

## Risk Assessment of *Nymphoides peltata*

<b>Name of Organism:</b>	<i>Nymphoides peltata</i> (S.G. Gmel.) Kuntze – Fringed Water-lily
<b>Objective:</b>	Assess the risks associated with this species in Ireland
<b>Version:</b>	Final 15/09/2014
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<b>Expert reviewer</b>	Jonathan Newman

### Stage 1 - Organism Information

### Stage 2 - Detailed Assessment

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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

<b>Name of Document:</b>	Risk Assessment of <i>Nymphoides peltata</i>				
<b>Author (s):</b>	Dr Michael Millane and Dr Joe Caffrey				
<b>Authorised Officer:</b>	Dr Joe Caffrey				
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### Version Control Table

Version No.	Status	Authors(s)	Reviewed by	Approved by	Date of issue
Draft 1	Complete	Dr Michael Millane	Dr Joe Caffrey	Dr Joe Caffrey	21/01/2014
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Final	Complete	Dr Michael Millane	Dr Joe Caffrey	Dr Cathal Gallagher	15/09/2014

<b>Stage 1 - 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>
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	<i>Nymphoides peltata</i> (Gmel.) O. Kuntze, <i>Limnanthemum peltatum</i> Gmel., <i>Nymphoides nymphaeoides</i> (L.) Britt., entire marshwort, floating heart, fringed water lily and yellow floating heart (Global Invasive Species Database 2006).
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.		<i>Nymphoides peltata</i> is an "aquatic, bottom-rooted perennial with long branched stolons" which extend up to one meter or more along or below the water-sediment interface. "The node on the stolons typically produces a plant and many thread-like roots. The floating heart- shaped to almost circular leaves are 3-10 cm in diameter and are present on long stalks (up to 2 m). The leaves are frequently purple underneath, with slightly wavy, shallowly scalloped margins. The flowers are bright yellow, 5-petalled and 3-4 cm in diameter. The flowers are held above the water surface on stalks, with one to several flowers per stalk. The flower edges are distinctively fringed. The fruit is a capsule to 2.5 cm long containing numerous seeds. The seeds are flat, oval and about 3.5 mm long with hairy edges. <i>Nymphoides peltata</i> spreads by seeds and vegetatively" (NWCB 2008).
5	Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	YES	Two preliminary risk assessments were previously carried out in Ireland as follows. A stage one risk assessment as part of <i>Ireland's National Plant Conservation Strategy - Target 10 - Managing Invasive Alien Species</i> (Botanic Gardens 2007); and a prioritisation risk assessment as part of the <i>Risk Analysis and Prioritisation for Invasive and Non-native Species in Ireland and Northern Ireland</i> (Kelly <i>et al.</i> 2013). The former assessment designated the plant as a "most significant invasive plant" and the latter assessment designed the plant as a 'high risk' invasive species.
6	If there is an earlier risk assessment is it still entirely valid, or only partly valid?	PARTIAL	Only preliminary risk assessments were previously conducted in Ireland (refer to Question 5).
7	Where is the organism native?		Asia-temperate; Asia-tropical; south, central and eastern mainland Europe; central and eastern England (USDA-ARS 2013).

**Stage 1 - Organism Information**

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

<b>N</b>	<b>QUESTION</b>	<b>RESPONSE</b>	<b>COMMENT</b>
8	What is the current global distribution of the organism (excluding Ireland)?		North America (USDA-ARS 2013), Northern Ireland (National Invasive Species Database 2014), Sweden (Josefsson and Andersson 2001) and the regions listed in answer to Question 7.
9	What is the current distribution of the organism in Ireland?		<i>Nymphoides peltata</i> is recorded in 5 x 10 km squares in Ireland (National Invasive Species Database 2014). It is locally established in ponds and lakes where it thrives in shallow (<1.5 m deep) and nutrient rich water bodies (Kelly and Maguire 2009; National Invasive Species Database 2014).
10	Is the organism known to be invasive anywhere in the world?	YES	United States, Canada (USDA-ARS 2013), Northern Ireland (), Sweden (Josefsson and Andersson 2001); and formerly New Zealand where it is now considered to be eradicated (Champion and Clayton 2003).

**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)?	MANY	VERY HIGH	Horticultural and aquarium trade, boating, angling and other water activities.
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 and aquarium trade 2. Boating 3. Angling		<i>Nymphoides peltata</i> is imported into Ireland <i>via</i> the horticultural and aquarium sectors for sale to the public in garden centres. It is also sold periodically in some other retail outlets, such as supermarkets, and is available to buy on the internet (Kelly and Maguire 2009). The risk of introduction by boats and anglers arises from any travel to Ireland from an infested area abroad where equipment is inadvertently contaminated with viable plant material.

**Pathway 1 - Horticultural and aquarium 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	<i>Nymphoides peltata</i> is deliberately imported for trade.
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?	VERY LIKELY	VERY HIGH	<i>Nymphoides peltata</i> is deliberately imported for trade and subsequently sold in a wide range of outlets in Ireland as an ornamental plant for artificial watercourses, garden ponds and aquaria.
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	VERY LIKELY	VERY HIGH	Awareness by the relevant competent authorities at points of entry to recognise and identify this species is limited or non-existent at present.
1.06	How likely is the organism to survive during passage along the pathway?	VERY LIKELY	VERY HIGH	As the organism is distributed deliberately <i>via</i> trade, survival is considered very likely.

Pathway 1 - Horticultural and aquarium trade				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	VERY LIKELY	VERY HIGH	Trade imports and purchases of <i>Nymphoides peltata</i> may occur throughout the year. The plant can overwinter as dormant rhizomes. It can reproduce from seeds, and from broken stems and leaves with some stem attached. It produces an abundance of floating seeds, which readily germinate in April/May. The main growing season is from April to late October (Global Invasive Species Database 2006). It is considered that these factors confer the plant with an ability to establish throughout most of the year, or at the least survive in a dormant state after an introduction until growing conditions become favourable.
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	LIKELY	HIGH	Available habitat for <i>Nymphoides peltata</i> is widespread in Ireland. It is known to colonise lakes, reservoirs, ponds, slow moving rivers and swamps that are 0.5 to 4 metres deep. It can also grow on damp mud (Global Invasive Species Database 2006; Kelly and Maguire 2009). The practice of planting <i>Nymphoides peltata</i> in artificial watercourses and private ponds, which are often proximal to these systems, and its use in aquaria, increases the likelihood of it transferring from this pathway to a suitable habitat.
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	VERY LIKELY	VERY HIGH	It is already deliberately imported for trade.
1.10	Do other pathways need to be considered?	YES		

Pathway 2 – Boating				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.03	Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (e.g. the organism is a contaminant of imported goods)?	ACCIDENTAL	HIGH	The overland or cross-channel movement of boats, boat trailers and boat engines from an infested to uninfested area has the potential to inadvertently spread this organism if viable plant material is attached. This includes the import of used boats from abroad.
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 LIKELY	HIGH	In the absence of implementing appropriate biosecurity measures, there is an increased potential for the inadvertent spread of viable plant material on boating equipment from infested to uninfested waters.

Pathway 2 – Boating				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	VERY LIKELY	VERY HIGH	Awareness by the relevant competent authorities at points of entry to recognise and identify this species is limited or non-existent at present.
1.06	How likely is the organism to survive during passage along the pathway?	LIKELY	HIGH	As the seeds and seedlings of <i>Nymphoides peltata</i> are resistant to desiccation (Smits <i>et al.</i> 1989), it increases the ability of this organism to survive during passage along this pathway. Indeed, under experimental conditions seeds subject to desiccation treatment can remain viable for up to 15 months (Smits <i>et al.</i> 1989).
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	LIKELY	HIGH	See Pathway 1 Question 1.07. Boat movements may occur throughout the year.
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	MODERATELY LIKELY	HIGH	Available habitat for <i>Nymphoides peltata</i> is widespread in Ireland. It is known to colonise lakes, reservoirs, ponds, slow moving rivers and swamps 0.5 to 4 metres deep. It can also grow on damp mud (Global Invasive Species Database 2006; Kelly and Maguire 2009). Boat movements act as a direct pathway to transfer this organism from an infested water to a suitable habitat elsewhere.
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	MODERATELY LIKELY	HIGH	This pathway depends on the transfer of viable plant material surviving an overland or cross-channel journey in association with boats from an infested water outside Ireland to an uninfested water in the country. As there is no specific information available on the movement of boats from infested areas abroad that are colonised by <i>Nymphoides peltata</i> into Ireland it is considered moderately likely that the organism can enter <i>via</i> this pathway.
1.10	Do other pathways need to be considered?	YES		

Pathway 3 – Angling				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.03	Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (e.g. the organism is a contaminant of imported goods)?	ACCIDENTAL	HIGH	The overland or cross-channel movement of angling equipment (e.g. landing or keep net, stink bag, angling box and stand, boots and waders) from an infested to uninfested area has the potential to inadvertently spread this organism if viable plant material is attached.
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 LIKELY	HIGH	In the absence of implementing appropriate biosecurity measures, there is an increased potential for the inadvertent spread of viable plant material on angling equipment from infested to uninfested waters.
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	VERY LIKELY	VERY HIGH	Awareness by the relevant competent authorities at points of entry to recognise and identify this species is limited or non-existent at present.
1.06	How likely is the organism to survive during passage along the pathway?	MODERATELY LIKELY	HIGH	As the seeds and seedlings of <i>Nymphoides peltata</i> are resistant to desiccation (Smits <i>et al.</i> 1989), it increases the ability of this organism to survive during passage along this pathway. Indeed, under experimental conditions seeds subject to desiccation treatment can remain viable for up to 15 months (Smits <i>et al.</i> 1989).
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	LIKELY	HIGH	See Pathway 1 Question 1.07. Movement in association with anglers may occur throughout the year.
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	LIKELY	HIGH	Available habitat for <i>Nymphoides peltata</i> is widespread in Ireland. It is known to colonise lakes, reservoirs, ponds, slow moving rivers and swamps that are 0.5 to 4 metres deep. It can also grow on damp mud (Global Invasive Species Database 2006; Kelly and Maguire 2009). The movement of anglers acts as a direct pathway to transfer this organism from an infested water to a suitable habitat elsewhere.
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	MODERATELY LIKELY	HIGH	This pathway depends on the transfer of viable plant material surviving an overland or cross-channel journey in association with angling equipment from an infested water outside Ireland to an uninfested water in the country. As there is a paucity of specific information available on the movement of anglers from areas abroad that are colonised by <i>Nymphoides peltata</i> into Ireland, it is considered moderately likely that the organism can enter <i>via</i> this pathway.

<b>Pathway 3 – Angling</b>				
<b>N</b>	<b>QUESTION</b>	<b>RESPONSE</b>	<b>CONFIDENCE</b>	<b>JUSTIFICATION</b>
1.10	Do other pathways need to be considered?	NO		

<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).	VERY LIKELY	VERY HIGH	The primary pathway of entry into Ireland is through deliberate trade <i>via</i> the horticultural and aquarium sectors. The movement of boats and anglers from infested areas outside the country may also facilitate entry as viable plant material can survive transit <i>via</i> these pathways.

**Stage 2 - Detailed assessment: Section B – Establishment**

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.01	Is the organism well established in Ireland (if there is any uncertainty answer 'unsure')	NO	VERY HIGH	<i>Nymphoides peltata</i> is recorded in 5 x 10 km squares in Ireland (National Invasive Species Database 2014). It is locally established in ponds and lakes where it thrives in shallow (<1.5 m deep) and nutrient rich waterbodies (Kelly and Maguire 2009; National Invasive Species Database 2014).
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	VERY HIGH	Based on its present occurrence and prolific growth at localised sites in Ireland, climatic conditions are not considered to be limiting.
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	VERY HIGH	Based on its present occurrence in Ireland, it is very likely there are no overriding abiotic factors to limit its further establishment in habitat types which are similar to those it occupies throughout its global range and already in Ireland.
2.04	How likely is the organism to encounter habitats necessary for the survival, development and multiplication of the organism in Ireland?	VERY LIKELY	VERY HIGH	Available habitat for <i>Nymphoides peltata</i> is widespread in Ireland. It is known to colonise lakes, reservoirs, ponds, slow moving rivers and swamps that are 0.5 to 4 metres deep. It can also grow on damp mud (Global Invasive Species Database 2006; Kelly and Maguire 2009).
2.05	How likely is it that establishment will occur despite competition from existing species in Ireland?	VERY LIKELY	VERY HIGH	<i>Nymphoides peltata</i> can out-compete and extirpate native plant species. Individual fragments of the plant are capable of colonising an entire water body within a few years (Kelly and Maguire 2009; J Caffrey pers. comm.).
2.06	How likely is it that establishment will occur despite predators, parasites or pathogens already present in Ireland?	VERY LIKELY	VERY HIGH	There are no known natural predators, parasites or pathogens of this species in Ireland that will have an effect on its establishment.
2.07	How likely is it that establishment will occur despite existing management practices?	UNLIKELY	HIGH	In general, the state management of waterways are undertaken cognisant of ensuring biosecurity measures are in place to mitigate for the spread of aquatic invasive species. An increase in awareness by some private stakeholders of the threat from aquatic invasive species has also reduced this risk. Most infestations with this species are in artificial ponds or very localised sites in natural lakes (e.g. Lough Leane, Co Kerry). Most of these are not managed or are locally cut to facilitate private angling or boating.

**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>
2.08	How likely is it that management practices in Ireland will facilitate the establishment of the organism?	UNLIKELY	HIGH	Refer to Question 2.07.
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	Mechanical or manual control conducted with disregard for the potential generation and spread of vegetative fragments is a risk factor.
2.10	How likely is it that the biological characteristics of the organism will facilitate its establishment?	VERY LIKELY	VERY HIGH	The ability of <i>Nymphoides peltata</i> to reproduce asexually from vegetative fragments, produce seeds and survive extended periods of desiccation can facilitate its establishment (Smits <i>et al.</i> 1989).
2.11	How likely is it that the organism's capacity to spread will facilitate its establishment?	VERY LIKELY	VERY HIGH	Within systems, the principal means of natural spread is through sexual reproduction (i.e. seeds) and asexual vegetative fragmentation. In Sweden, vegetative reproduction is more common (Larson 2007). Between watersheds, there is a moderate potential for natural spread as seeds may be transferred epizoochorically <i>via</i> migrating water fowl (Smits <i>et al.</i> 1989). Seed hairs help the seeds float and aid their attachment to waterfowl (NWCB 2008). Anthropogenic-mediated transfer is the principal pathway to facilitate the spread and establishment of the plant to uncolonised waters.
2.12	How likely is it that the organism's adaptability will facilitate its establishment?	VERY LIKELY	VERY HIGH	As <i>Nymphoides peltata</i> can establish in a range of habitat types (refer to Question 2.04), overwinter as dormant rhizomes and the seeds are highly resistant to desiccation (Smits <i>et al.</i> 1989), this confers it with a good level of adaptability to establish under a range of habitat conditions or to persist in a habitat that is subject to temporary environmental stress (e.g. desiccation stress from water level fluctuations). The plant has a wide pH tolerance from 6.5 – 11 (reviewed in NWCB 2008). However, growth is restricted in poorly-buffered or acidic waters with insufficient calcium present (Smits <i>et al.</i> 1992).
2.13	How likely is it that the organism could establish despite low genetic diversity in the founder population?	VERY LIKELY	MEDIUM	<i>Nymphoides peltata</i> is already present in Ireland. No research has been carried out on its genetic diversity in the country. In Japan, where it is a native species, sub-populations are considered to have a high risk of extinction because of low genetic diversity (Uesugi <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
2.14	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	VERY HIGH	It has already demonstrated this capacity in Ireland. It can currently be found, often growing abundantly, in artificial fishery watercourses, in sheltered bays on large rivers and lakes (localised) and in small natural lakes. Most are meso- to eutrophic. Based on its history of invasion, it is unknown, why it has not, to date, become problematic in more places in Ireland, considering that it has been in the country for many years, and is growing abundantly in a moderate number of locations (J. Caffrey pers. comm.).
2.15	If the organism does not establish, then how likely is it that transient populations will continue to occur?	N/A		
2.16	Estimate the overall likelihood of establishment. Mention any key issues in the comments box	VERY LIKELY	VERY HIGH	Available habitat for <i>Nymphoides peltata</i> is widespread in Ireland. The ability of <i>Nymphoides peltata</i> to reproduce asexually from vegetative fragments, produce seeds and survive extended periods of desiccation can facilitate its establishment (Smits <i>et al.</i> 1989). It can currently be found, often growing abundantly, in artificial fishery watercourses, in sheltered bays on large rivers and lakes (localised) and in small natural lakes

**Stage 2 - Detailed assessment: Section C - Spread**

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
3.01	What area (given in % or 10km squares) in Ireland could the organism establish (0% - 10%, 11% - 33%, 34% - 67%, 68% - 90% or 91% - 100%)?	34% - 67% of 10 km squares	HIGH	Refer to Questions 8, 2.11 and 2.12.
3.02	How important is the expected spread of this organism in Ireland by <u>natural</u> means (minimal, minor, moderate, major or massive)?	MAJOR	VERY HIGH	As <i>Nymphoides peltata</i> is known to disperse <i>via</i> seeds, vegetatively and epizoochorically (refer to Question 2.11) there is a major potential for natural spread from presently colonised sites in Ireland.
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	VERY HIGH	In the absence of restrictions of their sale and distribution, deliberate introduction to waters such as garden ponds will likely continue. To date, such anthropogenic-mediated transfer has been the principal pathway to facilitate the spread of <i>Nymphoides peltata</i> to uncolonised waters in Ireland.
3.04	Within Ireland, how difficult would it be to contain the organism (minimal, minor, moderate, major or massive)?	MODERATE	HIGH	<i>Nymphoides peltata</i> is locally distributed in Ireland (refer to Question 8). Therefore, containment is feasible if routine biosecurity measures to limit its further spread are implemented and proposed restrictions on its importation and sale are enforced.
3.05	What proportion (%) of the area in Ireland suitable for establishment, if any, has already been colonised by the organism?	0% -10%	VERY HIGH	Refer to Question 8 and Pathway 1, Question 1.08.
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	It is considered likely that <i>Nymphoides peltata</i> will remain largely confined to its current range if restrictions on its sale are enforced and biosecurity practices are further promoted and implemented. The potential for epizoochoric spread to uncolonised waters is a risk factor which cannot be easily assessed.
3.07	What other timeframe would be appropriate to estimate any significant further spread of the organism (10, 20, 40, 80 or 160 years)? Please comment on why this timeframe is chosen.	20 - 40 years	MEDIUM	In the absence of restrictions on sale and the implementation of routine biosecurity measures, further spread is considered likely in the next 20 - 40 years (refer to Question 3.06).

**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.*

<b>N</b>	<b>QUESTION</b>	<b>RESPONSE</b>	<b>CONFIDENCE</b>	<b>JUSTIFICATION</b>
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%		Refer to Questions 3.06 and 3.07.
3.09	Based on the answers to questions on the potential for establishment and spread in Ireland, define the area endangered by the organism. Be as specific as possible. If available, provide a map showing the area most likely to be endangered.	-	HIGH	Available habitat for <i>Nymphoides peltata</i> is widespread in Ireland. It is known to colonise lakes, reservoirs, ponds, slow moving rivers and swamps that are 0.5 to 4 metres deep. It can also grow on damp mud (Global Invasive Species Database 2006; Kelly and Maguire 2009). The plant has a wide pH tolerance (6.5-11). However, growth is restricted in poorly-buffered or acidic waters with insufficient calcium present (Smits <i>et al.</i> 1992).
3.10	Estimate the overall potential for future spread for this organism in Ireland (very slowly, slowly, moderately, rapidly or very rapidly). Use the justification box to indicate any key issues .	SLOWLY	HIGH	If restrictions on sale are enforced and biosecurity measures are routinely implemented, further range extensions will be slow as the principal mechanism of spread is human-mediated.

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

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.01	How great is the economic loss caused by the organism within its global distribution (excluding Ireland), including the cost of any current management?	MODERATE	HIGH	The tangible costs are difficult to accurately quantify. Dense growths of <i>Nymphoides peltata</i> can impede angling, restrict the passage of boats (both impacting on tourism income) and require measures to be implemented to protect or restore impacted species or habitats (Global Invasive Species Database 2006). The loss of recreational and aesthetic value associated with the plant can also cause a decline in lakefront property values (Robinson 2004).
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.	MINIMAL	MEDIUM	This is difficult to quantify but is likely to be low due to the limited occurrence of the plant in Ireland.
	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.	MODERATE	MEDIUM	Unknown (see Question 4.01 for an overview of known economic impacts likely to occur should <i>Nymphoides peltata</i> spread in Ireland). The spread of <i>Nymphoides peltata</i> to other freshwaters may deter some anglers from fishing. It is worth noting that the economic value of recreational angling to Ireland (including sea angling) is estimated at €755 million per annum (Inland Fisheries Ireland 2013). Further to this, infestations may impede boating on navigable inland waters. Recreational boating is estimated to be worth €70 million to the Irish economy (Martin 2012). There may also be financial implications if conservation goals such as those specified in the EC Habitats Directive and the EU Water Framework Directive are under threat.
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> ?	MINIMAL	HIGH	This is difficult to quantify but is likely to be low due to the limited occurrence of the plant 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	HIGH	Kelly and Maguire (2009) have estimated costs to control or eradicate infestations of <i>Nymphoides peltata</i> to be as follows. "Small scale control programmes for this species i.e. garden ponds are estimated to cost less than £500 GBP. Larger ponds or river systems will require additional funding on a continuous basis until eradication is achieved. This is estimated to cost up to £5,000 GBP annually. Should a lake, canal, or river system become colonised, costs associated will increase and are estimated to fall between the £50,000 - 100,000 GBP in the first year."

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

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.06	How important is environmental harm caused by the organism within its global distribution?	MODERATE	HIGH	According to Robinson (2004) " <i>Nymphoides peltata</i> is a very aggressive plant that is capable of rapid growth and spread". It "can displace native species, reduce biodiversity, limit recreation, diminish aesthetic value, and decrease water quality and flow". Dense floating mats "can form on the water's surface, restricting light to the complete exclusion of other native plants, and decreasing the air exchange between the water's surface and the atmosphere". "Algae, a major component of the base of the food chain, can be shaded out by dense mats" of the plant. "The resulting decline in algae can disrupt the entire food web in a lake. <i>N. peltata</i> may form dense single species stands that often do not provide ideal habitat or food for native wildlife and may limit access to the water for some species. These native wildlife populations may be forced to relocate or perish, ultimately resulting in a loss of biodiversity and a disruption in the balance of the ecosystem. Sediment levels increase with increasing <i>N. peltata</i> abundance".
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	MINIMAL	MEDIUM	There is a paucity of specific information or documented case studies available to answer this. Where it is introduced to relatively static, shallow and organically rich habitats it can spread rapidly and carpet extensive areas of a watercourse. Intuitively, this can restrict light to any resident submerged aquatic plants present and result in their extirpation (Inland Fisheries Ireland 2014). There is some evidence to suggest <i>Nymphoides peltata</i> can interact with and out-compete other floating leaved species (Zhongua <i>et al.</i> 2007).
4.08	How important is the impact of the organism on biodiversity likely to be in the <u>future</u> in Ireland?	MODERATE	HIGH	If <i>Nymphoides peltata</i> establishes in other suitable freshwaters in Ireland, detrimental impacts on biodiversity as outlined in answer to Questions 4.06 and 4.07 are considered likely.
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	MINIMAL	MEDIUM	This is difficult to quantify due to a lack of specific information but is likely to be low and site specific due to the localised occurrence of the plant in Ireland.

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

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.10	How important is alteration of ecosystem function caused by the organism likely to be in Ireland in the <u>future</u> ?	MODERATE	VERY HIGH	Any further spread of <i>Nymphoides peltata</i> in Ireland will likely see similar impacts on ecosystem function to that outlined 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.	MINIMAL	VERY HIGH	There has been no decline in conservation status observed to date in Ireland, likely due to the confined distribution of <i>Nymphoides peltata</i> in the country.
4.12	How important is decline in conservation status caused by the organism likely to be in the <u>future</u> in Ireland?	MODERATE	VERY HIGH	If <i>Nymphoides peltata</i> is to expand its range and establish in conservation watercourses, there is a strong likelihood based on known impacts that it will result in detrimental impacts to native habitats and species in Ireland. This may have implications for the classification of ecological status under the EU Water Framework Directive and the conservation status of certain species and habitats and under the EU Habitats Directive (Kelly and Maguire 2009).
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	HIGH	There is a paucity of specific information available on this. A report from Long Lake in Washington State, USA states that “dense patches of the weed make it difficult to fish, water ski, swim or paddle a canoe through” (NWCB2008).
4.14	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within Ireland?	MINOR	HIGH	There is no information relating to any substantial social or human health damage caused by <i>Nymphoides peltata</i> in Ireland. However, angling for carp has been locally obstructed in a number of fisheries (e.g. Maynooth fishery, Ballyhonock Lake near Youghal) and local cutting and herbicide application has been invoked.
4.15	How important is it that genetic traits of the organism could be carried to other organisms / species, modifying their genetic nature and making their economic, environmental or social effects more serious?	MINIMAL	VERY HIGH	Highly unlikely - there is no evidence for this.

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

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

<b>N</b>	<b>QUESTION</b>	<b>RESPONSE</b>	<b>CONFIDENCE</b>	<b>JUSTIFICATION</b>
4.16	How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	MINIMAL	VERY HIGH	
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.	MINIMAL	VERY HIGH	
4.18	How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in Ireland?	MINIMAL	HIGH	<i>Nymphoides peltata</i> is not naturally controlled by any predator, parasite or pathogen in Ireland.
4.19	Indicate any parts of Ireland 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.		HIGH	Available habitat for <i>Nymphoides peltata</i> is widespread in Ireland. It is known to colonise lakes, reservoirs, ponds, slow moving rivers and swamps that are 0.5 to 4 metres deep. It can also grow on damp mud (Global Invasive Species Database 2006; Kelly and Maguire 2009). The movement of anglers acts as a direct pathway to transfer this organism from an infested water to a suitable habitat elsewhere.
4.20	Estimate the overall potential impact of this organism in Ireland. Use the justification box to indicate any key issues.	MODERATE to MAJOR	VERY HIGH	Overall, the literature indicates that <i>Nymphoides peltata</i> has the potential to cause serious ecological, environmental and socio-economic impacts should it become widely established in freshwaters in Ireland.

**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).	MODERATE to MAJOR	HIGH	The impact of this species is limited to a very few sites in Ireland. Where it is present it is abundant, but the impacts have not been quantified. Its spread is slow, and the impacts on other components of the aquatic ecosystems are poorly understood. It is relatively easily controlled in small populations. Therefore, in a national context, it is considered to have a moderate to major risk to native biodiversity, native ecosystems and conservation goals as well as having the potential to cause negative socio-economic impacts in a wide-range of still or slow-flowing waters in Ireland.

**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?		LOW	<p>Climate change is expected to increase water temperatures over time, with increased periods of drought in summer and higher rainfall in winter leading to more flooding events (Desmond <i>et al.</i> 2008). It is uncertain how this will affect the current risk assessment for <i>Nymphoides peltata</i>. Increased flooding events have the potential to increase the rate of natural spread of <i>Nymphoides peltata</i> within systems by enhancing vegetative and seed dispersal. The plant is desiccation tolerant so that may confer an advantage over other species in habitats subject to drought events.</p> <p>Global climate and regional environmental niche modelling both project that there will be little change in the suitable range of <i>Nymphoides peltata</i> in the island of Ireland by 2080 (based on the International Panel on Climate Change high emissions climate change scenario) (Kelly <i>et al.</i> 2014).</p>
6.02	What is the likely timeframe for such changes (5, 10, 15, 20, 50 or 100 years)?	50 -100 YEARS	LOW	
6.03	What aspects of the risk assessment are most likely to change as a result of climate change		LOW	Refer to Questions 6.01.
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.			There is a paucity of information available to elucidate the impact of <i>Nymphoides peltata</i> on ecosystem functioning and biodiversity in Ireland. Such research may strengthen confidence in the impact section (Stage 2, Section D) of the risk assessment.

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