Information about GB Non-native Species Risk Assessments

The Convention on Biological Diversity (CBD) emphasises the need for a precautionary approach towards non-native species where there is often a lack of firm scientific evidence. It also strongly promotes the use of good quality risk assessment to help underpin this approach. The GB risk analysis mechanism has been developed to help facilitate such an approach in Great Britain. It complies with the CBD and reflects standards used by other schemes such as the Intergovernmental Panel on Climate Change, European Plant Protection Organisation and European Food Safety Authority to ensure good practice.

Risk assessments, along with other information, are used to help support decision making in Great Britain. They do not in themselves determine government policy.

The Non-native Species Secretariat (NNSS) manages the risk analysis process on behalf of the GB Programme Board for Non-native Species. Risk assessments are carried out by independent experts from a range of organisations. As part of the risk analysis process risk assessments are:

- Completed using a consistent risk assessment template to ensure that the full range of issues recognised in international standards are addressed.
- Drafted by an independent expert on the species and peer reviewed by a different expert.
- Approved by an independent risk analysis panel (known as the Non-native Species Risk Analysis Panel or NNRAP) only when they are satisfied the assessment is fit-for-purpose.
- Approved for publication by the GB Programme Board for Non-native Species.
- Placed on the GB Non-native Species Secretariat (NNSS) website for a three month period of public comment.
- Finalised by the risk assessor to the satisfaction of the NNRAP.

To find out more about the risk analysis mechanism go to: www.nonnativespecies.org

Common misconceptions about risk assessments

To address a number of common misconceptions about non-native species risk assessments, the following points should be noted:

- Risk assessments consider only the risks posed by a species. They do not consider the practicalities, impacts or other issues relating to the management of the species. They therefore cannot on their own be used to determine what, if any, management response should be undertaken.
- Risk assessments are about negative impacts and are not meant to consider positive impacts that may also occur. The positive impacts would be considered as part of an overall policy decision.
- Risk assessments are advisory and therefore part of the suite of information on which policy decisions are based.
- Completed risk assessments are not final and absolute. Substantive new scientific evidence may prompt a re-evaluation of the risks and/or a change of policy.

Period for comment

Draft risk assessments are available for a period of three months from the date of posting on the NNSS website*. During this time stakeholders are invited to comment on the scientific evidence which underpins the assessments or provide information on other relevant evidence or research that may be available. Relevant comments are collated by the NNSS and sent to the risk assessor. The assessor reviews the comments and, if necessary, amends the risk assessment. The final risk assessment is then checked and approved by the NNRAP.

*risk assessments are posted online at:
https://secure.fera.defra.gov.uk/nonnativespecies/index.cfm?sectionid=51
comments should be emailed to nnss@fera.gsi.gov.uk

GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

For more information visit: www.nonnativespecies.org

	Name of Organism:	***Muntiacus reevesi Ogilby 1839.*** **Reeves' (Chinese) muntjac.** ***Order Artiodactyla. Mammalia***	
	Objectives:	Assess the risks associated with this species in GB	
	Version:	FINAL 29/03/11	
N	**QUESTION**	**RESPONSE**	**COMMENT**
1	What is the reason for performing the Risk Assessment?		
2	What is the Risk Assessment area?	Great Britain	
3	Does a relevant earlier Risk Assessment exist?	NO OR UNKNOWN (Go to 5)	
4	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?		
A	**Stage 2: Organism Risk Assessment SECTION A: Organism Screening**		
5	Identify the Organism. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	YES (Go to 7)	Distinct from all other deer in GB. Two poorly differentiated sub spp. of Reeves' Muntjac exist: 1) *Muntiacus reevesi reevesi* from the mainland of S. China; and 2) *M. r. micrurus* from Taiwan (Ellerman & Morrison-Scott 1951).
6	If not a single taxonomic entity, can it be redefined?		
7	Is the organism in its present range known to be invasive, i.e. to threaten species, habitats or ecosystems?	YES (Go to 9)	
8	Does the organism have intrinsic attributes that indicate that it could be invasive, i.e. threaten species, habitats or ecosystems?		
9	Does the organism occur outside effective containment in the Risk Assessment area?	YES (Go to 10)	Long-established populations (Chapman, Harris & Stanford 1994) continue to expand their range (Ward, Etherington & Ewald 2008).
10	Is the organism widely distributed in the Risk Assessment area?		By 2007, reported in 816 10-km squares (Ward, Etherington & Ewald 2008).
11	Does at least one species (for herbivores, predators and parasites) or suitable habitat vital for the survival, development and multiplication of the organism occur in the Risk Assessment area, in the open, in protected conditions or both?	YES (Go to 12)	Mixed or deciduous woodland with a diverse ground flora and shrub layer are the most suitable habitats but it occurs in other woodlands, scrub at old quarries, along railway lines, neglected cemeteries and in gardens (Chapman & Harris 1996). Also occurs in road verge and hedgerow habitats within farmland, particularly in proximity to woodland, and in conifer-dominated (rather than mixed) forest. In examples of mixed forest there needs to be an adequate year-round understorey.
12	Does the organism require another species for critical stages in its life cycle such as growth (e.g. root symbionts), reproduction (e.g. pollinators; egg incubators), spread (e.g. seed dispersers) and transmission, (e.g. vectors)?	NO (Go to 14)	
13	Is the other critical species identified in question 12 (or a similar species that may provide a similar function) present in the Risk Assessment area or likely to be introduced? If in doubt, then a separate assessment of the probability of introduction of this species may be needed.		
14	Does the known geographical distribution of the organism include ecoclimatic zones comparable with those of the Risk Assessment area or sufficiently similar for the organism to survive and thrive?	YES (Go to 16)	Although native to sub-tropical forests, Muntjac have adapted very well to the ecoclimatic zones of southern Britain. Prolonged periods of snow/frozen ground resulted in high mortality in the winter of 1962/63 (Chapman, Harris & Stanford 1994).
15	Could the organism establish under protected conditions (e.g. glasshouses, aquaculture facilities, terraria, zoological gardens) in the Risk Assessment area?		
16	Has the organism entered and established viable (reproducing) populations in new areas outside its original range, either as a direct or indirect result of man's activities?	YES (Go to 17)	All populations in Britain have resulted from releases/escapes from enclosed populations (from 1901 onwards), deliberate translocations and natural spread from these foci (Chapman, Harris & Stanford 1994). In the 1990s they were liberated in The Netherlands (G. J. Spek pers.com.) and Belgium (J. Casaer pers. com.). Present in Irish Republic (Anon 2008), which has concerned the Northern Ireland Environment Agency (Dick, Provan & Reid 2009). Introduced to Japan (Kimura & Fukuta 2006). Reports of feral Muntjac in France no longer verified (Whitehead 1993).
17	Can the organism spread rapidly by natural means or by human assistance?	YES (Go to 18)	Natural rate of spread about 1 km/yr (Chapman, Harris & Stanford 1994) but much longer dispersal movements known from tagged animals e.g. 13 km which included crossing major road, minor roads and a railway line (Chapman & Harris 1996). Harding (1986) stated 2.5 km/yr but assumed all spread was natural. Examples of individual dispersion by tagged Muntjac are variable, mostly <5 km but examples of 13, 16 and 22 km over variable periods, but an immature female was killed 10.6 km from where she was tagged 13 weeks earlier. Ward (2005) considered the number of 10 km squares occupied in 1972 (40) and 2002 (463) and there were losses in 32 squares. The annual rate of increase was the calculated compound annual rate over the 3 decades (0.082).
18	Could the organism as such, or acting as a vector, cause economic, environmental or social harm in the Risk Assessment area?	YES OR UNCERTAIN (Go to 19)	Many reports of impact on native vegetation especially in conservation woodland e.g.. Cooke (1996, 2004, 2006a); Tabor (1999). Gill & Fuller (2007) showed that at 13 sites the overall abundance of breeding birds associated with low vegetation, and breeding migrant species was lower in coppice browsed by deer (mixed species) than in unbrowsed coppice. However, bird species that select more open habitats may respond positively. Holt *et al.* (submitted) in a detailed study in one ancient coppiced woodland, found that over a 9 year period the mean density of nightingales in unbrowsed plots was 15 times greater than in paired browsed plots. Muntjac, Roe and Fallow were all present but the latter two species spent some time foraging out of the woodland, on adjacent fields.
19	This organism could present a risk to the Risk Assessment area and a detailed risk assessment is appropriate.	Detailed Risk Assessment Appropriate GO TO SECTION B	
20	This organism is not likely to be a harmful non-native organism in the Risk Assessment area and the assessment can stop.		

B	SECTION B: Detailed assessment of an organism's probability of entry, establishment and spread and the magnitude of the economic, environmental and social consequences			
	Probability of Entry	**RESPONSE**	**UNCERTAINTY**	**COMMENT**
1.1	List the pathways that the organism could be carried on. How many relevant pathways can the organism be carried on?	very many - 4	LOW - 0	1) Natural spread from the many areas of established populations. 2) Escapes from captive collections. 3) Deliberate translocations by man. 4) Releases by unlicensed rehabilitators or, 4a) licensed rehabilitators not abiding by the rules of their licence with regard to where to release. Numbers 2 - 4a came under Schedule 9 of the Wildlife and Countryside Act 1981 in 1997, but numbers 2 and 4 are almost impossible to monitor and it is doubtful whether returns are received/demanded from licensed rehabilitators.
1.2	Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.	Natural spread		
1.3	How likely is the organism to be associated with the pathway at origin?	very likely - 4	LOW - 0	The distribution of feral Muntjac is so great that there are many places from which dispersal can occur. Recorded in 816 10-km squares by 2007 (Ward, Etherington & Ewald 2008), i.e. one third of the area of GB.
1.4	Is the concentration of the organism on the pathway at origin likely to be high?	very likely - 4	LOW - 0	In 1994 the population was estimated at 52,000 (almost all in England, 250 in Wales, <50 in Scotland) (Harris, Morris, Wray & Yalden 1995). 2004 estimate 128,500 (Ward 2004), but both figures extrapolated from small sample size and not necessarily comparable.
1.5	How likely is the organism to survive existing cultivation or commercial practices?	very likely - 4	LOW - 0	In China numbers may be decreasing (due to over hunting) especially in Eastern provinces (Sheng 1991). In Britain the species has established under past and present agricultural/sylvicultural practices.
1.6	How likely is the organism to survive or remain undetected by existing measures?	likely - 3	LOW - 0	In the past populations became established before the fact was widely realised (Chapman, Harris & Stanford 1994). Public now more aware but initial colonisers could remain undetected and their presence remain unknown to environmental policy planners.
1.7	How likely is the organism to survive during transport /storage?	likely - 3	MEDIUM -1	In a well-designed crate, after careful handling, Muntjac are able to withstand a journey of some hours.
1.8	How likely is the organism to multiply/increase in prevalence during transport /storage?	N/A		
1.9	What is the volume of movement along the pathway?	moderate - 2	MEDIUM -1	In any one area likely to be moderate, but over country as a whole, could be major.
1.10	How frequent is movement along the pathway?	very often - 4	LOW - 0	Dispersal from established populations must be continuous. Age at dispersal likely to depend upon habitat and density of deer; it often occurs when about 1 year old but older animals also known to disperse (Chapman & Harris 1996).
1.11	How widely could the organism be distributed throughout the Risk Assessment area?	very widely - 4	LOW - 0	The potential for further colonisation is present wherever suitable habitat can be reached. Muntjac are able to adapt to a range of habitats, providing they encompass suitable forage and cover.
1.12	How likely is the organism to arrive during the months of the year most appropriate for establishment ?	very likely - 4	LOW - 0	The species is well and widely established and dispersals likely to be successful at all times of the year.
1.13	How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) or other material with which the organism is associated to aid transfer to a suitable habitat?	N/A	LOW - 0	The Muntjac is the commodity.
1.14	How likely is the organism to be able to transfer from the pathway to a suitable habitat?	very likely - 4	LOW - 0	Individuals dispersing from many existing populations are likely to find suitable, even if not prime, habitats.

	Probability of Establishment	RESPONSE	UNCERTAINTY	COMMENT
1.15	How similar are the climatic conditions that would affect establishment in the Risk Assessment area and in the area of current distribution?	similar - 3	LOW - 0	Muntjac are well established within the climatic conditions of southern Britain. Northern Britain, being generally colder and with a shorter growing season for ground vegetation, is likely to be less favourable. Milder winters are likely to favour this aseasonal breeder.
1.16	How similar are other abiotic factors that would affect establishment in the Risk Assessment area and in the area of present distribution?	similar - 3	LOW - 0	The present wide distribution of Muntjac encompasses a wide range of abiotic factors.
1.17	How many species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism species are present in the Risk Assessment area? Specify the species or habitats and indicate the number.	very many - 4	LOW - 0	As a "concentrate selector" (browser) Muntjac feed on a very diverse range of plants (mostly dicotyledons), selecting the parts low in fibre but rich in soluble nutrients i.e. buds, flowers, herbs, leaves of shrubs, fungi and fruits (latter include energy-rich acorns, horse chestnuts and sweet chestnuts). Gardens provide a wide variety of suitable plants (Chapman & Harris 1996; Cooke 2006b). Native woodland vegetation is highly favoured (Cooke 1996, 2004, 2006a; Tabor 1999). Eighty-six plant species have been recognised from faecal pellet analysis in woodland habitat regarded as not being particularly floristically diverse (Harris & Forde 1986).
1.18	How widespread are the species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism in the Risk Assessment area?	widespread - 4	LOW - 0	Suitable habitats are widespread. From radio-collared Muntjac it is known that individuals will travel routinely across fields to encompass several copses within a home range (Blakeley *et al*. 1997). A recent increase in re-establishing coppice, production of wood fuel and the planting of National Forests has provided more habitats. Increasingly, home ranges are established in villages (gardens, hedgerows) and even suburban situations.
1.19	If the organism requires another species for critical stages in its life cycle then how likely is the organism to become associated with such species in the risk assessment area?	N/A	LOW - 0	
1.20	How likely is it that establishment will not be prevented by competition from existing species in the Risk Assessment area?	very likely - 4	LOW - 0	Muntjac have established in habitats that were already long-occupied by other species of deer, especially Roe and Fallow. Muntjac have been shown to out-compete Roe in coniferous forest (Hemani 2003) and also Chinese water deer living in drier habitats (Cooke 1998b; Cooke & Farrell 2002). Muntjac reach considerably higher numerical density than other native and non-native deer species, even when living in sympatry. One example was demonstrated in 12.8 km^2 of conifer forest, where mean density of Roe was 13.9/km^2 but 17.3/km^2 for Muntjac (Hemani *et al.* 2007).
1.21	How likely is it that establishment will not be prevented by natural enemies already present in the Risk Assessment area?	very likely - 4	LOW - 0	The present populations of Muntjac have established in the presence of foxes *Vulpes vulpes,* the only natural enemy to predate on young Muntjac. Fox predation was believed to account for nearly 50% of fawns predicted to be born in one study area (Chapman & Harris 1996).
1.22	If there are differences in man's management of the environment/habitat in the Risk Assessment area from that in the area of present distribution, are they likely to aid establishment? (specify)	unlikely - 1	LOW - 0	Current distribution is so great that it includes a whole range of types of management/lack of management. A further increase in planting woodland will increase available habitat e.g. of the 12 new Community Forests (several of which encompass areas already occupied by Muntjac), since 1990 >10,000 ha of new woodland have been planted (www.forestry.gov.uk).
1.23	How likely is it that existing control or husbandry measures will fail to prevent establishment of the organism?	very likely - 4	LOW - 0	Shooting takes place on a large scale in state forests. From 1997/98 to 2007/08 on Forestry Commission land in England, over 19,000 Muntjac were killed (culled + known Deer Vehicle Collisions). In the 2007/08 period, the total was 2281 of which 69% were in East Anglia, 23% in Northants., 3% in Sherwood and Lincs. and less than 2% in each of southeast England, West Midlands and Forest of Dean (pers. com. C. Critchley). Some private estates where populations are high also cull large numbers. There is some trophy shooting by fee-paying overseas visitors and some control by conservation organisations in woodland where Muntjac are having a negative effect on biodiversity. Elsewhere, shooting is mostly by "hobby stalkers". Despite high cull numbers in state forests, large areas of countryside and peri-urban areas receive little or no deer management. Much control by conservation organisations is undertaken by agreements with hobby stalkers rather than paid deer managers, and is not tied to management objectives, and is therefore ineffectual in achieving any substantial reduction. The necessary combination of the acceptance of the need to cull, skilled stalkers and feasibility/safety of the site (especially peri-urban) is often lacking.
1.24	How often has the organism been recorded in protected conditions, e.g. glasshouses, elsewhere?	N/A	LOW - 0	.
1.25	How likely is the reproductive strategy of the organism and duration of its life cycle to aid establishment?	very likely - 4	LOW - 0	Aseasonal breeding - male fertile at all stages of antler cycle (unlike our other deer species); 80% of females likely to conceive before 1 year old, post-partum oestrus so potential to produce single fawn at intervals of 211 days into teen age (Chapman & Harris 1991; Chapman 2008). Demographic data from several localities indicated that mortality was 75% by 3 years (Harris, Morris *et al.* 1995).
1.26	How likely is it that the organism's capacity to spread will aid establishment?	very likely - 4	LOW - 0	Dispersal from a dense population mostly occurs when the Muntjac are about one year old. Distance moved will depend upon available habitat and its present occupancy. Most movements of tagged Muntjac within a large forest were <4 km but some individuals travelled much further. Older animals ousted from a good home range also need to disperse (Chapman & Harris 1996).
1.27	How adaptable is the organism?	adaptable - 3	LOW - 0	As long as there is year-round adequate food for a concentrate selector (browser) and cover, manta thrive in a variety of habitats. Adaptable and very tolerant of human disturbance, favours further spread. These traits have become increasingly obvious of late e.g. in gardens, on well-used public footpaths, village roads and walking alongside motorways in daytime. In early days of colonisation they were regarded as secretive.
1.28	How likely is it that low genetic diversity in the founder population of the organism will not prevent establishment?	very likely - 4	LOW - 0	The origin of the earliest populations in England was Woburn Park where 27 Muntjac were imported between 1894 and 1903. Eleven released from there in 1911 with subsequent releases of stock from Woburn until the 1950s. Many more translocations from the colonies that had established (Chapman, Harris and Stanford 1994). Some genetic data is not consistent with Woburn being the sole ancestral gene pool (Williams *et al.* 1995). Possibly some animals of unknown origin escaped/released from collections in second half of the 20th century.
1.29	How often has the organism entered and established in new areas outside its original range as a result of man's activities?	few - 1	LOW - 0	Outside its native China: 1) England; 2) France - no longer feral; 3)The Netherlands; 4) Belgium; 5) Japan; 6) Republic of Ireland; 7) unconfirmed reports in N. Ireland where it is in captivity.
1.30	How likely is it that the organism could survive eradication campaigns in the Risk Assessment area?	very likely - 4	LOW - 0	So widely established and so numerous that eradication impossible even if it were desirable. Containment within existing occupied regions would require concerted efforts to shoot any entering new environmentally sensitive areas, but the task would be on-going.
1.31	Even if permanent establishment of the organism is unlikely, how likely is it that transient populations will be maintained in the Risk Assessment area through natural migration or entry through man's activities (including intentional release into the outdoor environment)?	N/A	LOW - 0	Firmly established, further natural spread expected, more accidental or deliberate liberations or illegal translocations may occur.

	Spread	RESPONSE	UNCERTAINTY	COMMENT
2.1	How rapidly is the organism liable to spread in the Risk Assessment area by natural means?	intermediate - 2	LOW - 0	Natural rate of spread considered to be about 1km/yr (Chapman, Harris & Stanford 1994).
2.2	How rapidly is the organism liable to spread in the Risk Assessment area by human assistance?	very rapid - 4	LOW - 0	Translocations illegal since 1997 under Schedule 9 of the Wildlife and Countryside Act. Release back into the wild of casualty Muntjac is permitted by licensed rehabilitators within 1 km of where taken within 12 named counties (Beds., Berks., Bucks., Cambs., Essex, Herts., Leics., Norfolk, Northants., Oxon., Suffolk, Warwicks.). Enforcement is near impossible. Translocation/escapes from captivity have enabled Muntjac to reach areas that they may never have reached by natural dispersal e.g. Scotland, most northerly English counties (Chapman, Harris & Stanford 1994).
2.3	How difficult would it be to contain the organism within the Risk Assessment area?	very difficult - 4	LOW - 0	Any attempt to eliminate Muntjac moving into new areas would require much effort and be on-going.
2.4	Based on the answers to questions on the potential for establishment and spread define the area endangered by the organism.		LOW - 0	Further expansion expected especially in counties south of a line drawn from Gloucester to Chelmsford, in South Yorkshire and in Wales. Few scattered reports from northern England and Scotland probably do not represent established populations so these areas regarded as at least risk (Chapman, Harris & Stanford 1994; Staines & Rose 2001; Ward 2005). However, if the mechanisms by which these animals arrived there are unchecked, there may be potential for establishment and subsequent spread of populations. Further information is required on climatic potential of these regions for establishment and viability of populations. A spate of records from the NE (Northumbria, Durham, Cleveland, N. Yorks) have emerged, mostly in the last decade, including an escape (perhaps release?) of six Muntjac (Bond 2009). Schedule 9 of the Wildlife and Countryside Act is almost impossible to enforce. Unless long severe winters are the norm, Muntjac are likely to survive if they are allowed to become established.

	Impacts	RESPONSE	UNCERTAINTY	COMMENT
2.5	How important is economic loss caused by the organism within its existing geographic range?	minimal - 0	LOW - 0	In its native country it is valued for its meat and skin products (650,000 annual hunting harvest - Sheng 1991). It is largely confined to forest and is rarely likely to impact on agriculture.
2.6	Considering the ecological conditions in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, livestock health and production, likely to be? (describe) in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, likely to be?	minor - 1	MEDIUM -1	Losses to agriculture have not been assessed but are regarded as minimal (Cooke & Farrell 2001; Putman & Moore 1998). The small mouths of Muntjac prevent their biting into whole large root crops; they will "glean" small/broken pieces after harvesting (pers. obs.). Losses to market gardens (crops of parsley, coriander) have been reported (Chapman & Harris 1996). Horticultural and sylvicultural nurseries can be vulnerable to economic losses unless adequately fenced. Saplings planted within Muntjac areas require protection from fraying (0.75m tree shelters and stake, unit cost 69p in 2004 (White *et al*.)). Coppiced woodland is very vulnerable to economic loss and even death of the stool if browsing is persistent (Cooke 1998b). Young shoots need to attain a height of 1m to reduce their vulnerability (Cooke 2006a) so fencing is advised (discussed by Tabor 2009). Impact on plants in gardens can be very costly, necessitating expensive fencing (Chapman, Harris & Harris 1994; Cooke 2006b).
2.7	How great a loss in producer profits is the organism likely to cause due to changes in production costs, yields, etc., in the Risk Assessment area?	moderate - 2	MEDIUM -1	This would apply to those producers who need to fence their crops/plants/woodland/nurseries against entry by Muntjac. Of vegetation with commercial (as opposed to conservation) value, coppice and new tree plantings are likely to receive the most impact. The current drive for greater production of woodfuel (e.g. Eastern Region, by 2013 a further 15,000 - 20,000 ha to be brought back into productivity) means more restored and new coppicing/planting will be needed. In the presence of deer this will be successful only if mitigation measures are taken, at considerable cost (Joys *et al.* 2004). For these areas risk can be massive (4) but for the country overall, 1 to 2.
2.8	How great a reduction in consumer demand is the organism likely to cause in the Risk Assessment area?	minimal - 0	LOW - 0	Possibly nurseries will sell fewer roses bushes, tulip bulbs and other plants especially favoured by Muntjac in some localities, but sales may increase for Muntjac-resistant plants.
2.9	How likely is the presence of the organism in the Risk Assessment area to cause losses in export markets?	very unlikely - 0	LOW - 0	No losses to export markets known to result from the presence of Muntjac.
2.10	How important would other economic costs resulting from introduction be? (specify)	moderate - 2	MEDIUM -1	Fencing, erection of high seats, training of more stalkers, and stalkers' time are important factors in the areas where Muntjac are established.
2.11	How important is environmental harm caused by the organism within its existing geographic range?	minimal - 0	LOW - 0	No reports known of environmental harm within its native land.
2.12	How important is environmental harm likely to be in the Risk Assessment area?	major - 3	LOW - 0	There is extensive literature on the impact when densities are high, on native woodland flora, coppice, habitat used by spring migrants e.g. nightingales (e.g. Cooke 1996, 2004, 2006a; Fuller & Gill 2001; Gardiner &
2.13	How important is social and other harm caused by the organism within its existing geographic range?	minimal - 0	LOW - 0	Social harm has not been reported in China. Muntjac are trapped and snared and utilised for food and their skins, so regarded as beneficial (Sheng 1991).
2.14	How important is the social harm likely to be in the Risk Assessment area?	major - 3	LOW - 0	Greatest social harm must be the involvement of this species in Deer Vehicle Collisions; estimated by the Deer Initiative to be about 15,000 Muntjac/year. Also possibly irate gardeners or rare instances of panicked Muntjac crashing through glass doors.
2.15	How likely is it that genetic traits can be carried to native species, modifying their genetic nature and making their economic, environmental or social effects more serious?	unlikely - 1	LOW - 0	The correct answer here is IMPOSSIBLE. There is no possibility of this species mating with any other species in Britain.
2.16	How probable is it that natural enemies, already present in the Risk Assessment area, will have no affect on populations of the organism if introduced?	very likely - 4	LOW - 0	The existing populations of Muntjac have established in the presence of foxes. Anecdotal reports that where fox density is high, Muntjac density is low and where fox density is low Muntjac density is higher. In one population studied it was suspected that nearly 50% of fawns died before 2 months of age, mostly because of predation by foxes (Chapman & Harris 1996). Increase in fox populations in eastern England has not prevented further spread and increase in numbers of Muntjac.
2.17	How easily can the organism be controlled?	with some difficulty - 2	LOW - 0	Shooting this small deer which spends much time in cover can take many man-hours and it requires regular effort to keep a population in check. Incentive is lacking in some areas where there is no marketing plan for the carcasses.
2.18	How likely are control measures to disrupt existing biological or integrated systems for control of other organisms?	very unlikely - 0	LOW - 0	There is no Close Season for Muntjac (it would not be appropriate for a species breeding at any time of the year), but on many estates the period for shooting Muntjac has to take account of game bird shooting interests. In the same habitats, shooting to control other deer (mostly Roe and/or Fallow) will also be in progress.
2.19	How likely is the organism to act as food, a host, a symbiont or a vector for other damaging organisms?	moderately likely - 2	LOW - 0	Tick *Ixodes ricinus* (vector for Lyme disease) are carried by Muntjac but with much smaller burdens than Roe deer in the same habitat (pers. obs.). One recorded case of bovine Tb (Delahay *et al*. 2002). Shown experimentally to be susceptible to Foot and Mouth Disease, but 6 of 9 Muntjac infected died within a few days (Gibbs *et al*. 1975).

2.20	Highlight those parts of the endangered area where economic, environmental and social impacts are most likely to occur			Currently environmental impact greatest (or at least best known) in eastern region. Many SSSIs/nature reserves are failing to reach target condition because of the impact of deer, often by more than one species, but in many examples this includes Muntjac. Any woodland habitat that provides adequate year-round forage and cover for Muntjac to establish is potentially at risk for impact. Work by Robin Gill (Gill 2007) suggests combined impacts also considerable in other regions, including East Midlands, that is likely to include a major contribution from Muntjac. Eighty woodland SSSIs where deer impacts were a concern were surveyed in 2006. Seventy-two of the Sites were categorised as being in the two poorest (E and D) conditions; these were in the W. Midlands, E. Midlands, South-East and Eastern England. No distinction was made between the species of deer (2 or 3 present at some) contributing to deterioration. In the South-East I suspect Roe and Fallow were of greater significance than Muntjac. Damage by rabbits/hares may have contributed to the impact at some sites. Niche overlap between Muntjac and hares can be appreciable, e.g. 0.35 in one mainly coniferous forest (Wray

Summarise Entry	very likely - 4	LOW - 0	1) By natural spread from wide range occupied by many tens of thousands of Muntjac; 2) Risk of further illegal translocations to new areas which the deer would not reach without human assistance.
Summarise Establishment	very likely - 4	LOW - 0	Since the first liberation over 100 years ago, subsequent translocations and natural spread from many foci, Muntjac have become a firmly established species in the British fauna (Chapman, Harris & Stanford 1994).
Summarise Spread	intermediate - 2	MEDIUM -1	Attempts to reduce the rate of spread possibly could be achieved by adequate culling as they enter new areas, but the effort would need to be maintained indefinitely. Effort would need to be concentrated on the most vulnerable sites and cooperation of landowners at a landscape level would be of paramount importance. After arrival of the first colonisers there is a period of slow build-up followed by rapid increase (Cooke 2006; Chapman & Whitta 1996).
Summarise Impacts	major - 3	LOW - 0	Environmental impacts are the most important - conservation woodland habitats being most affected, with a wide range of direct and indirect effects on biodiversity. Impacts on horticulture potentially locally important. Large number of DVCs with potentially serious outcome to occupants of vehicle and damage to the vehicle. Increase in Muntjac can suppress the number of Roe but unlikely to totally replace this species except possibly in small localised areas. Muntjac are increasingly resident in locations where Roe do not occur, or very rarely. Muntjac add to the overall deer populations.
Conclusion of the risk assessment	MEDIUM -1	LOW - 0	Muntjac are widely established - reported from almost every county in England but the main concentrations are in East Anglia, the Home Counties and Midlands. Still increasing in England and Wales. Scottish reports few and no certainty of breeding populations (Ward 2005). Densities vary with habitat; estimates include 15 - 30/km^2 (Blakeley *et al.)* ; 33/km^2 (White *et al*. 2004) and 64±12.8/km^2 (Hemani 2003) - all these in predominantly coniferous forest - and up to 100/km^2 in deciduous woodland (Cooke 2006).
Conclusions on Uncertainty		LOW - 0	

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