

**Risk Assessment of *Hyacinthoides hispanica*, including *H. non-scripta* x *H. hispanica***

<b>Name of Organism:</b>	<i>Hyacinthoides hispanica</i> (Mill.) Rothm. including <i>H. non-scripta</i> (L.) Chourd ex Rothm. x <i>H. hispanica</i> - Spanish Bluebell and Hybrid Bluebell
<b>Objective:</b>	Assess the risks associated with this species in Ireland
<b>Version:</b>	Final 15/09/2014
<b>Author(s)</b>	Erin O'Rourke and Liam Lysaght
<b>Expert reviewer</b>	Matthew Jebb - National Botanic Gardens

**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 **Non-native species Application based Risk Analysis (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

<b>Name of Document:</b>	Risk Assessment of <i>Hyacinthoides hispanica</i> (including <i>H. non-scripta</i> x <i>H. hispanica</i> )				
<b>Author (s):</b>	Dr Erin O'Rourke and Dr Liam Lysaght				
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### Version Control Table

Version No.	Status	Authors(s)	Reviewed by	Approved by	Date of issue
Draft 1	Complete	Dr Erin O'Rourke	Dr Liam Lysaght		15/07/2014
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**Stage 1 - Organism Information and Screening: Section A - 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	<p><i>Hyacinthoides hispanica</i> (Mill.) Rothm. including <i>H. non-scripta</i> (L.) Chouard ex Rothm. x <i>H. hispanica</i> - Spanish bluebell and hybrid bluebell</p> <p>The common or native bluebell in Britain and Ireland, <i>Hyacinthoides non-scripta</i> (L.) Chouard ex Rothm., is now joined by a garden escape, <i>Hyacinthoides hispanica</i> (Mill.) Rothm. and a hybrid between the two, <i>H. non-scripta</i> x <i>H. hispanica</i>.</p> <p>Taxonomy:            Kingdom: Plantae            Phylum: Tracheophyta            Subphylum: Spermatophytina            Class: Magnoliopsida            Order: Asparagales            Family: Asparagaceae            Genus: <i>Hyacinthoides</i>            Species: <i>hispanica</i></p> <p>Synonyms of <i>H. hispanica</i>: <i>Endymion campanulatus</i>, <i>Endymion hispanicus</i>, <i>Endymion patulus</i>, <i>Scilla campanulatus</i> and <i>Scilla hispanica</i> (NHM, 2014).</p> <p>Common name(s) of <i>H. hispanica</i> (English): Spanish bluebell</p> <p>Synonyms of <i>Hyacinthoides non-scripta</i> x <i>H. hispanica</i>: <i>Hyacinthoides x massartiana</i> and <i>Hyacinthoides x variabilis</i> (BSBI, 2010)</p> <p>Common name(s) of <i>H. non-scripta</i> x <i>H. hispanica</i>: Hybrid bluebell</p> <p>Similar species: <i>Hyacinthoides non-scripta</i> – native bluebell or common bluebell. There are unresolved questions about the taxonomic status of these taxa; whether the 'Spanish' bluebell is the same as the bluebells in Spain and whether it is merely a subspecies of the common bluebell, as the two hybridise freely (BSBI, 2010; Rix, 2004; Taylor, 2002)</p>

<b>Stage 1 - Organism Information and Screening: Section A - Organism Information</b>			
<i>The aim of this section is to gather basic information about the organism.</i>			
<b>N</b>	<b>QUESTION</b>	<b>RESPONSE</b>	<b>COMMENT</b>
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.	-	<p>Alien (here after refers to both the Spanish and hybrid bluebell) and native bluebells are spring-flowering, bulbous perennials, producing the fresh season's leaves in about December (Kohn <i>et al.</i>, 2009). Flower spikes appear in May and the flowers are insect-pollinated (Hackney, 2008). The hybrid is fully fertile and produces abundant seed. All bluebells retain much of their seed in the papery fruits until well into the winter and leaves die back completely from about the end of summer (Hackney, 2008).</p> <p>The native bluebell, <i>H. non-scripta</i>, "stems to 50cm; leaves up to 20mm wide; racemes pendent at apex, 1-sided, with pendent strongly sweetly scented flowers; tepals 14-20mm, forming +/- parallel-sided tubular perianth, strongly recurved at apex, outer 3 stamens fused to perianth for &gt;3/4 their length" (Stace, 1997).</p> <p>The Spanish bluebell, <i>H. hispanica</i> "stems to 40cm; leaves up to 35mm wide; racemes erect, not 1-sided, with erect to patent, faintly scented flowers; tepals 12-18mm, forming bell-shaped perianth, not recurved at apex; outer 3 stamens fused to perianth for &lt;3/4 their length" (Stace, 1997)</p> <p>The hybrid bluebell, <i>H non-scripta x H. hispanica</i>, is intermediate in all characters and fertile, forming a complete spectrum between the parents (Stace, 1997).</p>
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 Spanish and hybrid bluebell as a "low 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>The Spanish bluebell, <i>H. hispanica</i>, is native to the western Iberian peninsula (Portugal and western Spain) and North Africa (Hackney, 2008; Meek, 2011; Parnell and Curtis, 2012; Taylor, 2002).</p> <p>The common bluebell, <i>H. non-scripta</i>, is native to Ireland, Britain &amp; western Europe as far south as central Spain (Hackney, 2008; Kohn <i>et al.</i>, 2009 Taylor, 2002).</p>

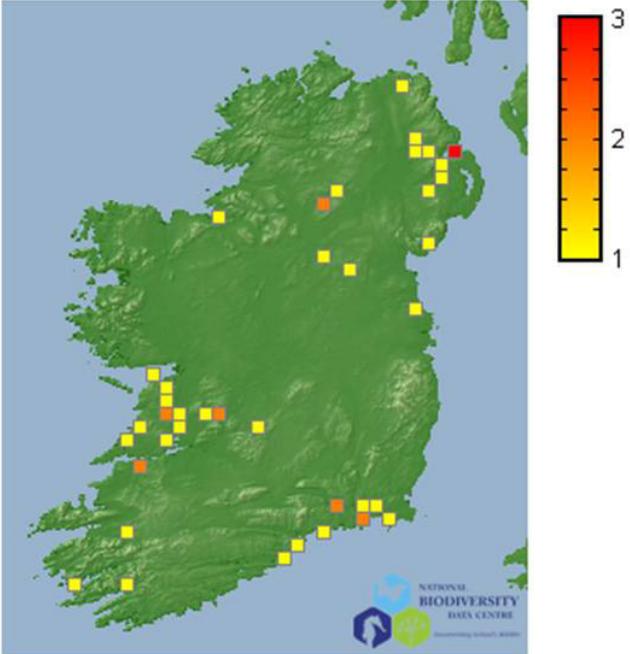
**Stage 1 - Organism Information and Screening: Section A - Organism Information**

The aim of this section is to gather basic information about the organism.

N	QUESTION	RESPONSE	COMMENT
			The hybrid bluebell, <i>H. hispanica x H non-scripta</i> , is perhaps the commonest cultivated bluebell in gardens (Taylor, 2002). In the wild this hybrid arises spontaneously where the native and/or introduced ranges of the parents meet (Taylor, 2002).
8	What is the current global distribution of the organism (excluding Ireland)?		Including <i>H. hispanica</i> 's native range (refer to Question 7) the species is naturalised elsewhere in southern and western Europe (Taylor, 2002). The hybrid bluebell, <i>H. hispanica x H non-scripta</i> , is naturalised in western Europe (Taylor, 2002).
9	What is the current distribution of the organism in Ireland?		<p>Alien bluebells have a localised distribution in Ireland, with most existing records of the species concentrated in the south east and south, respective (BSBI, 2010, Taylor, 2002). The hybrid bluebell's range and frequency is increasing but it is still unevenly recorded (Taylor, 2002). The Spanish bluebell may be continuing to increase slowly, but it has long been confused with <i>H. hispanica x H. non. scripta</i> and probably remains somewhat over recorded in error for the hybrid (Hackney, 2008; Reynolds, 2002; Taylor, 2002).</p> <p>One hundred and seventy records of the hybrid covering 59 10km<sup>2</sup> are verified in Ireland by the National Biodiversity Data Centre; (Figure 1; National Biodiversity Data Centre, 2014). Taylor (2002) report 80 10km<sup>2</sup> occurrences, all of which were recorded between 1987-1999. Forty eight records of the Spanish bluebell covering 39 10km<sup>2</sup> are verified in Ireland by the National Biodiversity Data Centre; (Figure 2; National Biodiversity Data Centre, 2014). Taylor (2002) report 76 10km<sup>2</sup> occurrences, all except one were recorded between 1987-1999. The native bluebell has a very frequent distribution (Parnell and Curtis, 2012; Stace, 1997; Taylor, 2002) The National Biodiversity Data Centre hold 3728 verified recordings covering 662 10km<sup>2</sup> (Figure 3.; National Biodiversity Data Centre, 2014)</p>

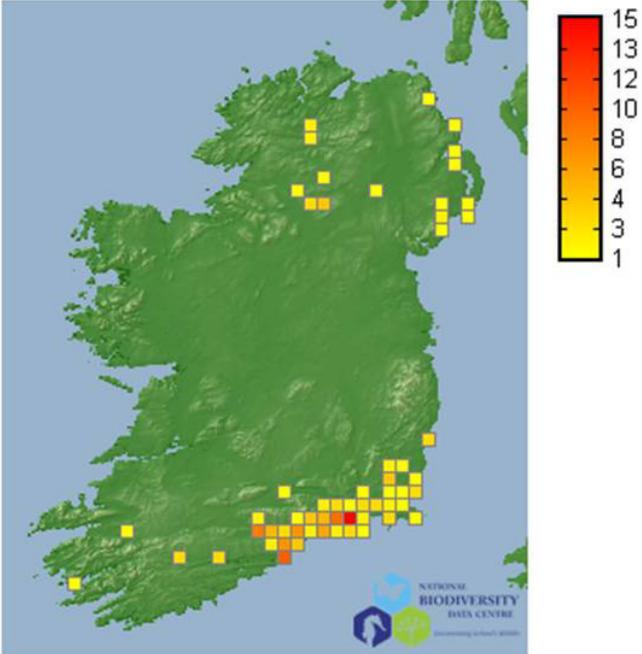
**Stage 1 - Organism Information and Screening: Section A - Organism Information**

*The aim of this section is to gather basic information about the organism.*

N	QUESTION	RESPONSE	COMMENT
			 <p><b>Figure 1.</b> Map showing most of the verified records for <i>Hyacinthoides hispanica</i> per 10km<sup>2</sup> in Ireland. Colour scale bar shows density of records per 10km (National Biodiversity Data Centre, 2014).</p>

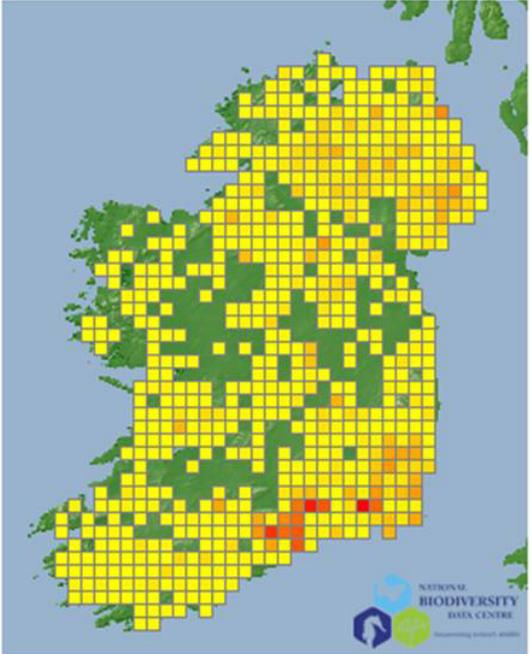
**Stage 1 - Organism Information and Screening: Section A - Organism Information**

The aim of this section is to gather basic information about the organism.

N	QUESTION	RESPONSE	COMMENT
			 <p><b>Figure 2.</b> Map showing most of the verified records for <i>Hyacinthoides hispanica</i> x <i>H. non. scripta</i> per 10km<sup>2</sup> in Ireland. Colour scale bar shows density of records per 10km (National Biodiversity Data Centre, 2014).</p>

**Stage 1 - Organism Information and Screening: Section A - Organism Information**

*The aim of this section is to gather basic information about the organism.*

N	QUESTION	RESPONSE	COMMENT
			 <p><b>Figure 3.</b> Map showing most of the verified records for <i>Hyacinthoides non-scripta</i> per 10km<sup>2</sup> in Ireland. Colour scale bar shows density of records per 10km (National Biodiversity Data Centre, 2014).</p>
10	Is the organism known to be invasive anywhere in the world?	YES	<p>Alien bluebells are thought to be potentially invasive (i.e. known to have intrinsic attributes that indicate a species is, or could be, threatening to other species, habitats or ecosystems), posing possible genetic and competitive displacement threats to the native bluebell in Britain and Ireland.</p> <p><i>H. non-scripta</i> is a species of bluebell native to Ireland, Britain and western Europe as far south as central Spain (Hackney, 2008; Taylor, 2002). It is estimated that 25-50% of the world's population of <i>H. non-scripta</i> is found in Britain and Ireland (Ingrouille, 1995). The native bluebell is highly valued in landscape and cultural</p>

**Stage 1 - Organism Information and Screening: Section A - Organism Information**

*The aim of this section is to gather basic information about the organism.*

N	QUESTION	RESPONSE	COMMENT
			<p>term. It is often considered an ancient woodland indicator and is sometimes classified as an axiophyte – a plant with strong association to habitat considered to be of high merit for conservation (BSBI, 2010). Although the species is ubiquitous on the scale of 10km<sup>2</sup> across Britain and Ireland (refer to Question 9; National Biodiversity Data Centre, 2014; Taylor, 2002) populations can be threatened by commercial over-exploitation, land use change and intensified grazing (Kohn <i>et al.</i>, 2009). Threats may also be posed by introduced and horticultural varieties of bluebell; <i>H. hispanica</i> – Spanish bluebell, and <i>H. hispanica</i> x <i>H. non-scripta</i> – hybrid bluebell (Kohn <i>et al.</i>, 2009; Pilgrim and Hutchinson, 2004). In Ireland both alien congeners are recorded in the wild (refer to Question 9). It is suggested that extensive hybridisation of these alien congeners with the native bluebell, <i>H. non-scripta</i>, which produces fertile seed, will contaminate native populations, threatening their genetic integrity and possibly causing introgression (hybridisation out of existence) of the native plant (Hackney, 2008; Huxel, 1999; Pilgrim and Hutchinson, 2004). To-date, there has been little attempt to examine or quantify these threats and these concerns may be overestimated (Hackney, 2008; Meek, 2011).</p> <p>In efforts to provide a basis for understanding the scale and urgency of a threat to Britain's native bluebells a Scottish based study by Kohn <i>et al.</i> (2009) examined whether native bluebells are at risk from alien congeners. The study found that 10% of natives co-occurred with aliens at the records scale and over 40% of natives were within 1–2 km of aliens (Kohn <i>et al.</i>, 2009). These distribution and co-occurrence patterns could provide considerable opportunities for genetic interactions and the study concluded that alien <i>Hyacinthoides</i> taxa pose a significant potential risk to native <i>H. non-scripta</i>. It must be noted the Kohn <i>et al.</i> (2009) did not examine actual hybridization, but only inferred the likelihood based on distribution and co-occurrence patterns. There are no such studies which exist for Ireland.</p> <p>It is also suggested that the generally larger alien taxa may outcompete the native for space (Huxel, 1999; Pilgrim and Hutchinson, 2004), but this has yet to be demonstrated empirically (BSBI, 2010; Meek, 2011).</p>

**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 alien bluebells is the horticultural trade.
1.02	List <u>significant</u> 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, via the Internet and garden centres and nurseries. It is known to be used as an ornamental plant of shaded areas of gardens and parks and also planted directly into the wild for perceived 'landscape improvement'. From domestic or wild habitats to which it is introduced it may become naturalised and potentially invasive.

**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	Entry of the species along this pathway is deliberate.
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?	MODERATELY	MEDIUM	There are no reliable data that exists to allow a reasonable assessment to be made of the number of plants that may, or may not, be brought into Ireland e.g. no figures available on the number of seeds, bulbs or plants sold and subsequently planted. However, movement would be dependent on the level of supply and demand, with demand expected to be moderately high considering the bluebell is one of Irelands most familiar and striking wild flower (Devlin, 2014; Hackney, 2008). What is more, there may be little, to no, appreciation for the potential invasiveness of the species, which does little to reduce possible demand.
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	LIKELY	MEDIUM	It is likely that the species could enter Ireland undetected and without the knowledge of the relevant authority as seed or bulb, particularly via the Internet and/or mail order trade. Hybrid bluebells are widely sold as native bluebells (Meek, 2011), which compounds the matter of detection. Sales of the Spanish bluebell are most likely the hybrid, not the pure species (Hackney, 2008).

<b>Pathway 1 – Horticultural trade</b>				
<b>N</b>	<b>QUESTION</b>	<b>RESPONSE</b>	<b>CONFIDENCE</b>	<b>JUSTIFICATION</b>
1.06	How likely is the organism to survive during passage along the pathway?	LIKELY	HIGH	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. The bulbous nature of the species means that survival is more or less guaranteed. The Spanish bluebell is known to have previously established via this pathway (Reynolds, 2002), substantiating that survival during passage is likely. It is often not possible to distinguish between naturally occurring and originally planted populations of the hybrid (Reynolds, 2002).
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	LIKELY	HIGH	Horticultural traders and gardeners are likely to stock and buy alien bluebells at the time of year most appropriate to planting. Seeds are sown best in spring and bulbs sown best in late summer into early autumn. However, the plant can establish from seed sown at any time of the year (Seedaholic, 2014)
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	VERY LIKELY	HIGH	Spanish and hybrid bluebells are intentionally planted domestically in horticultural habitat e.g. gardens demesnes, parkland, churchyards, cemeteries. From cultivation in horticultural habitat the species can spread via natural and human assisted dispersal (refer to Questions 3.02 and 3.03) into the wild e.g. woodlands, roadsides and waste ground. Spanish and hybrid bluebell are also intentionally planted in the wild, particularly woodland areas for perceived 'landscape improvement'. The species is likely to encounter and/or be introduced to such suitable habitat within the Irish landscape (CORINE, 2006; Fossitt, 2000).
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	MODERATELY LIKELY	HIGH	Horticultural trade is the main pathway for alien bluebells into the country. It is known to be used as an ornamental plant of shaded areas of gardens and parks and also planted directly into the wild for perceived 'landscape improvement'. Entry of alien bluebells along this pathway would be dependent on the level of supply and demand, with demand expected to be moderately high considering the bluebell is one of Irelands most familiar and striking wild flower (Devlin, 2014; Hackney, 2008). What is more, there may be little, to no, appreciation for the potential invasiveness of the species, which does little to reduce possible demand. It is likely that the species could enter Ireland undetected and without the knowledge of the relevant authority as seed or bulb, particularly via the Internet and/or mail order trade. Hybrid bluebells are widely sold as native bluebells (Meek, 2011), which compounds the matter of detection.
1.10	Do other pathways need to be considered?	NO	HIGH	

<b>Overall likelihood</b>				
<b>N</b>	<b>QUESTION</b>	<b>RESPONSE</b>	<b>CONFIDENCE</b>	<b>JUSTIFICATION</b>
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.*

<b>N</b>	<b>QUESTION</b>	<b>RESPONSE</b>	<b>CONFIDENCE</b>	<b>JUSTIFICATION</b>
2.01	Is the organism well established in Ireland (if there is any uncertainty answer 'unsure')	NO	HIGH	The Spanish and hybrid bluebell are established in Ireland. Both alien taxa have a localised distribution (refer to question 9) and may not be best described as <u>well</u> established i.e. widespread as yet.
2.02	How likely is it that the organism will be able to establish in Ireland based on the similarity between local <u>climatic conditions</u> and the organism's current global distribution?	VERY LIKELY	HIGH	The Spanish and hybrid bluebell's geographical range (refer to Questions 7-9) falls within the north temperate climatic zone. The species is also established in Britain (Meek, 2011), Ireland's nearest and climatically similar neighbour. The species range, therefore, includes 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).
2.03	How likely is it that the organism will be able to establish in Ireland based on the similarity between other local <u>abiotic conditions</u> and the organism's current global distribution?	VERY LIKELY	HIGH	There is a low to no habitat differentiation between native and alien bluebells (Kohn <i>et al.</i> , 2009). They thrive in similar environmental conditions to that of the native bluebell, particularly damp slightly acidic and nutrient-rich deciduous forests (Kohn <i>et al.</i> , 2009) and can be sensitive to drought (Blackman and Rutter, 1954). Expectation would, therefore, be for alien bluebells to have the potential to become a ubiquitous plant of the same habitat.
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	Alien bluebells are intentionally planted domestically in horticultural habitat e.g. gardens, demesnes, parkland, churchyards, cemeteries. From cultivation the species can spread via natural and human assisted dispersal into the wild e.g. woodlands, roadsides, riparian areas and waste ground. Wild habitats in which alien bluebells are found are usually associated with human habitation or the dumping of garden waste (Kohn <i>et al.</i> , 2009). Spanish and hybrid bluebell are also intentionally planted in the wild, particularly woodland areas. Native bluebells are ubiquitous on the scale of 10km <sup>2</sup> across Ireland, with occurrence in 662 of the ~1081 10km <sup>2</sup> (National Biodiversity Data Centre, 2014). Kohn <i>et al.</i> (2009) report little evidence of habitat exclusivity between native and alien bluebells. The species is very likely to encounter and/or be 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.*

<b>N</b>	<b>QUESTION</b>	<b>RESPONSE</b>	<b>CONFIDENCE</b>	<b>JUSTIFICATION</b>
2.05	How likely is it that establishment will occur despite competition from existing species in Ireland?	LIKELY	MEDIUM	Spanish and hybrid bluebell may be competitively advantaged; coming into growth and flowering early in the spring allows for the species to become dominant before competition from other species becomes an issue. Alien bluebells may be in direct competition with native bluebells. However, as aliens are much less numerous than natives (refer to Question 9), the current risk arising from direct competition may be small (Kohn <i>et al.</i> , 2009). Nothing is known of bulb interactions that could anticipate the outcome of underground competition (Kohn <i>et al.</i> , 2009).
2.06	How likely is it that establishment will occur despite predators, parasites or pathogens already present in Ireland?			There is a paucity of information, but native bluebells are generally pest-free in cultivation.
2.07	How likely is it that establishment will occur despite existing management practices?	LIKELY	HIGH	At present we are not aware of any existing management strategies that will limit or prevent the establishment of alien bluebells in Ireland i.e. the species is not under targeted control.
2.08	How likely is it that management practices in Ireland will facilitate the establishment of the organism?	LIKELY	HIGH	<p>The intentional planting of alien bluebells in the wild for perceived landscape improvement', or as an ornament of gardens and parks from which it can escape, clearly facilitate establishment (refer to Stage 1 - Entry).</p> <p>The trimming of hedgerows and roadside verges at the time the species is flowering, and the inappropriate dumping and transportation of soil or vegetation with seed or bulbs, including contamination of the earth-moving machinery, particularly within landscape gardening and the forestry sector, may facilitate the spread and establishment of the species.</p>
2.09	How likely is it that the biological characteristics of the organism would allow it to survive eradication campaigns in Ireland?	MODERATELY LIKELY	MEDIUM	Reproduction by seed and bulb division may allow alien bluebells to survive eradication, although the longevity of the seed is not known and no dormancy has been detected beyond the ability to remain quiescent through their first winter (Blackman and Rutter, 1954; Meek, 2011; Thompson and Grime, 1979). In mixed stands it is likely that introgression will have already allowed substantial gene flow to occur, consequently there will be a need for substantial collateral damage to the native plants in such situations.

**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
2.10	How likely is it that the biological characteristics of the organism will facilitate its establishment?	MODERATELY LIKELY	MEDIUM	Reproduction is both by seed and by bulb division (Blackman and Rutter, 1954). It is said to have no, to some, self-compatibility, with insect pollinators consisting mainly of <i>Bombus</i> species and syrphids (Corbet, 1998). The bulb is entirely renewed annually and as a result flowering and plant size are sensitive to drought and leaf loss experienced in the previous year (Blackman and Rutter, 1954; Littlemore and Barker, 2001). Seeds have no apparent adaptations for dispersal (Knight, 1964) and no dormancy detected beyond the ability to survive their first winter (Thompson and Grime, 1979). Germination in late autumn responds to seed conditioning at high temperatures followed by a gradual drop in temperature to 11°C or less (Thompson and Cox, 1978). Seedling survival and establishment is facilitated by mycorrhizal associations (Merryweather and Fitter, 1995).
2.11	How likely is it that the organism's capacity to spread will facilitate its establishment?	UNLIKELY	MEDIUM	Alien bluebells are considered to be poor natural dispersers and spread of the taxa is largely depended on human-assisted dispersal (refer to Question 3.02 and 3.03).
2.12	How likely is it that the organism's adaptability will facilitate its establishment?	LIKELY	MEDIUM	As detailed in Question 2.03, alien bluebells have the potential to be ubiquitous like the native bluebell.
2.13	How likely is it that the organism could establish despite low genetic diversity in the founder population?	LIKELY	HIGH	Low genetic diversity in the founder population is unlikely to prevent establishments. <i>Hyacinthoides</i> species readily hybridise (Reynolds, 2002).
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	Both the Spanish and hybrid bluebell have a localised distribution in Ireland, with most existing records of the species concentrated in the south east and south, respective (BSBI, 2010, Taylor, 2002).  Although <i>H. hispanica</i> was introduced into British gardens before 1683 its presence in the wild was noted just 100 years ago. And while the hybrid was first recorded in the wild in 1963 its increasing distribution was only recognised by 1987 (Taylor, 2002). This naturalisation of the alien taxa is a relatively recent phenomenon (refer to Question 9).
2.15	If the organism does not establish, then how likely is it that transient populations will continue to occur?	VERY UNLIKELY	MEDIUM	Alien bluebells are established and there are no reports of short-lived 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	<p>Alien bluebells are already established in Ireland, but presently could not be described as widespread. The climatic and abiotic conditions and habitats necessary for the establishment of alien bluebells exist in Ireland. There is a low to no habitat differentiation between native and alien bluebells (Kohn <i>et al.</i>, 2009). They thrive in similar environmental conditions to that of the native bluebell, particularly damp slightly acidic and nutrient-rich deciduous forests (Kohn <i>et al.</i>, 2009) and can be sensitive to drought (Blackman and Rutter, 1954). Expectation would, therefore, be for alien bluebells to have the potential to become a ubiquitous plant of the same habitat.</p> <p>Alien bluebells maybe in direct competition with native bluebells. However, as aliens are much less numerous than natives (refer to Question 9), the current risk arising from direct competition may be small (Kohn <i>et al.</i>, 2009). The species possesses biological traits which are considered moderately likely to aid establishment. There is a paucity of information with respect to the influence of natural enemies on establishment. In addition to intentional planting, existing management practices, particularly within the agricultural and transport sectors are likely to aid any potential establishment i.e. trimming of hedgerows and roadside verges at the time the species is flowering, and the inappropriate dumping and transportation of soil or vegetation with seed or bulbs. The establishment of alien bluebells hinges more on the successful entry and less on the species potential to grow and develop as a potentially invasive species in Ireland.</p>

**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	<p>Typical habitats where alien bluebells are known to invade or be introduced to, include gardens, demesnes, parks, churchyards, cemeteries, woodlands, roadsides, riparian areas and waste ground (Reynolds, 2002; Stace, 1997). The species is likely to encounter and/or be introduced to such suitable habitat within the Irish landscape (CORINE, 2006; Fossitt, 2000).</p> <p>With reference to the CORINE (2006) land cover classification alien bluebells have the potential to establish <u>in and/or along</u> the edges of road and rail networks - 0.06%, green urban areas - 0.04%, land principally occupied by agriculture with areas of natural vegetation (i.e. hedgerows and field margins) – 6.27%, broad leaved forests -0.42%, coniferous forest - 3.23%, mixed forest -0.42%, natural grassland -1.26%, transitional woodland (i.e. scrubland) - 5.89% and stream courses - 0.11%.</p>
3.02	How important is the expected spread of this organism in Ireland by <u>natural</u> means (minimal, minor, moderate, major or massive)?	MINOR	HIGH	Alien bluebells spread naturally by seed and offsets (Meek, 2011). They are considered poor natural dispersers, with seeds having no apparent adaptations for dispersal (Knight, 1964; Thompson and Grime, 1979) and although patches increase in size they do not appear to spread much from their original planting sites (BSBI, 2010).
3.03	How important is the expected spread of this organism in Ireland by <u>human assistance</u> (minimal, minor, moderate, major or massive)?	MAJOR	HIGH	Alien bluebells are primarily dispersed by humans. They are intentionally introduced by humans into domestic habitat and wild habitat for ornament and for perceived 'landscape improvement' (refer to Stage 1 - Entry). Human assisted spread of alien bluebells into the wild is also due to the careless disposal of garden rubbish containing seed and bulbs (Hackney, 2008; Meek, 2011). The spread of alien bluebells is rarely seen far from lines of human habitation and Kohn <i>et al.</i> (2009) found the presence of alien bluebells related to variables correlated with human density.
3.04	Within Ireland, how difficult would it be to contain the organism (minimal, minor, moderate, major or massive)?	MODERATE	MEDIUM	Containment of existing patches of alien bluebells is likely, but perhaps only if they are kept in check, by the removal of plants as and when discovered. Containment is feasible as natural dispersal does not appear to play a significant role in spread (refer to Question 3.02).

### 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	The Spanish bluebell is present in 39 of the ~1018 10 km squares that constitute Ireland; whilst the hybrid bluebell is present in 59 10 km squares (National Biodiversity Data Centre, 2014). Alien bluebells do not currently occur in more than 0-10% of land cover. However, the distribution of the hybrid, as revealed by the more thorough recording undertaken in County Waterford, suggests the alien taxa may already be much more widespread across 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	For further spread a period longer than 5 years is likely to be required. This is because natural dispersal is slow and it would be hoped that a developing appreciation for the potential invasiveness of the taxa would reduce introductions by humans to new sites.
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.	10-160	MEDIUM	Based on the knowledge of spread (refer to Questions 3.05 and 3.06), a longer timeframe would be appropriate in estimating any significant further spread via natural dispersal. The naturalisation of the alien bluebells is a relatively recent phenomenon (refer to Question 9), which has been strongly dependent on human introduction. Conversely, therefore, a shorter timeframe may be appropriate in estimating any significant further spread via human aided dispersal.
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	It is likely that local populations will consolidate in the medium term, and the occasional rare occurrence of long distance dispersal or discard of plants will establish new populations.
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	Alien establishment and spread is closely tied to the built environment, which likely explains the negative relationship found for aliens with heathland and conifer plantations that are often a distance from urban areas (Kohn <i>et al.</i> , 2009). Any woodlands, roadsides, riparian areas and waste ground near human habitation are most at risk 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.	MODERATELY	MEDIUM	Typical habitats where alien bluebells are known to invade or be introduced to include gardens, demesnes, parks, churchyards, cemeteries, woodlands, roadsides, riparian areas and waste ground (Reynolds, 2002; Stace, 1997). The species is likely to encounter and/or be introduced to such suitable habitat within the Irish landscape (CORINE, 2006; Fossitt, 2000). Spread would therefore not be

**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
				<p>considered to be restricted by the availability of habitat.</p> <p>The primary vector of spread is mostly likely human aided dispersal, where spread is closely tied to the built environment and alien bluebells rarely seen far from lines of human habitation. The rate of human aided dispersal may be best considered as moderate, particularly given the high landscape and cultural value placed on bluebells. They are considered poor natural dispersers, with seeds having no apparent adaptations for dispersal (Knight, 1964; Thompson and Grime, 1979) and although patches increase in size they do not appear to spread much from their original planting sites (BSBI, 2010).</p>

<b>Stage 2 - Detailed assessment: Section D - Impact</b>				
<i>This section evaluates the probability of impact of an organism within Ireland.</i>				
<b>N</b>	<b>QUESTION</b>	<b>RESPONSE</b>	<b>CONFIDENCE</b>	<b>JUSTIFICATION</b>
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?	N/A	MEDIUM	There is no knowledge of any global economic costs incurred to-date (Meek, 2011).
4.02	How great has the economic cost of the organism been in Ireland from the <u>time of introduction to the present</u> ? Exclude any costs associated with managing the organism from your answer.	N/A	MEDIUM	There is no knowledge of any economic costs incurred to-date in Ireland.
4.03	How great is the economic cost of the organism likely to be in the <u>future</u> in Ireland? Exclude any costs associated with managing the organism from your answer.	N/A	MEDIUM	If any economic costs were to be incurred they are likely to only be associated with management of the species.
4.04	How great have the economic costs of managing this organism been in Ireland from the <u>time of introduction to the present</u> ?	N/A	MEDIUM	There is no knowledge of any economic costs incurred to-date in Ireland
4.05	How great is the economic cost of managing this organism likely to be in the <u>future</u> in Ireland?	MODERATE	MEDIUM	Economic cost would only arise if the species was to become subject to control measures. Eradication of alien bluebells from extensively contaminated sites is probably uneconomic and undesirable (Hackney, 2008). Focus of management would be to ensure only native province bluebells were available to cultivate and the prevention of alien spread into natural woodland or other natural habitats by the removal of intentionally planted or garden escapes as and when discovered (Hackney, 2008)
4.06	How important is environmental harm caused by the organism within its global distribution?	MINOR	MEDIUM	<p>It is suggested that extensive hybridisation of these alien congeners with the native bluebell, <i>H. non-scripta</i>, which produces fertile seed, will contaminate native populations, threatening their genetic integrity and possibly causing wholesale introgression (hybridisation out of existence) of the native plant (Hackney, 2008; Huxel, 1999; Pilgrim and Hutchinson, 2004). To-date, there has been little attempt to examine or quantify these threats and these concerns may be overestimated (Hackney, 2008; Meek, 2011).</p> <p>It is also suggested that the generally larger alien taxa may outcompete the native for space (Huxel, 1999; Pilgrim and Hutchinson, 2004), but this has yet to be demonstrated empirically (BSBI, 2010; Meek, 2011).</p>

<b>Stage 2 - Detailed assessment: Section D - Impact</b>				
<i>This section evaluates the probability of impact of an organism within Ireland.</i>				
<b>N</b>	<b>QUESTION</b>	<b>RESPONSE</b>	<b>CONFIDENCE</b>	<b>JUSTIFICATION</b>
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	MINOR	MEDIUM	The potential impact of alien bluebells to biodiversity in Ireland is largely anecdotal. There is no published literature on the impact of alien bluebells on biodiversity to-date in Ireland. In other words, there are no direct scientific links that attributes (i.e. hybridisation, or even potential attributes i.e. competition) of alien bluebells are threatening to other species, habitats or ecosystems.
4.08	How important is the impact of the organism on biodiversity likely to be in the <u>future</u> in Ireland?	MODERATE	MEDIUM	The potential for aliens to spread or be introduced to woodlands or semi-natural grassland, may pose a threat to the genetic integrity of indigenous bluebell populations. The life cycle of aliens and their potential to form dense monocultural masses means it has the potential to effect low growing spring flowers, with native bluebells considered to be at risk. The potential environmental impact may be over-estimated and to-date there is little research conducted in this area. In order to place a high confidence on the potential impact of aliens bluebells on Irish biodiversity, specifically the threat o native bluebell populations, research is required.
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	MEDIUM	There is no knowledge of any alteration of ecosystem function in Ireland to-date.
4.10	How important is alteration of ecosystem function caused by the organism likely to be in Ireland in the <u>future</u> ?	MINIMAL	MEDIUM	Any potential alteration to ecosystem functioning would be considered minimal. The main treat is the potential for alien bluebells to compromise the genetic integrity of the native bluebell, which is often considered an ancient woodland indicator and is sometimes classified as an axiophyte – a plant with strong association to habitat considered to be of high merit for conservation (BSBI, 2010).
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.	MINOR	MEDIUM	<p>The increasing prevalence of alien bluebells in Ireland is interpreted as a potential threat to the native bluebell. Such a potential threat is also likely to impact upon the status of areas of conservation interest where the native bluebell is indigenous. There, however, is no data available to make an informed assessment of the decline in conservation status caused by alien bluebells in Ireland.</p> <p>The degree to which areas of conservation interest (i.e. ancient or natural Irish woodland) are contaminated with alien bluebells is unknown. Based on the current distribution and occurrence of alien bluebells (refer to Question 9) contamination is probably not extensive (Hackney, 2008). In Britain the native bluebell is protected under the Wildlife and Countryside Act (WCA, 1981).</p>

**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 <u>future</u> in Ireland?	MODERATE	MEDIUM	Alien bluebells may already be impacting upon the conservation status of protected and/or important sites. The potential for aliens to spread or be introduced to woodlands or semi-natural grassland, may pose a threat to the genetic integrity of indigenous bluebell populations. In order to place a high confidence on the potential impact of alien bluebells on the conservation status of Irish biodiversity, specifically the threat of native bluebell populations, research is required.
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?	MINIMAL	MEDIUM	The potential degradation of the integrity of the native bluebell by introgression with alien bluebells may negatively affect society given that the native has a cultural importance within the Irish landscape, as one of the most familiar and much loved wildflowers (Devlin, 2014; Hackney, 2008; Meek, 2011).  Information on health impacts tends to refer to the native <i>H. non-scripta</i> , which is said to be poisonous, but have diuretic and styptic properties, and also have sap which can be used as a glue and as a starch (Meek, 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?	MINIMAL	MEDIUM	Refer 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?	MODERATE	MEDIUM	Genetic traits of <i>H. hispanica</i> , the Spanish bluebell, are carried when it hybridises with the native, <i>H. non-scripta</i> . The resulting hybrid, <i>H. non-scripta</i> x <i>H. hispanica</i> , is fully fertile and produces abundant seed. The poses a potential threat to the genetic integrity of indigenous bluebell populations which may result in economic, environmental or social impacts, as outline above.
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)?	N/A	HIGH	The Spanish and hybrid bluebell are not known as a food, a host, a symbiont or a vector for other damaging organisms.
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 these alien species would have.

**Stage 2 - Detailed assessment: Section D - Impact**

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.18	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?	UNKNOWN	HIGH	As with Question 2.06, there is a lack of information.
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	There are possible economic and environmental problems for conservation sites, particularly ancient woodland (BSBI, 2010).
4.20	Estimate the overall potential impact of this organism in Ireland. Use the justification box to indicate any key issues.	MINOR	MEDIUM	<p>There are no known economic impacts to-date. If any economic costs were to be incurred they are likely to only be associated with management of the species. Eradication of alien bluebells from extensively contaminated sites is probably uneconomic and undesirable (Hackney, 2008). Focus of management would be to ensure only native province bluebells were available to cultivate and the prevention of alien spread into natural woodland or other natural habitats by the removal of intentionally planted or garden escapes as and when discovered (Hackney, 2008).</p> <p>It is suggested that extensive hybridisation of these alien congeners with the native bluebell, <i>H. non-scripta</i>, which produces fertile seed, will contaminate native populations, threatening their genetic integrity and possibly causing wholesale introgression (hybridisation out of existence) of the native plant (Hackney, 2008; Huxel, 1999; Pilgrim and Hutchinson, 2004). It is also suggested that the generally larger alien taxa may outcompete the native for space (Huxel, 1999; Pilgrim and Hutchinson, 2004), but this has yet to be demonstrated empirically (BSBI, 2010; Meek, 2011). To-date, there has been little attempt to examine or quantify these threats and these concerns may be overestimated (Hackney, 2008; Meek, 2011).</p>

**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	MINOR	MEDIUM	<p>Horticultural trade is the main pathway for Spanish and hybrid bluebells into the country. Bluebells are known to be used as ornamental plants of shaded areas of gardens and parks and also planted directly into the wild for perceived 'landscape improvement'. Entry of alien bluebells along this pathway would be dependent on the level of supply and demand, with demand expected to be moderately high considering the bluebell is one of Ireland's most familiar and striking wild flower (Devlin, 2014; Hackney, 2008). It is likely that the species could enter Ireland undetected and without the knowledge of the relevant authority as seed or bulbs, particularly via the Internet and/or mail order trade. Hybrid bluebells are widely sold as native bluebells (Meek, 2011), which compounds the matter of detection.</p> <p>Alien bluebells are already established in Ireland, but presently could not be described as widespread. The climatic and abiotic conditions and habitats necessary for the establishment of alien bluebells exist in Ireland. There is a low to no habitat differentiation between native and alien bluebells (Kohn <i>et al.</i>, 2009). They thrive in similar environmental conditions to that of the native bluebell, particularly damp slightly acidic and nutrient-rich deciduous forests (Kohn <i>et al.</i>, 2009) and can be sensitive to drought (Blackman and Rutter, 1954). Expectation would, therefore, be for alien bluebells to have the potential to become a ubiquitous plant of the same habitat.</p> <p>In addition to intentional planting, existing management practices, particularly within the agricultural and transport sectors are likely to aid any potential establishment i.e. trimming of hedgerows and roadside verges at the time the species is flowering, and the inappropriate dumping and transportation of soil or vegetation with seed or bulbs. The establishment of alien bluebells hinges more on the successful entry and less on the species potential to grow and develop as a potentially invasive species in Ireland.</p> <p>The primary vector of spread is mostly likely human aided dispersal, where spread is closely tied to the built environment and alien bluebells rarely seen far from lines of human habitation. The rate of human aided dispersal may be best considered as moderate, particularly given the high landscape and cultural value place on bluebells. They are</p>

				<p>considered poor natural dispersers, with seeds having no apparent adaptations for dispersal (Knight, 1964; Thompson and Grime, 1979) and although patches increase in size they do not appear to spread much from their original planting sites (BSBI, 2010).</p> <p>It is suggested that extensive hybridisation of these alien congeners with the native bluebell, <i>H. non-scripta</i>, which produces fertile seed, will contaminate native populations, threatening their genetic integrity and possibly causing wholesale introgression (hybridisation out of existence) of the native plant (Hackney, 2008; Huxel, 1999; Pilgrim and Hutchinson, 2004). It is also suggested that the generally larger alien taxa may outcompete the native for space (Huxel, 1999; Pilgrim and Hutchinson, 2004), but this has yet to be demonstrated empirically (BSBI, 2010; Meek, 2011). To-date, there has been little attempt to examine or quantify these threats and these concerns may be overestimated (Hackney, 2008; Meek, 2011).</p>
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**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?	-	MEDIUM	<p>A milder, moister climate, with more extreme weather events is predicted for Ireland under global warming (Sweeney <i>et al.</i>, 2003)</p> <p>Climate, specifically temperature effects on seed germination, undoubtedly plays a role in delimiting the global distribution of the native bluebell and might be expected to play a similar role for alien bluebells (Kohn <i>et al.</i>, 2009). Given Spanish bluebells' native range in the warmer regions of the temperate climatic zone (Southern Europe and North Africa), any temperature increases in Ireland as a result of climate change may be significant to further establishment and spread.</p> <p>Kohn <i>et al.</i> (2009) found increasing rainfall to be associated with increasing densities of native bluebells and decreasing densities of alien bluebells. Therefore, a moister climate may hamper alien bluebell establishment and spread, which is converse to the potential negative effect a warming climate may have.</p> <p>Whilst alien and native bluebells are known to have different climate profiles (Kohn <i>et al.</i>, 2009), the distribution of the alien bluebells likely reflects more the affect of human assisted introduction rather than strict climatic limits or potential changes to the climate. This is reflected in the occurrence of alien bluebells in the north, south, east and west of the country (refer to Figure 1 and 2)</p>
6.02	What is the likely timeframe for such changes (5, 10, 15, 20, 50 or 100 years)?	5-100	MEDIUM	Any timeframe during which the Irish climate experiences a warming effect as a result of climate change may be significant to the further spread of the species.
6.03	What aspects of the risk assessment are most likely to change as a result of climate change	-	MEDIUM	The increasingly favourable climatic conditions as a result of climate change would require for the risk assessment on the potential invasiveness of alien bluebells to reconsider establishment and spread and their associated potential impacts to the Irish economy, environment and society.
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	Research into the actual existing impacts that the establishment and spread of aliens have on the native bluebell population in Ireland is required. A start point may be an examination of the extent of co-occurrence of the taxa (Kohn <i>et al.</i> , 2009).

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