Risk Assessment of *Hydrocotyle ranunculoides*

Name of Organism:	*Hydrocotyle ranunculoides* Linnaeus filius – Floating Pennywort
Objective:	Assess the risks associated with this species in Ireland
Version:	Final 15/09/2014
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Expert reviewer	Jonathan Newman

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About the risk assessment

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

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

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

DOCUMENT CONTROL SHEET

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Authorised Officer:	Dr Joe Caffrey				
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Version Control Table

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Final	Complete	Dr Michael Millane	Dr Joe Caffrey	Dr Cathal Gallagher	15/09/2014

Stage 1 - Organism Information *The aim of this section is to gather basic information about the organism.*			
N	**QUESTION**	**RESPONSE**	**COMMENT**
1	What is the reason for performing the risk assessment?		A risk assessment is required as this species is listed as a "Non-native species subject to restrictions under Regulations 49 and 50" in the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011, SI 477/2011.
2	Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	YES	*Hydrocotyle ranunculoides* L.f. (preferred scientific name) (CABI 2014). Other Scientific Names are: *Hydrocotyle adoënsis* Hochst. *1841*; *Hydrocotyle americana* Walt. 1788; *Hydrocotyle batrachioides* DC 1830; *Hydrocotyle cymbalarifolia* Muhl. 1813; *Hydrocotyle natans* Cirillo 1788; *Hydrocotyle nutans* G. 1830; *Hydrocotyle ranunculoides f. minima* Kuntze 1898; *Hydrocotyle ranunculoides var.* genuina Urban 1879; *Hydrocotyle ranunculoides var. natans* (Cirillo) Urban 1879; (CABI 2014). Floating Pennywort (preferred common name) (CABI 2014); Marsh Pennywort (incorrect label used in sale, Plantlife undated), Water Pennywort (sale name Plantlife undated); Greater water pennywort (EPPO 2006); Irish Marsh Pennywort (Robert *et al*. 2013). The plant may also be traded under the name of a related species, *Hydrocotyle leucocephala* (Brunel 2009). Further to this, "The actual scale of the sale of *H. ranunculoides* is difficult to ascertain because of the misapplied names. *H. ranunculoides* could be traded under the misapplied name *Hydrocotyle vulgaris* or the synonym *H. natans*. In Belgium, the species has also been sold as *H. leucocephala*. Other *Hydrocotyle* species are in trade which, although being different species, could be mislabelled *H. umbellata*, *H. novae zeelandiae*, *H. verticillata, H. moschata*, *H. sibthorpioides*. *H. ranunculoides* is cited as *H. americana* L. in various catalogues" (reviewed in EPPO 2009).
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.		*Hydrocotyle ranunculoides* is an "aquatic stoloniferous plant with creeping stem with nodes at between 40 and 150 mm intervals. Profuse filiform roots occur at each node. Leaves are emergent, with the leaf stalks coming from the nodes on the horizontal stolons. Leaf matter extends up to 40 cm above the water surface and the interwoven mat of roots and stems can sink to 50 cm into the water (EPPO 2005). Stipules are present. Leaves are reniform in shape, non-sclerophyllous,

Stage 1 - Organism Information *The aim of this section is to gather basic information about the organism.*			
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			less than 1 mm thick and vary in size from 20-45 mm to 100-150 mm, depending on nitrate availability, and have shallow-lobed edges. Flower stalks also derive from the nodes. The species produces very small creamy yellow flowers approximately 3 mm in diameter on a short umbel below the leaf canopy. Each umbel averages nine flowers (Klemm *et al*. 1993). Fruit are ovoid-ellipsoid to suborbicular, strongly flattened dorsally; mericarps with three subequal ribs; fruit wall a woody inner layer. Disseminules globose or somewhat flattened mericarps (Cook 1990)." (Excerpt from CABI 2014). The plant resembles a very large, robust version of the native Irish marsh pennywort (*Hydrocotyle vulgaris* L.). It varies little throughout the year, although in the winter, it is most likely to be found at the water's edge (Invasive Species Ireland undated).
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 *Ireland's National Plant Conservation Strategy - Target 10 - Managing Invasive Alien Species* (Botanic Gardens 2007); and a prioritisation risk assessment as part of the *Risk Analysis and Prioritisation for Invasive and Non-native Species in Ireland and Northern Ireland* (Kelly *et al*. 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?	PARTLY (Ireland) / ENTIRELY VALID (EPPO)	Only preliminary risk assessments were previously conducted in Ireland (refer to Question 5). The European And Mediterranean Plant Protection Organisation (EPPO), of which Ireland is a member, undertook a Pest Risk Analysis for *Hydrocotyle ranunculoides*. This is entirely valid for this risk assessment (EPPO 2009).

Stage 1 - Organism Information *The aim of this section is to gather basic information about the organism.*			
N	**QUESTION**	**RESPONSE**	**COMMENT**
7	Where is the organism native?		The native range of *Hydrocotyle ranunculoides* is poorly defined and literature can be somewhat confusing and give contradictory information (Roberts *et al*. 2013). A review by EPPO (2009) citing Everett (1981), states the plant is "native to North and South America"; with EPPO (2006) also referring to 19th century collections from Ethiopia, indicating the plant may also be native to Africa. Alternatively, a review by CABI (2014) citing Mathias (1936) and Cook (1974) suggests the plant is native to south-eastern North America and possibly Central America. In the USA, the species is likely native as far north as Alabama / Georgia etc, but even there it is unlikely that it is truly native. The origin is much more likely to be in the pantanal region of Brazil / Argentina where there is a biodiversity hotspot of *Hydrocotyle* species (J. Newman, personal communication).
8	What is the current global distribution of the organism (excluding Ireland)?		Europe (Belgium, England, France, Germany, Italy, Netherlands, Northern Ireland, Wales); Africa (Angola, Ethiopia, Kenya, Madagascar, Malawi, Rwanda, Sudan, Tanzania, Uganda and Zambia); Asia (Georgia, Iran, Israel, Lebanon, Syria and Yemen); Central America (Costa Rica, Cuba, Guatemala, Nicaragua and Panama); North America (Canada and USA); South America (Argentina, Bolivia, Brazil, Chile, Columbia, Ecuador, Paraguay, Peru and Uruguay); and Australia (reviewed in CABI 2014).
9	What is the current distribution of the organism in Ireland?		*Hydrocotyle ranunculoides* is not recorded in Ireland, but is present in Northern Ireland since 2002, when it was recorded in ponds in a clay pit on the Ards Peninsula in Co. Down. Since that time, it has been recorded at 16 sites, all of which are ponds, with some of these infestations expanding to adjoining waterways, notably the River Lagan (BBC News 2010; National Invasive Species Database 2014). At most of these sites, control operations have been conducted, with varying degrees of success. In at least two of the 16 sites, the resident *Hydrocotyle ranunculoides* population has been described as abundant or dominant (Balloo Nature Reserve, Bangor; and Comber; both in Co. Down). The infestation of the plant in the Comber site has been described as a, "Large pond almost fully covered in it. The mat of pennywort is around a foot to two foot thick in places. " (National Invasive Species Database 2014).
10	Is the organism known to be invasive anywhere in the world?	YES	According to an overview by CABI (2014), "The characteristics that indicate its invasiveness are typical of many aquatic weeds: high growth rates, adaptability to prevailing nutrient conditions, very effective vegetative propagation, plasticity in growth response, overwintering to avoid low temperature stress, resistance to herbivory, resistance to chemical control, and absence of specific pests and

Stage 1 - Organism Information *The aim of this section is to gather basic information about the organism.*			
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			diseases in introduced environments. In Belgium, the Netherlands, and the UK in particular, it is considered a serious invader having escaped into the wild following its introduction to Europe in the 1980s through the aquatic nursery trade (often wrongly labelled as the native, *H. vulgaris).* This species was added to the EPPO alert list in 2004 (EPPO 2005) and the serious threat it poses to habitats has led to it being added to Schedule 9 of the Wildlife and Countryside Act in the UK, and its ban in the Netherlands. It has spread into water bodies in a number of other European countries including France, Germany and Italy. Control measures have been applied in Western Australia (Klemm *et al*. 1993)."

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)?	MODERATE	HIGH	Horticultural and aquarium, boating, angling and other water activities (see 1.02 to further comment on this).
1.02	List significant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways.	1. Horticultural and aquarium trade 2. Boating, angling and other water activities.		The horticultural and aquarium pathway for *Hydrocotyle ranunculoides* may not be active as the authors are unaware of this plant being traded in Ireland to date (i.e. commercially sold or non-commercially gifted). In the recent past in Northern Ireland (*c.* 15 years), there appears to have been some trade in this species, hence its discovery there in 2002 (National Invasive Species Database 2014). However, no specific information is available to comment further on this. It is possible that the plant could be a hitch-hiker with the import of other aquatic plants or be mis-labelled under the name of other similar species e.g. *Hydrocotyle verticillata* (GB Non-Native Species Secretariat 2011). The plant is not now officially traded in England as recent legislation (April 2014) there has banned this (The Wildlife and Countryside Act 1981 (Prohibition on Sale etc. of Invasive Non-native Plants) (England) Order 2014 http://www.legislation.gov.uk/uksi/2014/538/made). The authors can find no current listings by any on-line vendor who exports to Ireland advertising the plant for sale (search date 23/06/2014). The risk of introduction by boaters, anglers or other water users arises from any travel to Ireland from an infested area abroad where equipment is inadvertently contaminated with viable plant material. Presently, it is considered that it is moderately likely that *Hydrocotyle ranunculoides* could be introduced or transferred to Ireland by boaters, anglers or other water users from abroad. This is because it is uncommon in Northern Ireland and it is primarily restricted to isolated pond systems (refer to response to Question 9). In Britain, although the distribution *of Hydrocotyle ranunculoides* is more widespread (see below), there is unlikely to be much movement of contaminated equipment from these waters to Ireland. In Britain, *Hydrocotyle ranunculoides* was originally introduced to the country in the 1980s *via* the ornamental trade. The plant was first recorded in the wild in 1990 and since that time it has established around

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
				London (particular to the north-west of the city), at a number of sites on the south coast, the Gwent levels and in the north-west midlands (150 sites in a total of *c.* 50 x 10 km squares). The plant has not been recorded in the wild in Scotland to date (reviewed in GB Non-Native Species Secretariat 2011 and CABI 2014).

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	Although there is no record of *Hydrocotyle ranunculoides* being traded (i.e. commercially or non-commercially) in Ireland, entry would be intentional if it was.
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 UNLIKELY	VERY HIGH	There is no record of *Hydrocotyle ranunculoides* being traded in Ireland to date.
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 would be 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 *via* trade, survival is considered very likely.
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	MODERATELY LIKELY	MEDIUM	There is no record of *Hydrocotyle ranunculoides* being traded in Ireland to date. The information presented below suggests that the plant could survive an introduction and subsequently establish throughout most of the year in Ireland, but the viability of unplanted vegetative fragments to survive a winter introduction is unknown. It is reasonable to assume that seeds can over-winter under Irish conditions as this would be the case elsewhere in introduced mainland European populations, many of which are subjected to more extreme winter conditions than that experienced in Ireland.

Pathway 1 - Horticultural and aquarium trade				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
				According to Hussner and Lösch, (2007) as cited in EPPO (2009), "in Europe, plants grow slowly in spring and form [leaves] up to 10 cm². The plants flower and produce fruits between May and October. The maximal growth rate is reached during June and July". Furthermore, "The species is endangered in parts of its native* range (U.S. federal states of Illinois, New Jersey and New York (New York Environmental Regulations 2000; USDA 2004)) where it is vulnerable to low temperatures. However, in its introduced range, even if emergent leaves die at the first night frosts and floating leaves die when enclosed in ice, leaves of *H. ranunculoides* that are submerged below ice cover are reported to survive the winter months, and new plants can grow up in spring from these overwintering parts (Hussner & Lösch 2007). In Western Europe populations may be strongly reduced during cold winters, but recovery occurs quickly in the following season." (Excerpt from EPPO 2009). * It is unlikely to be native to these parts of the USA. It is probably native as far north as Alabama / Georgia etc, but even there it is unlikely that it is truly native. The origin is much more likely to be in the pantanal region of Brazil / Argentina where there is a biodiversity hotspot of *Hydrocotyle* species. I would probably treat the northern US states as an invaded range (J. Newman, personal communication).
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	LIKELY	HIGH	Experience from abroad (refer to response to Questions 9 and 10) suggest that *Hydrocotyle ranunculoides* is very likely to be able to transfer from this pathway by either deliberate or inadvertent means to a suitable habitat (GB Non-Native Species Secretariat 2011) and that this mechanism is principally responsible for its occurrence in the wild (EPPO 2009; GB Non-Native Species Secretariat 2011). Available habitat for *Hydrocotyle ranunculoides* appears to be widespread in Ireland. The plant is found in static, slow-flowing and occasionally flowing water bodies, especially ditches, canals, lakes and ponds (Newman and Dawson 1999). It can be found in a broad range of water quality conditions from mesotrophic pools to the eutrophic lake margins and has a preference for eutrophic conditions where it grows best at high concentrations of nitrate and phosphate, and/or organic matter (reviewed in EPPO 2006).

Pathway 1 - Horticultural and aquarium trade				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	MODERATELY LIKELY	HIGH	Although *Hydrocotyle ranunculoides* does not appear to be traded in Ireland, there remains some potential that the plant could be imported and sold in Ireland under a different trade name, arrive as an hitch-hiker in other aquatic plant consignments (which has occurred in Europe) or may brought back from abroad by a private individual for planting in a pond or for an aquarium. *Hydrocotyle ranunculoides* is no longer imported in the EPPO region because local production is far more cost effective. In general, the volume of the plant being produced and sold is considered to be very low in the EPPO region (EPPO 2009).
1.10	Do other pathways need to be considered?	YES		

Pathway 2 – Boating, angling and other water activities.				
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	VERY HIGH	The overland or cross-channel movement of boats, boat trailers, boat engines, angling gear and other items used in water activities 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?	VERY UNLIKELY	HIGH	In the absence of implementing appropriate biosecurity measures, there is some potential for the inadvertent spread of viable plant material overland from infested to uninfested waters. It is very unlikely that 'large numbers' of *Hydrocotyle ranunculoides* will travel along this pathway but, in theory, occasional transfer of this species by this pathway is possible.
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.

Pathway 2 – Boating, angling and other water activities.				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
1.06	How likely is the organism to survive during passage along the pathway?	MODERATELY LIKELY	MEDIUM	Survival along this pathway is ultimately dependent on environmental conditions and duration of transport. It is considered that viable plant material can survive in a damp environment on equipment for at least several days. According to EPPO (2009), *Hydrocotyle ranunculoides* "is not considered to be susceptible to air drought or humidity as long as it rooted in water". No other specific information can be found in the literature on the desiccation tolerance of the plant..
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	MODERATELY LIKELY	MEDIUM	Boating, angling and other water activities are not necessarily restricted to a particular season and may occur throughout the year. Viable plant material could, in theory, be inadvertently transferred from colonised to uncolonised areas *via* this pathway at any time of year. Refer to Question 1.07 in Pathway 1 for relevant cold tolerance information and the potential for establishment during different times of 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	MEDIUM	As noted in Pathway 1 , Question 1.08, Ireland has a high density and abundance of natural freshwaters, many of which appear to be suitable for the establishment of *Hydrocotyle ranunculoides*. The movement of boats, boat trailers, boat engines, angling gear and other items used in water activities can act as a direct pathway to transfer aquatic plants from an infested water to a suitable habitat elsewhere. Successful transfer would be dependent on the environmental conditions and duration of transport. The tolerance of the plant to such factors is not fully clear from the literature reviewed. Nevertheless, any introduced vegetative fragments or seeds should be capable of establishing a population during the spring to autumn period (refer to response to Question 1.07, Pathway 1).

Pathway 2 – Boating, angling and other water activities.				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	MODERATELY LIKELY	MEDIUM	This pathway depends on viable plant material surviving an overland or cross-channel journey in association with the movement of boats, boat trailers, boat engines, angling gear and other items used in water activities from an infested water abroad to an uninfested water in Ireland. There is no specific data available on the movement of boats, boat trailers, boat engines, angling gear and other items used in water activities from infested areas abroad to Ireland. In Northern Ireland *Hydrocotyle ranunculoides* is recorded in only 16 sites, the majority of which are isolated ponds (National Invasive Species Database 2014). In Britain, the distribution *of Hydrocotyle ranunculoides* is more widespread (refer to response to Question 1.02). Nevertheless, there is unlikely to be much movement of contaminated equipment from these waters to Ireland.
1.10	Do other pathways need to be considered?	NO		

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	HIGH	The primary potential pathway of entry into Ireland is through deliberate trade *via* the horticultural and aquarium sectors. Although there appears to be no inter-country trade of the plant in the EPPO region (EPPO 2009), there may be some inadvertent imports as the plant may be mis-labeled. The movement of boats, angling gear and other equipment used in water activities from infested areas outside Ireland to the country could also facilitate entry if viable plant material can survive transit *via* these pathways. The potential for this may increase in the coming years if *Hydrocotyle ranunculoides* populations expand in Northern Ireland, and to a lesser extent, Britain.

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	*Hydrocotyle ranunculoides* is not recorded in Ireland
2.02	How likely is it that the organism will be able to establish in Ireland based on the similarity between local climatic conditions and the organism's current global distribution?	VERY LIKELY	VERY HIGH	Based on its present occurrence at localised sites in Northern Ireland and the distribution of the plant in England and Wales, climatic conditions are not considered to be limiting in Ireland. Global climate and regional environmental niche modelling also indicate that present climatic conditions in Ireland are suitable for the species (Kelly *et al*. 2014). Furthermore, according to a CLIMEX simulation*, Ireland along with many other EPPO countries in the Atlantic and Mediterranean regions, which are characterised by mild winters, are suitable for the establishment of *Hydrocotyle ranunculoides* (EPPO 2009). The species may be somewhat limited by cold temperatures in North America populations. However in Western Europe, although populations may be strongly reduced during cold winters, recovery occurs quickly in the following season (reviewed in EPPO 2009). (Refer to Question 1.07, Pathway 1 for more information on the cold tolerance of *Hydrocotyle ranunculoides*). * *The CLIMEX model is a computer programme aiming at predicting the potential geographical distribution of an organism considering its climatic requirements. It is based on the hypothesis that climate is an essential factor for the establishment of a species in a country (EPPO 2009).*
2.03	How likely is it that the organism will be able to establish in Ireland based on the similarity between other local abiotic conditions and the organism's current global distribution?	VERY LIKELY	VERY HIGH	*Hydrocotyle ranunculoides* is subjected to a range of abiotic conditions throughout its global range (reviewed in EPPO 2009). Based on its present occurrence at localised sites in Northern Ireland and the distribution of the plant in England and Wales, there appears to be no over-riding abiotic conditions to prevent establishment of the species in Ireland. In Ireland, unsuitable habitats may include acidic waters, fast flowing waters or salt waters (EPPO 2009).

Stage 2 - Detailed assessment: Section B – Establishment

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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?	VERY LIKELY	VERY HIGH	Available habitat for *Hydrocotyle ranunculoides* appears to be widespread in Ireland. As stated previously, the plant is found in static, slow-flowing and occasionally flowing water bodies, especially ditches, canals, lakes and ponds (Newman and Dawson 1999). It can be found in a broad range of water quality conditions from mesotrophic pools to eutrophic lake margins and has a preference for eutrophic conditions where it grows best at high concentrations of nitrate and phosphate, and/or organic matter (reviewed in EPPO 2006).
2.05	How likely is it that establishment will occur despite competition from existing species in Ireland?	VERY LIKELY	VERY HIGH	Based on its occurrence at localised sites in Northern Ireland and the prevalence of the plant in England and Wales (GB Non-Native Species Secretariat 2011), competition is very unlikely to prevent the establishment of the species in Ireland. Indeed, in many introduced areas, *Hydrocotyle ranunculoides* is known to out-compete and extirpate native plant species (reviewed in EPPO 2009).
2.06	How likely is it that establishment will occur despite predators, parasites or pathogens already present in Ireland?	VERY LIKELY	HIGH	There are no known natural predators, parasites or pathogens of this species in Ireland that will have an effect on its establishment. There have been no known reports of predators, parasites or pathogens from Northern Ireland or Britain that have negatively affected its establishment there.
2.07	How likely is it that establishment will occur despite existing management practices?	UNLIKELY	HIGH	In general, the public management of waterways is increasingly undertaken cognisant of ensuring that biosecurity measures are in place to mitigate for the spread of aquatic invasive species. An increase in awareness of the threat from aquatic invasive species by some private entities has also somewhat reduced this risk.
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?	LIKELY	HIGH	Mechanical or manual control conducted with disregard for the potential generation and spread of vegetative fragments is a risk factor which may spread *Hydrocotyle ranunculoides*. Roots can develop from every node of the stoloniferous growth form (CABI 2014) and such fragments are capable of rapid growth (GB Non-Native Species Secretariat 2011). According to Hussner *et al*. (2012), "New shoots are formed even from small stem fragments. Up to 90% of stem fragments 1 cm in length and

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
				with only one node, with or without leaves, regenerate within one week; single leaves and internode fragments do not regenerate." Transport on machinery used to clear watercourses may also be a factor in local spread (EPPO 2009) either through the spread of vegetative fragments or *via* seed dispersal. Although, the latter has not been documented to date (Hussner *et al*. 2012).
2.10	How likely is it that the biological characteristics of the organism will facilitate its establishment?	VERY LIKELY	VERY HIGH	The ability of *Hydrocotyle ranunculoides* to reproduce asexually from vegetative fragments or ramets (i.e. genetically identical individual plants which break off from a clonal colony) and to produce seeds, coupled with its non-specific abiotic requirements, over-wintering capability and fast growth rate are biological characteristics which facilitate the establishment and spread of this species in introduced regions (reviewed in EPPO 2009, GB Non-Native Species Secretariat 2011 and CABI 2014). In general, the climatic, habitat and abiotic requirements of *Hydrocotyle ranunculoides* (as well as the history of establishment in Northern Ireland and Britain), indicate that this plant is ideally suited to establish in Ireland. *Hydrocotyle ranunculoides* has a capacity for rapid growth. According to a review by CABI (2014), "This species grows and regenerates rapidly. In the UK, [growth] rates of 23 cm per day have been recorded (JR Newman, Centre for Aquatic Plant Management, Wallingford, UK, personal communication 2004). Growth in waste water treatment systems has produced 19.7 tonnes per hectare (Boyd and Bayne 1988). Studies in Germany showed increased growth under high nutrient conditions, up 0.132 g g^{-1} dry weight d^{-1} (Hussner and Lösch, 2007)." According to Newman (2002) as cited in EPPO (2009), the plant shows a much higher growth rate in high nutrient conditions, while maintaining similar rates of growth to native species in low nutrient conditions.

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?	VERY LIKELY	VERY HIGH	Within contiguous water systems, the principal means of natural dispersal is through asexual reproduction (ramets and vegetative fragments) and sexual reproduction (i.e. seeds) (Robert *et al*. 2013; CABI 2014). Anthropogenic-mediated transfer is believed to be the principal pathway to facilitate the introduction of the plant to uncolonised waters (EPPO 2009; GB Non-Native Species Secretariat 2011; Robert *et al*. 2013; CABI 2014).
2.12	How likely is it that the organism's adaptability will facilitate its establishment?	VERY LIKELY	VERY HIGH	Refer to response to Question 2.10.
2.13	How likely is it that the organism could establish despite low genetic diversity in the founder population?	VERY LIKELY	HIGH	There is a paucity of information available to adequately answer this. Any population that establishes in Ireland would most likely come from Northern Irish, British or, to a lesser extent, mainland European sources. Many other non-native aquatic plants have established robust populations in Ireland in spite of apparent low genetic diversity in their founder populations. The genetic diversity of founder populations is not important for species that reproduce vegetatively. Flowers are formed and seeds are set, but seed require high autumn temperatures to germinate (such as those found in tropical aquaria). Clonal growth is characteristic of several important noxious weeds, including *Fallopia japonica*. (J. Newman, personal communication) According to a review in CABI (2014), "In a short genetic study *of H. ranunculoides* in the UK (JR Newman, Centre for Aquatic Plant Management, Wallingford, UK, unpublished data, 2004), four groups of the species were distinguished in the UK population by AFLP analysis. One clone was found to be relatively similar to the native *H. vulgaris*, perhaps indicating hybridization. In the same study, the chromosome number was found to be 96, indicating tetraploidy over the same species assessed by Federov (1974). This may indicate that the horticulturally derived weed of Europe is different to the native species but further work is needed to confirm this."

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	The recent history of invasion of *Hydrocotyle ranunculoides* in both Northern Ireland and Britain (as outlined elsewhere in this document) provide a strong indication of the likely invasion pattern that will occur in Ireland should the plant become traded or introduced here. Two examples from Western Europe are provided to further Illustrate this as follows: In the Netherlands, *Hydrocotyle ranunculoides* was first recorded in 1994 in a watercourse near Utrecht (reviewed in Robert *et al*. 2013). In 1995, this watercourse had become fully overgrown over a distance of 2 km. In 1998, the species has become a nuisance in North Brabant province and by 2004, the plant had spread all over the country to ditches, canals, brooks and smaller rivers, except brackish waters (Robert *et al*. 2013 and references therein). It is now present in all provinces, and only absent from the Wadden Islands, which are separated by salt water from the mainland (EPPO 2009). In Belgium, *Hydrocotyle ranunculoides* was first officially recorded in the wild in 1999 (Robert *et al*. 2013). By 2004, it had become widespread and well established in Flanders, especially in the East-Flanders and Antwerp provinces. The species is continuing to spread, mainly in Flanders but it is also present in the Brussels region and, since 2000, in part of the Walloon region (Robert *et al*. 2013 and references therein).
2.15	If the organism does not establish, then how likely is it that transient populations will continue to occur?	VERY UNLIKELY	VERY HIGH	Factors such as climate suitability, abiotic and habitats preferences (as well as the recent history of establishment in Northern Ireland and Britain), indicate that *Hydrocotyle ranunculoides* is ideally suited to establish in Ireland and that solely transient populations are very unlikely to occur.
2.16	Estimate the overall likelihood of establishment. Mention any key issues in the comments box	VERY LIKELY	VERY HIGH	The climatic, habitat and abiotic requirements of *Hydrocotyle ranunculoides* as well as the recent history of establishment in Northern Ireland and Britain, indicate that this plant is ideally suited to establish and thrive in Ireland.

Stage 2 - Detailed assessment: Section C - Spread

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
3.01	What area (given in % or 10km squares) in Ireland could the organism establish (0% - 10%, 11% - 33%, 34% - 67%, 68% - 90% or 91% - 100%)?	34% - 67% of 10 km squares	HIGH	As previously mentioned, available habitat for *Hydrocotyle ranunculoides* appears to be widespread in Ireland. The plant is found in static, slow-flowing and occasionally flowing water bodies, especially ditches, canals, lakes and ponds (Newman and Dawson 1999). It can be found in a broad range of water quality conditions from mesotrophic pools to the eutrophic lake margins and has a preference for eutrophic conditions where it grows best at high concentrations of nitrate and phosphate, and/or organic matter (reviewed in EPPO 2006).
3.02	How important is the expected spread of this organism in Ireland by natural means (minimal, minor, moderate, major or massive)?	MINOR / MAJOR	HIGH	At present, it is considered that there is a minor risk from natural spread of *Hydrocotyle ranunculoides* to Ireland from Northern Irish populations as the species is localised there and there are currently no direct connections colonised waters there to Ireland that could facilitate natural spread. Natural spread overland to Ireland is unlikely as it would involve the transfer of vegetation (or seeds) by migrating waterfowl. *Hydrocotyle ranunculoides* has been reported to be able to reach new regions "very easily" in association with waterfowl (Huckle 2002 as cited in Hussner *et al*. 2012). As *Hydrocotyle ranunculoides* is known to disperse *via* seeds and asexually (*via* ramets and vegetative fragments) (refer to response to Question 2.11), there is a major potential for natural spread within contiguous water systems should the plant become introduced to Ireland.
3.03	How important is the expected spread of this organism in Ireland by human assistance (minimal, minor, moderate, major or massive)?	MINOR / MAJOR	HIGH	At present, it is considered that there is a minor risk from the inadvertent human-mediated spread of *Hydrocotyle ranunculoides* to Ireland from abroad. A deliberate introduction in future from plant material sourced from abroad cannot be fully discounted, however. Experience from other European countries (e.g. Belgium, England, France, Germany, Northern Ireland, The Netherland and Wales) strongly suggests that anthropogenic-mediated introduction has been the principal pathway responsible for the spread of *Hydrocotyle ranunculoides* to the wild. Once established, subsequent spread appears to be anthropogenic or natural in contiguous waters (reviewed in EPPO 2009; GB Non-Native Species Secretariat 2011, Robert *et al*. 2013 and CABI 2014). This will most likely be the case in Ireland in future if the plant is introduced for trade or illicitly introduced in a private capacity.

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
3.04	Within Ireland, how difficult would it be to contain the organism (minimal, minor, moderate, major or massive)?	MAJOR	HIGH	This would depend on the extent of establishment. Based on experiences from abroad, as reported elsewhere in this assessment, successful long-term containment is highly unlikely. However, within isolated ponds, containment is feasible. The spread of the species in Northern Ireland has been slow to date presumably because of its localised distribution there, being largely confined to geographically isolated ponds, and the implementation of measures to attempt to eradicate or control it where it has been found (National Invasive Species Database 2014).
3.05	What proportion (%) of the area in Ireland suitable for establishment, if any, has already been colonised by the organism?	0%	VERY HIGH	*Hydrocotyle ranunculoides* has not been recorded in Ireland to date.
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%	VERY HIGH	*Hydrocotyle ranunculoides* is unlikely to establish in the wild in Ireland in the next five years. This is because the plant is not currently traded in Ireland. In addition, it is locally distributed in Northern Ireland where it is largely confined to geographically isolated ponds and it is subject to on-going control measures by the authorities there. Further to this, the enactment of Regulation 50 of the European Communities (Birds and Natural Habitats) Regulations (2011), which prohibits the trade of this species should discourage any future trade here. The potential for epizoochoric spread to Ireland is a risk factor which cannot be easily assessed. As mentioned previously, an illegal deliberate introduction from plant material sourced abroad cannot be fully discounted. Nevertheless, it is highly likely, even in that scenario, that at most ≤ 10% of the 'area in Ireland suitable for establishment' would be invaded.
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	LOW	*Hydrocotyle ranunculoides* has not been recorded in Ireland to date. Any future introductions to the country are likely to be epizoochoric from Northern Ireland or as a result of an illegal deliberate introduction. This species has not been traded in Ireland to date, and is unlikely to be traded here in future. The presence of *Hydrocotyle ranunculoides* in the Lagan River in Northern Ireland could, in theory, facilitate its eventual spread to Ireland if both the Lagan Canal and Ulster Canal are re-opened for navigation as

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
				proposed by some stakeholders. This would link the River Lagan to the Shannon-Erne system (*via* the Lagan Canal, Lough Neagh and the Ulster Canal).
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%	LOW	Refer to responses 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.	-	VERY HIGH	As previously mentioned, available habitat for *Hydrocotyle ranunculoides* appears to be widespread in Ireland. The plant occurs in static, slow-flowing and occasionally flowing water bodies, especially ditches, canals, lakes and ponds (Newman and Dawson 1999). It can be found in a broad range of water quality conditions from mesotrophic pools to the eutrophic lake margins and has a preference for eutrophic conditions where it grows best at high concentrations of nitrate and phosphate, and/or organic matter (reviewed in EPPO 2006). In Ireland, unsuitable habitats may include acidic waters, fast flowing waters or salt waters (EPPO 2009).
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	MEDIUM	*Hydrocotyle ranunculoides* is unlikely to establish in the wild in Ireland in the coming years. This is because the plant is not currently traded in Ireland. In addition, it is locally distributed in Northern Ireland where it is largely confined to geographically isolated ponds and it is subject to on-going control measures by the authorities there. Further to this, the enactment of Regulation 50 of the European Communities (Birds and Natural Habitats) Regulations (2011), which prohibits the trade of this species should discourage any future trade here. The potential for epizoochoric spread to Ireland is a risk factor which cannot be easily assessed.

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 to MAJOR	HIGH	No overall figures are available on this. According to EPPO (2009), "In the Canning River in Western Australia *H. ranunculoides* became a serious problem in 1992. A program costing over AU$ 200,000 in the first year was implemented (Atkins 1994; Ruiz Avila and Klemm 1996; Newman & Dawson 1999), and the species is still present in Australia. In the Netherlands, some water boards faced a doubling of costs each year during the 1990s, and, in 2000, the total annual control costs were around €1 Million (van der Krabben & Rotteveel 2003). In 2007, in the Netherlands, 11 water boards out of 26 responded to an inquiry stating that they spent an additional €1.8 million for the management of *H. ranunculoides* over and above normal operating costs for this plant (van Valkenburg, pers. comm., 2009). In Flanders, the estimated cost for the management of *H. ranunculoides* is €1.5 million per year (needed during 3 years from 2009) (Triest, pers. comm., 2009). In the UK, the estimate for control of the total area infested by *H. ranunculoides* by herbicides was between £250,000 and £300,000 per year (Harper 2002). In 2008, £1.93 million was spent for the management and disposal of *H. ranunculoides* (Newman, pers. comm.., 2009). In 6 years, the costs were multiplied 7 fold. Flooding caused by the plant may also have an economic impact due to loss of crops (Newman, pers. comm., 2009). " In Northern Ireland, financial costs likely to be in the tens of thousands of pounds have been incurred since the mid-2000s in association with operations there to eradicate/control *Hydrocotyle ranunculoides*.
4.02	How great has the economic cost of the organism been in Ireland from the time of introduction to the present? Exclude any costs associated with managing the organism from your answer.	NONE	VERY HIGH	*Hydrocotyle ranunculoides* has not been recorded in Ireland to date.
	How great is the economic cost of the organism likely to be in the future in Ireland? Exclude any costs associated with managing the organism from your answer.	MODERATE to MAJOR	MEDIUM	Significant costs are likely to be incurred should *Hydrocotyle ranunculoides* become established widely in Ireland (see response to Question 4.01 for an overview of potential economic impacts that may occur should *Hydrocotyle ranunculoides* establish in Ireland).
4.04	How great have the economic costs of managing this organism been in Ireland from the time of introduction to the	MINIMAL	VERY HIGH	*Hydrocotyle ranunculoides* has not been recorded in Ireland to date. Only minimal costs have been incurred to date by public agencies (e.g. Inland Fisheries Ireland and Invasive Species Ireland) in relation to

Stage 2 - Detailed assessment: Section D - Impact *This section evaluates the probability of impact of an organism within Ireland.*				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
	present?			raising public awareness of the threat from *Hydrocotyle ranunculoides* or carrying out preliminary screening risk assessments on it.
4.05	How great is the economic cost of managing this organism likely to be in the future in Ireland?	MODERATE to MAJOR	MEDIUM	Significant costs are likely to be incurred should *Hydrocotyle ranunculoides* become established widely in Ireland (see response to Question 4.01 for an overview of potential economic impacts that may occur should *Hydrocotyle ranunculoides* establish in Ireland).
4.06	How important is environmental harm caused by the organism within its global distribution?	MAJOR	HIGH	According to GB Non-Native Species Secretariat (2011), "There appear to be no quantified assessments of environmental harm caused by this species within its existing geographic range. There is a high risk of spread of *Hydrocotyle ranunculoides* in eutrophic still and slow flowing waterbodies in countries where it is already established, and there is a high risk of introduction where it is not already present. Dense mats of vegetation can seriously affect species, habitats and ecosystems". According to the risk assessment by EPPO (2009), "The EWG (Expert Working Group) concluded that in most sites, 100% cover is often observed over large distances (25 km), which is detrimental for the ecosystem. The plant is perennial and present all year long in the UK. In Belgium, it has been observed to reduce by more than 50% the number of native aquatic plant species up to 100% of the submerged species, and to reduce the native cover from 50% to 10 (Nijs *et al*. 2009). In Sardinia, the species is considered invasive, and although no specific impacts have been studied, the thick coverage of the species at the surface of the water is considered to outcompete other species (G Brundu, pers. comm., 2009). In the PRA (Pest Risk Analysis) area, where present, *H. ranunculoides* competes with many plant species due to its ability to establish in different habitats. Examples: different *Carex*/sedge and *Juncus* species, *Rorippa amphibia*, *Myosotis palustris* (syn. *M. scorpioides*), *Nasturtium officinale* (A. Hussner, pers. comm.., 2009). In Germany, the native *Myriophyllum spicatum*, *Callitriche* spec. and *Potamogeton crispus* were displaced (Hussner, 2008). Nevertheless, these species are not endangered. Due to the high LAI (Leaf Area Index) of up to 5.57 +/- 0.2 it seems obvious, that the species is able to outcompete submerged vegetation (Hussner and Lösch 2007). Many more species can be outcompeted due to *H. ranunculoides'* capability to build floating carpets

Stage 2 - Detailed assessment: Section D - Impact *This section evaluates the probability of impact of an organism within Ireland.*				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
				that shade out other plants. Data on impacts in dense infestation are rare because of dangerous surveillance conditions underneath dense floating mats. Indirect effects on other biota and food web (phytoplankton, zooplankton, fishes) is caused by its summer biomass and by moments of decay (lowering of oxygen) and alteration of detritus (impact on macroinvertebrates) (Alien impact report 2009; L Triest, pers. comm., 2009). The EWG considered that *H. ranunculoides* causes many significant changes of ecological processes and structures by : - reduction in flow; - increased sedimentation resulting in acceleration of ecological succession; - changes in O_2 concentration; - loss of accessible open water at the margins for wildlife (e.g. birds); - loss of light; - increased flood risk."
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	NONE	VERY HIGH	*Hydrocotyle ranunculoides* has not been recorded in Ireland to date.
4.08	How important is the impact of the organism on biodiversity likely to be in the <u>future</u> in Ireland?	MODERATE to MAJOR	MEDIUM	If *Hydrocotyle ranunculoides* becomes established in Ireland, similar impacts as outlined in response to Question 4.06 are likely to occur. The extent of such impacts would depend on how widely the species would be established in the country.

Stage 2 - Detailed assessment: Section D - Impact

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.09	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	NONE	VERY HIGH	*Hydrocotyle ranunculoides* has not been recorded in Ireland to date.
4.10	How important is alteration of ecosystem function caused by the organism likely to be in Ireland in the future?	MAJOR	VERY HIGH	If *Hydrocotyle ranunculoides* becomes established in Ireland, similar impacts to those outlined in response to Question 4.06 are likely to occur. The extent of such impacts would depend on how widely the species would be established in the country. According to EPPO (2006), "Due to the high Leaf Area Index of up to 5.47 ± 0.2, the species is able to outcompete submerged vegetation (Hussner and Lösch, 2007) and as a result ecosystem functions can be altered."
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.	NONE	VERY HIGH	*Hydrocotyle ranunculoides* has not been recorded in Ireland to date.
4.12	How important is decline in conservation status caused by the organism likely to be in the future in Ireland?	MODERATE to MAJOR	MEDIUM	If *Hydrocotyle ranunculoides* was to establish in Ireland, there would a strong likelihood based on known impacts that it would rresult in detrimental impacts to native habitats and species. 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 under the EU Habitats Directive.
4.13	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within its global distribution?	MODERATE	MEDIUM	There is a paucity of specific information available on this. According to EPPO (2009), "Effects on tourism (swimming, water sports, fishing, navigation, leisure etc.) can locally be expected to be large. As waterways covered with *H. ranunculoides* are not attractive for recreation and may hinder traffic, even the movements of boats, some profit losses have been observed in the Netherlands (van Valkenburg, pers. comm., 2009). Dense vegetation mats can present a direct safety risk to the public and livestock. Cattle have drowned in the UK (Newman, pers. comm., 2009). Loss of aesthetic value in nature reserves has been

Stage 2 - Detailed assessment: Section D - Impact *This section evaluates the probability of impact of an organism within Ireland.*				
N	**QUESTION**	**RESPONSE**	**CONFIDENCE**	**JUSTIFICATION**
				reported in Belgium (Triest, pers. comm., 2009). Increased costs for drainage and/or flood prevention will be borne by the users (agriculture and general society)."
4.14	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within Ireland?	NONE	VERY HIGH	*Hydrocotyle ranunculoides* has not been recorded in Ireland to date.
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. According to GB Non-Native Species Secretariat (2011), "".
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	LOW	Unknown, but unlikely.
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	HIGH	All known potential impacts have been covered elsewhere is this assessment.
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	*Hydrocotyle ranunculoides* has not been recorded in Ireland to date. However, there have been no reports of natural control by other organisms in Northern Irish, British or mainland European populations.

Stage 2 - Detailed assessment: Section D - Impact

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.19	Indicate any parts of 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	As previously mentioned, available habitat for *Hydrocotyle ranunculoides* appears to be widespread in Ireland. The plant is typically found in static, slow-flowing and occasionally flowing water bodies, especially ditches, canals, lakes and ponds (Newman and Dawson 1999). It can be found in a broad range of water quality conditions from mesotrophic pools to the eutrophic lake margins and has a preference for eutrophic conditions (reviewed in EPPO 2006). Impacts are particularly likely to occur in any of these habitats but may be more pronounced in areas where there is a level of enrichment which would promote more vigorous growth.
4.20	Estimate the overall potential impact of this organism in Ireland. Use the justification box to indicate any key issues.	MAJOR	HIGH	Overall, the literature indicates that *Hydrocotyle ranunculoides* has the potential to cause serious ecological, environmental and socio-economic impacts should it 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).	MAJOR	HIGH	*Hydrocotyle ranunculoides* poses a 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. The plant has a high capacity to establish dense infestations here in suitable habitats which would result in a range of negative impacts as reported from elsewhere in its introduced range. Despite that this species has not arrived in Ireland to date, its ability to spread should not be underestimated. Banning its sale has worked well in Britain, but new sites continue to be recorded each year. (J Newman, personal communication)

Stage 2 - Detailed assessment: Section F – Additional questions

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
6.01	What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?		HIGH	Climate change is expected to increase water temperatures over time in Ireland, with increased periods of drought in summer and higher rainfall in winter leading to more flooding events (Desmond *et al*. 2008). Global climate and regional environmental niche modelling project that the suitable range for *Hydrocotyle ranunculoides* in the island of Ireland will remain suitable for the species (the model is based on the International Panel on Climate Change high and low emissions climate change scenario modelled to the year 2080) (Kelly *et al*. 2014). Increased flooding may promote the spread of the species within catchments by dispersing vegetative or seed inoculum. In general, predicted climate change is unlikely to greatly affect the risk assessment for this species.
6.02	What is the likely timeframe for such changes (5, 10, 15 , 20, 50 or 100 years)?	N/A	-	Refer to response to Question 6.01 above.
6.03	What aspects of the risk assessment are most likely to change as a result of climate change	NONE	LOW	Refer to Questions 6.01 above.
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.			It would be worthwhile to ascertain whether *Hydrocotyle ranunculoides* is traded in Ireland under a pseudonym. The on-going status of Northern Irish populations should be monitored as any expansion there may increase the risk of spread to Ireland.

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