

## Risk Assessment of *Hydropotes inermis*

<b>Name of Organism:</b>	<i>Hydropotes inermis</i> Swinhoe, 1870 – Chinese Water Deer
<b>Objective:</b>	Assess the risks associated with this species in Ireland
<b>Version:</b>	Final 15/09/2014
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### Stage 1 - Organism Information

### Stage 2 - Detailed Assessment

Section A - Entry  
Section B - Establishment  
Section C - Spread  
Section D - Impact  
Section E - Conclusion  
Section F - Additional Questions

### **About the risk assessment**

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

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

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

## DOCUMENT CONTROL SHEET

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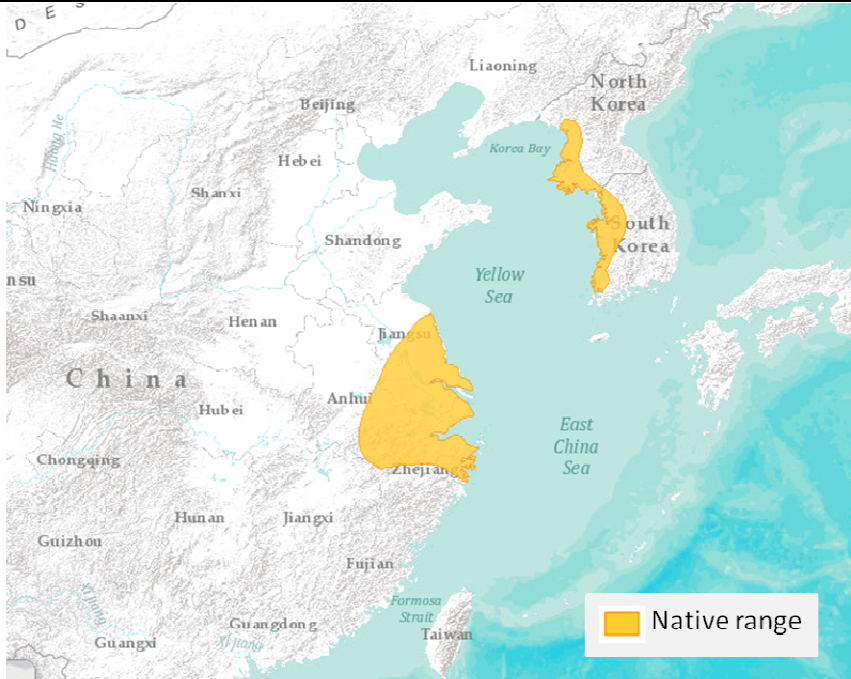
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**Stage 1 - Organism Information and Screening: Section A - Organism Information**

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


N	QUESTION	RESPONSE	COMMENT
1	What is the reason for performing the risk assessment?	-	A risk assessment is required as this species is listed as a "Non-native species subject to restrictions under Regulations 49 and 50" in the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011, SI 477/2011.
2	Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	YES	<p><i>Hydropotes inermis</i> Swinhoe, 1870 – Chinese water deer</p> <p>Taxonomy: Kingdom: Animalia Phylum: Chordata Subphylum: Vertebrata Class: Mammalia Order: Artiodactyla Family: Cervidae Subfamily: Capreolinae Genus: <i>Hydropotes</i> Species: <i>Hydropotes inermis</i></p> <p>Synonyms: <i>Hydropotes affinis</i> Brooke, 1872; <i>Hydropotes argyropus</i> Heude, 1884; <i>Hydropotes kreyenbergi</i> Hilzheimer, 1905</p> <p>Common name (English): Chinese water deer, vampire deer</p> <p>Phylogenetic studies have shown <i>Hydropotes</i> to be nested within the subfamily Capreolinae, being particularly closely related to <i>Capreolus</i> spp. (Cooke and Farrell, 2008)</p> <p>There are two subspecies. <i>Hydropotes inermis inermis</i> Swinhoe, 1870, is found in parts of eastern China and <i>H. i. argyropus</i> Heude, 1884, is found in Korea (Harris and Duckworth, 2008). <i>Hydropotes inermis inermis</i> is the species assumed to have been introduced into Britain (Cooke, 2009a, 2011)</p>
3	If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)	N/A	
4	Describe the organism.	-	<i>Hydropotes inermis</i> , notable as the only true deer species without antlers (males have long curved upper canines), is described by Cooke and Farrell (2008) as follows: "Thick winter coat of hollow hairs, 40-55 mm long, white at base, buff or ginger at tip and black in between. Individual deer vary in appearance from pale fawn to grey-brown. Muzzle may have white, grey or black

<b>Stage 1 - Organism Information and Screening: Section A - Organism Information</b> <i>The aim of this section is to gather basic information about the organism.</i>			
N	QUESTION	RESPONSE	COMMENT
			<p>band, last type especially in males. Summer coat sleek and reddish-brown. Deer with rough, transitional coats seen mainly March-May; by May most in summer coat. Fawns have pale spots in lines at birth but lose these after 2 months. Large, hairy ears, held erect. Eyes rounded, black and button-like. Tail short, stumpy, occasionally sticks out. Although no conspicuous caudal patch, rump can appear paler below tail. Hind legs muscular and longer than front ones, so hindquarters higher than shoulders".</p> <p>Chinese water deer are slightly taller than muntjac (<i>Muntiacus reevesi</i>) and differ in having a straight or concave back (muntjac often hunched). Further distinguished from muntjac by short tail, which is never held erect but may stick out, especially on males in winter (Marchant, 2012). Lack black facial markings of muntjac. Stance and movement more like roe deer (<i>Capreolus capreolus</i>), but roe larger and has conspicuous white caudal patch (Cooke and Farrell, 2008).</p>
5	Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	YES	In Ireland, a preliminary risk assessment was previously carried out. This was a prioritisation risk assessment as part of the Risk Analysis and Prioritisation for Invasive and Non-native Species in Ireland and Northern Ireland (ISI, 2012). It designated <i>Hydropotes inermis</i> as a "low risk" invasive species.
6	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?	PARTIAL	Only a preliminary risk assessment was previously conducted in Ireland (refer to Question 5)
7	Where is the organism native?		The species has a fragmented and shrinking range in the Yangtse Basin of eastern China, perhaps now restricted to the Poyang Lake and Yancheng Nature Reserves, and separate populations in North and South Korea (Harris and Duckworth, 2008; Marchant, 2012). The species has becoming progressively rarer in its native range, primarily as a result of poaching and habitat destruction (Harris and Duckworth, 2008; Marchant, 2012; Zhang, 1996). Recent estimates of the Chinese population are 10,000-30,000 (Sheng and Ohtaishi, 1993) and about 10,000 in 2009 (Cooke, 2009a). Little, to no information is available for the north Korean populations, but densities of 1.3 to 6.9 per km <sup>2</sup> have been recorded for various environments in South Korea (Kim <i>et al.</i> 2011).

<b>Stage 1 - Organism Information and Screening: Section A - Organism Information</b> <i>The aim of this section is to gather basic information about the organism.</i>			
N	QUESTION	RESPONSE	COMMENT
			 <p><b>Figure 1.</b> Native range of Chinese water deer (<i>Hydropotes inermis</i>; modified from Harris and Duckworth, 2008).</p>
8	What is the current global distribution of the organism (excluding Ireland)? (map optional)		<p>The species has a current global distribution spanning China, North Korea, South Korea (refer to Question 6), Britain (Figure 2; Chapman, 1995) and France (Dubost <i>et al.</i>, 2008; Lever, 1977). Chinese water deer has a limited distribution in Britain, being established only in parts of eastern England (Figure 1; Marchant, 2012; Ward <i>et al.</i>, 2008). The species is well established in parts of the Fens, the Norfolk Broads, and western Bedfordshire. They also occur in Suffolk and are occasionally reported elsewhere (Marchant, 2012). In 2004, around 1500 Chinese water deer were thought to be living in the wild, with about 600 in captivity (Cooke and Farrell, 2008; Marchant, 2012; Ward, 2005). In 2009 there were estimated to be 4000 individuals in the wild</p>

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

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

N	QUESTION	RESPONSE	COMMENT
			<p>(Marchant, 2012). Apart from a small group in France (Dubost <i>et al.</i>, 2008; Lever, 1987), no other non-native populations of this species are known.</p>  <p>Figure 2. Records of Chinese water deer in Britain; information from British Deer Society enquires 1972-2007 (from Ward <i>et al.</i>, 2008).</p>
9	What is the current distribution of the organism in Ireland? (map optional)		To-date, the species is not known to be present in Ireland.

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

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

N	QUESTION	RESPONSE	COMMENT
10	Is the organism known to be invasive anywhere in the world?	NO	<p>On a world scale, there is considerable conservation concern for the Chinese water deer (Cook, 2009). The species has a vulnerable status on the current International Union for Conservation of Nature (IUCN) Red List (Harris and Duckworth, 2008) and the British population may currently represent as much as 10% of the species total global population (Marchant, 2012). To the authors knowledge there is no published literature documenting Chinese water deer as an invasive species (i.e. known to have intrinsic attributes that indicate a species is, or could be, threatening to other species, habitats or ecosystems). As in its Chinese native range it may be considered as an agricultural pest, eating root crops and sprouting grain when other food is scarce, but in which event the impacts are reported locally and are considered negligible (refer to Question 4.01; Cooke, 2009a,b). Compared with the muntjac, which is well known to damage conservation features in woodland reserves the Chinese water is not such an extreme concentrate selector, lives in more robust habitats and seldom occurs at high densities (Cooke, 2009a, 2011). It is, however, noteworthy that 20 years ago in Britain muntjac were described as not invasive (Alastair Ward, per. comm., 1<sup>st</sup> March 2014). It, therefore, cannot be discounted that invasive impacts of Chinese water deer have potential to manifest, especially in a country such as Britain where the species continues to establish and spread to new areas (Alastair Ward, per. comm., 1<sup>st</sup> March 2014).</p>

<b>Stage 2 - Detailed assessment: Section A - Entry</b> <i>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.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.01	How many active/future pathways are relevant to the potential entry of this organism (n/a, very few, few, moderate number, many or very many)?	VERY FEW	HIGH	There are no active and very few future pathways relevant to the entry of <i>H. inermis</i> .
1.02	List <b>significant</b> pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways.	1. Deliberate introduction	HIGH	The species, as good swimmers, are known to naturally colonise islands in China. Naturalised populations of the species in Britain are not present along the western seaboard to the Irish sea (Figure 2) and it is unlikely that there will spread to this region of Britain due to large swathes of unfavourable environments (Alastair Ward, per. comm., 1 <sup>st</sup> March 2014). If Chinese water deer were ever to establish along the western seaboard of Britain natural entry of the species to Ireland would require animals of either sex or a pregnant female carrying at least one male, to swim across, which seem implausible (Alastair Ward, per. comm., 1 <sup>st</sup> March 2014). Therefore, the only relevant future pathway to the potential entry of the species is one of deliberate introduction. As was the case in Britain, where over a 100 years ago, Chinese water deer were introduced as ornamental animals for parkland estates (Chapman, 1995; Marchant 2012).

Pathway 1 – Deliberate introduction				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.03	Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (e.g. the organism is a contaminant of imported goods)?	INTENTIONAL	VERY HIGH	As there is no plausible natural pathway for this species to enter, any entry has to be intentional i.e. introduced by man. It is likely that introductions would be for hunting sport and as ornamental animals for perceived 'landscape improvement'.
1.04	How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year?	UNLIKELY	MEDIUM	In Britain, Chapman (1995) reported that nineteen Chinese water deer had been imported into the park at Woburn Abbey in Bedfordshire by 1913, but it is not known whether any have been imported since then. If not, all of the current British population, which account for a significant



Pathway 1 – Deliberate introduction				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
				proportion of the global population, are descended from this founding stock (Cooke, 2009a). Making reference to this initial introduction of the species to Britain, the number of Chinese water deer potentially entering Ireland via a future pathway of deliberate introduction would be expected to be low, infrequent and dependent on the demand for the species by hunting enthusiasts and/or estate managers.
1.05	How likely is the organism to enter Ireland undetected or without the knowledge of relevant competent authorities?	LIKELY	MEDIUM	It is likely that this species could enter Ireland without the knowledge of the competent authorities. This assumption is somewhat substantiated by the recordings of the non-native muntjac deer in Ireland; indicating that successful introductions of a similar species have taken place without the knowledge of the competent authorities.
1.06	How likely is the organism to survive during passage along the pathway?	MODERATELY LIKELY	MEDIUM	Likely for the species nutritional and housing requirements to be catered for by the importer. Deer are easily stressed (Harris and Yalden, 2008) and may suffer mortality during transport but as discussed in Question 1.04, nineteen Chinese water deer were successfully imported into England, in 1913 (Chapman, 1995).
1.07	How likely is the organism to arrive during the months of the year appropriate for establishment?	MODERATELY LIKELY	MEDIUM	Establishment success would be initially dependent on the introduction of one sexually mature Chinese water deer of each sex to a suitable habitat during the breeding season. The rut, in England, starts in late November and extends through December and occasionally into January (Harris and Duckworth, 2008).
1.08	How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	LIKELY	MEDIUM	Chinese water deer occur in marshes and wet grassland with reeds, sedges or coarse grasses, and in woodland where there is a mixture of cover and open areas (Marchant, 2012). They also feed on arable farmland (Marchant, 2012). In Norfolk and Suffolk, in England, many water deer are found close to the coast (Ward <i>et al.</i> , 2008), and the species may be able to exploit suitable coastal habitat elsewhere (Cooke, 2011). The species is likely to be introduced to and or encounter such suitable habitat within the Irish landscape (Fealy <i>et al.</i> , 2009; Fossitt, 2000).

Pathway 1 – Deliberate introduction				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.09	Estimate the overall likelihood of entry into Ireland based on this pathway?	MODERATELY LIKELY	MEDIUM	Entry is moderately likely via deliberate introduction. If the species were to enter Ireland the stock would most likely come from Britain. In Britain, the documented deliberate introduction of a small number of animals to Woburn Abbey Park over 100 years ago has resulted in successful translocations by man to other sites and release/escapes from captive populations (Cooke, 2009a).
1.10	Do other pathways need to be considered?	NO	MEDIUM	

Overall likelihood				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
1.11	Estimate the overall likelihood of entry into Ireland based on all pathways (comment on the key issues that lead to this conclusion).	MODERATELY LIKELY	MEDIUM	Refer to Question 1.09

<b>Stage 2 - Detailed assessment: Section B – Establishment</b> <i>This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.01	Is the organism well established in Ireland (if there is any uncertainty answer 'unsure')	NO	HIGH	Chinese water deer are not known to be present in Ireland.
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?	LIKELY	MEDIUM	In the species native range (China, North Korea and South Korea), the climate is considerably hotter and wetter (Papadakis, 1970) compared to Ireland, a temperate oceanic climate which is mild, moist and changeable, with abundant rainfall and lack of temperature extremes (Keane and Collins, 2004). However, Ireland shares a similar climate to Britain where Chinese water deer are established. Therefore, it is likely that the species could establish within the island of Ireland. In Britain, the species primarily occur in eastern England, but are established elsewhere and are considered to have the potential to spread over much of lowland southern Britain (Cooke, 2009a). As the principal difference between the Irish climate and that in their native range is the hotter, more humid summers (Zhang, 1996), climatic conditions most suitable to any potential establishment of the species are to be found in the south and south east of Ireland, where mean daily minimum temperatures are 5-7°C and mean daily maximum temperatures are 5.5-7.5°C (Cummins and Collins, 1996).
2.03	How likely is it that the organism will be able to establish in Ireland based on the similarity between other local <u>abiotic conditions</u> and the organism's current global distribution?	LIKELY	MEDIUM	It is likely that the species could establish in Ireland due to the similarities of their abiotic conditions with Britain.
2.04	How likely is the organism to encounter habitats necessary for the survival, development and multiplication of the organism in Ireland?	LIKELY	MEDIUM	If deliberately introduced to Ireland, introductions are likely to take place in habitats suitable for survival, development and multiplication of the species (refer to Question 1.08). In their native range the species favour undisturbed, tall, damp grassland or reed-bed (Zhang <i>et al.</i> , 2006) and it is in such habitat in Britain where the species forms densest populations (Cooke and Farrell, 1998). Although primarily associated with wet habitats the species can also occur in woodland and on arable farmland (Marchant, 2012). The species is likely to be introduced and/or encounter such suitable habitat within the Irish landscape (CORINE, 2006; Fossitt, 2000).

<b>Stage 2 - Detailed assessment: Section B – Establishment</b> <i>This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.05	How likely is it that establishment will occur despite competition from existing species in Ireland?	VERY LIKELY	MEDIUM	Competition has not significantly prevented Chinese water deer from becoming established in England (Cooke, 2009a). If Chinese water deer are introduced into Ireland they may compete with the muntjac ( <i>Muntiacus reevesi</i> ), the latter considered a superior competitor (Zhang 1996, Cooke 1998; Cooke and Farrell, 2001). For example, in England Chinese water deer have apparently been out-competed by the muntjac in woodland sites (Cooke, 1998; Cooke and Farrell, 2001, 2002). Roe deer ( <i>Capreolus capreolus</i> ), not currently present in Ireland, occupy a similar niche to the muntjac (Chapman <i>et al.</i> , 1993), and if roe deer and Chinese water deer are introduced they are likely to compete (Cook, 2009). At Wicken Fen in Cambridgeshire and at Redgrave and Lopham Fen in Suffolk, England, where muntjac and roe are established, water deer are still rare or occasional (National Trust, 2008).
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 reported important natural predators of Chinese water deer in Britain. A few fawns may be taken by foxes ( <i>Vulpes vulpes</i> ) and some adults by large dogs (Cooke and Farrell, 2008; Marchant, 2012; Zhang, 1996), but in insufficient numbers to prevent the spread of water deer as recorded by Ward <i>et al.</i> (2008) in East Anglia. A few endoparasites are known (Cooke and Farrell, 2008). <i>Demodex</i> mites cause mange and ticks <i>Ixodes</i> spp., keds <i>Lipoptena</i> sp. and lice <i>Cervicola meryeri</i> and <i>Damalinia</i> sp. have been recorded on the animal, with more parasites on park deer than wild ones (Cooke and Farrell, 2008).
2.07	How likely is it that establishment will occur despite existing management practices?	N/A	N/A	As Chinese water deer are not known to be present in Ireland there are no management practices geared towards control of this deer species, but if needed practices would be largely the same as used for control of impacts and spread fallow, sika and red deer Ireland. How likely establishment will be despite the implementation of management practices, will be largely dependant on policies and incentives to prevent their spread. Provided early action is taken if or where Chinese water deer are noted to have been introduced, it is likely that their establishment and spread could be slowed significantly or prevented using existing methods of deer control. If the species were to become established they may be discriminately or indiscriminately hunted and numbers controlled by sporting hunters. If species' establishment resulted

<b>Stage 2 - Detailed assessment: Section B – Establishment</b> <i>This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
				in negative economic, environmental and/or social impacts governmental led management through routine and systematic culling of the species may be required.
2.08	How likely is it that management practices in Ireland will facilitate the establishment of the organism?	MODERATELY LIKELY	LOW	One factor that could aid establishment is the switch from spring to winter sown arable crops (Cooke, 2009a, 2011). Winter sown crops have been found to afford young protection from both predators and hyperthermia (Chaplin, 1995; Cooke, 2009a, 2011). Any potential restoration or creation of fen and reed-bed habitat may aid the species establishment (Cooke, 2009a).
2.09	How likely is it that the biological characteristics of the organism would allow it to survive eradication campaigns in Ireland?	MODERATELY LIKELY	LOW	The species is under one metre in height, has a tendency to be solitary, is most active around dawn and dusk and is a good swimmer (Cooke and Farrell, 2008). If the species were to establish in Ireland, these characteristics could make eradication difficult. However, Chinese water deer have small home ranges and specific habitat requirements, so if they do establish they are likely to be localised, which would aid eradication.
2.10	How likely is it that the biological characteristics of the organism will facilitate its establishment?	MODERATELY LIKELY	MEDIUM	The rutting period, in England, starts in late November and extends through December and occasionally into January (Harris and Duckworth, 2008). From May to July, females will deliver litters of up to six fawns although the most common figure is only from one to three (Cooke and Farrell, 1998; Harris and Duckworth, 2008). Chinese water deer can breed successfully in their first winter (Cooke, 2011), when 5-8 months old, but 1 <sup>st</sup> winter deer are less successful at holding a territory or mating (Cooke and Farrell, 2008). These reproductive traits may allow for fast colonisation or recovery (Cooke, 2011). Offspring mortality is, however, high, with up to 40% of juveniles dying during their first four weeks (Dubost <i>et al.</i> , 2008; Harris and Duckworth, 2008). For example, the calculated turnover in the adult population at Woodwalton Fen in Cambridgeshire, England, is on average 20% per annum (Cooke and Farrell, 2000).

<b>Stage 2 - Detailed assessment: Section B – Establishment</b> <i>This section evaluates the probability of establishment of an organism within Ireland. For organisms which are already well established in Ireland there is no need to complete this section - move straight to the Spread section.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
2.11	How likely is it that the organism's capacity to spread will facilitate its establishment?	MODERATELY LIKELY	MEDIUM	Water deer bucks are territorial and young deer will be forced to disperse (Cooke & Farrell, 1998, 2000). However, bucks' territories can be <10 ha so rate of dispersal is not necessarily rapid, and has been no greater than 1 km per annum in Cambridgeshire (Cooke & Farrell, 1998) and Bedfordshire (Nau, 1992; McCarrick, 2007).
2.12	How likely is it that the organism's adaptability will facilitate its establishment?	UNLIKELY	MEDIUM	This species is not particularly adaptable and appears to be rather sensitive to environmental changes (Harris, and Duckworth, 2008)
2.13	How likely is it that the organism could establish despite low genetic diversity in the founder population?	LIKELY	MEDIUM	Low genetic diversity of British stock has not prevented establishment but is suggested to hinder further spread (Cooke, 2009a)
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	LIKELY	MEDIUM	In Britain, Chinese water deer were first noted in the wild in Bedfordshire in 1954, Norfolk in 1968, Cambridgeshire in 1971 and Suffolk in 1987; and in 2009, they were estimated to a numbered population of about 4000 (Marchant, 2012). If introduced to Ireland it is likely that the species could establish, as Ireland shares a similar climate and landscape to Britain where it is already established.
2.15	If the organism does not establish, then how likely is it that transient populations will continue to occur?	MODERATELY LIKELY	MEDIUM	To-date, there are no records of Chinese water deer in Ireland. There have been unsuccessful deliberate or accidental introductions of the species in areas of Britain (Ward, 2005), which may highlight the potential for short-lived individuals or populations to occur in Ireland, most likely under less favoured habitat and climatic conditions.
2.16	Estimate the overall likelihood of establishment. Mention any key issues in the comments box	LIKELY	MEDIUM	If introduced it is likely that the species could establish, as Ireland shares a similar climate and landscape to Britain where it is already established. Establishment of the species in Britain appears to be limited due to climatic constraints. Climatic conditions most suitable to any potential establishment of the species in Ireland are to be most likely found in the south and south east of the country.

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

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
3.01	What area (given in % or 10km squares) in Ireland could the organism establish (0% - 10%, 11% - 33%, 34% - 67%, 68% - 90% or 91% - 100%)?	11% -33%	MEDIUM	Chinese water deer are associated mainly with undisturbed wet habitats, such as marshes and wet grassland with reeds, sedges or coarse grasses, but also occur in woodland and on arable farmland (Zhang <i>et al.</i> , 1996; Cooke and Farrell, 2008; Marchant, 2012). About 13.3% of Ireland is covered with suitable habitat for the species to occupy: marshes (wetland, 0.54%), fen (0.19%), wet grassland (5.74%), mature forest (3.65%), forest (unclosed canopy) and scrub (3.04%) and possibly coastal complex (0.11%) (Fealy <i>et al.</i> 2009). It is likely for Chinese water deer to find such habitat (Fossitt, 2000), but the chances of the species finding prime wetland habitat, i.e. marshes (0.54%), is much lower due to the scarcity of this resource (Cooke, 2011).
3.02	How important is the expected spread of this organism in Ireland by <u>natural</u> means (minimal, minor, moderate, major or massive)?	MODERATE	LOW	<p>If introduced to Ireland the potential natural spread of Chinese water deer would be expected to be similar to that for the species in Britain, which is reported to be about 1km per year (Cooke and Farrell, 2008).</p> <p>Between 1972 and 2002 water deer expanded their range in England by a compound annual rate of 2% (Ward, 2005). A similar rate might be expected during the early years if they establish in Ireland. Between 2003 and 2007 they expanded their range by a compound annual rate of 22% (Ward <i>et al.</i>, 2008) A similar rate may be expected in Ireland if they are allowed to become established and persist for many years.</p>
3.03	How important is the expected spread of this organism in Ireland by <u>human assistance</u> (minimal, minor, moderate, major or massive)?	MODERATE	LOW	In Ireland, any entry and subsequent establishment and spread of Chinese water deer is dependent on deliberate introduction of the species i.e. introduced by man (refer to section stage 2, section A). Natural rates of spread are apparently very slow, and translocation has been an important factor in their dispersal in Britain (Marchant, 2012). Ward (2005) does report that introductions usually fail to establish a colony and the presence of the species in Britain is apparently due as much to unintentional escapes from collections as to deliberate release and translocation (Marchant, 2012).

**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)?	MODERATE	MEDIUM	In Ireland, the habitats suitable for the establishment and spread of Chinese water deer are varied and constitute a sizable land cover (refer to Question 3.01) likely making containment of the species moderately difficult. In Britain, elimination of outlying populations and containment within the species current core of East Anglia and adjacent counties would be a possibility by means of shooting (Cooke, 2011). Significant reasons for their persistence in the wild in Britain are because locals seem to value their presence as a curiosity and landowners can charge for stalking. If Chinese water deer were to be introduced to Ireland such social factors may play a role in the species containment, or potential lack of, i.e. intentional release/translocation from captive collections.
3.05	What proportion (%) of the area in Ireland suitable for establishment, if any, has already been colonised by the organism?	N/A	N/A	To-date, the species is not known to be present in Ireland.
3.06	What proportion of the area in Ireland suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)?	0% -10%	LOW	At present, about 13.3% of the island of Ireland has suitable habitat for this species and we know that the rate of colonisation in Britain is about 1 km per year (Cooke and Farrell, 2008). Therefore, we could expect that if a breeding population(s) came to establish at a site in Ireland, in five years the species would have expanded its range by 5 km at the site(s).
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.	5-10	MODERATE	The British Deer Society conducts a national survey of its members to record the presence of each species of deer every 5 years. This has allowed detection of a substantial increase in the rate of spread in Britain in recent years.
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	Between 1972 and 2002 water deer expanded their range in England by a compound annual rate of 2% (Ward, 2005). A similar rate might be expected during the early years if they establish in Ireland. Between 2003 and 2007 they expanded their range by a compound annual rate of 22% (Ward <i>et al.</i> , 2008) A similar rate may be expected in Ireland if they are allowed to become established and persist for many years.



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

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
3.09	Based on the answers to questions on the potential for establishment and spread in Ireland, define the area endangered by the organism. Be as specific as possible. If available, provide a map showing the area most likely to be endangered.	-	LOW	Lowland, rural Ireland, covered by undisturbed marshes, fen, wet grassland, woodland and arable farmland (Zhang <i>et al.</i> , 1996; Cooke and Farrell, 2008; Marchant, 2012) mainly in the south and south east of the country is most endangered.
3.10	Estimate the overall potential for future spread for this organism in (very slowly, slowly, moderately, rapidly or very rapidly). Use the justification box to indicate any key issues.	SLOWLY	LOW	Chinese water deer are associated mainly with undisturbed wet habitats, such as marshes and wet grassland with reeds, sedges or coarse grasses, but also occur in woodland and on arable farmland (Zhang <i>et al.</i> , 1996; Cooke and Farrell, 2008; Marchant, 2012). At present, about 13.3% of the island of Ireland has suitable habitat for this species. Spread will, in the first instance, be dependent on deliberate introduction of the species by man. If breeding populations establish then we can expect the rate of spread of this species to be similar to that recorded in Britain i.e. 1 km per year (Cooke and Farrell, 2008) during the early years. Suitable habitat for this species to spread is present within the landscape (Fossitt, 2000).

<b>Stage 2 - Detailed assessment: Section D - Impact</b> <i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.01	How great is the economic loss caused by the organism within its global distribution (excluding Ireland), including the cost of any current management?	MINIMAL	MEDIUM	In Korea <i>H. i. argyropus</i> is reported as a low-concern pest of rice fields (Harris and Duckworth, 2008). It is trapped as a pest in China, where it is valued for its meat and use in traditional medicine, making it unclear as to whether labelling the species as a pest is an excuse to kill it (Harris and Duckworth, 2008). Woodland is not typically the preferred habitat of Chinese water deer and impact reviews of wild deer did not consider them as a forestry problem (Putman and Moore, 1998; White <i>et al.</i> , 2005). They are occasional road casualties and so contribute a small amount to the economic and human costs of traffic accidents caused by non-native deer (Langbein, 2007; Marchant, 2012). In Britain the species may be an agricultural pest, eating root crops, growing cereal and newly sown grass when other food is scarce (Cooke, 2009a, 2011; Cooke and Farrell, 1998; Marchant, 2012). Grazing on winter grain in the early months of the year is unlikely to affect yield markedly because densities are not high and there is an opportunity for compensatory growth to occur before harvest (Punman, 2003). There was, although, a report from Woodwalton farmland of barley ears knocked off just prior to harvest and grazing damage to root crops, such as carrots, had been noticed (Cooke, 2009b). Grazing impact on newly sown grass has also been documented (Cooke, 2009b) but was only of consequence had the land been intended to commercially grazed (Cooke, 2009b). Any economic costs incurred as a result of the presence of the species are reported as negligible.
4.02	How great has the economic cost of the organism been in Ireland from the <u>time of introduction to the present</u> ? Exclude any costs associated with managing the organism from your answer.	N/A	N/A	To-date, the species is not known to be present in Ireland.
4.03	How great is the economic cost of the organism likely to be in the <u>future</u> in Ireland? Exclude any costs associated with managing the organism from your answer.	MINIMAL	LOW	Any economic costs incurred as a result of the presence of the species are reported as negligible. It is, therefore, not possible at this time to infer any potential economic costs in Ireland. If
4.04	How great have the economic costs of managing this organism been in Ireland from the <u>time of introduction to the present</u> ?	N/A	N/A	To-date, the species is not known to be present in Ireland.

<b>Stage 2 - Detailed assessment: Section D - Impact</b>				
<i>This section evaluates the probability of impact of an organism within Ireland.</i>				
<b>N</b>	<b>QUESTION</b>	<b>RESPONSE</b>	<b>CONFIDENCE</b>	<b>JUSTIFICATION</b>
4.05	How great is the economic cost of managing this organism likely to be in the <u>future</u> in Ireland?	MINIMAL	LOW	Reports of economic costs of the species in its native and non-native range are negligible. It is, therefore, not possible at this time to infer any potential economic costs in Ireland.
4.06	How important is environmental harm caused by the organism within its global distribution?	MINIMAL	LOW	In the species' native and non-native range there are no reported significant environmental impacts.
4.07	How important has the impact of the organism on biodiversity* been in Ireland from the time of introduction to the present? *e.g. decline in native species, changes in community structure, hybridisation	N/A	N/A	To-date, the species is not known to be present in Ireland.
4.08	How important is the impact of the organism on biodiversity likely to be in the <u>future</u> in Ireland?	MINIMAL	LOW	There are no reports of ecological damage either from China or Britain (White <i>et al.</i> , 2008).
4.09	How important has alteration of ecosystem function* caused by the organism been in Ireland from the time of introduction to the present? *e.g. habitat change, nutrient cycling, trophic interactions	N/A	N/A	To-date, the species is not known to be present in Ireland.
4.10	How important is alteration of ecosystem function caused by the organism likely to be in Ireland in the <u>future</u> ?	MINIMAL	LOW	Chinese water deer tend to graze in robust habitats such as marshes and reed-beds and their ecosystem impact is thought to be low (Marchant, 2012).
4.11	How important has decline in conservation status* caused by the organism been in Ireland from the time of introduction to the present? *e.g. sites of nature conservation value, WFD classification, etc.	N/A	N/A	To-date, the species is not known to be present in Ireland.
4.12	How important is decline in conservation status caused by the organism likely to be in the <u>future</u> in Ireland?	MINOR	LOW	There is potential for Chinese water deer grazing to effect ground flora of conservation interest (Cooke, 2009a).

<b>Stage 2 - Detailed assessment: Section D - Impact</b> <i>This section evaluates the probability of impact of an organism within Ireland.</i>				
N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
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	LOW	Chinese water deer were implicated in 0.5-0.6% of deer-related road traffic accidents in Britain during 2003-2005 (Langbein, 2007).
4.14	How important is social or human health harm (not directly included in economic and environmental categories) caused by the organism within Ireland?	N/A	N/A	To-date, the species is not known to be present in Ireland.
4.15	How important is it that genetic traits of the organism could be carried to other organisms / species, modifying their genetic nature and making their economic, environmental or social effects more serious?	MINIMAL	LOW	Phylogenetic studies have shown <i>Hydropotes</i> to be nested within the subfamily Odocoileinae, being particularly closely related to roe deer ( <i>Capreolus capreolus</i> ; Cooke and Farrell, 2008). There is no evidence of inter-breeding in sympatric populations in England. It is highly unlikely that the two species would breed successfully (Cooke, 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	HIGH	It could be possible in the future for Chinese water deer to be implicated in the spread of human and livestock disease such as Lyme disease, bovine TB and bluetongue (Cooke, 2011). They have been found to host <i>Anaplasma</i> spp. and <i>Brucella</i> spp. in their native range (Kang <i>et al.</i> , 2011).
4.17	How important might other impacts not already covered by previous questions be resulting from introduction of the organism? Specify in the justification box.	N/A	MEDIUM	We are not aware of any other impacts the introduction of this species would have.
4.18	How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in Ireland?	MINIMAL	LOW	To date, the species has had negligible impacts, and it is, therefore, of little consequence as to whether or not the species is under natural control by other organism (but refer to Question 2.06) .
4.19	Indicate any parts of where economic, environmental and social impacts are particularly likely to occur. Provide as much detail as possible, where possible include a map showing vulnerable areas.	-	LOW	Potential impacts of Chinese water deer in Ireland are mostly likely to be centred in the agricultural sector.

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

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

N	QUESTION	RESPONSE	CONFIDENCE	JUSTIFICATION
4.20	Estimate the overall potential impact of this organism in Ireland. Use the justification box to indicate any key issues.	MINIMAL	LOW	The Chinese water deer, unlike other non-native deer species, does not impact upon forestry or significantly on sites of conservation interest. This is because the species is not such an extreme concentrate selector, lives in more robust habitats and seldom occurs at high densities (Cooke, 2009a, 2011). In arable crops and pasture grown in the vicinity of dense populations, damage has occasionally been seen, but has been insignificant economically (Cooke 2009a,b).

**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	MEDIUM	<p>Entry is moderately likely via deliberate introduction. If the species were to enter Ireland the stock would most likely come from Britain. In Britain, the documented deliberate introduction of a small number of animals to Woburn Abbey Park over 100 years ago has resulted in successful translocations by man to other sites and release/escapes from captive populations (Cooke, 2009a).</p> <p>If introduced it is likely that the species could establish, as Ireland shares a similar climate and landscape to Britain where it is already established. Establishment of the species in Britain appears to be limited due to climatic constraints. Climatic conditions most suitable to any potential establishment of the species in Ireland are to be most likely found in the south and south east of the country.</p> <p>Chinese water deer are associated mainly with undisturbed wet habitats, such as marshes and wet grassland with reeds, sedges or coarse grasses, but also occur in woodland and on arable farmland (Zhang <i>et al.</i>, 1996; Cooke and Farrell, 2008; Marchant, 2012). Spread will, in the first instance, be dependent on deliberate introduction of the species by man. If breeding populations establish then we can expect the rate of spread of this species to be similar to that recorded in Britain i.e. 1 km per year (Cooke and Farrell, 2008). Suitable habitat for this species to spread is present within the landscape (Fealy <i>et al.</i>, 2009; Fossitt, 2000).</p> <p>The Chinese water deer, unlike other non-native deer species, does not impact upon forestry or sites of conservation interest. This is because the species is not such an extreme concentrate selector, lives in more robust habitats and seldom occurs at high densities (Cooke, 2009a, 2011). In arable crops and pasture grown in the vicinity of dense populations, damage has occasionally been seen, but has been insignificant economically (Cooke 2009a,b).</p>

**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	Irvine <i>et al.</i> (2007) reviewed the potential consequences of climate change for deer in Britain. They concluded that if we assume increasing winter temperatures and longer growing seasons, we might expect survival, condition and annual recruitment for all species to be greater in 2050 than they are now, potentially facilitating the growth and spread of all deer, including Chinese water deer. However, the authors also noted that declining summer rainfall is likely to result in more frequent and prolonged droughts, particularly in the south and east of England, and hence might reduce survival of sensitive species, such as roe deer. The same may be true for Chinese water deer. Moreover, since climate change may operate differently between the species, the consequences of altered competitive ability between the species are far from clear. Consequently, predictions of the effects of climate change on Chinese water deer populations are highly uncertain (Irvine <i>et al.</i> , 2007).
6.02	What is the likely timeframe for such changes (5, 10, 15, 20, 50 or 100 years)?	50	LOW	Refer to Question 6.01.
6.03	What aspects of the risk assessment are most likely to change as a result of climate change	-	LOW	Refer to Question 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.	-	LOW	Research to compare likely range with landuse would indicate where potential impacts of Chinese water deer might be greatest.

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