

Risk Assessment of *Lysichiton americanus*

Name of Organism:	<i>Lysichiton americanus</i> Hultén and H. St. John, 1931 – American Skunk Cabbage
Objective:	Assess the risks associated with this species in Ireland
Version:	Final 15/09/2014
Author(s)	Erin O'Rourke, Colette O'Flynn
Expert reviewer	Matthew Jebb - National Botanic Gardens

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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

Name of Document:	Risk Assessment of <i>Lysichiton americanus</i>				
Author (s):	Dr Erin O'Rourke and Ms. Colette O'Flynn				
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		02/03/2014
Expert review	Complete	Dr Erin O'Rourke	Dr Matthew Jebb	Dr Liam Lysaght	09/05/2014
Public consultation	Complete	Dr Erin O'Rourke		Dr Liam Lysaght	24/07/2014
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

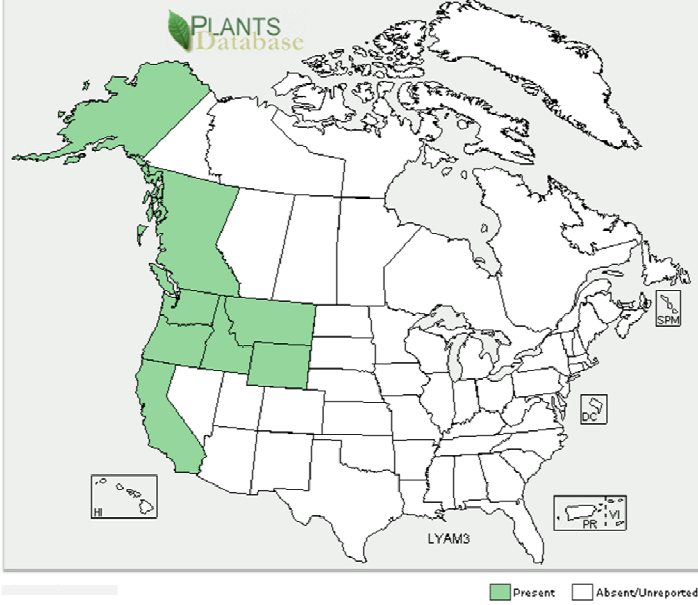
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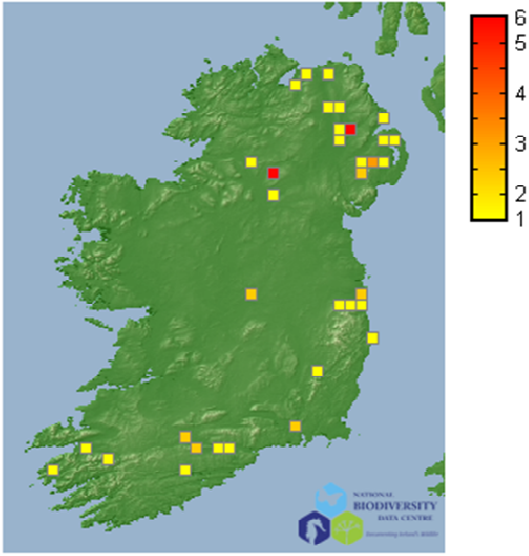
N	QUESTION	RESPONSE	COMMENT
1	What is the reason for performing the risk assessment?	-	A risk assessment is required as this species is listed as a "Non-native species subject to restrictions under Regulations 49 and 50" in the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 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>Lysichiton americanus</i> Hultén and H. St. John, 1931– American skunk cabbage</p> <p>Taxonomy: Kingdom: Plantae Phylum: Spermatophyta Subphylum: Angiospermae Class: Monocotyledonae Order: Arales Family: Araceae Genus: <i>Lysichiton</i> Species: <i>americanus</i></p> <p>Synonyms: <i>Lysichiton americanum</i>, <i>Lysichitum americanum</i> (ARKIVE, 2014; Klingenstein and Alberternst, 2010)</p> <p>Common name (English): American skunk-cabbage, American yellow skunk cabbage, meadow cabbage, skunk cabbage, skunk weed, swamp cabbage, western skunk cabbage, yellow arum, yellow skunk cabbage, swamp lantern (CABI, 2014)</p> <p><i>Lysichiton americanus</i> is an easily recognised (refer to Question 4) and highly ornamental plant that has been introduced outside its natural range (CABI, 2014).</p> <p><i>Lysichiton camtschatcensis</i> (L.) Schott, is the only other species in the genus (Parnell and Curtis, 2012; Stace, 1997). <i>Lysichiton camtschatcensis</i>, originally restricted to north east Asia, is also grown as an ornamental in the same habitats as <i>L. americanus</i>, and to which it is closely related (CABI, 2014; RHS, 2014; Stace, 1997). <i>Lysichiton camtschatcensis</i> differs from <i>L. americanus</i> (refer to Question 4) in slightly smaller spathe and spadix; white spathe; tepals 2-3 mm; anthers 0.06-0.8 mm; and scentless flowers (Stace, 1997).</p> <p>Stace (1997) comments that the two taxa hybridise, are often confused, and might be better treated as subspecies. A hybrid between the two has been given the designation <i>L. hortensis</i> 'Billy' (Armitage and Phillips, 2011).</p>

Stage 1 - Organism Information <i>The aim of this section is to gather basic information about the organism.</i>			
N	QUESTION	RESPONSE	COMMENT
			<p>The epithet <i>americanum</i> has been used as well, but is now considered wrong and the genus name <i>Lysichiton</i> is also misspelled on occasion as <i>Lysichitum</i> (JFP, 2001; St. John & Hultén, 1956)</p> <p><i>Lysichiton americanus</i> (refer to Question 4) may be confused with the native <i>Arum maculatum</i>, but <i>A. maculatum</i> has a smaller spathe and differs in colour from the bright yellow spathes of <i>L. americanus</i> (O'Flynn and Duffy, 2013).</p>
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>Klingenstein and Alberternst (2010) describe <i>L. americanus</i> as “a tall herb (up to 1.5 m high, covering approximately 1 m² ground) with large (40-70 cm up to 1.5 m) tobacco-like, stemmed leathery leaves with a light sheen and stems as thick fleshy rhizomes (up to 30 cm long and 2.5-5 cm diameter) under the ground. The 1 to 2 (sometimes up to 4) inflorescences are coated by a showy bright yellow spathe up to 45 cm high, enclosing one fleshy, up to 25 cm big spadix carrying many flowers at the bottom. Flowers are small yellowish green, often monoecious with female flowers below and male above (with generally 4, sometimes 6 stamens); also bisexual flowers are found. Flowers consist of generally 4, sometimes 6 free or fused tepals. They usually flower between March and May (June) (in Germany and in Finland in May) before leaves appear. The fruits are green berries at the end of the spadix, mature in its natural range from June to July, in Germany in July or early August”.</p>
5	Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	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 <i>Lysichiton americanus</i> as a “medium risk” invasive species.
6	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?	PARTIAL	Only a preliminary risk assessment was previously conducted in Ireland (refer to Question 5)
7	Where is the organism native?		American skunk cabbage originates from the wetland areas in the north western pacific coastal zone of North America, from south east Alaska to northern California (Alaska, British Columbia, Washington, Oregon, California, Montana, Idaho and Wyoming; Hickman, 1993; FNA, 1993; USDA-NRCS, 2014). In its native distribution it is a plant that is typical for a number of both shaded and open swamp communities (CABI, 2014).

Stage 1 - Organism Information

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

N	QUESTION	RESPONSE	COMMENT
			 <p>Figure 1. Native range of <i>Lysichiton americanus</i> (American skunk cabbage; taken from USDA-NRCS, 2014) .</p>
8	What is the current global distribution of the organism (excluding Ireland)? (map optional)		Including its native range (refer to Question 7) the species has been introduced to eleven European countries: Britain, Ireland; Sweden; Germany; Belgium; Norway; Finland; France; Netherlands; Denmark; Switzerland (Alberternst <i>et al.</i> , 2009). <i>Lysichiton americanus</i> was first introduced in Europe for cultivation in Britain in 1901 (Hill, 2011).
9	What is the current distribution of the organism in Ireland? (map optional)	-	In Ireland <i>L. americanus</i> has a scattered distribution, which is locally abundant in places (O'Flynn and Duffy, 2013; Stace, 1997). Sixty-nine records are verified for this species in Ireland by the National Biodiversity Data Centre; the majority of which are found in the north east of the island (Figure 2; National Biodiversity Data Centre, 2014). The species was first deliberately introduced into the wild in Ireland around 1930, when it was planted in Woodfield Bog, Co. Offaly (Doyle and

Stage 1 - Organism Information <i>The aim of this section is to gather basic information about the organism.</i>			
N	QUESTION	RESPONSE	COMMENT
			<p>Duckett, 1985; Reynolds, 2002).</p>  <p>Figure 2. National biodiversity data centre map showing verified records for <i>Lysichiton americanus</i> Hultén and H. St. John, 1931– American skunk cabbage, per 10km² in Ireland. Colour scale bar shows density of records per 10km (NBDC, 2014).</p>
10	Is the organism known to be invasive anywhere in the world?	YES	<p>In <i>L. americanus</i> native range, no economic, social or environmental impacts are reported (Alberternst <i>et al.</i>, 2009). Of the eleven European countries the species has been introduced to, the European and Mediterranean Plant Protection Organisation report invasive populations to exist in Britain, Ireland and Germany (Alberternst <i>et al.</i>, 2009).</p> <p>Well established populations are able to out-compete native vegetation and over time create a problem for biodiversity (CABI, 2014). Studies in Germany by König and Nawrath (1992) and Alberternst and Nawrath (2002) report displacement and local extinction of mosses, vascular plants and orchid species.</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	There are very few active/future pathways relevant to the entry of <i>L. americanus</i> .
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 (as seed, rhizome and/or plant) to be sourced through the horticultural trade for use as a garden plant. From gardens to which it is introduced it may escape and become naturalised/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	VERY HIGH	As there is no natural pathway for this species to enter, any entry has to be intentional i.e. deliberately introduced by man.
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	<i>Lysichiton americanus</i> has been introduced via the horticulture pathway into many (water and swamp) gardens over a long time period and on a considerable scale in many European countries (CABI, 2014). It has never been a very popular species and is not grown on a large scale (CABI, 2014). Both the size of the plant, its habitat and the smell of its flowers prohibit popularity of full grown specimens for small gardens (CABI, 2014). <i>Lysichiton americanus</i> is most likely used in large scale gardens and ponds where it can "take care of itself" (CABI, 2014). Today, with a developing appreciation for the invasiveness of the species, intentional planting in gardens would only be expected to account for a small volume of entry. In many cases introduction into the wild has been carried out on purpose (e.g. Woodfield Bog in Ireland and in Taunus in Germany) or via old swamp-nurseries that have been abandoned and returned to the wild (CABI, 2014).

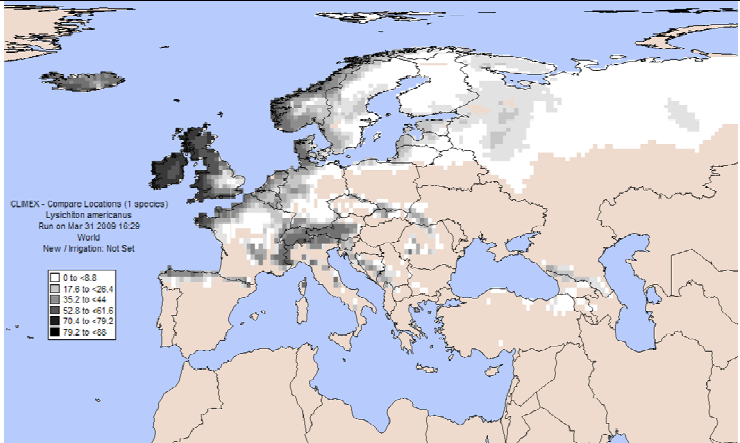
Pathway 1 – Horticultural trade				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	LIKELY	HIGH	It is likely that the species could enter Ireland undetected and without the knowledge of the relevant authority, particular as seed via internet horticultural trade. It may be less likely for the species to go undetected as a plant, especially if it is labeled and checked at an entry point into the country. Once planted it is only likely to be detected during growth and development in spring.
1.06	How likely is the organism to survive during passage along the pathway?	LIKELY	HIGH	Likely for the species nutritional and housing requirements to be catered for by the importer. The species is known to have previously establishment via this pathway (refer to Question 1.04), substantiating that survival during passage is likely.
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	LIKELY	MEDIUM	Horticultural traders and gardeners are likely to stock and buy <i>L. americanus</i> at the time of year most appropriate to planting.
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	LIKELY	MEDIUM	The species is intentionally planted domestically in horticultural habitat i.e. swamp-like/wet gardens. From gardens the species can spread via natural and human assisted dispersal (refer to Questions 3.02 and 3.03). Typical habitats where it is known to invade or naturalise include wet woodlands, lakeside, raised bogs, swamps, riverbanks, pond margins, in permanently wet soils, in alluvial forests, moorlands and wet meadows (Alberternst & Nawrath, 2002; Doyle & Duckett, 1985; Vanderhoeven, <i>et al.</i> , 2007). 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	MEDIUM	The horticultural trade is the primary factor in the entry of this species to new areas and <i>L. americanus</i> has a long history of cultivation and introduction, though it has never been a particularly popular species and is not grown on a large scale (CABI, 2014). Both the size of the plant, its habitat and the smell of the flowers restrict its popularity in small gardens (CABI, 2014). <i>Lysichiton americanus</i> is most likely used in large scale gardens and ponds where it can “take care of itself” (CABI, 2014).
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 <i>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.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.01	Is the organism well established in Ireland (if there is any uncertainty answer 'unsure')	NO	HIGH	Stokes <i>et al.</i> (2004) describes <i>L. americanus</i> as an alien plant established in natural and semi-natural habitats in Ireland. The species is established with a scattered distribution, which is locally abundant in places (O'Flynn and Duffy, 2013; Stace, 1997). The species is persistent once established, but only rarely forms large stands (Reynolds, 2002). Within Europe the largest and longest established populations are found in Britain and Ireland (Klingenstein and Alberternst, 2010). The species could not be described as <u>well</u> established in Ireland i.e. widespread.
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	<i>L. americanus</i> is typically associated with climates Cf, Dfb and Dfc in Köppen's classification, i.e. cool to hot summer, very cold to cool winter, wet year round (CABI, 2014); and the species is hardy at least to zone 7 (–15°C). A climatic prediction with the software CLIMEX has been performed (Figure 3) and highlights that Northern and Western Europe are the most at risk to invasion/naturalisation, with the Mediterranean area not considered at risk as it is assumed to be too warm and too dry during summer (Alberternst <i>et al.</i> , 2009). Areas shown to be particularly at risk are areas having an Atlantic influence (Britain, Ireland, Northern coast of Spain, Bretagne in France, the Netherlands, Denmark, Norway) and mountainous areas (the Massif central in France, the Alps, the Pyrenees, the Carpatian Mountains, Bolsoj Kavkaz in Georgia, Ural Mountains in Russia; Figure 3; Alberternst <i>et al.</i> , 2009). It is, therefore, not surprising that the species has acclimatised to Ireland, 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), and other European countries in a comparable climatic zone.

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
				 <p>Figure 3. Climatic prediction for <i>Lysichiton americanus</i> - CLIMEX model aiming at predicting the potential geographical distribution of an organism considering its climatic requirements and based on the hypothesis that climate is an essential factor for the establishment of a species in a country (Modified from Alberternst <i>et al.</i>, 2009).</p>
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?	LIKELY	HIGH	<p>As long as the habitat is wet, <i>L. americanus</i> has no specific soil requirements (from light sand soils to heavy clay soils of acid, neutral or basic reaction) and can grow in shade or full light (CABI, 2014; Alberternst <i>et al.</i>, 2009; Klingenstein and Alberternst, 2010). It is hardy to at least -15°C and grows from 0-1400 m altitude (Klingenstein and Alberternst, 2010). In contrast to most other alien plant species it is restricted to these more or less natural habitats which in Europe, including Ireland, are rare and often highly endangered or protected (CORINE, 2006; Fossitt, 2000; Klingenstein and Alberternst, 2010). Favoured abiotic conditions for growth and establishment are permanently wet, acidic, humus (nutrient) rich soils in semi-shaded situations (CABI, 2014; Alberternst <i>et al.</i>, 2009).</p>

Stage 2 - Detailed assessment: Section B – Establishment <i>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.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.04	How likely is the organism to encounter habitats necessary for the survival, development and multiplication of the organism in Ireland?	LIKELY	MEDIUM	In its natural and introduced range <i>Lysichiton americanus</i> grows in the transition zone of terrestrial, semi-aquatic and aquatic habitats (Klingenstein and Alberternst, 2010). It has typically been found in wetlands including wet woodlands, lakeside, raised bogs, swamps, riverbanks, pond margins, in permanently wet soils, in alluvial forests, moorlands and wet meadows (Vanderhoeven, <i>et al.</i> , 2007; Doyle & Duckett, 1985; Alberternst & Nawrath, 2002). The species is likely to be introduced to and/or encounter such suitable habitat within the Irish landscape (CORINE, 2006; Fossitt, 2000).
2.05	How likely is it that establishment will occur despite competition from existing species in Ireland?	VERY LIKELY	HIGH	Competition is not suspected to play a role in preventing the growth of <i>L. americanus</i> , especially as the species can already be found in Ireland. In the species' preferred habitat in under storey forest, there are no serious competitors (Alberternst <i>et al.</i> , 2009), although Alberternst and Nawrath (2002) mention competition with <i>Viola palustris</i> and orchids. Additionally, <i>L. americanus</i> has a competitive advantage because leaf development starts earlier in spring and the plants form large and dense clumps of vegetation which are generally taller than native under storey plants, and out compete them (CABI, 2014; Alberternst <i>et al.</i> , 2009).
2.06	How likely is it that establishment will occur despite predators, parasites or pathogens already present in Ireland?	LIKELY	HIGH	In its native range, this species is eaten by black tailed deer (<i>Odocoileus hemionus sitkensis</i>) (Gillingham <i>et al.</i> , 1997, 2001) and by Grizzly bear (<i>Ursus arctos</i>) (Gyug <i>et al.</i> , 2004), but the plant is not reported to be eaten by animals in its introduced range. During establishment seedlings may be eaten by slugs and leaves may be eaten by snails, as was observed in the Haute-Vienne station in France (Lebreton, 2007). Herbivory does not, however, play a significant role in preventing the establishment of the species, which is understandable because of the toxicity of the plant (contains calcium oxalate raphides) (Alberternst <i>et al.</i> , 2009).
2.07	How likely is it that establishment will occur despite existing management practices?	LIKELY	MEDIUM	At present we are not aware of any existing management strategies that will limit or prevent the establishment of this species in Ireland i.e. the species is not under targeted control.

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
2.08	How likely is it that management practices in Ireland will facilitate the establishment of the organism?	MODERATELY LIKELY	MEDIUM	In managed environments planting of the species along watercourses and in ponds and artificial lakes may favour establishment. Natural habitats where <i>L. americanus</i> is found (refer to Question 2.04) can be rare and are often endangered or protected (CORINE, 2006; Fossitt, 2000; Klingenstein and Alberternst, 2010). Protection of such habitat may unintentionally favour the establishment of the species, which highlights the need to flag protected wetland habitats as areas endangered to invasion by the species. Conversely, landscape improvement, particularly land drainage, would decrease the area of land favourable to potential establishment.
2.09	How likely is it that the biological characteristics of the organism would allow it to survive eradication campaigns in Ireland?	LIKELY	MEDIUM	There are no known eradication campaigns currently in place in Ireland. Dispersal of the plant's seeds via water may make eradication difficult. Seeds are readily produced after flowering, and can remain viable in the soil for 6-8 years (Alberlernst and Nawrath, 2002; Klingenstein and Alberternst, 2010). If fragments of the plant's rhizome receive light it is capable of regenerating into a new plant, control measures should be in place to ensure that the whole plant is removed (Klingenstein and Alberternst, 2010).
2.10	How likely is it that the biological characteristics of the organism will facilitate its establishment?	LIKELY	MEDIUM	Seed reproduction, vegetative reproduction and the plants competitive superiority are biological traits which may facilitate establishment. <i>Lysichiton americanus</i> produces many seeds (each spadix has between 100-300 berries (FNA, 1993); 300-650 seeds per spadix in Germany (Alberternst & Nawrath 2002)), and a large seed bank can build up in the soil, remaining viable for many years (Alberlernst and Nawrath, 2002; Klingenstein and Alberternst, 2010). Vegetative reproduction by fragmentation of rhizomes is also possible (Klingenstein and Alberternst, 2010). <i>Lysichiton americanus</i> has a competitive advantage because leaf development starts earlier than many native plants in spring and they form large and dense clumps of vegetation which are generally taller than native under storey plants, and out compete them (CABI, 2014; Alberternst <i>et al.</i> , 2009).

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
2.11	How likely is it that the organism's capacity to spread will facilitate its establishment?	MODERATELY LIKELY	MEDIUM	Movement and dispersal of this species compared to other invasive species is very slow. It takes decades to dominate even small sites, for example, in the Netherlands it took about 50 years to establish a small but viable and locally spreading population (CABI, 2014). Natural spread is primarily by seed. When mature most seeds fall to the ground with the withered spadix so that most seeds germinate directly next to the mother plant (Klingenstein and Alberternst, 2010) but can also spread naturally over several tens of metres from the mother plant. When growing near or in running water, seed/berries can also be transported downstream. In its native range long distance dispersal is ensured by birds and other animals (squirrels, birds, but also bears) eating the berries or collecting them for winter stock (Klingenstein and Alberternst, 2010). In its European range it is not known if the species is distributed by transportation of berries/seeds by birds, although close relatives of the dispersing birds of North America also occur (tits, crow-like birds) (Klingenstein and Alberternst, 2010). The plant can also reproduce from rhizome and stems which can be transported naturally or unintentionally by machinery and by fly-tipping of garden waste.
2.12	How likely is it that the organism's adaptability will facilitate its establishment?	MODERATELY LIKELY	MEDIUM	As outlined in Questions 2.02, 2.03 and 2.04 <i>L. americanus</i> has a rather wide climatic and environmental amplitude, however the species does require for the habitat to be wet (CABI, 2014).
2.13	How likely is it that the organism could establish despite low genetic diversity in the founder population?	LIKELY	MEDIUM	The species is not thought to demonstrate lowered fertility in garden populations, so a low genetic diversity is probably of no significance.
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	<i>Lysichiton americanus</i> has a century long history of cultivation and introduction in Europe, though it has never been a very popular species and is not grown on a large scale (CABI, 2014; Alberternst <i>et al.</i> , 2009). Within Europe the most numerous and longest established populations are found in Britain and Ireland (Klingenstein and Alberternst, 2010). Both the size of the plant, its wet habitat requirements and the smell of the flowers restrict its popularity for small gardens (CABI, 2014). <i>Lysichiton americanus</i> has mostly been used in large scale gardens and ponds where it can "take care of itself" and it is known to spread slowly but surely (CABI, 2014).

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
2.15	If the organism does not establish, then how likely is it that transient populations will continue to occur?	UNLIKELY	MEDIUM	When cultivated the species has been noted as a particular hard plant to grow successfully (CABI, 2014). However individual plants established in the wild are clearly persistent and long-lived (Reynolds, 2002).
2.16	Estimate the overall likelihood of establishment. Mention any key issues in the comments box	VERY LIKELY	HIGH	<i>Lysichiton americanus</i> is already established in Ireland, but presently could not be described as widespread. In the Netherlands it has been observed to take a long time (50 years) to establish a small but viable and locally spreading population (CABI, 2014). In the SW of Ireland it has demonstrated to establish at a faster pace, for example along the River Laune, Co. Kerry where it has achieved pest status since 1982 (Reynolds, 2002). Establishment of the species will be restricted by the plants requirement for wet habitat.

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%	HIGH	In its natural and introduced range <i>Lysichiton americanus</i> grows in the transition zone of terrestrial, semi-aquatic and aquatic habitats (Klingenstein and Alberternst, 2010). It is typically found in wetlands including wet woodlands, lakeside, raised bogs, swamps, riverbanks, pond margins, in permanently wet soils, in alluvial forests, moorlands and wet meadows (Alberternst & Nawrath, 2002; Doyle & Duckett, 1985; Vanderhoeven, <i>et al.</i> , 2007). With reference to the CORINE (2006) land cover classification <i>Lysichiton americanus</i> has the potential to establish in moors and heath (0.78%), inland marshes (0.23%), peat bogs (15.37%), stream courses (0.11%), coastal lagoons (0.01%), estuaries (0.47%), water bodies (1.67%), which together constitute about 19% of Irish land cover. Further potential exists for the species to establish in broad leaved forest (0.41%), coniferous forest (3.23%), mixed forest (0.42%), and transitional woodland (5.89%) provided that these habitats are continually wet.
3.02	How important is the expected spread of this organism in Ireland by <u>natural</u> means (minimal, minor, moderate, major or massive)?	MODERATE	HIGH	Natural spread is primarily by seed. When mature most seeds fall to the ground with the withered spadix so that most seeds germinate directly next to the mother plant (Klingenstein and Alberternst, 2010) but can also spread naturally over several tens of metres from the mother plant. When growing near or in running waters, seed/berries can also be transported downstream. In its native range long distance dispersal is ensured by birds and other animals (squirrels, birds, but also bears) eating the berries or collecting them for winter stock (Klingenstein and Alberternst, 2010). In its European range it is not known if the species is distributed by transportation of berries/seeds by birds, although close relatives of the dispersing birds of North America also occur (tits, crow-like birds; Klingenstein and Alberternst, 2010). The plant can also reproduce from rhizome and stems which can be transported naturally.

Stage 2 - Detailed assessment: Section C – Spread <i>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.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
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	<i>Lysichiton americanus</i> is a species that is introduced intentionally for ornamental purposes into a new habitat i.e. spread of the species to new areas depends on human assistance. When the sites of introduction are close to, or part of natural habitats, localised natural spread to nature reserves may occur (CABI, 2014). Equally important or possibly more important might be intentional planting in natural areas, for perceived 'landscape improvements' (Alberternst and Nawrath, 2002).
3.04	Within Ireland, how difficult would it be to contain the organism (minimal, minor, moderate, major or massive)?	MINOR	HIGH	<i>Lysichiton americanus</i> requirement of wet habitat for growth and establishment likely restricts the spread of the species in Ireland which favours containment.
3.05	What proportion (%) of the area in Ireland suitable for establishment, if any, has already been colonised by the organism?	0% -10%	HIGH	In Ireland <i>L. americanus</i> has a scattered distribution, which is locally abundant in places (O'Flynn and Duffy, 2013; Stace, 1997). It seems that the species is very specific in which habitat this will occur. Sixty-nine records are verified for this species in Ireland by the National Biodiversity Data Centre; the majority of which are found in the north east of the island (Figure 2; National Biodiversity Data Centre, 2014).
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	Movement and dispersal of this species in Continental Europe is said to be very slow (CABI, 2014). In County Kerry, however, a population has been known to develop and spread rapidly (Reynolds, 2002). It would therefore not be expected for the species to spread to more than 0%-10% of land cover in the next five years.
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	MEDIUM	As the species is known to form large colonies in certain sites (Co. Kerry) there is a need for reviewing the distribution of the species in the light of climate change being a possible contributing factor for future spread.
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	Habitat specificity may limit the spread of the species to only a small percentage of any given habitat.

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
3.09	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	Wetlands including wet woodlands, lakeside, raised bogs, swamps, riverbanks, pond margins, in permanently wet soils, in alluvial forests, moorlands and wet meadows (Alberternst & Nawrath, 2002; Doyle & Duckett, 1985; Vanderhoeven, <i>et al.</i> , 2007) are most at risk to invasion by the species.
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.	VERY SLOWLY	HIGH	Spread of the species to new sites in Ireland is likely to be very slow and restricted by a limited availability of suitable habitats.

Stage 2 - Detailed assessment: Section D – Impact <i>This section evaluates the probability of impact of an organism within Ireland.</i>				
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?	MINIMAL	MEDIUM	Positive economic and social effects of the plant are reported from its native range where it has been used as food (in famine times), medicine (for burns and injuries) and waxed paper by Native Americans (Klingenstein and Alberternst, 2010). The economic impact of invasion by and naturalisation of <i>L. americanus</i> in its introduced range is considered negligible unless expressed in terms of effort involved in eradication campaigns (CABI, 2014; Alberternst <i>et al.</i> , 2009). In Switzerland, one hundred plants were dug out in the first season and controlled in the second season, at a cost of around €1000 (Alberternst <i>et al.</i> , 2009). Whilst in Taunus, Germany, several thousand plants in many localities were dug out by volunteers and forest workers and removal costs since 2001 up to 2008 including research work on the species (e.g. mapping, ecological studies, documentation, monitoring) were estimated at €53,000 (Alberternst <i>et al.</i> , 2009). The cost of chemical control is €600/ha/site visit in Britain (Alberternst <i>et al.</i> , 2009).
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. If any economic costs were to be incurred they are likely to only be associated with management of the species.
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	With reference to Question 4.01 economic impact of invasion by and naturalisation of <i>L. americanus</i> in its introduced range is considered negligible unless expressed in terms of effort involved in eradication campaigns (CABI, 2014; Alberternst <i>et al.</i> , 2009). The species is not present in crops or cultivated lands and has no associated social impact (Alberternst <i>et al.</i> , 2009; Hill, 2011). Any potential future economic costs are expected to be solely related to the control of the species; the cost of which would be expected to be minimal (Alberternst <i>et al.</i> , 2009).
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. Economic cost would only arise if the species was to become subject to control measures.

Stage 2 - Detailed assessment: Section D – Impact <i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.05	How great is the economic cost of managing this organism likely to be in the <u>future</u> in Ireland?	MINIMAL	HIGH	The reported economic impact of <i>L. americanus</i> from Britain, Germany and Switzerland is only related to the cost of control measures and are considered low (Alberternst <i>et al.</i> , 2009). Minimal economic cost would only arise if the species was to become subject to control measures.
4.06	How important is environmental harm caused by the organism within its global distribution?	MINOR	MEDIUM	No environmental impacts are reported in the species native range (CABI, 2014; Alberternst <i>et al.</i> , 2009). <i>Lysichiton americanus</i> is able to establish in vulnerable habitats such as woods and bog woodlands which are nature conservation areas listed under EU Directive 92/43 (EU, 1992) (EPPO, 2006). After some years its huge leaves can build a dense canopy layer excluding light from native species which are not adapted to extreme darkness and can result in species displacement and local extinctions (Alberternst <i>et al.</i> , 2009). There is locally high damage in the Taunus in Germany, where <i>L. americanus</i> has been shown to displace, and cause local extinction of rare species of mosses (e.g. <i>Sphagnum</i> spp.) and vascular plants (<i>Carex echinata</i> , <i>Viola palustris</i> , and orchids) (Alberternst & Nawrath, 2002; König & Nawrath, 1992) with a reduction in species number of more than 50% in dense stands (Alberternst <i>et al.</i> , 2009). In other countries, environmental impacts have not yet been documented. It can, however, be expected that the reduction in biodiversity and displacing effects attributed to the presence of <i>L. americanus</i> in the Taunus area of Germany, also appear in other countries where the impact may be judged differently due to the higher frequency of the habitats and species affected (Klingenstein and Alberternst, 2010).
4.07	How important has the impact of the organism on biodiversity* been in Ireland from the time of introduction to the present? *e.g. decline in native species, changes in community structure, hybridisation	N/A	MEDIUM	To-date, there is no available literature on the impact of <i>L. americanus</i> on Ireland's biodiversity.
4.08	How important is the impact of the organism on biodiversity likely to be in the <u>future</u> in Ireland?	MINOR	MEDIUM	If the species is allowed to establish and spread, environmental impacts are likely to be in line with those discussed in Question 4.06.

Stage 2 - Detailed assessment: Section D – Impact <i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
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	To-date, there is no knowledge of any alteration to ecosystem function.
4.10	How important is alteration of ecosystem function caused by the organism likely to be in Ireland in the <u>future</u> ?	MINOR	MEDIUM	If the species, over time, is allowed to establish dense stands the environmental impacts are likely to be in line with those discussed in Question 4.06.
4.11	How important has decline in conservation status* caused by the organism been in Ireland from the time of introduction to the present? *e.g. sites of nature conservation value, WFD classification, etc.	N/A	MEDIUM	To-date, there is no knowledge of a decline in conservation status caused by the presence of <i>L. americanus</i> in Ireland.
4.12	How important is decline in conservation status caused by the organism likely to be in the <u>future</u> in Ireland?	MINOR	MEDIUM	If the species, over time, is allowed to establish dense stands in protected or vulnerable habitats, the environmental impacts are likely to be in line with those discussed in Question 4.06.
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	American skunk cabbage contains calcium oxalate raphides which are mildly harmful if eaten but this is thought not to present a great risk to animals or man (Alberternst <i>et al.</i> , 2009). Social damage is considered minimal (Hill, 2011); appearance and smell thought unpleasant by some people, though others like it and continue to plant it in gardens (Hill, 2011). In its native range the roots have some value as medicine (Thomas & Schumann, 1993).

Stage 2 - Detailed assessment: Section D – Impact <i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.14	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within Ireland?	N/A	MEDIUM	To-date, there is no reported social or human health harm caused by <i>L. americanus</i> in Ireland.
4.15	How important is it that genetic traits of the organism could be carried to other organisms / species, modifying their genetic nature and making their economic, environmental or social effects more serious?	N/A	MEDIUM	Hybridisation with the closely related alien species <i>L. camtschaticensis</i> does occur (Stace, 1997), but this is not reported to make the plants economic, environmental or social impacts more serious.
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	MEDIUM	<i>Lysichiton americanus</i> was used as food, as medicine, and also in the material culture of Native Americans of north-western North America (Hill, 2011), all of which reflect a positive impact of the plant in its native range. The species is not known as a host or habitat for pests or diseases.
4.17	How important might other impacts not already covered by previous questions be resulting from introduction of the organism? Specify in the justification box.	N/A	MEDIUM	We are not aware of any other impacts the introduction of this species would have.
4.18	How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in Ireland?	MINOR	HIGH	Refer to Question 2.06

Stage 2 - Detailed assessment: Section D – Impact <i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.19	Indicate any parts of where economic, environmental and social impacts are particularly likely to occur. Provide as much detail as possible, where possible include a map showing vulnerable areas.	-	MEDIUM	It may be an economic problem in areas of conservation interest. After a few years of growth, <i>Lysichiton americanus</i> can build a dense canopy layer excluding light from native species causing species displacement and a reduction in overall biodiversity. It may become particularly problematic if <i>L. americanus</i> establishes dense stands in protected habitat in Ireland; for example damp woodlands, where rarer plant, mosses and lichens may be out-competed for light, as has been the case in the Taunus area of Germany (Alberternst <i>et al.</i> , 2009).
4.20	Estimate the overall potential impact of this organism in Ireland. Use the justification box to indicate any key issues.	MINOR	MEDIUM	No economic, social or environmental impacts are reported in the species native range. With the exception of costs related to control/eradication measures, the economic and social impacts of <i>L. americanus</i> in its introduced range are negligible. Known environmental impacts are largely confined to an invasive population of the species in Germany. It can, however, be expected that the reduction in biodiversity and displacing effects attributed to the presence of <i>L. americanus</i> in the Taunus area of Germany, would also manifest if the species establishes dense stands in vulnerable Irish habitat.

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	MINOR	MEDIUM	<p>The horticultural trade is the primary factor in the entry of this species to new areas and <i>L. americanus</i> has a long history of cultivation and introduction, though it has never been a particularly popular species and is not grown on a large scale (CABI, 2014). Both the size of the plant, its habitat and the smell of the flowers restrict its popularity for small gardens (CABI, 2014). <i>Lysichiton americanus</i> is most likely used in large scale gardens and ponds where it can "take care of itself" (CABI, 2014).</p> <p><i>Lysichiton americanus</i> is already established in Ireland, but is not widespread. Regionally it is very abundant in sites where populations have established, such as Kerry (Reynolds, 2002). It is known to have taken decades to settle and dominate even small sites in the Netherlands where it took about 50 years to establish a small but viable and locally spreading population (CABI, 2014). Establishment and spread of new populations in Ireland is likely to be very slow and restricted by a limited availability of wet habitat.</p> <p>No economic, social or environmental impacts are reported in the species native range. With the exception of costs related to control/eradication measures, the economic and social impacts of <i>L. americanus</i> in its introduced range are negligible. Known environmental impacts are largely confined to an invasive population of the species in Germany. It can, however, be expected that the reduction in biodiversity and displacing effects attributed to the presence of <i>L. americanus</i> in the Taunus area of Germany, would also manifest themselves if the species establishes dense stands in vulnerable Irish habitat.</p>

Stage 2 - Detailed assessment: Section F – Additional questions <i>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.</i>				
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?	LIKELY	MEDIUM	<i>L. americanus</i> is typically associated with climates which have a cool to hot summer, very cold to cool winter, wet year round (CABI, 2014). A milder, moister climate, as predicted for Ireland under global warming (Sweeney et al., 2003) is likely to favour establishment and spread of the species.
6.02	What is the likely timeframe for such changes (5, 10, 15, 20, 50 or 100 years)?	5	MEDIUM	The likely timeframe for such changes is 5 years as we are already experiencing the increasing frequency of milder, wetter winters (winter 2009/2010 is an exception).
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 invasiveness of <i>L. americanus</i> to reconsider establishment and spread and the species associated 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	<p>Research on the germination and recruitment of seedlings in sites where the species has been static compared to sites where large stands are present would be a valuable indicator of whether it is habitat specificity or some other biological factor that accounts for these differences.</p> <p>Modelling of the species potential rate of spread and likely distribution in Ireland presently and under climate change would significantly strengthen the confidence in this risk assessment.</p>

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