et al*., 2002, Reynolds, 2002). It thrives on well drained, acid soils, in mild, damp climates, and has naturalised in such situations across the country (Higgins, 2008). Establishment is best in disturbed areas where the native vegetation has been in some way disrupted, providing an opening in the plant cover (Hulme, 2006). It has the capacity to colonise a range of habitats from managed and ancient woodlands to moorland and urban areas, also invading peatlands, scrub woods, heathlands and woodlands, and has spread from gardens to invade woodland and national parks (Higgins, 2008; Hulme, 2008; Thomson *et al*., 1993). *Rhododendron ponticum* has the potential to spread at a moderate rate due to the species prolific seed production and the relative easy at which the seed can be dispersed. Spread, however, dependent on seedling germination success at 'safe sites' i.e suitable seed bed such as rotting stumps and fallen logs. Within the Irish landscape the species is likely to encounter its favoured wild habitats of mixed deciduous forest, temperate heaths, and raised and blanket bogs (CORINE, 2006; Fossit, 2000; Hulme, 2006). *Rhododendron ponticum* is the most expensive alien plant conservation problem in Britain and Ireland (Dehnen-Schmutz and Williamson, 2006). It is an economic problem in commercial forests, moorlands managed for gamebirds and conservation sites (Hulme, 2006). As of yet only

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
				economic management costs have a momentary value. There are massive projected annual costs of *R. ponticum* to Irish Forestry based on estimates from Britain (Williams *et al*., 2010; Kelly *et al*., 2013). The main direct environmental harm caused by *R. ponticum* is the change of species composition and reduced biodiversity in invaded habitats. *Rhododendron ponticum* hosts a serious plant health pathogen called *Phytophthora ramorum*. This is a fungus that has the potential to attack a wide variety of native woody plants and is the causative agent of 'Sudden Oak Death' (Barron, 2007; Maguire *et al*., 2008). As an aggressive invasive species and also as a host of *P. ramorum*, *R. ponticum* is one of the biggest conservation issues facing Irish woodlands today.

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	A milder, moister climate, as predicted for Ireland under global warming is likely to further facilitate annual flowering and abundant seed production from 10-12 years. Additionally, seedlings in more humid and milder climate may achieve establishment in otherwise less than ideal conditions e.g. on mineral soil (Higgins, 2008). Additionally, soil disturbance as a result of windthrow owing to increased frequency and intensity of storms, will increase the vulnerability to invasion in sites where there is a proximate seed source. This is particularly relevant at forestry sites and in woodland stands where the level of infestation is currently kept in check by a lightly grazed and well developed field layer.
6.02	What is the likely timeframe for such changes (5, 10, 15, 20, 50 or 100 years)?	20	MEDIUM	
6.03	What aspects of the risk assessment are most likely to change as a result of climate change	-	MEDIUM	Warmer, wetter climatic conditions as a result of climate change would be expected to favour the fecundity, spread and establishment of *R. ponticum*, 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	Investigation into the impact of *R.ponticum* on soil, with respect to (i) possible allelopathic effects and (ii) mycorrhizae would enhance our understanding and ability to facilitate faster post-clearance recovery. The extent of introgression with cold tolerant species in Ireland has not been fully examined.

References

BARRON, C. 2007. The Control of Rhododendron in Native Woodlands. *In:* LITTLE, D. (ed.) *Native Woodland Scheme Information Note No. 3.* Forest Service: Woodlands of Ireland Coillearnacha.

CABI. 2014. *Rhododendron ponticum (rhododendron)* [Online]. Invasive Species Compendium: Wallingford, UK: CAB International. Available: www.cabi.org/isc [Accessed 9th February 2014].

CROSS, J. R. 1975. Biological flora of the British Isles: Rhododendron ponticum L. . *Journal of Ecology,* 63**,** 345–364.

CROSS, J. R. 1981. THE ESTABLISHMENT OF RHODODENDRON-PONTICUM IN THE KILLARNEY OAKWOODS, SW IRELAND. *Journal of Ecology,* 69**,** 807-824.

CROSS, J. R. 1982. The invasion and impact of Rhododendron ponticum in native Irish vegetation. *Journal of Life Sciences - Royal Dublin Society* 3**,** 209-220.

CULLEN, J. 2011. Naturalised rhododendrons widespread in Great Britain and Ireland. *Hanburyana,* 5**,** 11-29.

DEHNEN-SCHMUTZ, K. 2013. *GB Non-native Organism Risk Assessment for Rhododendron ponticum* [Online]. Available: www.nonnativespecies.org [Accessed 6th February 2014].

DEHNEN-SCHMUTZ, K., PERRINGS, C. & WILLIAMSON, M. 2004. Controlling Rhododendron ponticum in the British Isles: an economic analysis. *Journal of Environmental Management,* 70**,** 323-332.

DEHNEN-SCHMUTZ, K. & WILLIAMSON, M. 2006. Rhododendron ponticum in Britain and Ireland: Social Economic and Ecological Factors in its Successful Invasion. *Environment and History,* 6**,** 325-350.

EDWARDS, C. 2006. *Managing and controlling invasive rhododendron* [Online]. Forestry Commission, Edinburgh. Available: http://www.forestry.gov.uk/PDF/fcpg017.pdf/$FILE/fcpg017.pdf [Accessed 5th February 2014].

ERFMEIER, A. & BRUELHEIDE, H. 2004. Comparison of native and invasive Rhododendron ponticum populations: Growth, reproduction and morphology under field conditions. *Flora-Morphology, Distribution, Functional Ecology of Plants,* 199**,** 120-133.

ERFMEIER, A. & BRUELHEIDE, H. 2005. Invasive and native Rhododendron ponticum populations: is there evidence for genotypic differences in germination and growth? *Ecography,* 28**,** 417-428.

EŞEN, D. & ZEDAKER, S. M. 2004. Control of rhododendron (Rhododendron ponticum and R. flavum) in the eastern beech (Fagus orientalis) forests of Turkey. *New Forests,* 27**,** 69-79.

FDP. 2014. *Phytophthora ramorum* [Online]. Forestry Directory & Portal - Irish Forest & Timber Industry, 17 Castle Street, Dalkey, Co. Dublin Available: http://www.forestry.ie/Forests-pests-diseases/phytophthora-ramorum [Accessed 10th February 2014].

FLYNN, V. 2014. *Invasive species cost Ireland €261 million per year* [Online]. Journal.ie. Available: http://www.thejournal.ie/invasive-species-cost-ireland-e261-million-per-year-858495-Apr2013/#slide-slideshow1 [Accessed 26th February 2014].

GREEN, S. 2003. A review of the potential for the use of bioherbicides to control forest weeds in the UK. *Forestry,* 76**,** 285-298.

HIGGINS, G. T. 2008. Rhododendron ponticum: A guide to management on nature conservation sites. *Irish Wildlife Manuals, No. 33. .* National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland.

HLADYZ, S., ÅBJÖRNSSON, K., GILLER, P. S. & WOODWARD, G. 2011. Impacts of an aggressive riparian invader on community structure and ecosystem functioning in stream food webs. *Journal of Applied Ecology,* 48**,** 443-452.

HULME, P. E. 2006. *Rhododendron ponticum* [Online]. Delivering Alien Invasive Species Inventories for Europe. Available: http://www.europe-aliens.org/speciesFactsheet.do?speciesId=17261 [Accessed 6th February 2014].

HULME, P. E. 2009. *Rhododendron ponticum* L., rhododendron (Ericaeae, Magnoliophyta). *In:* DAISIE (ed.) *The Handbook of European Alien Species.* Springer, Dordrecht.

ISI 2012. *Rhododendron ponticum.* Risk analysis and prioritisation access database: Invasive Species Ireland.

JACKSON, P. 2008. Rhododendron in Snowdonia and a strategy for its control. Snowdonia National park Authority

KELLY, J., TOSH, D., DALE, K. & JACKSON, A. 2013. The economic cost of invasive and non-native species in Ireland and Northern Ireland. The Northern Ireland Environment Agency and the National Parks and Wildlife Service: Invasive Species Ireland.

MAGUIRE, C. M., KELLY, J. & COSGROVE, P. J. 2008. Best Practice Management Guidelines Rhododendron Rhododendron ponticum and Cherry Laurel Prunus laurocerasus. Prepared for NIEA and NPWS as part of Invasive Species Ireland.

MEJIAS, J. A., ARROYO, J. & OJEDA, F. 2002. Reproductive ecology of Rhododendron ponticum (Ericaceae) in relict Mediterranean populations. *Botanical Journal of the Linnean Society,* 140**,** 297-311.

MILNE, R. I. & ABBOTT, R. J. 2000. Origin and evolution of invasive naturalized material of Rhododendron ponticum L. in the British Isles. *Molecular Ecology,* 9**,** 541-556.

NATIONAL BIODIVERSITY DATA CENTRE. 2014. *Rhododendron ponticum* [Online]. National Biodiversity Data Centre. Available: http://maps.biodiversityireland.ie/#/Designation/1/DesignationGroup/1/Species/29245?FullDictionary=false&UseCommonNames=false [Accessed 6th February 2014].

PERRIN, P. M., MARTIN, J.R., BARRON, S.J., O'NEILL, F.H., MCNUTT, K.E. & DELANEY, A.M. 2008. National Survey of Native Woodlands 2003-2008: Volume I: Main report. Report submitted to National Parks & Wildlife Service, Dublin.

ROTHERHAM, I. 2001. Rhododendron gone wild: conservation implications of Rhododendron ponticum in Britain. *Biologist (London, England),* 48**,** 7-11.

STEPHENSON, C., MACKENZIE, M., EDWARDS, C. & TRAVIS, J. 2006. Modelling establishment probabilities of an exotic plant, Rhododendron ponticum, invading a heterogeneous, woodland landscape using logistic regression with spatial autocorrelation. *Ecological Modelling,* 193**,** 747-758.

STOUT, J. C. 2007. Pollination of invasive Rhododendron ponticum (Ericaceae) in Ireland. *Apidologie,* 38**,** 198-206.

THOMSON, A., RADFORD, G., NORRIS, D. & GOOD, J. 1993. Factors Affecting the Distribution and Spread of Rhododendron in North Wales. *Journal of Environmental Management,* 39**,** 199-212.

WILLIAMS, F., ESCHEN, R., HARRIS, A., DJEDDOUR, D., PRATT, C., SHAW, R. S., VARIA, S., LAMONTAGNE-GODWIN, J., THOMAS, S. E. & MURPHY, S. T. 2010. The Economic Cost of Invasive Non-Native Species on Great Britain. Wallingford: CABI for The Scottish Government, Department for Environment Food and Rural Affairs UK Government, and Department for Economy and Transport Welsh Assembly Government.