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:	***Cervus nippon* - Sika Deer**
	Objectives:	Assess the risks associated with this species in GB
	Version:	FINAL 22/03/11

N	QUESTION	RESPONSE	COMMENT
1	What is the reason for performing the Risk Assessment?		Request made by GB Programme Board.
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	YES (Give the full name & Go to 7)	*Cervus nippon* Japanese Sika (deer). Distinct from other deer species found in GB, but can hybridise with native Red deer *Cervus elaphus* to produce fertile
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)	Invasive: Sika pose a threat to species (through hybridisation with native Red deer) and can impact on habitats, crops and the economics of deer management (further details and refs. see answers Q.18 below).
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)	Yes - present outside of effective containment in each of the devolved regions of GB - see Question 10.
10	Is the organism widely distributed in the Risk Assessment area?	NO (Go to 11)	Following their first introduction to GB in 1860 and several subsequent translocations and releases (Ratcliffe 1987), Sika have established free-living populations throughout many parts of Scotland, covering an estimated range of 14,000 km^2 (Putman, in Harris & Yalden 2008). They have also become well-established in England, though they have a more localised distribution, including Dorset, Hampshire, Cumbria, Northamptonshire and Bedfordshire. Small numbers of free-living animals also occur in several other counties of England and Wales, including Brownsea and Lundy Islands. Sika have continued to expand their range in all these regions over recent decades (Ward, Etherington, Ewald 2008). Sika are also well-established in Ireland (Lowe 1994).
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)	Commercial conifer plantations appear to be their preferred habitat in Scotland where Sika are most widely established, but Sika will adapt readily to live in other habitats, including mixed woods and moorland (New Forest) and estuarine reed beds (Purbeck), provided some woodland or other dense cover is available (e.g. Ratcliffe 1987; Perez-Espona *et al.* 2009; Putman in Harris & Yalden 2008). Sika are intermediate grazers (Hofman 1985), well-adapted to grazing on pastures as well as for browsing coarser vegetation such as heather, conifer needles and deciduous tree leaves.
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)	N/A
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 Japan and East Asia, Sika have adapted readily to the ecoclimatic zones of both Scotland as well as southern Britain. Most mixed environs throughout GB that include at least some woodland habitats, offer the potential to support self-sustaining populations of Sika.
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)	Sika populations in GB have resulted mainly from (accidental) releases/escapes from enclosed populations from the late 19th century onwards, as well as deliberate translocations and natural spread from these locations (Ratcliffe 1987). Ward (2005) calculated rates of spread of Sika (based mainly on records of Scottish populations) between 1972 to 2002 as 5.3%, rising to a 7.3% range expansion between 2002 and 2007 (Ward *et al.* , 2008).

17	Can the organism spread rapidly by natural means or by human assistance?	YES (Go to 18)	Natural spread may not at first be very fast as Sika are not territorial and are fairly tolerant socially of high local density; young and adult males are likely to make longer dispersal movements. More recently, Sika deer have been added to Schedule 9 of the Wildlife and Countryside Act [1981, as amended 1997], thus translocation and release of Sika to areas outside their existing range is now illegal in any part of Britain. However this is difficult to control and monitor and further new escapes of Sika as well as Red-Sika hybrids from parks and deer farms remain likely, unless tighter restrictions are imposed on keeping Sika and Sika hybrids in enclosures.
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)	Sika are known to: a) hybridise with Red deer within the Risk Assessment area, with a resulting impact on the genetic diversity of native Red deer stocks (Harrington 1973, 1982; Abernethy 1994; Ratcliffe 1987; Perez-Espona *et al.* 2009); b) at high density cause economic harm to commercial timber production in Scotland (Chadwick *et al.* 1996; Abernethy 1998; Ratcliffe 1989; Lowe 1998); c) have potential to cause significant damage to agricultural crops as in their native range (Kaji 1999). However, significant agricultural crop damage has not at present been reported as of widespread economic significance in Scotland or England; d) at high density Sika can cause some significant impact on semi-natural habitats (Diaz *et. al.* 2005).
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?	many - 3	LOW - 0	NOTE: Sika are already widespread with contiguous populations throughout much of Scotland. They are increasing in England, but here and in Wales, populations are currently more localised. Hence answers are provided here mainly to review 'probability of entry' to <u>further</u> parts of the risk assessment area. Pathways include: 1) Natural spread from many areas of established populations; 2) Further escapes from enclosed parks and deer farms, of Sika as well as of Sika-red hybrids; 3) Deliberate 'illegal' releases by man not abiding by the 1997 Amendments to Schedule 9 of the Wildlife and Countryside Act 1981 (prohibiting translocation and release to areas outside their existing range). Whilst natural spread on its own might remain moderately slow, its concurrence with continuing occasional releases from enclosures will tend to aid establishment of new populations where dispersing individuals from existing herds meet up with new releases.
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	Numerous different feral Sika populations are present in over 10 different counties in England and one known location at Teifi Marshes, Wales (Deer Initiative Wales, pers. comm.), in addition to widespread occurrence throughout Scotland. Natural spread from each location is possible. Such spread/persistence is aided further by the possibility of dispersing animals hybridising with Red deer if failing to encounter other members of their own species.
1.4	Is the concentration of the organism on the pathway at origin likely to be high?	very likely - 4	LOW - 0	GB wide population estimates in 1995 stood at 11,5000 (Harris *et al.* 1995), with 9,000 in Scotland; however numbers are likely to have increased substantially, possibly doubled, since (Putman, in Harris & Yalden, 2008). Densities based on recent 2008/9 visual counts in substantial areas of Purbeck, Dorset are now well over 15/km^2 to 20/km^2 (pers. comms. RSPB; National Trust; MOD). Reported densities in Scotland are generally lower, but reach a similar range in thicket habitats
1.5	How likely is the organism to survive existing cultivation or commercial practices?	very likely - 4	LOW - 0	Species is very adaptable and has established and persisted under current agri-forestry practices and commercial exploitation by shooting.
1.6	How likely is the organism to survive or remain undetected by existing measures?	very likely - 4	LOW - 0	The co-occurrence of several other deer species throughout much of the risk assessment area allows the spread of Sika and Sika hybrids to often go undetected for some time by landowners and the general public not fully familiar with deer species differences (e.g. Sika are mistaken by some for Fallow or Red deer). The presence of Sika hybrids may go undetected for a longer time, and the occurrence of Sika-red hybridisation is often disbelieved even by hunters until demonstrated by DNA analysis (Bartos 2009).
1.7	How likely is the organism to survive during transport /storage?	likely - 3	LOW - 0	No transport/storage is associated with the natural spread pathway considered here. More generally, Sika appear more prone to and suffer higher levels of mortality as result of stress from man-handling and transport than is the case for Red and Fallow deer (own experience; Marshall pers. comm.; see Putman 2008). Nevertheless, park Sika have frequently been transported successfully between different park populations in GB (Marshall pers. comm.).
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	Natural spread from each localised population is likely to be moderate but will vary depending on the extent of deer management and disturbance. Overall, Ward *et al.* (2008) calculated a 7.3% increase in the spread of Sika countrywide (based on presence in numbers of new OS 10km grid squares in 2007 compared to 2002).
1.10	How frequent is movement along the pathway?	often - 3	LOW - 0	Sika are tolerant of a build up of high local density before spreading out, but some annual dispersal from natal ranges is likely, especially by young males when 1 year old. The likelihood of dispersing animals establishing new populations is increased further by their ability to produce fertile hybrids with Red deer, where the species overlap.
1.11	How widely could the organism be distributed throughout the Risk Assessment area?	very widely - 4	LOW - 0	Potential for further colonisation is very widespread as Sika are adaptable to survive in most mixed habitats with some woodland (Harris & Yalden 2008). Progression of spread is likely to be not dissimilar to that of Fallow deer (which are very widespread throughout England), which were also initially mainly of park origin followed by numerous separate escapes or releases when parks were disbanded. Although they have spread slowly Fallow today still tend to be found in highest concentrations near to points of origin (Langbein & Chapman 2003; Langbein *et. al.* 2008). By comparison, Sika releases from parks have been less numerous, and hence would not be predicted to reach as wide a distribution in England, although Sika also appear to survive better than Fallow in conifer forests in northern Britain
1.12	How likely is the organism to arrive during the months of the year most appropriate for establishment ?	very likely - 4	LOW - 0	Establishment of dispersing unlikely to be affected significantly by season.
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		
1.14	How likely is the organism to be able to transfer from the pathway to a suitable habitat?	very likely - 4	LOW - 0	Animals dispersing through natural spread are highly likely to find suitable habitats for survival throughout the risk assessment area, except in areas devoid of any woodland.

	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?	very similar - 4	LOW - 0	Sika are well established and thriving within the mild climatic conditions of southern Britain, as well as the more extreme and cooler conditions in northern Scotland. Although currently less widespread than in Scotland, the milder conditions in southern Britain are likely to lead to faster rates of population growth.
1.16	How similar are other abiotic factors that would affect establishment in the Risk Assessment area and in the area of present distribution?	very similar - 4	LOW - 0	Sika occur across a wide range of regions and abiotic factors. These abiotic factors are unlikely to limit spread in the risk assessment area.
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	Sika are intermediate feeders (Hofmann 1985) anatomically well adapted to grazing as well as browsing more selectively; they adapt well to wide variety of feed sources according to availability, ranging from grasses, ericaceous shrubs and other moorland vegetation, to deciduous and conifer browse as well as agricultural crops, without significant reliance on any one particular food source (Mann & Putman 1989; Quirke 1991).
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	Sika are already established across a wide range of habitats from conifer plantations on acid soils in Scotland, to mixed deciduous woodland, moorland, and estuarine reed beds in England and Wales (e.g. Ratcliffe 1987; Perez-Espona *et al.* 2009); similar suitable habitats where Sika could establish are very widespread throughout the risk assessment area.
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		N/A
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	Although potential for competition with other deer species exists throughout almost the entire risk assessment area, such competition is unlikely to prevent establishment (e.g. Abernethy 1994; Putman & Sharma 1987). Sika are sympatric with Red deer and Roe deer in most parts of their Scottish range, and generally sympatric with Roe deer where Sika occur in England, as well as with Fallow and Red deer in some parts (e.g. New Forest) (Ratcliffe 1987; Putman in Harris & Yalden 2008).
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	Sika have established in GB in the presence of foxes Vulpes vulpes, the only abundant natural enemy to predate on young deer. Potentially some raptors (e.g. Golden Eagle) could also take Sika fawns, but have rarely been reported to do so. Adult mortality is largely restricted to non-natural causes, such as deliberate culling by man (Perez-Espona et al. 2009) and deer/vehicle collisions (Langbein 2007).
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	Continued increases in afforestation in general would produce further suitable habitat, aiding the spread and establishment of Sika, whereas current polices to establish fewer conifer thickets (one of their preferred habitats) in preference for more deciduous planting may possibly negate this to some extent.
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	Some annual culling by rifle of Sika has been undertaken in many parts of their current range in Great Britain for many years; firm figures are not available but published estimates range from 6,000 to 7,500 Sika culled annually in Scotland and over 1300 annually in England (DCS 2007; Macdonald *et al.* 2000). The past level of culling has mostly failed to prevent range expansion in many areas, in large part likely due to lack of coordination of culling across sub-population ranges, with some landowners carrying out little or no control of numbers. However, in some areas such as the New Forest, where Sika have been established for many years, regular culling has succeeded in containing numbers, with limited range expansion observed over the past 30 years (Putman & Langbein 1999).
1.24	How often has the organism been recorded in protected conditions, e.g. glasshouses, elsewhere?	frequent - 3	LOW - 0	No reports found - unless including farm/zoo and park collections as 'protected conditions' . Sika have been kept in many fenced enclosures in different parts of GB (e.g. see Whitehead 1964, Hingsten 1988) ever since the Royal Zoological Society was first presented with a number of specimens of both C. n. nippon and C. n. Hortulorum in 1860, and Sika were introduced during the same year to a park in Co. Wicklow, Ireland (Powerscourt 1884). Feral populations present today have largely arisen through escapes or disbandment of former parks followed by the subsequent spread of the deer. Although deliberate introduction of Sika to the wild is illegal in Britain, further escapes of Sika from parks are highly likely, and will continue to supplement establishment through natural spread of those feral populations already present.
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	Sika are seasonal breeders with most births during early summer when food and shelter are abundant, although births are less well synchronised than for native deer species; late births in August and September are not uncommon (Putman 2008). The life cycle, including autumn mating season (rut) also overlaps with that of Red deer, with which they may hybridise to produce fertile offspring, again likely to be born in the favourable season.
1.26	How likely is it that the organism's capacity to spread will aid establishment?	likely - 3	LOW - 0	Where a continuous, good suitable habitat into which to expand is present, Sika have exhibited a range expansion estimated at 3 to 5 km per year in, for example, Argyll, Scotland (Swanson & Putman 2009). Where feral populations are present in smaller areas of preferred habitat, dispersal may be slow until very high local densities have built up. Young males tend to disperse first and are often observed to establish in new areas as much as 10 to 15 years before the first female Sika are noted (Ratcliffe 1987a; Staines 1998). Early arrival of male Sika into areas without other Sika, but with the presence of red deer hinds, is thought to increase the likelihood of cross breeding (Bartos 2009; Putman & Swanson 2009; Perez-Espona *et al.* 2009)

1.27	How adaptable is the organism?	very adaptable - 4	LOW - 0	As discussed above, Sika have a varied diet which is readily satisfied in a wide range of habitats and few other specific needs aside from the availability of some woodland or other cover, allowing them to adapt to surviving in most parts of Britain. Although it has been noted that they become more nocturnal in areas of high disturbance (Putman & Mann 1990), in some areas of high population density Sika are increasingly observed during the day close to human activity (pers. obs.).
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	Many of the separate releases of Sika in GB during the early 20th century can be traced back to founder populations introduced to Powerscourt Park, but in addition, at least two later introductions are known to have occurred directly from Japan, to Peeble-shire and Devon (Ratcliffe 1987), with a number of other populations of unclear origin. Sika have also been introduced widely to countries in mainland Europe, with some of these introductions also from separate introductions from the Far East (Eick 1995; Bartos 2009). In addition, Red-Sika hybrids are believed to have escaped from deer farms at various times. Most Sika populations now established in Britain have been shown to contain hybrid genes, with the only populations of pure or nearly pure Japanese Sika believed to be those in the New Forest and around Peebles and Moray in Scotland (Ratcliffe *et al.* 1992; Goodman *et al.* 1999; Putman & Hunt 1994; Diaz *et al.* 2006). Perez-Espona *et al.* (2009) note "that despite generally low levels of genetic variation in Sika, there is nevertheless some genetic variation between Sika populations subjected to either molecular genetic (Swanson 1999; Díaz *et al* . 2006) or morphometric (Putman and Hunt 1994) analysis. While this variation could be attributed to different levels of low-grade introgression from Red, it could also be due to the initial genetic variation associated with the individuals used to found the populations ".
1.29	How often has the organism entered and established in new areas outside its original range as a result of man's activities?	very many - 4	LOW - 0	Outside of native Japan: 1) Several times entered and established in Britain (see 1.28 above); 2) Mainland Europe, including populations established in Austria, Czech Republic, Germany, Denmark, Estonia, France, Hungary, Lithuania, Poland, Switzerland, Ukraine and Russia (Bartos 2009); 3) New Zealand; 4) North America including feral populations in Maryland, Virginia, Texas and North Carolina (Putman 2008).
1.30	How likely is it that the organism could survive eradication campaigns in the Risk Assessment area?	likely - 3	LOW - 0	Very likely that in view of the wide contiguous distribution, especially in Scotland, total eradication from Britain now impossible to achieve. However, extirpation or prevention of spread into new areas may remain achievable in parts of the risk assessment area where recent releases have occurred or sub-populations remain quite localised; or else aim to maintain 'Sika' free regions of the risk assessment areas (e.g. few currently established in Wales, and various Scottish Islands where 'pure' Red deer believed to remain (Pemberton *et al.* 2006; Perez-Espona *et al.* 2009).
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)?	very likely - 4	LOW - 0	Under current UK legislation, those parts of the country where Sika establishment could be prevented or existing populations could potentially still be eradicated, continue to remain vulnerable to further new introductions of Sika through the pathway of 'accidental' releases from Sika introduced to fenced enclosures. Although 1997 Schedule 9 amendments to the Wildlife and Countryside Act 1981 make deliberate release of Sika or Red-Sika hybrids into areas of Britain where they are not already established illegal, legislation currently does not prevent Sika from being introduced on deer farms, from which further escapes are likely.

	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	Ward (2005) calculated rates of spread of Sika (based mainly on records of long-established contiguous Scottish populations) between 1972 to 2002 at 5.3% , rising to a 7.3% range expansion between 2002 to 2007 (Ward *et al.* 2008). However, the spread of more localised (managed) populations in England has occurred at quite moderate rates, with for example, populations in the New Forest having shown only little range expansion over the past 20 years (Putman & Langbein 1999). Rates of natural spread outside of Scotland are likely to remain moderate, with the potential to reduce the rate further by close management of population numbers and selective culling of dispersing individuals.
2.2	How rapidly is the organism liable to spread in the Risk Assessment area by human assistance?	intermediate - 2	MEDIUM -1	Schedule 9 (amendment 1997) of Wildlife and Countryside Act 1981 makes further deliberate release of Sika or Red-Sika hybrids into areas of Britain where they are not already established illegal. Further spread by human assistance is thus restricted to illegal activities (which are difficult to monitor), but also see comments at 1.31, regarding continued ability to keep Sika on deer farms, from which occasional escapes are likely.
2.3	How difficult would it be to contain the organism within the Risk Assessment area?	very difficult - 4	LOW - 0	The prevention of Sika from moving into new areas would require much more concerted and regionally co-ordinated efforts at deer management than currently occurs, and to be successful would most likely need to be backed by new legislation requiring control/eradication of Sika found in regions outside of their established range. Nationwide containment (including main Scottish range) is likely to be prohibitively costly, but it may remain feasible to contain small populations such as those present in Hampshire/Lancashire/Devon, and eliminate other smaller herds.
2.4	Based on the answers to questions on the potential for establishment and spread define the area endangered by the organism.			Sika are already widespread throughout most of northern Scotland and the Borders (see Harris & Yalden 2008), with further spread into NE Scotland and in southern Scotland likely. In England, populations of Sika remain more localised, with significant overlap with Red deer populations in only some areas. From the view of preventing hybridisation with Red deer, areas possibly most endangered by the spread of Sika are those where significant Red deer populations occur not far from current pockets of Sika presence, which in England includes: Exmoor and environs (Devon & Somerset), the New Forest and the Peak District. Scottish Island populations of Red deer are now at a somewhat lower risk from the spread of Sika as deliberate release is illegal; but this does not fully protect such areas as deer may occasionally swim between islands (Perez-Espona *et al.* 2009).

	Impacts	RESPONSE	UNCERTAINTY	COMMENT
2.5	How important is economic loss caused by the organism within its existing geographic range?	moderate - 2	MEDIUM -1	In their native Japan Sika have been reported to cause significant impacts to agriculture (Kaji *et al.* 2000), as well as forestry. On the island of Hokkaido, damage to forestry and agriculture was estimated at over 30 million US dollars for 1996 (Kaji 1999). Economic losses to agriculture within the current range occupied by Sika in Britain have not been studied in detail specifically for this species, but as in the case of Red and Fallow deer, agricultural losses from deer occurring even at high density tends to be of mostly localised importance in Britain rather than of wide economic significance at a regional or national scale (Putman and Moore 1998; Putman 2004; Rutter and Langbein 2005); similar conclusions arise from experience with Sika in Europe (Reimoser and Putman 2009). More extensive damage is reported to commercial forestry, especially in Scotland, and is considered of greater economic significance (Ratcliffe 1989; Chadwick *et al.* 1996; Abernethy 1998), both through browsing of young growing trees as well as bark-stripping and bole scoring (antler rubbing).
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	To consider the direct net economic impacts from Sika if they were to spread throughout the risk assessment area, it is important to note that much of the potential habitat available for colonisation by Sika already mostly has one or more other deer species present, in particular Red deer in the case of potential habitats in Scotland and Fallow in England. Hence economic impacts may not necessarily be additive or increase, unless overall numbers of deer increase. The losses currently due to deer of other species are more likely to show a local shift in the type of damage sustained according to how the balance of species changes. There are currently relatively low numbers of Sika deer present in Britain (estimated at <25,000 in Scotland, England and Wales and 20-25,000 in Ireland (Putman in Harris & Yalden 2008)) and they are hugely outnumbered in terms of the total population of all deer in Britain, estimated at over 1.25 million. There are few good economic assessments available giving the cost of economic losses due to Sika. Total economic losses to agriculture in England due to all deer species have been broadly assessed at up to £5 million (Wilson 2003), of which only about 2% (£100,000) may be attributable to Sika. Similarly, while *c* . 50,000 deer/vehicle collisions cause considerable economic losses, among these Sika probably currently contribute less than 2.5% (Langbein 2007). Sika spread would be likely to increase overall losses only if this leads to an increase in total numbers of deer nationwide. Damage to commercial forestry from Sika is of lesser concern in England than Scotland, due to a reduced emphasis on conifer plantings over recent years. The main consequences of Sika spread would be likely to occur through hybridisations with Red deer, which could itself bring associated economic losses which are however difficult to predict. While there is significant concern among deer management and conservation organisations about the threat posed by Sika to the genetic integrity of Red deer, whether this would translate into net changes to income (e.g. through let stalking, trophy shooting) is again difficult to predict. However, the cost of deer control overall may increase, as within forest plantations greater effort in terms of man-hours tends to be required per Sika culled as compared to Red deer (McLean 1993).
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	LOW - 0	As discussed at 2.6, some losses will already be occurring in most parts of the risk assessment area from other deer species. The spread of Sika into areas where previously only smaller deer such as Roe or Muntjac were present, may increase the cost of crop or roadside protections due to the need for taller tree guards or fencing (these are also needed where attempts are made to exclude Fallow or Red deer). Deer control by shooting may also pose greater challenges where Sika establish, as Sika are more difficult to cull than Red deer, especially in conifer thicket habitat (McLean 1993).
2.8	How great a reduction in consumer demand is the organism likely to cause in the Risk Assessment area?	minor - 1	MEDIUM -1	Commercial Red deer stalking is an important part of the economy of North and West Scotland and has been assessed as contributing > £105 M annually to the Scottish economy (PACEC 2006). There is some concern that increased hybridisation with Sika will compromise the genetic integrity of native Red deer stocks, and that this may also potentially reduce the trophy value of Red deer, which tend to have larger antlers than Sika. However, Sika stags have also increasingly become a valuable sporting asset in Scotland (Perez-Espona *et al.* 2009) as well as England, with no actual evidence at present of any downturn in consumer demand related to where Sika have established.
2.9	How likely is the presence of the organism in the Risk Assessment area to cause losses in export markets?	moderately likely - 2	MEDIUM -1	See comments at 2.8. Much of consumer demand for deer stalking and trophy shooting comes from abroad, so could be considered 'export'. However, there is no known evidence of losses caused to export markets.
2.10	How important would other economic costs resulting from introduction be? (specify)	moderate - 2	MEDIUM -1	See also comments at 2.7. Main costs would depend on objectives set for deer management. Containment or extermination where Sika are beginning to establish is likely to increase cost in terms of stalkers' time (increases per cull beast where density is low), provisions of high seats and fencing for crop protection, whereas if Sika spread is not viewed as being of serious concern by individual landholders, their costs may remain similar to deer management already in place.
2.11	How important is environmental harm caused by the organism within its existing geographic range?	major - 3	LOW - 0	In continental Europe, introduced Sika are reported to have displaced native Red, Roe and Fallow deer in several different areas (references see Bartos 2009). Environmental harm within the current range occupied by Sika in Britain is also already occurring in terms of: 1) displacement or reduction in numbers of Red deer, which in Scotland in particular is regarded as a keystone species, by Sika and Sika hybrids (Chadwick *et al.* 1996; Peres-Espona *et al.* 2009), although direct competition for resources between the species is not well documented in GB; 2) A detrimental impact on the biodiversity of ground vegetation in semi-natural heathland and wetland areas where Sika are present at high density (Diaz *et al.* 2005).

2.12	How important is environmental harm likely to be in the Risk Assessment area?	major - 3	MEDIUM -1	Further spread of Sika is regarded as a serious threat by governmental organisations in Scotland, both in terms of Red/Sika hybridisation as well as damage to forestry (Deer Commission for Scotland 1998). Nationwide 1997 amendments of Schedule 9 of the Wildlife and Countryside Act [1981] were made to reduce the likelihood of further spread of Sika and the environmental harm likely to be caused by the species. The latter may help slow the rate of new releases and spread of Sika to parts of the risk assessment area where they currently have only localised distribution. Without management aimed at containment, some increased displacement of Red deer by Sika or Sika/Red hybrids is likely to occur in most areas in time. That likelihood could be reduced and further spread slowed down significantly through organised culling (Perez-Espona *et al.* 2009).
2.13	How important is social and other harm caused by the organism within its existing geographic range?	moderate - 2	MEDIUM -1	Social harm (excluding economic losses to crops and forestry) is not widely reported in the native Japanese range, though by contrast, deer hunting (stalking) is popular and also creates some economic gains.
2.14	How important is the social harm likely to be in the Risk Assessment area?	moderate - 2	MEDIUM -1	In the event of substantial spread and increase in numbers of Sika to new parts of the risk assessment area, increased social harm through deer/vehicle collisions may be expected; such collisions with Sika are currently estimated at 350 - 600 per annum (Langbein 2007), contributing less than 2.5% of all deer/vehicle collisions in England and Scotland. Sika do not appear any more prone to involvement in such collisions than other deer species.
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?	very likely - 4	LOW - 0	Extensive evidence is now available that hybridisation between free-living Sika and Red deer in Britain, has produced fertile offspring. This has occurred in several areas, rather than only within enclosures prior to release (Harrington 1973; Pemberton *et al.* 2006; Goodman *et al.* 1999; Senn & Pemberton, in press). Hybridisation with Red deer is also known from other countries in Europe where Sika have been introduced by man (Bartos 2009). In addition, hybrids are also known to occur naturally rather than due to man's activities, e.g. along the Ussuri River on the Russia-China border where Red deer and Sika deer are in natural contact (Flerov 1952; Sokolov 1959; Heptner *et al.* 1961).
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	Sika have established in GB in the presence of foxes *Vulpes vulpes* , the only abundant natural enemy known to predate occasionally on newly-born young deer. Potentially, some raptors (e.g. Golden Eagle) could also take Sika fawns, but have rarely been reported to do so. Adult mortality is largely restricted to non-natural causes such as deliberate culling by man (Perez-Espona *et al.* 2009), deer/vehicle collisions (Langbein 2007) and attacks by domestic dogs.
2.17	How easily can the organism be controlled?	with some difficulty - 2	LOW - 0	Control of Sika numbers is undertaken widely by shooting with rifles, which is legal provided it is undertaken outside of close seasons and various other restrictions on permitted firearms and ammunition laid down in the Deer Act 1991 (England & Wales) and Deer (Scotland) Act 1996 are followed. If shooting is well co-ordinated across their full range it has a high potential to enable control. High levels of culling of Sika have been advocated for some years by the Deer Commission in Scotland, and numbers taken in England as well as Scotland have increased steadily over recent years (to *c* . 6,000 - 7,500 annually - see 1.23 above). However, to date, this has been insufficient to halt the spread or reduce population sizes significantly in most parts of Britain where Sika are established (Swanson & Putman 2009). Difficulties in achieving adequate culls to reduce numbers and spread include: 1) reliance on persuasion of landowners to cull sufficient numbers without legal powers of enforcement; 2) some landowners/stalkers welcoming the presence of Sika in significant numbers as an additional species for commercial stalking; 3) fears that when culling Sika to low levels, the lack of mates of their own species remaining will increase the risk of cross-breeding with Red deer; 4) tendency of Sika to occur in small social groups and to spend much of their time in thickets or other dense vegetation; control of Sika, particularly in coniferous plantations, has been found to be significantly more costly in terms of man-hours required per animal culled as compared to control of Red deer (McLean 1993).
2.18	How likely are control measures to disrupt existing biological or integrated systems for control of other organisms?	unlikely - 1	LOW - 0	Control of Sika by shooting poses no greater disruption than control of other deer species, which has been ongoing for numerous years. Some conflicts can arise at times through potential disruption of game bird shooting if undertaken during the same month/days. However, recent shortening of the close season for female Sika as well as Red, Fallow, Roe and Chinese Water deer [Regulatory Reform (Deer) (England and Wales) Order 2007 to Deer Act 1991] now extends the time when deer of either sex can be culled well beyond the end of game bird shooting seasons.
2.19	How likely is the organism to act as food, a host, a symbiont or a vector for other damaging organisms?	likely - 3	LOW - 0	Sika like all other deer species established in Britain, are carriers of Ticks *Ixodes ricinus* (which are a vector for Lyme disease). Some instances of bovine and avian TB have been recorded among Sika (Delahay *et al.* 2002), but they are not known to be any more prone to TB than other deer species, with recorded incidence generally well below 5% of animals sampled.

2.20	Highlight those parts of the endangered area where economic, environmental and social impacts are most likely to occur			An economic impact is most likely where Sika are already present and are allowed to increase in numbers to reach a high local density. Greatest concern about environmental impact relates to the spread by Sika into areas where relatively pure Red deer stocks are not already known to be hybridised with Sika. In Scotland, most mainland populations are already hybridised, with deer management policies and legislation aimed at the prevention of spread of Sika to islands where currently the only pure native Red deer stocks are believed to remain (Pemberton 2006). In England, hybridisation would be of particular concern in Somerset and Devon where the largest English Red deer herds occur; Sika are known to be spreading naturally from Dorset into East Devon (Ward *et al.* 2008), with small numbers of Sika escaped from park collections also reported (Langbein 2009). Whilst Sika have been present in the New Forest for years and are not currently believed to have hybridised with Red deer (Diaz *et al.* 2006), the significant increase in Red deer numbers in the New Forest over the last two decades (Putman & Langbein 1999) makes eventual hybridisation likely. Red deer, assisted in part by accidental releases from deer farms, have become re-established in small numbers in many other parts of England and Wales, in addition to their very wide distribution in Scotland, with therefore some likelihood of hybridisation with Sika throughout the entire risk assessment area, wherever Sika and Red deer ranges overlap.

Summarise Entry	very likely - 4	LOW - 0	Sika have been widely introduced to numerous countries of Europe, including many parts Britain. Introduction is usually at first to fenced enclosures followed by subsequent escapes to the wild. Some natural spread into new parts of the risk assessment area is likely, and although on its own such spread might remain moderately slow, continuing occasional releases from parks and farms will tend to aid establishment of new populations where dispersing individuals from existing herds meet up with further new releases.
Summarise Establishment	very likely - 4	LOW - 0	Sika are already established widely through Scotland, with more localised strong populations in England, especially in the Poole Basin (Dorset), Bowland Forest (Lancashire), New Forest (Hampshire) and in the Lake District. In addition, numerous smaller herds occur in several other counties of England (Harris & Yalden 2008) and one area (Teifi Marshes) in Wales (Deer Initiative Wales, pers. comm.).
Summarise Spread	intermediate - 2	MEDIUM -1	Slow natural spread from established locations (see above) continues to be assisted by new (mainly accidental) releases from parks and farms. Ward (2005) calculated rates of spread of Sika (assessed in terms of their reported presence in new 10 by 10 km OS grid squares where they were not previously known) between 1972 to 2002 at 5.3%, rising to a 7.3% range expansion between 2002 to 2007 (Ward *et al* . 2008).
Summarise Impacts	major - 3	LOW - 0	Most extensive economic damage in the risk assessment area is reported to commercial forestry (Ratcliffe 1989; Chadwick *et al.* 1996; Abernethy 1998), with currently some though lesser concern at a national level, about the impact from Sika on agricultural crops (Doney and Packer 1998; Wilson 2003), or conservation habitats (Diaz *et al.* 2005). Greatest concern about the continuing spread of Sika however arises from that fact that hybridisation is already known to have occurred in many areas where their range overlaps with Red deer (Abernethy 1994; Goodman *et al.* 1999; Díaz *et al.* 2006; Pemberton *et al.* 2006; Senn & Pemberton, in press), and the further threat posed to the genetic integrity of the few remaining populations of native Red deer.
Conclusion of the risk assessment	HIGH -2	LOW - 0	The risk assessment area already has substantial populations of Sika in many different areas, most of which are continuing to expand, and further accidental releases from fenced herds remains likely. Greatest concern about Sika expansion arises from the likelihood of hybridisation with populations of native Red deer. The potential for impact on forestry and agricultural is also significant. Total extirpation of Sika from the risk assessment area, even if it were deemed desirable, is no longer likely to be feasible. However, containment of spread in areas where Sika still have only a localised distribution or occur in small numbers is still possible, but significant resources and possibly strengthening of legislation regarding control of feral Sika and the keeping of Sika in fenced enclosures would be required for success.
Conclusions on Uncertainty		LOW - 0	The scientific literature forming the basis of this risk assessment is extensive in the areas relating to the distribution of existing populations of Sika, their introduction and spread. Whilst hybridisation outside of enclosures, between Sika and Red deer has often been disputed by deer managers in the past, extensive DNA research and other scientific analyses undertaken in recent years leads to very low levels of uncertainty that hybridisation has taken place, and remains likely to continue. Economic impacts specifically for Sika are less well studied in Britain, but inferences from work on other deer species and on Sika in comparable parts of their geographic range worldwide, again leads to mostly moderate or low levels of uncertainty.
Should risk management options be considered?	YES (Go to Risk Management)		Although the distribution of Sika in some parts of the risk assessment areas is already too extensive to make their total extirpation feasible or economically viable, containment of the risks posed by Sika occurring in smaller isolated populations remains feasible, given the necessary resources and legislative backing. Some degree of risk management for Sika has already been introduced through the addition of Sika in 1997 to Schedule 9 of the Wildlife & Countryside Act 1981, making it an offense to translocate or release Sika or Sika hybrids to areas where they are not already established. However, this does not at present prevent the probability of further releases where Sika are kept in fenced enclosures, and this presents one area where risks could be managed better through additional legislation. In areas where free-living Sika have only a localised distribution, feasibility of their complete removal, or at least tight containment, should be considered. Removal by culling alone may be successful, although it becomes increasingly difficult and costly once numbers are at a low level, and very heavy shooting pressure could possibly increase dispersal. An alternative which could be explored (but may require exemption under licence from the Deer Acts) is the re-capture of feral Sika into fenced enclosures, via deer-leaps or one-way gates, before removal from the area. Consideration could also be given to the introduction of zero-tolerance policies for Sika in selected regions within the risk assessment area, where the greatest threats are identified (e.g. near substantial Red deer herds without significant present levels of hybridisation). Setting up official reporting schemes and early action (including assistance/support for landowners) to remove Sika whenever they are reported in new counties/regions, could have the potential to at least prevent widespread establishment in England and Wales, and those regions of Scotland where Sika have not yet colonised.

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